University of Doha for Science and Technology

College of Engineering and Technology

Mechanical Engineering Department

AEMA4302: Capstone Project II

Title: Designing and Manufacturing a Leather Machining Device

Conducted by:

Mohamed Abdulkarim, **SID:** 60104560

Mohamed Abdelshafie, **SID:** 60087589

AbdulWadood Fathah, **SID:** 60104538

Majad Al Sharshani, **SID:** 60072016

Supervised by:

Dr. Mansour Al Qubeissi

Mr. Sridhar Mohanasundararajan

Date: 27 March 2025

<table>
<tr><td colspan="2">Declaration: The work described in this report is our own product. Any content that has been obtained from other resources is fully cited and referenced. We fully understand that cheating and plagiarism constitute a breach of University Regulations and will be dealt with accordingly.</td></tr>
<tr><td>Student1 Name:
Mohamed Abdulkarim</td><td>Signature:</td></tr>
<tr><td>Student2 Name:
Mohamed Abdelshafie</td><td>Signature:</td></tr>
<tr><td>Student3 Name:
Majad Al Sharshani</td><td>Signature:</td></tr>
<tr><td>Student4 Name:
Abdul Wadood Fathah</td><td>Signature:</td></tr>
</table>

Acknowledgement

We would like to express our sincere gratitude to everyone who supported and contributed to the successful completion of our capstone project. Firstly, we extend our heartfelt thanks to our Capstone Instructor, Dr. Mansour Al Qubeissi, for his continuous guidance, motivation, and valuable feedback throughout the course of the project. His insights were instrumental in shaping our approach and final outcomes. We would also like to express our sincere gratitude to our Project Supervisor, Mr. Sridhar Mohanasundararajan, for his consistent support and valuable technical advice, particularly during the waterjet cutting process. His expertise greatly enhanced the quality of our work. Our appreciation also goes to Dr. Mohammad Jafar Hadad for his academic support and insightful suggestions that helped us improve various aspects of the design. Special thanks to Mr. Philip for his assistance in sourcing essential materials and components for the leather press. We acknowledge the important contributions of our welding instructors, Mr. Yahya and Mr. Adamu, whose hands-on guidance during the fabrication stage—particularly with welding techniques—was essential to assembling key components of our leather press. Our sincere thanks to the College of Engineering and Technology (CET) for providing access to essential facilities, including the Waterjet Cutting Room, CNC Lab, Welding Lab, and Computer Lab, which were vital for the design, manufacturing, and testing phases of our project. We gratefully acknowledge the financial support from CET, which enabled us to acquire necessary materials and components. Lastly, we appreciate the help of the technicians and fellow students who assisted us throughout the various stages of the project.

Abstract

This report details the design, development, and testing of a leather press prototype aimed at improving leatherworking precision and efficiency. The primary objective was to create a multi-functional machine capable of cutting, embossing, and shaping leather, while ensuring durability and ease of use for artisans and small-scale manufacturers. The design process focused on optimizing mechanical elements such as the lever arm, top plate, and column, with careful consideration of material selection to balance strength, cost, and manufacturability. The methodology involved using Finite Element Analysis (FEA) to simulate stress distribution on critical components, ensuring they could withstand operational loads. The fabrication process utilized CNC waterjet cutting and MIG welding to produce high-precision components. Once assembled, the press underwent a series of tests to evaluate its functionality, including testing the movement of the top plate, rotation for dye positioning, and the spring mechanism to ensure safety and ease of operation.

Key findings from testing revealed that while the press successfully met several design objectives, issues such as the misalignment of the top plate and the underperformance of the spring mechanism were identified. The use of aluminum for the column led to instability during operation, causing inconsistent cutting. This highlighted the importance of material selection in the design phase. The novelty of this project lies in the integration of a versatile, manually operated leather press, which incorporates multiple leatherworking functions into one machine. The report concludes with recommendations for improving the prototype, including replacing the aluminum column with steel, replacing the spring mechanism, and integrating advanced testing and automation for enhanced performance. This project successfully demonstrated the potential for a cost-effective and multi-functional leather press, offering a platform for further improvements and future commercial application.

Contents

List of Figures and Tables

Chapter 1: Introduction

1.1 Project Background

Leatherworking has been a vital industry for centuries, encompassing a wide range of applications, from fashion accessories and footwear to upholstery and automotive interiors. The versatility and durability of leather make it a highly sought-after material for various high-quality products. Traditionally, leatherworking was done by hand tools that were designed for single tasks. While these tools have served their purpose for many years, they often lack the precision, versatility, and efficiency required to meet the evolving demands of modern leather manufacturers. With the growing demand for high-volume production, increased precision, and cost-effectiveness, there is a clear opportunity for innovation in the design and functionality of leatherworking equipment. The traditional approach of relying on separate hand tools for each specific task—such as cutting, embossing, or shaping—results in increased downtime, higher costs, and inefficiencies in the workflow.

In modern leather manufacturing, the need for faster production times without compromising quality has become increasingly important. Leather presses available on the market are costly and often limited in their capabilities, and leatherworkers frequently need to rely on multiple tools to perform various tasks. This leads to higher labor costs, more space requirements, and inefficiencies in production. The objective of this project is to design and develop a multifunctional leather machining device that integrates cutting, embossing, and shaping capabilities into a single, compact machine. This innovative design aims to enhance operational efficiency, reduce production costs, and improve the overall user experience. By creating a system that is both versatile and easy to use, this project seeks to modernize the leatherworking industry, making it more cost-effective, precise, and adaptable to a variety of leather crafting needs.

1.2 Project aim

The aim of this project is to design and develop a compact, multi-functional leather machining device that combines cutting, punching, and shaping operations into one machine. This machine seeks to improve the precision, efficiency, and ease of use for leatherworkers while minimizing workspace requirements and costs associated with multiple tools.

1.3 Project objectives

1. To review the existing leather crafting tools and methods to identify their limitations.

2. To calculate the required force for effective cutting and punching operations and ensure structural integrity through stress analysis.

3. To design and model the leather machining device using AutoCAD and SolidWorks.

4. To simulate the stress and deflection behavior of key components using FEA tools in SolidWorks to validate material selection and design integrity.

5. To fabricate the machine components and assemble the prototype, integrating cutting, punching, and shaping operations into a single compact device.

6. To test the prototype for performance and durability using different leather materials, ensuring precision, efficiency, and user-friendliness.

1.1 Project deliverables

1. **Final Report:** A detailed report documenting research, design, testing, and development stages.
2. **Working Prototype:** A functional model of the multi-functional machine.
3. **CAD Drawings and Models:** Complete CAD files of the machine design.
4. **Test Analysis:** Performance data from testing the machine.

1.2 Dissertation layout

The report is organized as follows:

- Chapter 1: Introduction- Introduces the project background, aim, objectives, and deliverables.
- Chapter 2: Methodology- Describes the approach taken to design and develop the multi-functional leather machining device, including design, simulation, and testing methods.
- Chapter 3: Results & Discussion- Presents the test results and analysis of the prototype, along with a discussion of the findings.
- Chapter 4: Conclusions & Future Recommendations- Summarizes the project's outcomes and suggests recommendations for future improvements.
- Bibliography- Lists all references and sources used throughout the research.
- Appendices- Contains supplementary materials such as technical drawings, design models, and logbooks.

