GNG 2101A

Introduction to Product Development and Management

for Engineers and Computer Scientists

Project Deliverable J

User Manuel

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Abstract

The Special Adjustable Laptop Arm (SALA) is a telescoping, adjustable laptop arm. The main purpose of this product is to hold a laptop in order to optimize ergonomics for people with limited mobility. The design is made of three main parts, the base, the arms and the platform. The base is clamped to a desk, the arms are attached to the base and the platform is attached to the arms. Each of the components can be adjusted and tilted to the optimal orientation of the user. This document highlights the main features provided by this product, the components of each part, how it was constructed and assembled. In addition, this document highlights the health and safety guidelines, troubleshooting and maintenance guidelines for SALA. Finally, conclusions and recommendations for future work on the product are discussed along with an overall reflection of the project.

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Introduction

Patients at the St. Vincent Bruyère Hospital, especially those with limited arm mobility, have demonstrated a need for an adjustable laptop mount to prevent neck strain and its long term effects such as repetitive stress syndrome (RSS). RSS is the result of repetitive movement which causes pain, muscle strain, inflammation, and in serious cases, tissue damage. The patient, JM, uses a mouth stick and repeated neck movements to operate his laptop, which can lead to RSS. To prevent RSS from occurring, an adjustable laptop mount was made to improve JM's posture and reduce the magnitude of his neck movements while he uses laptop.

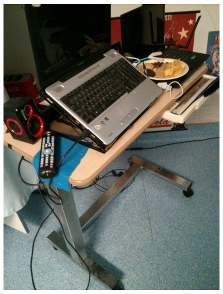


Figure 1: Client's current laptop setup.

JM's current laptop setup involves placing the laptop on a raised platform which can tilt towards him at a maximum angle of 25 degrees. This can be seen in figure 1. The setup has no means of adjusting his laptop's height, or moving it towards him. Since the only form of adjustability is tilt, JM hunches over his mobility device to reach the keyboard with his mouth stick, and frequently looks down to type, and back up at the screen to view his laptop.

SALA, the Special Adjustable Laptop Arm, allows the laptop's height, depth, and tilt to be adjusted. The laptop is secured in place to his current setup, without sacrificing his mouth-stick, and be clamped to his desk. Since SALA can be clamped to any flat surface, it can be clamped to any position on his desk, and still function fully.

SALA features two telescoping arms that allow for adjustability in discrete measurements so that the laptop can be moved closer to JM's vicinity, which allows him to reach his keyboard. Additionally the laptop can be secured on a platform that allows for various tilts, so that JM is able to view his laptop at an angle anywhere from horizontal to vertical. The vertical position of the laptop will enable him to view both his keyboard and his screen in an ergonomic position.

Features

The main features of the product are the adjustability and the compatibility. For compatibility, the laptop mount arm can be clamped to almost any desk or table. The arm can also be adaptable to any laptop by simply changing the platform and clip sizes. For adjustability, the arm can be set up in different ways. Firstly, the arm can be adjusted in length via telescoping motion using screws to lock in the arms at the desired length. The arm itself can also be adjusted in height by using the three preset angles in the base of the product, this is done simply by moving the outer arm upwards or downwards. Lastly, the platform on which the laptop sits, can be tilted upwards or downwards up to 180 degrees. The following figures outline the key features:

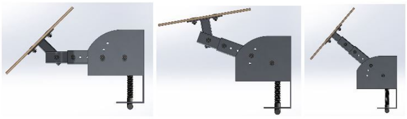


Figure 2: Demonstrates the 0, 20 and 40 degree angle adjustments

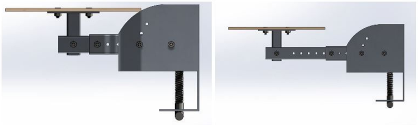


Figure 3: Demonstrates the length adjustment

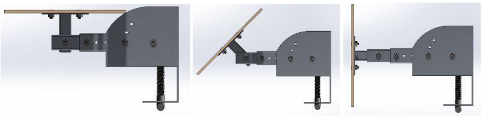


Figure 4: Demonstrates the tilting capabilities of the connection piece

On top of these two features, the product is lightweight (less than 2 kilograms) and can be secured and locked in once the arm is setup to avoid unwanted changes in the laptop's position. Low maintenance is also an added feature as the user should only deal with tightening the bolts once a day in order to keep arm secure.

Components

1. **Base**

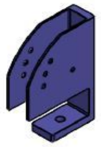


Figure 5: Isometric View of the Base

The base has an "L" shaped bottom portion which can wrap around the edge of a desk. It contains three holes at 0, 20 and 40 degrees where the outer arm can be locked into position. The hole nearest its centre is the main rotation point for the outer arm. Finally a larger hole on the bottom of the "L" portion is used for the clamping bolt.

