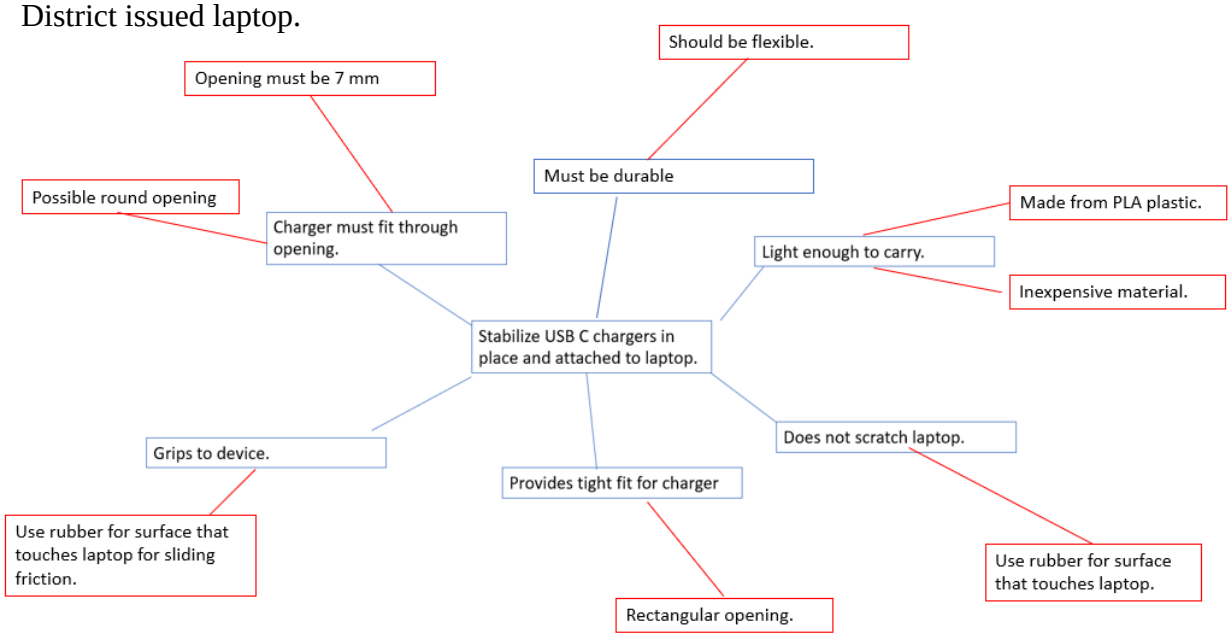
Paper B – *Charger Shield*

Brainstorming Process

While Interlake High School students are expected to charge their laptops between weekdays, the high volume of usage throughout the 7-hour school day can drain battery quickly. Students tend to charge their laptops in outlets located in the corners of classrooms, leading to outstretched wires. These consumers typically deal with long, and tangled cords that fall out of one's charging port easily. Therefore, our priority when coming up with solutions to this problem was to innovate a product to secure the charger in place. The look, design, weight, material, and size were aspects that varied across our different ideas as we wanted to come up with the ideal product that filled a need while not being a hinderance to the consumer. The expectation of the design is that it is a light mechanism that allows for a USB C charger to fit through and secure it to the charging port of a school-issued laptop through clamping down on the thickness of the keyboard.

Mind Map

The use of this mind map helped justify how the functions will be performed through the features. The functions are in blue boxes while the features are in red boxes. All features and functions must serve the main purpose of securing USB C chargers to the Bellevue School District issued laptop.



Intended Use

This product will serve the purpose of further securing the USB C charger intended to power the Bellevue School District issued Dell Latitude 7390 2-in-1 in place. The product will latch on to the side of the keyboard. It will utilize some attachment technique so that the product cannot be easily pulled off the keyboard.