Chapter 2: Methodology

2.1 Research and Design Approach

The development of the leather machining device followed a systematic approach, integrating core design and engineering principles with extensive testing. The process began by analyzing existing leatherworking tools and identifying limitations such as inconsistent cutting precision, limited multi-functionality, and inadequate material handling. This analysis helped define the key areas for improvement and set objectives for the new machine. A primary goal was to create a multi-functional leather press capable of cutting, embossing, and shaping, while ensuring durability and precision for different leather types. The design also needed to incorporate mechanical advantage for force multiplication, ensuring consistent performance over time.

Key considerations included optimizing the geometry of components for efficiency and reducing wear. The lever arm was a critical part of the design due to the significant bending stress it would experience. To ensure its durability, we calculated the maximum bending stress by considering the mechanical advantage and the applied stress on the cutting blade. The mechanical advantage was determined by the following equation:

$$F_{out} = F_{in}\left(\frac{L_{lever}}{d}\right)$$

where:

- F_in is the input force.
- L_lever is the lever arm length.
- d is the distance from Pivot to Cutting Head

The distance from the pivot to the cutting head determines the leverage, affecting force multiplication. The output load calculated was 8 tons, meeting design requirements and matching the performance of similar machines. The applied stress on the cutting blade was calculated by:

$$\sigma_{applied} = \frac{F_{out}}{A_{Cutting\ Blade}}$$

where A_cutting blade is the cross-sectional area of the blade. This calculation helped determine the stress applied by the blade on the leather during operation. Understanding this load was essential for ensuring that the machine could overcome the shear strength of the leather material, ensuring clean cuts without excessive force or damage to the material.

A critical part of the design process was assessing the bending stress on the lever arm. Given the significant forces at play, the lever arm needed to be robust enough to handle these loads. The bending stress was calculated as:

$$\sigma_{max} = \sigma_{bending} = \frac{M_y}{I} = \frac{F_{in} \times L_{lever}}{\pi D^4/64}$$

where:

- M_y is the moment (or bending force) acting on the lever.
- D is the diameter of lever

The calculated maximum bending stress was 226.4 MPa. Applying a safety factor of 1.5 resulted in a minimum required yield strength for the lever material of 339.6 MPa. This was a crucial step in selecting materials capable of withstanding operational stresses without failure, ensuring both safety and performance over time.

2.2 Design Process and CAD Modeling

The design of the leather machining device was initiated using AutoCAD and SolidWorks to develop detailed 2D and 3D models. These tools enabled precise modeling and allowed for the optimization of the machine's components. Key components include the base plate, top plate assembly, column, lever assembly, mechanical link, spring, and height-adjusting screw. The base plate serves as the foundation, providing support for the leather and positioning the cutting die during operation. The top plate assembly acts as a pressing mechanism, applying force to the leather and cutting die. The column provides vertical support for the machine, while the lever assembly and mechanical link transmit force, enabling the cutting action. The height-adjusting screw allows for precise adjustment to accommodate varying leather thicknesses.

The design was focused on integrating the cutting, embossing, and shaping features into a compact, efficient machine, ensuring mechanical advantage and ease of operation. Each component was thoroughly modeled to ensure a precise fit and optimal performance during the manufacturing phase.

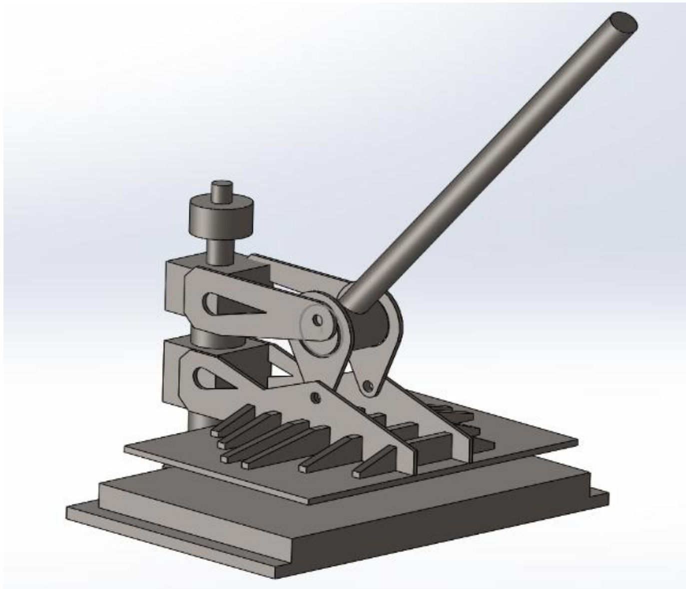


Figure 1 SolidWorks Model of Leather Press

2.3 Material Selection

The materials for the leather machining device were selected based on mechanical properties, ease of fabrication, and durability. Carbon steel was chosen for the frame and structural components due to its excellent strength, weldability, and cost-effectiveness. The material selection for the frame was supported by ANSYS Granta EduPack, which helped evaluate various materials based on yield strength, machinability, and cost.

Table 0-1 Material Selection Table

	Cast Iron	Low Carbon Steel	High Carbon Steel	Low Alloy Steel
Yield Strength (MPa)	228	355	433-924	469-1600
Density (kg/m^3)	7230	7823	7800	7800
Price (QR/kg)	2.4	4.7	4.62	5.28
Weldability	1	5	2-4	5
Machinability	3	3	1-2	1-2
Rank	4	3	1	2

Carbon steel was selected for its balance of yield strength (355 MPa) and density (7823 kg/m^3), providing sufficient strength to handle operational stresses, while also being easy to fabricate and weld. The selection of carbon steel for the machine's frame ensures high durability and performance during operation. The frame's material properties were crucial for ensuring the machine's structural integrity while maintaining cost efficiency.

2.4 Finite Element Analysis (FEA)

Finite Element Analysis (FEA) was performed on key components of the leather machining device using SolidWorks FEA to simulate static loads and ensure that the components would maintain their structural integrity under operational conditions. The FEA was conducted using SolidWorks FEA to evaluate the structural integrity of the components under static loads

- Lever: For the lever, a circular face was fixed, and a force of 300 N was applied to the edge of the opposite end. This setup was designed to simulate the bending stresses on the lever during operation and verify that it could withstand the forces without failure or excessive deformation.
- Column: The bottom face of the base plate was fixed, and an 800 N downward force was applied to the hollow cylinders on the holding arm that moved vertically along the column. This setup aimed to assess whether the column, made of aluminum, could withstand the expected loads while performing its function in the machine.
- Mechanical Link: In the analysis of the mechanical link, the hole connected to the top plate assembly was fixed, and a downward force of 150N was applied to the hole connected to the lever assembly. This simulation was done to ensure that the mechanical link could effectively transmit the applied forces without failure or significant deformation during operation.