2. **Inner & Outer Arms**

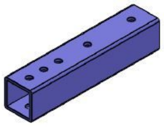


Figure 6: Isometric View of the Outer Arm

The outer arm contains 3 holes each 0.8 apart which acts as the main locking point between the inner and outer arms. The fourth hole is used to lock the arm at the desired angle with the base. The last hole is used as the main rotation point with the base.

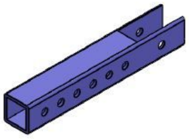


Figure 7: Isometric View of the Inner Arm

The inner arm contains 6 holes each 0.8in apart to provide up to 4.8in of adjustability. These holes are used to lock it into place with the outer arm at the desired extension length. The main hole at the top is the main rotation point for the connection piece. This allows the user to tilt the platform at angles up to 180 degrees.

3. Connection Piece

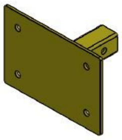


Figure 8: Isometric view of the Connection Piece

The connection piece acts as the tilting mechanism for the MDF platform and it connects to the inner arm. The MDF platform lays flat on the rectangular plate of the connection piece. The hole on the rectangular tubing portion attaches in between the inner arm.

4. Laptop Clips, Bar Clamp & Clamping Bolt Cap

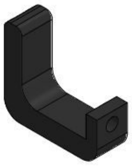


Figure 9: Isometric view of the laptop clips

The laptop clips are made to the size of the laptop. They attach to the MDF laptop platform. They are designed to hold the laptop in place while a laptop is mounted.

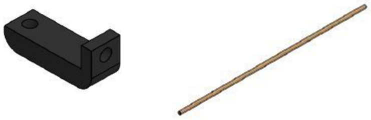


Figure 10: Isometric view of Bar Clamp Clip and Rod

The bar clamp clip and are made to the size of the laptop. The bar clamp clips attaches to the MDF laptop platform and the rod inserts in between the bar clamp clip. They are designed to prevent the laptop from falling over at extreme angles.

5. MDF Laptop Platform

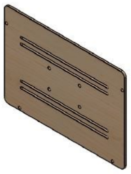


Figure 11: Isometric view of the MDF Laptop Platform

The MDF laptop platform is used to hold the laptop. The rectangular slots are used for ventilation and the various holes are used to screw in the clips and connection piece.

Constructing the Prototype

3D Printing

Most of SALA's components are constructed using 3D printing. To start all parts were created on solidworks. Afterwards, all CAD part files were converted to STL files so that they could be 3D printed. PLA was used as the printing material.

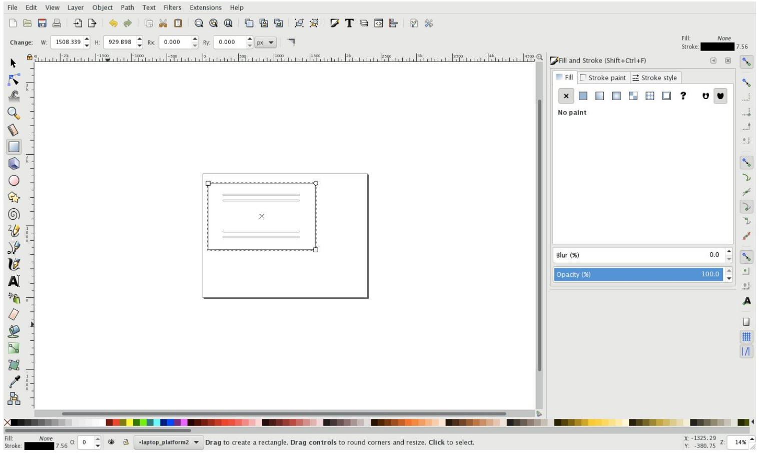
The recommended 3D printer is an Ultimaker 2+. To 3D print a file on Cura, open Cura and click on File and Open File(s). One by one, configure open each component's STL file and apply the appropriate settings as described in Table 1. Ensure that for any given print, there is enough room for each part on the printing plate.

Table 1: Lists the 3D printed parts and the main print settings of each component

Part	Nozzle	Infill Density	Layer Height	Infill Pattern	Print Speed
Base	0.8mm	50%	0.2mm	Cubic	80m/s
Inner & Outer Arms	0.8mm	50%	0.35mm	Cubic	80m/s
Connection Piece	0.6mm	50%	0.3mm	Cubic	70m/s
Clips, Clamp and Cap	0.4mm	50%	0.2mm	Cubic	65m/s

Laser Cutting

To laser cut the platform, the platform must first be designed on Inkscape. The dimensions of the MDF laptop platform can be found on the attached CAD sketches. To make a new document on Inkscape, **File** must be opened and **Document Properties** must be configured. The Document Properties emulated a 24 x 12 inch MDF board to help pinpoint where the laser would cut the MDF. Afterwards, the Rectangle tool was used to create the dimensions of the platform that were specified in the CAD drawings. In order to make an ellipse, the rectangle sketch was clicked twice. Once clicked, circular toggles will appear in order to adjust the fillets on the vertices of the rectangle. Slot sketches were made by utilizing the rectangle tool. In order to fully align the circular slots, the option **Align and Distribute**, under the **Object** tab, was configured. The slots were Aligned with respect to the largest object, which was the rectangular platform, and then Centred on the Vertical Axis. By selecting the cursor tool, the sketches made can be moved around onto the document.