Here are the dimensions for the laptop the product is intended for:

Dimensions & Weight

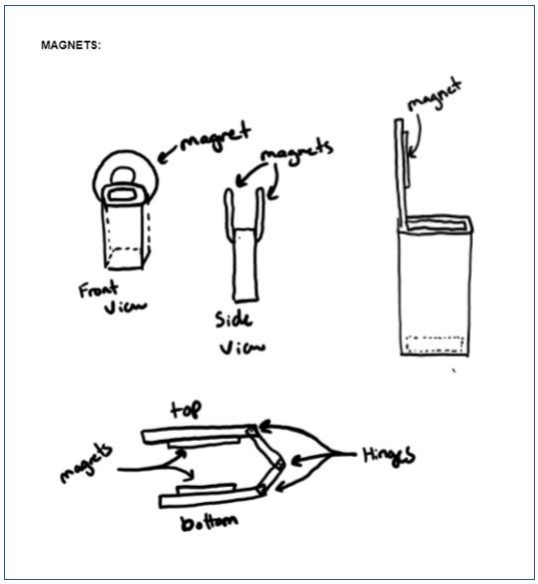
1.Narrow Bezel Height: 11.75-18.03mm / 0.47"- 0.71" (Front to Back)
Standard Bezel Height: 12.92-19.03mm / 0.51"- 0.75" (Front to Back)
2.Width: 305.1mm / 12"
3.Depth 210mm / 8.26"(211mm standard bezel)
Starting weight: 1.42kg / 3.12lb (with WLAN, 45Whr* 3-cell Battery, M.2 128GB SSD)

https://www.dell.com/en-aw/work/shop/cty/pdp/spd/latitude-13-7390-2-in-1-laptop

Initial Concept Modelling

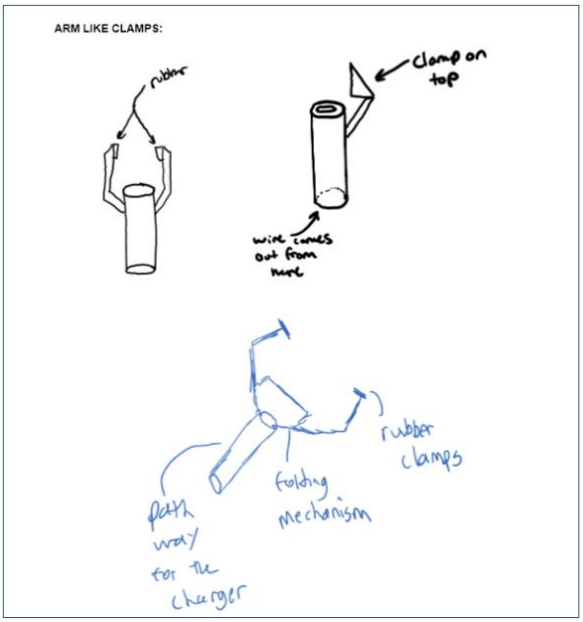
My group elected three possible ways of securing the BSD issued USB C charger to the laptop: magnets, arm-like clamps, and slot-opening clamps.

Magnets



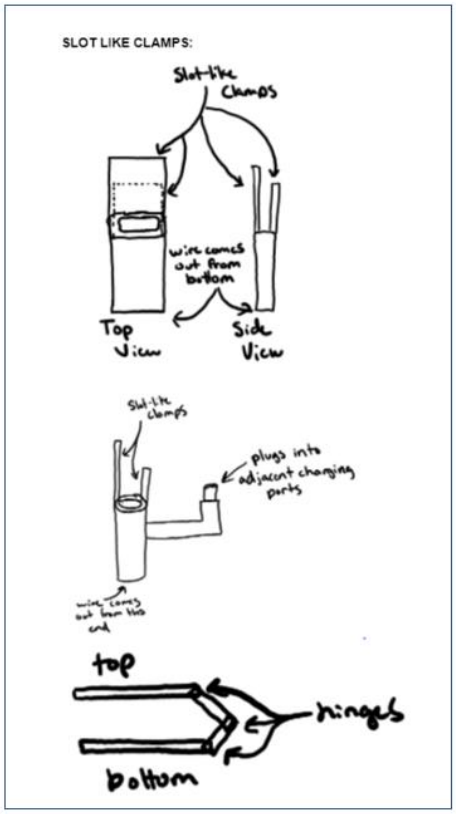
The designs for utilizing magnets optimized for ease of use. It would permit the mechanism to be attached to the magnetic strip located on the left side of the keyboard, similar to how the stylus is attached. This concept does not cause any unwanted elevation. However, the stylus does detach from the keyboard quite easily. Therefore, if the product uses a similar magnet, the effectiveness may be compromised. Additionally, adding a magnet will add to the overall weight of the product.