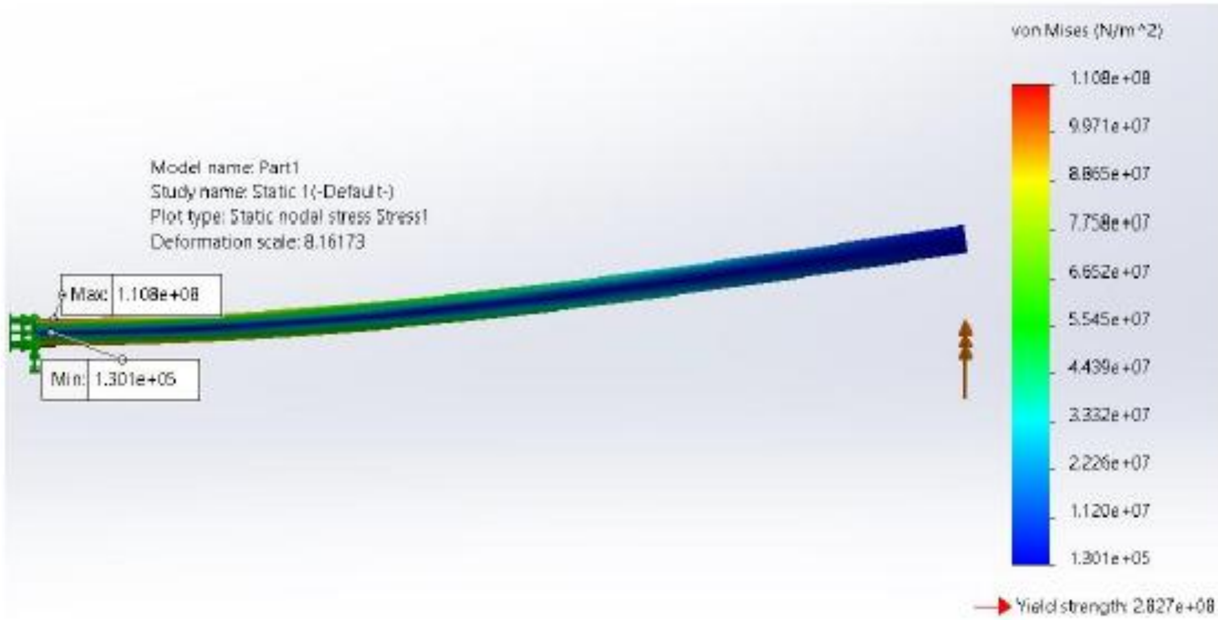


Figure 2 FEA of Lever

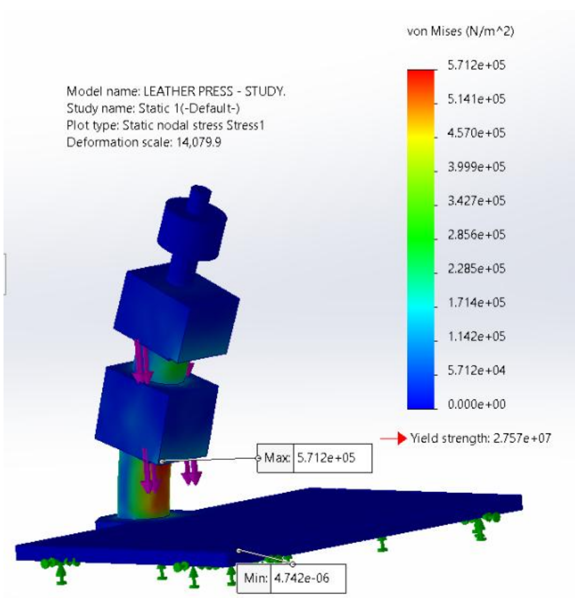


Figure 3 FEA of Column

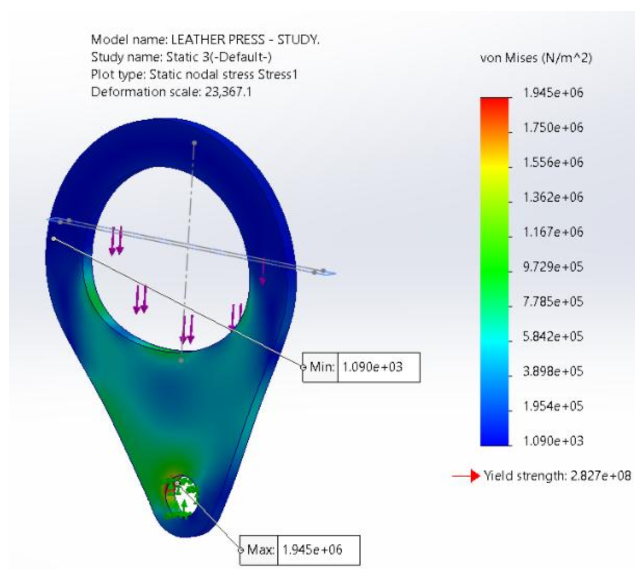


Figure 4 FEA of Mechanical Link

2.5 Fabrication and Manufacturing Process

The fabrication of the leather machining device involved sourcing materials, precise cutting, welding, and assembly to ensure structural integrity and functionality. The materials for the machine were sourced through both university and external suppliers. Steel plates for the top plate holder were obtained with the assistance of Mr. Philip, who guided us to available parts in Building 8. For the base plate and top plate, thicker steel plates were required, which were purchased externally, along with additional plates for a total cost of 800 QR. Steel tubes and a large wooden board were provided by Mr. Philip for constructing the table, with the board being cut using a hand saw to our requirement, and four wheels with brakes were also supplied for mobility. Nuts and bolts were also sourced from Building 8 for the assembly process. To create the required components, CNC waterjet cutting machine in room 9.1.39 was used with the help of Mr. Sridhar. This method was selected due to its precision in cutting through thick steel plates without affecting their material properties. We utilized AutoCAD drawings to generate the necessary tool paths for the cutting machine. The cut parts were then measured for accuracy using a measuring tape and Vernier calipers to ensure they adhered to the design specifications.

After the components were cut, MIG welding was used to join the parts of the top plate assembly. With the help of Mr. Yahya and Mr. Adamu, the welding process was carried out in the welding lab. Before welding, the components were grinded and polished to ensure clean surfaces for better joint integrity. During assembly, we encountered a slight issue with the top plate not being completely flat after welding. To address this, we applied heat to the top plate and clamped it to a flat surface, ensuring it returned to the correct shape. Once all components were fabricated and welded, the assembly process began. The top plate assembly was painted silver, while the base plate and lever were painted black. Moving parts were lubricated with grease to ensure smooth operation and reduce friction. The final assembly was mounted onto a table, which was constructed from the steel tubes and wooden board, providing a sturdy base for the press.

Figure 5 Water- Jet Cutting of Components

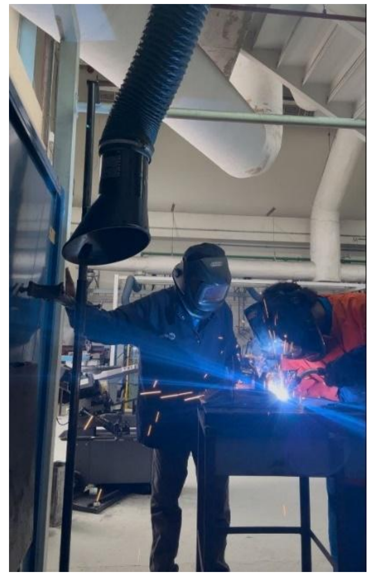


Figure 6 Welding of Components

Figure 7 Assembled Leather Press

2.6 Testing

After manufacturing, the components were tested for functionality to ensure the press operated as intended and met design specifications. Initial tests included verifying the main mechanism, ensuring that pulling the lever down correctly moved the top plate. We also checked the top plate assembly's rotation on the column to confirm access to the base plate and proper die positioning. The spring mechanism was tested to ensure it effectively raised the top plate after lowering, preventing it from falling and causing potential injury. The table was tested for stability, and the wheels and brakes were checked for smooth movement and functionality. Lastly, cutting, punching, and embossing operations were tested to confirm the press's precision and performance.

Chapter 3: Results & discussions

The development of the leather press involved a systematic design and fabrication approach, followed by extensive testing to ensure its functionality, safety, and precision. The testing phase focused on evaluating the performance of the machine, addressing any issues encountered, and comparing the results against the initial design objectives. This section outlines the main findings from the testing, evaluates them against the design goals, and discusses the challenges faced.