Change: W: 1508.339 H: 929.898 Rx: 0.000 Ry: 0.000 px

Fill: None
Stroke: 7.56

Blur (%) 0.0
Opacity (%) 100.0

Fill: None
Stroke: 7.56 O: 0 •laptop_platform2 **Drag** to create a rectangle. **Drag controls** to round corners and resize. **Click** to select.

X: -1325.29
Y: -380.75 Z: 14%

Figure 12 : Screenshot of Inkscape

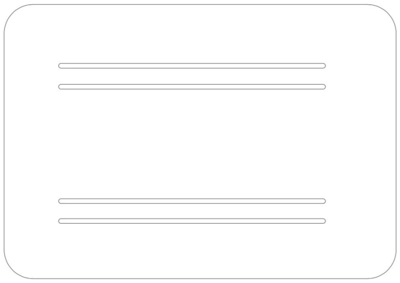


Figure 13: Outline of MDF laptop platform for inkscape

After the sketch was made, the file was saved as a .svg file, to edit for later iterations. A separate file was saved as a .pdf on a USB drive for the Epilog laser cutter to read. The file from the USB was uploaded to a laptop connected to the Epilog laser, then the Document settings changed the .pdf to a vectorized file. The speed, power, and frequency were set to 8, 50, and 500Hz respectively. After the settings were configured, the compressed air was turned on and the focus tool was used to level the platform of the laser cutter. The .pdf file was printed, so that the file could be uploaded as a job on the Epilog laser cutter. Lastly, the Go button was pressed.

Assembling the Whole Prototype

SALA comes with the following components:

Table 2: Lists the components and quantity of each

Component	Quantity
Connection Piece	1
MDF Laptop Platform	1
Base	1
Inner Arm	1

Outer Arm	1
Laptop Clip	2
Bar Clamp Clip	2
Cap	1
Rod for Bar Clamp 1/4in. diameter	1
Hex Bolt 0.25-20 x 1.5 x 0.75	1
Hex Bolt 0.25-20 x 2.0 x 0.75	3
Flat Head 0.25-20 x 0.75 x 0.75	4
Flat Head 0.25-20 x 1.0 x 1.0	4
Hex Bolt 0.25-20 x 3.0 x 3.0	1
Hex Nut 0.25-20	12

MDF Laptop Platform & Connection Piece Assembly

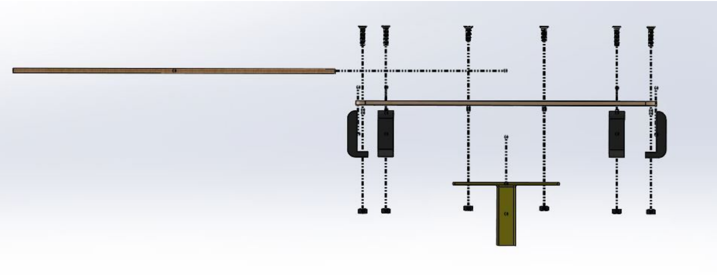


Figure 14: Exploded view of the MDF Laptop Platform & Connection Piece Assembly

1. Screw laptop clips and bar clamp clip onto MDF laptop platform using the flat head 0.25-20 x 1.0 x 1.0 screws and attach the hex nuts 0.25-20 on each end. Ensure that the screws are flush with the laptop platform.
2. Insert rod for bar clamp in-between the two bar clamps.
3. Align the holes on the connection piece with the four holes on the MDF laptop platform. Using the flat head 0.25-20 x 0.75 x 0.75 screws, attach the two components together and add hex nuts 0.25-20 on each end of the screw. Ensure that the screws are flush with the laptop platform.