Arm-Like Clamps



The designs utilizing arm-like clamps offered a way to effectively grip the side of the keyboard. These clamps would have a rubber texture to grip to the side. Additionally, this concept allows for the clamps to be flexible if the user needs to position the clamp a certain way. The arm-like structure also decreases the likelihood of the clamp breaking. However, due to the arm-like structure, there will be a slight elevation under the keyboard. This may hinder the user's laptop experience as they may need to place another object under the right side to even out the elevation.

Slot-Opening Clamps



The design using slot-opening clamps acts as a hybrid between the magnet and the arm-like clamp. It possesses the ease of use that the magnet concept contains, and the grip to the side of the keyboard that the arm-clamp contains. However, the slot pieces may not be as flexible as the arm-clamp pieces, making them more susceptible to breaking. While the bottom slot pieces are thinner than the bottom arm-clamp pieces, there will still be a slight elevation to the laptop which could be negligible to the user or slightly irritating.

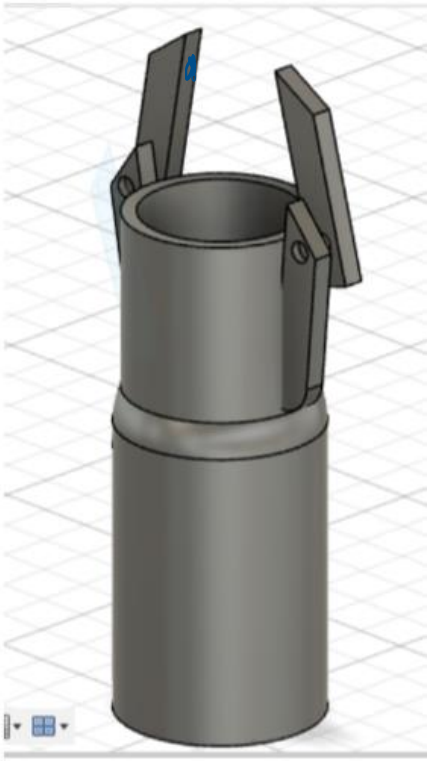
Idea Justification

While the magnet design is effective to an extent, the limitation that it could detach from the side of the keyboard easily defeats the purpose of the product when trying to find the ideal solution to stabilize one's charger to the charging port. Additionally, the weight and price of

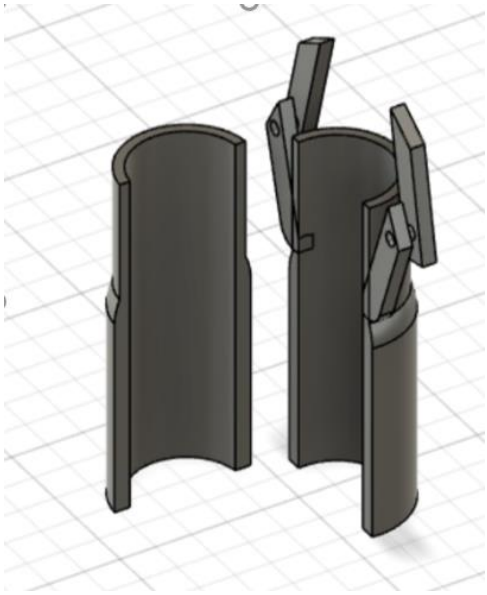
implementing the magnet into the design would be too costly to the production of such an item. The Arm-Like Clamp and Slot-Opening Clamp do not possess such limitations and do effectively execute the purpose of gripping the side of the keyboard while securing a USB C charger. Therefore, further analysis on two final designs for each of these concepts have been presented below.

Arm-Like Clamp Design

This design utilizes a claw-like feature to provide flexibility and security for the USB C charging cable. The roundness of the opening allows for the claws to attach with stability. The two pivots on the sides of the design replicate that of a claw. This feature allows the user to adjust the product depending on the angle they desire to secure their charger in. The simplicity of this design allows users to easily carry it wherever they go. It can slip easily onto the charging cable when not in use as its 50 mm length permits such a feature.