3.1 Testing of Mechanical Functionality

The core mechanical features of the leather press were tested to ensure they functioned as intended. The press's primary functions were evaluated based on the movement of the top plate, the ability to rotate the top plate for dye positioning, the performance of the spring mechanism, and the overall mobility of the machine.

Top Plate Movement: The top plate moved as expected when the lever was pulled, engaging the required force and downward movement for cutting, embossing, and shaping tasks. This confirmed the effectiveness of the lever mechanism in transferring the applied force, with no noticeable issues during operation.

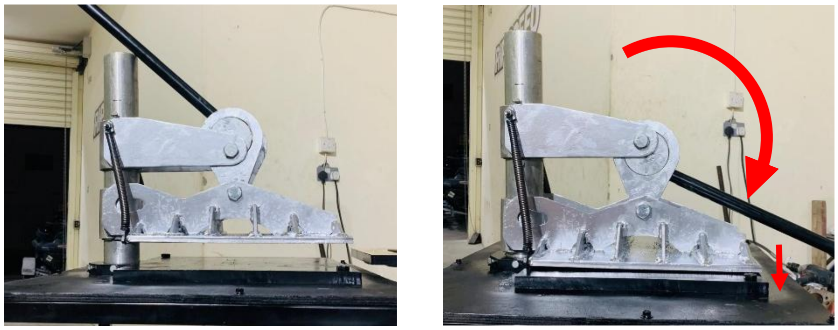


Figure 8 Testing of Main Mechanism

Top Plate Rotation: The rotational functionality of the top plate assembly was evaluated to ensure ease of dye positioning. The top plate assembly does not directly rest on the base plate; instead, it is supported at a defined height by two bolts affixed to directly opposite sides of the main column structure. The rotation of the top plate assembly for dye alignment is facilitated by pivoting around these supporting bolts. Testing included an assessment of the structural integrity of these bolted connections under both static loading (due to the weight of the top plate assembly) and dynamic loading (experienced during the rotational movement). The rotational mechanism performed as intended, allowing for seamless and practical dye positioning. The rotational mechanism facilitated seamless dye positioning, and the bolted connections remained robust under dynamic loading, confirming the support structure's suitability.

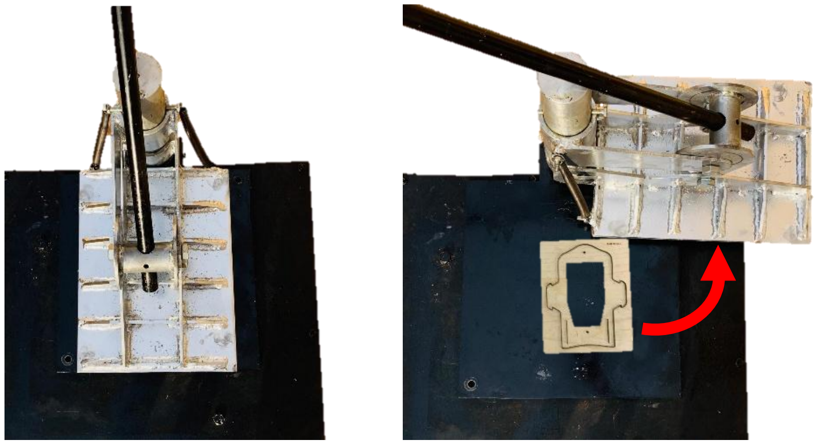


Figure 9 Testing of Top Plate Rotation

Figure 10 One of the Bolt on which supports the Top Plate Assembly

Spring Mechanism: The spring mechanism, designed to pull the top plate up after it was pressed down, was tested to ensure it would facilitate easier operation and prevent injury by keeping the top plate from falling onto the operator's hands. While the spring did not pull the top plate back as intended, it effectively held the top plate in place, preventing it from falling and minimizing the risk of injury. Although the spring's performance was not fully as anticipated, it did make the lever return easier.

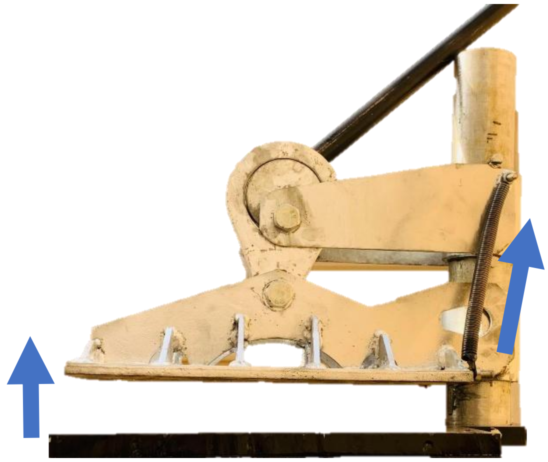


Figure 11 Spring Mechanism

3.2 Cutting, Punching, and Embossing Tests

The press’s ability to perform cutting, punching, and embossing tasks was evaluated with leather pieces of varying thicknesses. The aim was to assess the machine's consistency, precision, and effectiveness during these operations.

Cutting Performance: The press was able to cut leather, but the cuts were not consistently clean across the entire leather surface. Uneven cuts were primarily caused by the misalignment of the top plate relative to the base plate. During testing, it was observed that the front edge of the top plate lifted slightly when pressed, contributing to uneven cutting (See Figure 12). This misalignment was most noticeable with larger cutting dies, whereas smaller dies yielded more consistent cuts (See Figure 13). Measurements of the top plate at various points showed discrepancies (Table 1), indicating that the front edges (Points A and B) were slightly raised during the press operation, causing the inconsistency in cutting.

Figure 12 Sample Pieces cut using the cutting dye

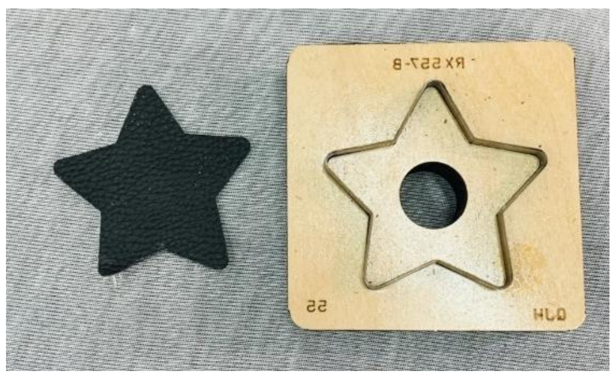


Figure 13 Sample Piece cut using a smaller dye

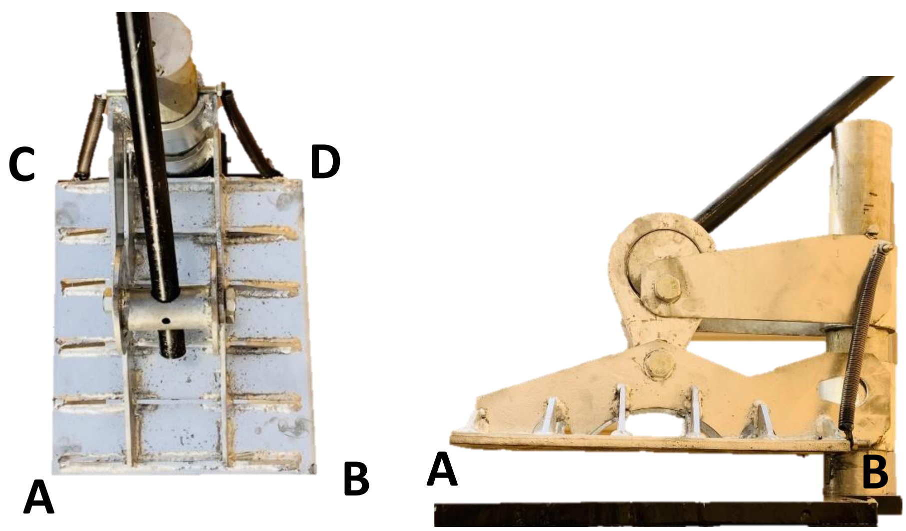


Figure 14 To Check Top plate Flatness with respect to bottom plate

Table 2 Measurement of Vertical Distance Between Plates to Evaluate Top Plate Flatness