Inner & Outer Arms, Base and MDF Laptop Platform Assembly

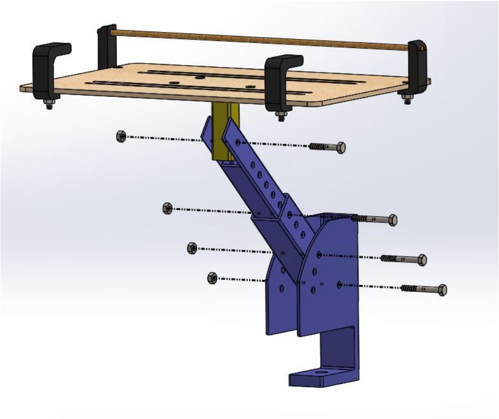


Figure 15: Exploded view of how to connect arms, base and laptop platform together

4. Attach outer arm to the base using the hex bolt 0.25-20 x 2.0 x 0.75 and add a hex nut 0.25-20 to the end of it. Ensure it is tightened fully.
5. Attach inner arm into the outer arm and extend it to the desirable length. Align the top hole of the outer arm to a hole in the inner arm and lock it into place using a hex bolt 0.25-20 x 2.0 x 0.75 and add a hex nut 0.25-20 to the end of it. Ensure it is tightened fully.

6. Attach MDF laptop platform assembly to the inner arm by aligning the hole on the connection piece to the hole at the top of the inner arm. Tilt the platform to the desirable angle and lock into place using the hex bolt 0.25-20 x 1.5 x 0.75 and add a hex nut 0.25-20 to the end of it. Ensure it is tightened fully.

Clamping onto Desk

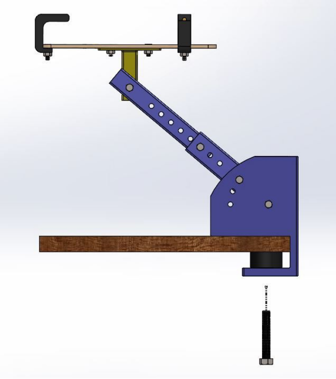


Figure 16: How to clamp the base onto the desk

7. Insert the clamp screw through the lower hole of the base component.
8. Add the cap to the end of the clamping screw and tighten them together.
9. Slot the base over the edge of a desk and tighten the clamping screw.. Ensure it is tightened fully.

Mounting the Laptop

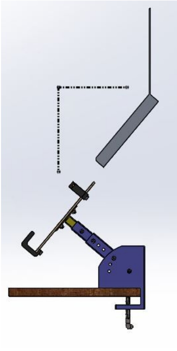


Figure 17: Sliding the laptop into place

10. Slide the laptop onto the platform until it rests against the laptop clips.
11. Installation is now complete.

Health and Safety Guidelines

The PLA, MDF, nuts, and bolts used are all non-toxic and the whole assembly is lightweight. This ensures this product will have no adverse affects on a user's health, even over prolonged use.

Long duration testing was not done on the laptop platform's locking mechanism; it was only tested to hold a laptop for up to 2 hours. During that 2 hours, the locking mechanism held firmly and showed no signs of loosening however, it is likely that some slippage may start to occur past a certain period of time. As a result, to ensure the laptop platform locking mechanism does not slip and cause the platform to rotate, it is recommended that the platform locking mechanism be checked and/or tightened at the start of every day or as needed. Should the locking mechanism fail, the bar clamps and laptop clips will prevent the laptop from falling off the platform, but the laptop's screen may be damaged if it hits the user's desk.

The PLA and desk clamping mechanism create a robust laptop mount that is strong for its weight, however it is still at risk of breaking should too much force be applied to it. The mount will easily support any laptop slotted in, but will be at risk of breaking or deforming if it is forced to support too much weight either on the laptop platform or along the extension arms. As such, it is recommended that users be conscientious of leaning on the apparatus or using the mount to support objects heavier than laptops.

Troubleshooting & Maintenance

The laptop platform can be adjusted by using wrenches to tighten and loosen the screws located in the telescoping arms. With usage of the product, some parts may loosen up. It is recommended to tighten the bolts once every week in order to make sure that the laptop arm is always safe and secure. The bolt connecting the platform to the arms should be tightened more frequently as described in the Health and Safety Guidelines. In the case where some parts break, they can be cheaply reprinted or recut using the machines in the MakerSpace at the University of Ottawa using the CAD files submitted alongside this manual.

Conclusions & Recommendations for Future Work

For future work, it is recommended that the screws and bolts be replaced by spring loaded pins in order to make adjustments easier and quicker. The option of adding more angles is also being explored to make the product even more adjustable. The platform can be redesigned to make it more adaptable to any type of laptop. As added customizability, the user can request a color in order to have a monochromatic arm or a multi colored arm if they wish. PLA can be replaced by carbon fiber to add stability and security. Finally, the product can be branded and marketed further in order to increase profitability and reach more clients who would find it useful.

Reflection

As a team, communication and commitment was the most important aspect going forward. On top of that, client meeting and interaction skills were developed in order to learn how to extract as much information as possible while keeping the meeting a friendly environment to develop a complete product that satisfies the client’s needs. Planning around busy schedules has been a challenge for most groups but learning how to overcome that will help the members grow as people and advance in their education and careers. Finally, it was noted that on top of planning, time for prototyping should always be made as tests and iterations are two of the most important parts needed to deliver a functioning design.