The 16mm distance between clamps allows a tight fit for the side of the BSD issued DELL laptop. This allows for the product to align perfectly with the dimensions of the keyboard thickness. Each clamp is 15 mm long, which provides enough surface area to grip onto the side of the keyboard while not interfering with key commands. The 5 mm rubber tips provide enough friction to ensure that the charging cable cannot be easily removed on accident. If the user intends to remove the mechanism, the clamps can simply open and release its grip on the laptop.

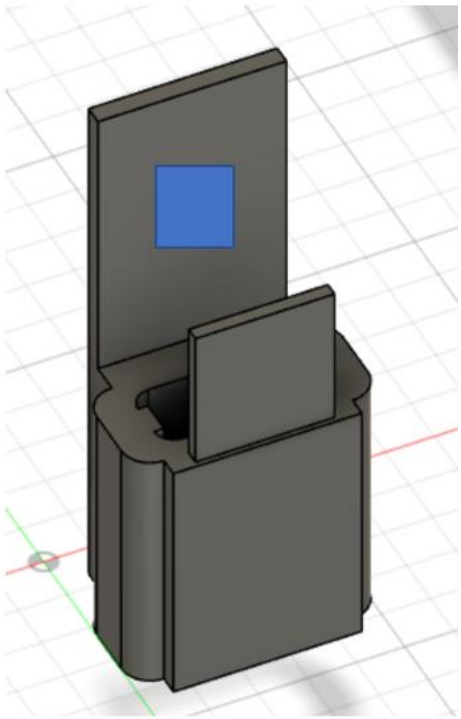


As shown above, the mechanism will be able to open and close along its 50 mm length. Since the intention is for the charger to be snug inside, it will be difficult for the user to remove the charger without opening and closing the product. However, while this design does cater to the need for flexibility, the round opening may still allow enough wiggle room for the charger to not be stable. Additionally, when latching the clamp to both sides of the keyboard, the bottom clamp may cause the laptop to raise 5 mm – 6 mm which may hinder

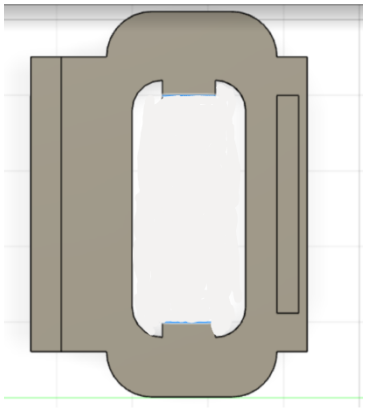
the user's laptop experience. The Dell Laptop charger that this product is intended for, has a rectangular shape that may not fit as well into the circular opening of this concept.

Slot-Opening Clamp

This design utilizes two flat rectangular pieces that extrude out from the top and bottom of the mechanism. The two pieces are 16 mm apart which allows for the side of the keyboard to fit tightly between. The 5 mm rubber pieces that are attached to the rectangular plastic piece will exhibit sliding friction, restricting the charger from being pulled out of its port by accident.



As shown in the figure above, the rectangular opening has a height of 2 mm and a width of 7 mm, which allows for the USB C charger to have a tight fit. This ensures that the charger does not get removed without intention. The top rectangular piece is 15 mm in length while the bottom rectangular piece is 30 mm in length. The purpose of having the top piece 15 mm shorter is so that there is no interference with key commands.



The 7 mm wide opening allows for the USB C cable to fit through perfectly. While this concept cannot open and close like the clamp design, its lack of materials will cater to the user's needs as it will be light enough to carry.