Positions	Point A	Point B	Point C	Point D
Open (Lever Arm Up)	4.8 cm	5.15 cm	4.4 cm	4.65 cm
Closed (Lever Arm all the way down)	0.35 cm	0.7 cm	0.2 cm	0.4 cm
Closed with Dye Positioned	2.6cm	3 cm	2.7 cm	2.7cm
Closed with dye Positioned and Applied load	2.7 cm	3.2 cm	2.55 cm	2.6 cm

Analysis of the data presented in Table 2 reveals a lack of parallelism between the top and bottom plates of the leather press. Specifically, measurements taken at Points A and B, located along the front edge of the top plate, consistently exhibit a greater separation distance compared to Points C and D, particularly when the press is in the closed position and under load. Comparing the "Close (Lever Arm Down)" and "Closed with dye positioned and under load" conditions, it is evident that the front edge (Points A and B) lifts by approximately 0.1 cm to 0.2 cm relative to the rear (Points C and D) when pressure is applied. This observation directly correlates with the reported inconsistencies in cutting performance, where uneven force distribution across the die leads to incomplete or irregular cuts.

The underlying cause of this non-parallelism is attributed, in part, to a slight backward tilting of the main aluminum column structure under load. This tilting effect would exert a non-uniform force distribution across the top plate, with the front edge experiencing less downward pressure. The decision to fabricate the column from aluminum, while the base plate is carbon steel, prevented the use of welding as a joining method due to the significant difference in their melting points. Instead, the aluminum column is affixed to the carbon steel base plate using a bolted connection. This bolted interface, compared to a rigid welded joint, likely introduces a degree of flexibility that allows for the observed column tilt under the applied force. This phenomenon is more pronounced when utilizing larger cutting dies, as they span a greater area and are thus more susceptible to variations in the platen gap. Smaller dies, being localized, can achieve more consistent cuts, particularly if positioned strategically.

Improvement in Cutting Consistency: To reduce the issue of uneven cutting, several operational adjustments were explored during testing. Rotating the top plate assembly to different angular orientations allowed for a slight redistribution of the applied force. Similarly, rotating the cutting die and leather workpiece relative to the top plate also yielded some improvement in cut evenness. Positioning the dye and leather deeper into the press, closer to the column and away from the operator, consistently resulted in more uniform cuts. This suggests that the area closer to the column experiences a more direct and less affected force transmission, minimizing the impact of the column's slight tilt.

3.3 Comparison of FEA with Experimental Results

The lever was analyzed using AISI 1020 steel in the FEA, with the material's yield strength set at 282.7 MPa and the maximum stress predicted by the simulation being 110.8 MPa. These values suggested that the lever could withstand the applied 300 N force without failure or excessive deformation. During physical testing, the lever showed no signs of deformation or failure under the 300 N force, confirming the FEA predictions. The results align well, indicating that the lever is sufficiently strong and performs as expected under normal operational conditions.

The column, made of aluminum, was subjected to an 800 N downward force in the FEA. The material properties of aluminum (yield strength = 27.57 MPa) and carbon steel (base plate yield strength = 275.7 MPa) were used in the simulation. In the FEA, the column was assumed to be rigidly welded to the base plate, which provided a fully fixed support condition. As a result, the simulation predicted no noticeable deformation under the applied load. However, during physical testing, the column tilted slightly backward—not due to the material properties, but because the column was bolted, not welded, to the base plate. The bolts used in the real setup were not rigid enough to completely prevent movement underload. This flexible bolted connection allowed a slight tilt when force was applied, leading to a misalignment between the top and bottom plates. Thus, the observed tilting during testing was a result of joint flexibility, rather than material failure.

Figure 15 Column bolted to Base Plate

The mechanical link, also made from AISI 1020 steel, was analyzed with a 150 N applied force in the FEA. The simulation predicted a maximum stress of 1.08 MPa, which is well below the yield strength of the material (282.7 MPa). During physical testing, the mechanical link performed as expected, with no signs of deformation or failure under the applied load. These results match the FEA predictions, confirming that the mechanical link is capable of handling the operational forces without compromising its integrity.

3.4 Table Stability and Mobility

Table Stability: The steel tubes and wooden board used to construct the table proved effective in supporting the press. The table was stable and held the press securely during operation, even when significant force was applied. No issues were observed with stability, confirming that the design of the table was adequate for supporting the press's weight and operational forces.

Mobility: The press's mobility was tested by moving it around the workspace. The four wheels effectively, allowing the press to be easily relocated. The wheel brakes performed well, preventing unintended movement when the press was in use.

Figure 16 Leather Press on the Table

3.5 Lever Pin System and Detachability

The lever was designed with a removable pin system to allow for easy disconnection. Initially, there were concerns about whether the pin system could handle the large forces applied during operation. However, testing confirmed that the pin system was effective in transferring the required force and did not result in failure. The pin system provided the necessary strength and durability underload, confirming its suitability for the design. The press was bolted to the table with two bolts, allowing for easy detachment if needed. This design provided flexibility for maintenance and portability.

Figure 17 Lever Pin System

Chapter 4: Conclusions & Future Recommendations

4.1 Conclusions

The leather press prototype successfully met several key design objectives, including its ability to cut, emboss, and shape leather. The lever mechanism operated effectively, and the top plate's rotation for dye positioning worked as intended. The table and wheels provided adequate stability and mobility, making it easy to move the press. However, certain challenges arose during testing. The primary issue was the misalignment of the top plate, leading to inconsistent cutting results. This misalignment was caused by the tilting of the aluminum column during operation, which resulted in uneven pressure distribution, particularly when using larger dies. While the spring mechanism prevented the top plate from falling, it did not pull it back effectively after each use. Material selection also posed some difficulties. The use of aluminum for the column, while cost-effective, resulted in welding challenges and contributed to the structural instability of the press.

4.2 Future Recommendations

Material Selection and Structural Improvements: Replacing the aluminum column with steel will enhance stability and rigidity, addressing the tilting issue during operation. Steel's higher strength will improve durability and ease of welding, leading to a more secure connection between the column and base plate, thus increasing the overall structural integrity.

Spring Mechanism Redesign: A stronger or more efficient spring mechanism is recommended to assist in returning the top plate after each use. A stronger spring, or possibly a pneumatic or hydraulic system, would enhance the ease of operation, improve safety by preventing the top plate from falling suddenly, and reduce the physical effort required by the operator.

Further Testing and Instrumentation: Additional testing with advanced instruments like force gauges, strain gauges, and displacement sensors will help measure force distribution and operational efficiency. This data can be used to refine components and ensure consistent performance, particularly in the areas of cutting, embossing, and shaping.

Integration of Hot Foil Press and Automation: Future versions of the press could integrate a hot foil press mechanism for stamping and foil embossing. Automation of tasks like dye positioning and lever movement would enhance efficiency, reduce operator effort, and improve consistency. This would make the press more suitable for commercial applications, increasing its versatility.

Data Measurement Integration: Incorporating real-time data measurement tools, such as force gauges and pressure sensors, would provide valuable insights into operational performance. These tools would help optimize the press's functionality by allowing for real-time adjustments and improving precision in cutting, embossing, and shaping.

In summary, while the leather press prototype achieved several design goals, improvements in material selection, spring mechanism design, and structural stability will significantly enhance its performance. Further testing, integration of additional features like hot foil pressing and automation, and the incorporation of data measurement tools will improve the press's efficiency and versatility for broader applications.

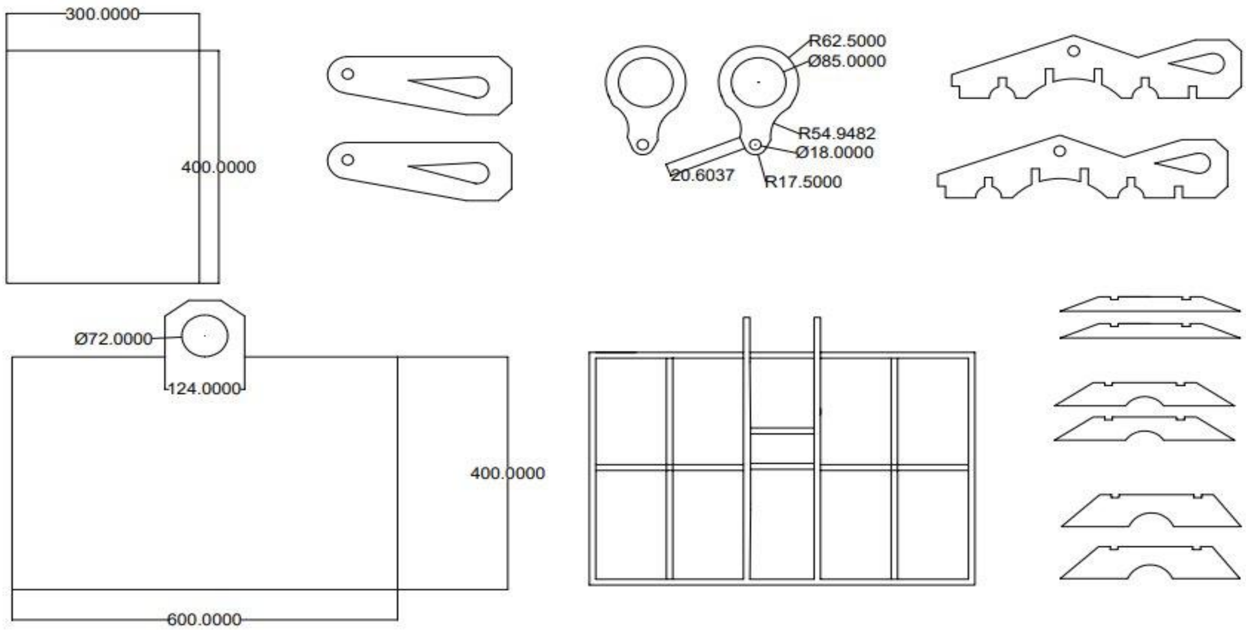
Bibliography

1. CSBAdmin. (2024, June 19). How are modern manufacturing techniques enhancing leather tools—Bridging tradition and innovation. CS Osborne Leather Tools. https://osborneleathertools.com/articles/how-are-modern-manufacturing-techniques-enhancing-leather-tools-bridging-tradition-and-innovation/ (Accessed December 2, 2024).
2. Epilog Laser. (2023, March 2). Laser engraving & cutting leather. Epilog Laser. https://www.epiloglaser.com/how-it-works/applications/laser-engraving-leather/ (Accessed December 2, 2024).
3. CSBAdmin. (2024, May 10). How have leatherworking tools evolved with modern engineering? CS Osborne Leather Tools. https://osborneleathertools.com/articles/how-have-leatherworking-tools-evolved-with-modern-engineering/ (Accessed December 2, 2024).
4. WP Oceans. (2023). The revolution of CNC laser cutting machines in leather crafting. Sigmatechnik.com. https://www.sigmatechnik.com/cnc-factory/the-revolution-of-cnc-laser-cutting-machines-in-leather-crafting (Accessed December 2, 2024).
5. LeatherNLuxury. (2024, April 5). The future of leather technology innovations: Brief overview. Leather N Luxury. https://leathernluxury.com/the-future-of-leather-technology-innovations-brief-overview/ (Accessed December 2, 2024).

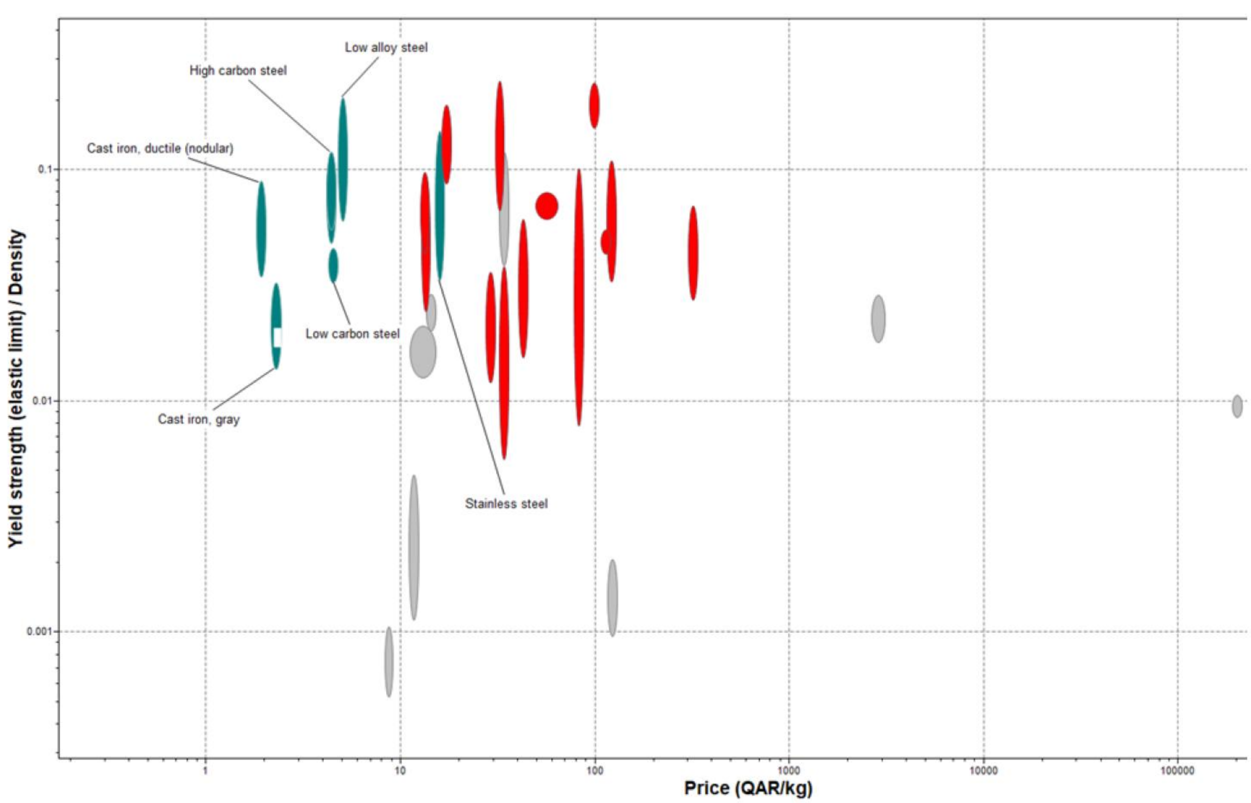
Books:

1. Budynas, R. G., & Nisbett, J. K. (2015). Shigley's mechanical engineering design (10th ed.). McGraw-Hill. ISBN: 0073398209.
2. Ashby, M. F. (2017). Materials selection in mechanical design (5th ed.). Butterworth-Heinemann. ISBN: 9780081005996.