Chosen Design Justification

This table allows us to compare our two final designs: the Arm-Like Clamp and the Slot-Opening Clamp. They are compared through deciding whether they fit the specifications outlined in the initial mind map. The specifications are ranked based on their level of priority (1 being the highest and 6 being the lowest). Each specification has an assigned point-value based on priority level. Therefore, the design with the highest sum of points would be the ideal design to use for the *Charger Shield.*

Specifications	**Arm-Like Clamp**	**Slot-Opening Clamp**
1. *Grips to keyboard so that the charger does*	This design meets this specification as the clamp will provide a strong hold on the keyboard.	This design meets this specification as the keyboard will fit tightly into the 7 mm slot.

not fall out accidentally. (6pts.)		
2. *Charger must fit through opening. (5pts.)*	This design allows for the charger to fit through the opening as the mechanism can be opened and closed at its length.	This design allows for the USB C charger to fit through exactly as that is what its rectangular shape permits.
3. *Provides tight fit for USB C charger (6mm width) so it does not fall out. (4pts.)*	This design possesses a round opening that does not provide a tight fit for USB C chargers.	This design possesses a rectangular shape that caters to the fit of the USB C charger.
4. *Does not scratch surface of keyboard for laptop or hinder the laptop using*	This design possesses a rubber surface that will not scratch the keyboard surface.	This design possesses a rubber surface that will not scratch the keyboard surface.

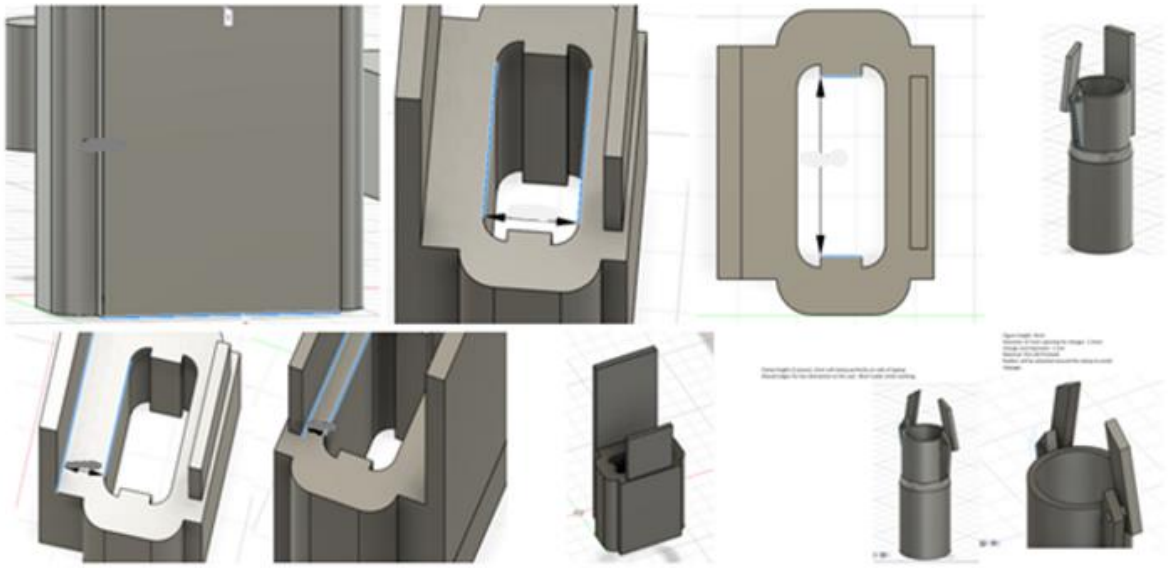
experience. (3pts.)		
5. *Light enough to carry. Product must be less than half of BSD issued stylus (19 grams) (2pts.)*	This design does possess the extra weight of the claws, hinges, and pivots which makes it relatively harder to carry.	This design is light and easy to carry as it is all one 3D printed plastic mold.
6. *Must be durable and be able to withstand bending. (1pt.)*	This design has pivots and hinges that make the mechanism more flexible when bent.	This design is made from one mold which makes it stiff and brittle, meaning it may break relatively more than the other design when bent.

Arm-Like Clamp Score: 6 + 5 + 3 + 1 = 15

Slot-Opening Clamp Score: 6 + 5 + 4 + 3 + 2 = 20

According to the Chosen Design Justification table, our ideal design is the Slot-Opening Clamp. It scored a 20 on my specifics priority points scale which is greater than the Arm-Like Clamp score of 15. The only limitation is that it is not as flexible, however, since it is catering to one type of laptop, the need to be flexible is low. It possesses an exact distance of 7 mm that will

allow the keyboard of the BSD issued Dell computer to fit right into the slot. Various angles of the solution are presented below:



Paper C – *Charger Shield*

Overview

The design is created from a single 3-D printed shape that the USC C charger will slide into. Except for the rubber padding used for the slot to grip to the keyboard, the design does not require the addition of materials other than plastic. The use of one plastic mold allows the product to be lighter than the idealized weight of 10 grams. Therefore, the product accomplishes the intended task while maintaining user friendliness.