Appendix A.1 AutoCAD Design



Appendix A.2 Material Selection Chart from Ansys Granta EduPack



Appendix B.1 Individual Logbook - AbdulWadood Fathah

Meeting 1: Project Kick-off & Initial Planning

Date: 2 September 2024

My Contributions:

- Discussed possible materials and design strategies for the machine’s mechanisms.
- Took responsibility for researching material properties for key machine components.

Agreed Actions:

- Continue material research and prepare a list of potential materials based on strength and durability.
- Begin working on CAD designs for the cutting and punching mechanisms.

Meeting 2: Research Findings & Material Selection

Date: 25 November 2024

My Contributions:

- Presented findings on material strength, including options like carbon steel and alloy steel.
- Provided analysis of material stress under cutting and punching loads.
- Suggested alloy steel for high-stress components.

Progress since last meeting:

- Completed material research and prepared a comparison table for materials.
- Collaborated with the team to finalize the material selection for critical components.

Agreed Actions:

- Begin detailed CAD modeling of cutting and punching systems.
- Perform stress analysis to confirm design integrity under load.

Meeting 3: CAD Model Review & Component Design

Date: 10 December 2024

My Contributions:

- Showed progress on designing the mechanism and its integration with the overall frame.
- Focused on optimizing the punching mechanism to ensure accuracy and minimal wear.

Progress since last meeting:

- Completed CAD models for the punching mechanism.
- Integrated punching die design into the overall machine CAD.

Agreed Actions:

- Continue refinement of CAD models.
- Conduct material selection for other components like the lever.

Meeting 4: Stress & Load Testing of Components

Date: 7 January 2025

My Contributions:

- Conducted stress analysis using FEA to simulate the mechanism's behavior under load.
- Provided insights into potential failure points in the design and suggested changes to reinforce weak areas.

Progress since last meeting:

- Ran FEA simulations on the frame.
- Addressed potential stress points in the design, focusing on alignment and material weaknesses.

Agreed Actions:

- Implement modifications based on stress analysis findings.
- Continue refining CAD models for final assembly.

Meeting 5: Prototype Fabrication Plan

Date: 30 January 2025

My Contributions:

- Worked with the team to finalize the fabrication process, including material procurement and tool selection.
- Suggested the use of CNC waterjet cutting for precise component fabrication.
- Organized the fabrication plan for the cutting and punching components.

Progress since last meeting:

- Identified all necessary materials for prototype fabrication.
- Completed the fabrication plan and ready to begin the prototype assembly.

Agreed Actions:

- Start prototype fabrication of components.
- Begin assembling the machine frame and critical components.

Meeting 6: Prototype Assembly & Integration

Date: 20 February 2025

My Contributions:

- Assisted in the assembly of the components, ensuring correct alignment.
- Focused on ensuring that all mechanical components were integrated smoothly into the frame.
- Test-fit key components and made adjustments where necessary.

Progress since last meeting:

- Prototype assembly is in progress.
- Identified a few alignment issues during the first assembly, which have since been addressed.

Agreed Actions:

- Complete the assembly of all components and prepare for the first testing phase.
- Begin testing the functionality of each mechanism.

Meeting 7: Prototype Testing & Performance Evaluation

Date: 15 March 2025

My Contributions:

- Led the initial testing of the cutting and punching operations.
- Observed the accuracy of cuts and embossing and documented performance.
- Identified minor issues with the punching mechanism not fully aligning during operation.

Progress since last meeting:

- Completed initial performance tests and observed some inconsistencies in the punching accuracy.
- Documented potential improvements.

Agreed Actions:

- Make adjustments based on testing feedback.
- Prepare for final testing of the machine.

Meeting 8: Final Adjustments & Reporting

Date: 5 April 2025

My Contributions:

- Made final adjustments to the punching mechanism to ensure better alignment and consistency.
- Contributed to the final report, focusing on the design and testing phases.
- Helped prepare the final presentation for the project.

Progress since last meeting:

- All major adjustments were made, and the punching mechanism is now functioning better.
- The project report and presentation are ready for submission.

Agreed Actions:

- Submit the final project report and presentation.
- Prepare for project presentation and showcase of the leather press.

Appendix B.2 Individual Logbook - Mohamed Abdulkarim

Meeting 1: Initial Planning & Design Concept

Date: 2 September 2024

My Contributions:

- Suggested the initial concept for the multifunctional machine integrating cutting, embossing, and shaping.
- Worked on drafting the design objectives.
- Started research on available leatherworking machines and their limitations.

Agreed Actions:

- Research current leather manufacturing methods and tools and prepare a summary report.
- Begin initial sketches and CAD drawings for the machine's frame.

Meeting 2: Research & Design Discussion

Date: 25 November 2024

My Contributions:

- Completed the summary of research findings on leather manufacturing tools.
- Suggested material selection for the machine frame based on durability and cost.
- Assisted in sketching the initial concept for the CAD model.

Progress since last meeting:

- Research report on leatherworking tools completed.
- Initial ideas for the machine's functionality were presented and discussed.

Agreed Actions:

- Start working on the CAD model for the machine frame.
- Assist in finalizing the design concept and prepare material selection criteria.

Meeting 3: CAD Modeling and Design Refinement

Date: 10 December 2024

My Contributions:

- Created a detailed CAD model for the machine frame and began assembling other components in AutoCAD.
- Assisted in selecting materials for key components based on durability and stress resistance.

Progress since last meeting:

- Finished the CAD model for the machine's frame.
- Material selection for frame and cutting tools confirmed.

Agreed Actions:

- Begin the FEA analysis of the frame design.
- Make CAD model in preparation for manufacturing.

Meeting 4: Stress and Deflection Analysis

Date: 7 January 2025

My Contributions:

- Conducted FEA on key components such as the lever arm and frame.
- Presented the stress analysis results, highlighting areas requiring reinforcements.

Progress since last meeting:

- Completed stress and deflection analysis on the machine frame and lever.
- Adjusted CAD model based on FEA feedback.

Agreed Actions:

- Assist with the fabrication process and ensure all components meet the required tolerances.
- Continue working on the stress analysis for additional components.

Meeting 5: Fabrication and Manufacturing Process

Date: 30 January 2025

My Contributions:

- Supervised the CNC cutting and welding processes.
- Assisted in fabricating the machine components, ensuring they adhered to design specifications.

Progress since last meeting:

- Machine components fabricated and partially assembled.

Agreed Actions:

- Continue assisting in the assembly process.
- Conduct testing to ensure the system operates smoothly.

Meeting 6: Assembly and Preliminary Testing

Date: 20 February 2025

My Contributions:

- Assisted in assembling the machine and conducting initial performance tests.
- Tested the machine’s ability to handle leather cutting and embossing tasks.

Progress since last meeting:

- Machine assembled and tested with initial results indicating successful operation for cutting and embossing.

Agreed Actions:

- Refine the CAD model to improve ease of operation.
- Conduct more extensive tests on cutting and embossing.

Meeting 7: Final Testing and Quality Control

Date: 15 March 2025

My Contributions:

- Conducted tests on different leather types for cutting and embossing precision.
- Identified issues with machine alignment and suggested improvements.

Progress since last meeting:

- Conducted extensive tests to assess the machine's performance on leather.
- Adjusted the alignment mechanism based on testing feedback.

Agreed Actions:

- Finalize the test data and complete the final report.
- Assist in preparing the presentation for the final review.

Meeting 8: Final Presentation and Report Submission

Date: 5 April 2025

My Contributions:

- Finalized the report and prepared presentation slides.
- Presented the project, highlighting key design and testing results.

Progress since last meeting:

- Final report completed and presentation slides ready for submission.
- Successfully demonstrated the machine's functionality in the presentation.

Agreed Actions:

- Submit the final report and present the project in the final review.

Appendix B.3 Individual Logbook - Mohamed Abdelshafie

Meeting 1: Initial Planning & Design Concept

Date: 2 September 2024

My Contributions:

- Contributed ideas for the machine’s cutting mechanisms.
- Helped establish the machine’s specifications, such as the type of materials it would handle.
- Assisted in planning the overall timeline for the design and production phases.

Agreed Actions:

- Begin researching potential materials for the machine’s cutting and embossing components.
- Assist with the creation of the machine’s specifications document.

Meeting 2: Research & Design Discussion

Date: 25 November 2024

My Contributions:

- Presented research on different materials suitable for cutting and embossing leather.
- Suggested using hardened steel for the cutting tools and aluminum alloy for the frame to reduce weight.
- Participated in finalizing the material selection.

Progress since last meeting:

- Completed material research for the frame and cutting components.
- Assisted in selecting the materials for the machine’s structural parts.

Agreed Actions:

- Start contacting suppliers for the materials and begin the procurement process.
- Continue working on material testing and assist with the CAD modeling.

Meeting 3: CAD Modeling and Design Refinement

Date: 10 December 2024

My Contributions:

- Reviewed the CAD model to ensure material choices align with the design.
- Assisted in determining the dimensions and tolerances for the cutting tools.
- Provided input on material testing methods for the machine’s components.

Progress since last meeting:

- The CAD model’s materials were updated based on the latest selections.
- Finalized testing methods for material durability and performance.

Agreed Actions:

- Manage the material procurement process.

- Assist in the final FEA analysis and ensure material compatibility with stress testing results.

Meeting 4: Stress and Deflection Analysis

Date: 7 January 2025

My Contributions:

- Assisted in reviewing the stress and deflection analysis results.
- Suggested minor adjustments to the design to improve strength and reduce weight.

Progress since last meeting:

- Stress testing for critical components was completed, and necessary adjustments were made to the design.
- Improved the structural integrity of the frame design based on analysis.

Agreed Actions:

- Continue to source materials and place orders with suppliers.
- Finalize the mechanical design and assist in the preparation for the manufacturing process.

Meeting 5: Fabrication and Manufacturing Process

Date: 30 January 2025

My Contributions:

- Supervised the procurement of materials and assisted in ensuring that the parts met design specifications.
- Assisted in troubleshooting and resolving issues during the assembly process.

Progress since last meeting:

- Materials were successfully procured, and fabrication began on time.
- The components for the frame were cut and shaped correctly.

Agreed Actions:

- Oversee the final assembly and ensure all components are fabricated according to the design.
- Prepare for the initial machine testing phase and ensure the quality of the assembly.

Meeting 6: Assembly and Preliminary Testing

Date: 20 February 2025

My Contributions:

- Assisted in machine assembly.
- Conducted initial performance tests

Progress since last meeting:

- Successfully mounted all components and performed initial testing.
- Discovered minor operational glitches, which were documented for improvement.

Agreed Actions:

- Oversee further testing and adjustments.
- Ensure that all issues are resolved before the final tests are conducted.

Meeting 7: Final Testing and Quality Control

Date: 15 March 2025

My Contributions:

- Conducted in-depth tests on different leather, evaluating the machine's cutting and embossing capabilities.
- Analyzed feedback and implemented necessary adjustments to the design.

Progress since last meeting:

- Major issues identified during preliminary testing were resolved.
- The machine now functions better with both cutting and embossing tasks.

Agreed Actions:

- Finalize the machine's performance documentation and report.
- Assist in preparing the final presentation for the project review.

Meeting 8: Final Presentation and Report Submission

Date: 5 April 2025

My Contributions:

- Compiled the final performance data and results into a comprehensive report.
- Contributed to the creation of the final presentation slides, focusing on material selection and manufacturing processes.

Progress since last meeting:

- Completed the final project report, highlighting the machine's development, performance, and testing results.
- Final presentation was completed and ready for submission.

Agreed Actions:

- Submit the final report and deliver the presentation.

Appendix B.4 Individual Logbook - Majad Al Sharshani

Meeting 1: Project Kick-off & Initial Planning

Date: 2 September 2024

My Contributions:

- Actively participated in defining the project scope and objectives.
- Suggested the use of hydraulic systems to assist in punching and shaping.

Agreed Actions:

- Continue researching hydraulic systems for incorporation into the design.
- Collaborate with the team on CAD model development.

Meeting 2: Research Review & Material Selection

Date: 25 November 2024

My Contributions:

- Contributed insights on the materials needed.
- Suggested options for durable materials for the frame and punching mechanism.

Progress since last meeting:

- Researched different components and materials like alloy steel.
- Prepared a list of recommended components.

Agreed Actions:

- Finalize material list and start testing the stress of the selected components.

Meeting 3: CAD Design Review

Date: 10 December 2024

My Contributions:

- Suggested design adjustments to improve efficiency in the punching system.

Progress since last meeting:

- Completed initial CAD model.
- Started working on optimizing the overall design for ease of use.

Agreed Actions:

- Finalize design and test for functionality.

Meeting 4: Stress Testing & Component Analysis

Date: 7 January 2025

My Contributions:

- Analyzed stress test results and offered design improvements.

- Suggested adjustments to ensure it can handle the pressure.

Progress since last meeting:

- Reviewed stress analysis for key components.
- Proposed solutions for minimizing wear and improving durability.

Agreed Actions:

- Modify the system based on stress analysis feedback.
- Re-run stress analysis after adjusting design.

Meeting 5: Fabrication & Manufacturing Plan

Date: 30 January 2025

My Contributions:

- Suggested appropriate fabrication techniques, such as CNC cutting and MIG welding.
- Worked on preparing a detailed list of required materials for fabrication.

Progress since last meeting:

- Finalized the selection of components and manufacturing methods.
- Prepared for the upcoming prototype assembly.

Agreed Actions:

- Begin fabrication of the first set of components.
- Coordinate with the team to begin assembly after fabrication.

Meeting 6: Prototype Assembly

Date: 20 February 2025

My Contributions:

- Helped troubleshoot initial issues during assembly, including alignment problems.

Progress since last meeting:

- Completed assembly of most components.
- Started testing functionality of the machine.

Agreed Actions:

- Conduct initial functionality testing.
- Identify improvements based on test results and feedback.

Meeting 7: Prototype Testing & Evaluation

Date: 15 March 2025

My Contributions:

- Ran tests for punching mechanisms.

- Collected performance data on the prototype’s cutting precision and efficiency.

Progress since last meeting:

- Completed initial testing of the machine.
- Gathered performance data, identifying some issues with uneven cuts.

Agreed Actions:

- Fine-tune alignment for improved accuracy in punching.

Meeting 8: Final Evaluation & Project Closure

Date: 5 April 2025

My Contributions:

- Reviewed final performance data.
- Suggested recommendations for future improvements, including automation and better material selection for durability.

Progress since last meeting:

- Finalized testing on all functions.
- Machine is now fully functional and has passed precision and durability tests.

Agreed Actions:

- Submit the final project report.
- Prepare a presentation for project demonstration.