Justification of Materials

Body Material

The ease of access to a 3D printer in the Interlake IB Design Tech classroom enables the cheap production of the product. Therefore, utilizing ABS (Acrylonitrile Butadiene Styrene) plastic would be the most cost-efficient solution than other materials. However, with hopes of producing an ideal product to solve the issue at hand, materials such as steel, wood, and PLA plastic were considered.

The green represents that the material met the function requirement while the red represents that the material failed to meet the function requirement.

Function Requirement	**ABS Plastic**	**Steel**	**Wood**	**PLA Plastic**
Lightweight				
Durability				
Cost-Effective				

Performance				

Optimizing for the function of mobility, the use of ABS plastic will be lightweight and provide durability. ABS plastic is famously known for its use in Lego building blocks. The combination of this and rubber will ensure that the keyboards of school laptops will not be scratched or damaged. The strength of steel was tempting to use; however, its heavy weight and sharp edges compromise the desire to create a product that does not hinder the laptop using experience. The use of wood could provide an aesthetically pleasing look and fit the weight requirements, but the need to season the wood to maintain its durability and its splinters could harm the consumer. Additionally, wood is difficult to shape which would contribute to higher production costs. PLA was a more serious consideration as it would be stronger, stiffer, and as cost-effective since the 3D printer can print the material as well but compared to ABS it lacks longevity. Its brittle nature may cause the plastic to snap, which was already a limitation of the Slot-Opening Design. Therefore, ABS plastic is the most cost friendly and ideal material to use for the body of the design.

ABS Plastic

Grip and Adhesive Material

Rubber tape is the leading candidate when finding a low cost material that will provide sliding friction while adhering to the product. Utilizing glue and rubber pieces was an initial consideration, but that would provide additional production and manufacturing costs that rubber tape does not possess.

Rubber Tape

Justification of Manufacturing

The two methods of manufacturing that were being contemplated were 3D printing and CNC cutting. The ease of access to both pieces of machinery in the Interlake High School IB Design Tech class equalizes the manufacturing prices.

The green represents that the material met the production requirement while the red represents that the material failed to meet the function requirement.

Production Requirements	**CNC Cutter**	**3D Printer**
Easy to Assemble		
Production Quality		

While both manufacturing techniques are accessible and will produce exact shapes of the product, the 3D printer will provide an easier assembly process. Since the product is one ABS plastic mold, it can be 3D printed at once instead of cutting small 2-dimensional CNC parts that would need to be fused together.

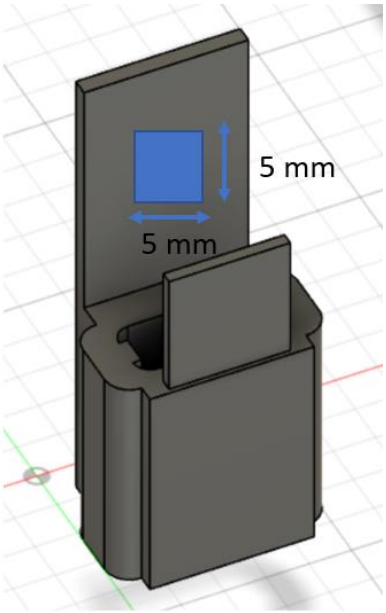
One pound of ABS plastic is typically $1.50, therefore if the product is around 10 grams, then 45 bodies for the unit could be made for less than $2.00. Adding a $13 roll of rubber tape, which is 5,588 square millimeters, will provide material for 558 units which will have 5 mm square rubber pieces on both clamps. In total, each unit of product would cost around 5 cents in materials. The cost to manufacture would include the one time costs of a laptop and 3D printer, which are free to access for the students at Interlake High School.

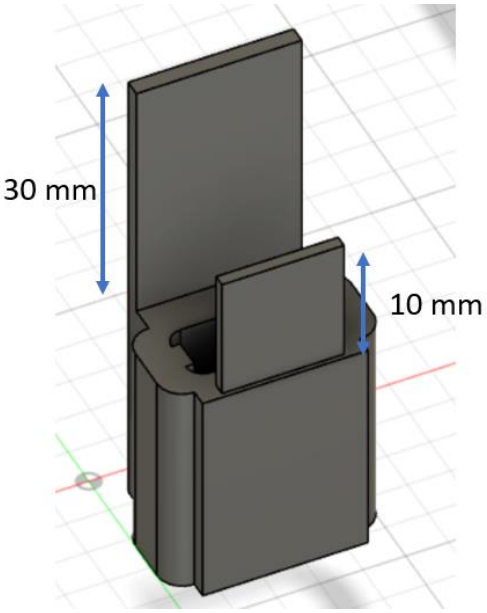
Design Proposal

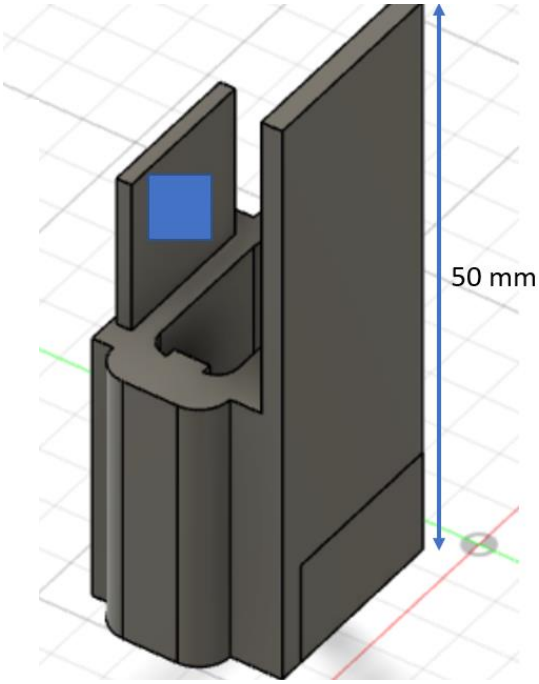
The *Charger Shield* product will be a 50 mm long, 10 mm wide and 2 mm thick, 3D printed, ABS plastic mechanism that restricts a USB C charger from being accidentally unplugged from its charging port located on the left side of a Bellevue School District issued Dell Latitude 7390 2-in-1 Laptop keyboard. The mechanism possesses a 7 mm wide and 2 mm tall rectangular opening that will enable the USB C charger to fit through without slipping out or bending. The mechanism's design contains a 30 mm long and 10 mm wide rectangular extrusion on its bottom that is 16 mm below a 15 mm long and 10 mm wide rectangular extrusion located on the top of the design. Both extrusions contain 5 mm square pieces of rubber tape that will grip to the 15 mm thickness of the laptop's keyboard. The top piece is 15 mm shorter so that the piece will not touch the key commands. After the design is printed, the rubber tape will be cut out into squares from the roll and applied onto the sides of the rectangular extrusions that face each other.

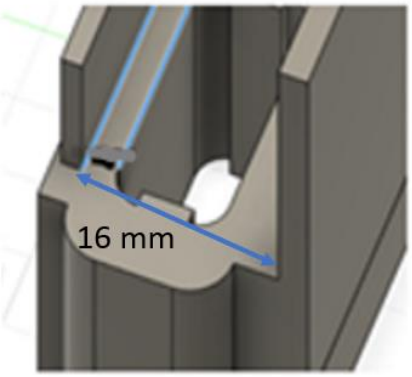
The computer-aided design software, Fusion 360, will be utilized to communicate the 3-dimensional shape to the printer.

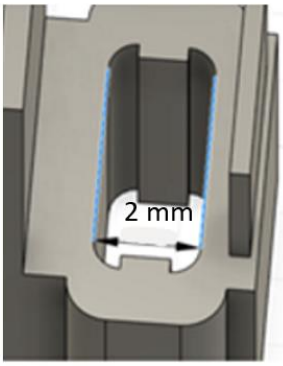
Computer Aided Design Blueprints

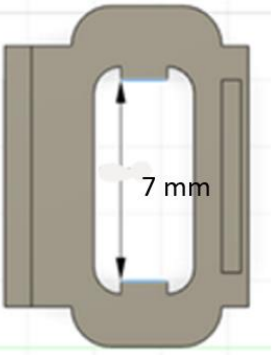










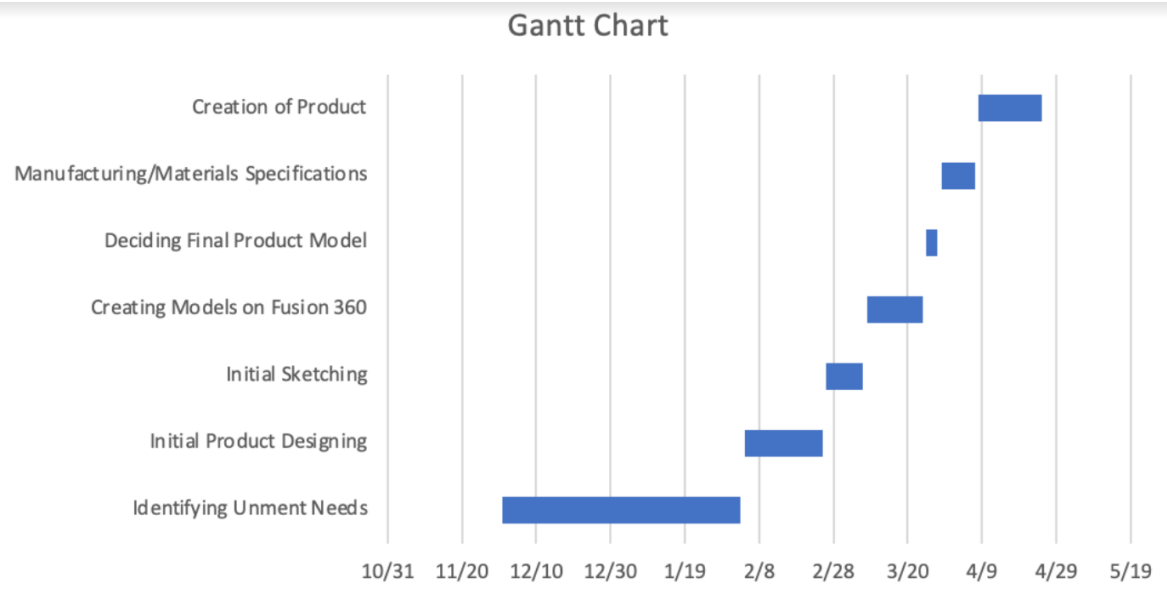


Risk Assessment

When creating a product that is trying to fulfill unmet needs, there is a risk that the consumer may still not use it. However, in this scenario my group has faced the problem of chargers constantly being broken and unplugged by accident as people trip over them. Therefore, we intended to target the very demographic that we were a part of: Interlake High School students. We decided to keep the manufacturing as simple as possible so that students can easily utilize its purpose. Therefore, our product only requires 3D printing and rubber tape. The risk and safety considerations when manufacturing this product would come with the 3D printing process. This is if the print fails, or if strands of plastic add a millimeter to the thickness of our design. Especially since our design is small, a millimeter difference would be noticeable. This could cause a user's laptop to be elevated more than they please, creating a worse laptop using experience. However, the purpose of a 3D printer is to precisely print the design that it is communicated and like any machine, it does possess a slight risk of failure.

Gantt Chart

The chart below represents our product's design schedule. Since December of 2021, we have been constantly working on various designs. Throughout the school year we have been brainstorming unmet needs to solve, concept modelling, and idea mapping. Below is a chart of the time periods of my group's design process.



Flow Chart

The chart below represents a summary of my group's brainstorming process to fulfill an unmet need. When tasked with this challenge, we looked for niche markets that were facing difficulties with aspects of their day-to-day functions. From our list of ideas, we then brainstormed the feasibility of transitioning the concepts to reality.