# ARVIND VINODH

MECHANICAL ENGINEERING AT THE UNIVERSITY OF WATERLOO

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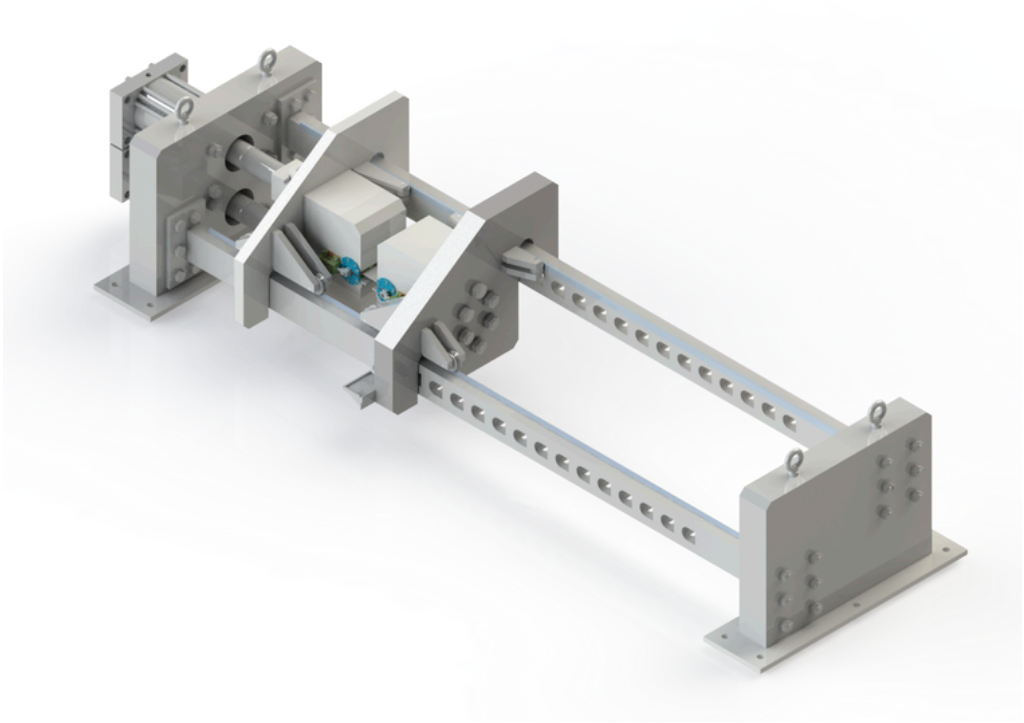
## STRETCH LEVELER QUAD



### Goals

- A stretch leveler is an equipment used in the steel industry that stretches steel plates beyond its point of elesticity to **eliminate internal stresses** resulting in superior flatness and consistency for downstream fabrication.
- A custom stretch leveler had to be designed with a **fixed cylinder stroke length** (due to space limitations) that can accomodate steel plates from 1ft -10ft in length.

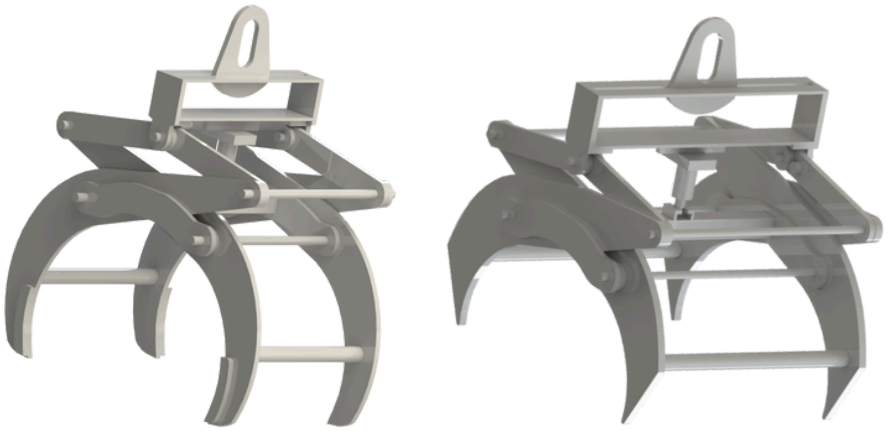
### Methods

- Initially **stretch force** calculations were done to figure out the necessary cylinder bore and rod diameter.
- A novel design was chosen which involved **two self-locking grippers**. One was attached to two 14" bore cylinders and the other would be stationary. The second gripper would be locked in its place using steel blocks which sits in slots along the 2 main load carrying beams.
- To accommodate **varying lengths**, the stationary gripper would move using **track rollers** that is guided by the beams. Electric motors would power the rollers.
- **Buckling analysis** was done on the beams to ensure the stretch force from the cylinders would not cause excessive deformation. **FEA** of the stationary gripper plate was necessary to optimize the design such that stress concentrations would be within acceptable levels.
- The full assembly was modelled in **Inventor**

### Results

- The 2 beam design allowed the plates to be easily loaded from the side or from the top contrary to the traditional 4 cylidrical rod design which caused difficulty in side loading
- The design was a success and is currently in the process of detail design for **production**

## LIFTING TONGS QUAD



**Goals**

- **Titanium rolls** needs to be **cleaned** to remove contaminants before they can be used for milling, welding, joining etc. This requires it to be placed in a **brine spraying station**. Heavy lifiting tongs are required to place and remove the rolls from the machine.
- 3D models of the tongs had to be created from basic drawings to perform **interference check** in the spray station assembly

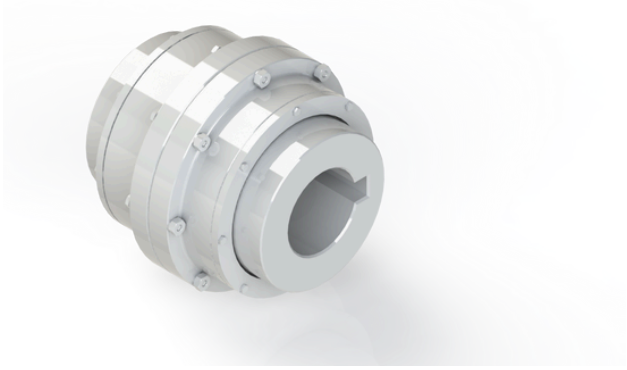
**Methods**

- Used **Inventor** to create a functional assembly model that can be used to check with **different titanium roll sizes**
- Two different types of tongs were made to accommodate **different lengths** of rolls

**Results**

- The tongs were successfully used by the process team to analyze the **clearances** available and necesssary modifications were done

## GEAR COUPLING QUAD



**Goals**

- A new gear coupling was to be drafted and modeled that would connect the **motors** to the **rollers** of a rolling mill. The shaft from the motor has a **different diameter** compared to the roller shaft which necessitates the need for this gear coupling.

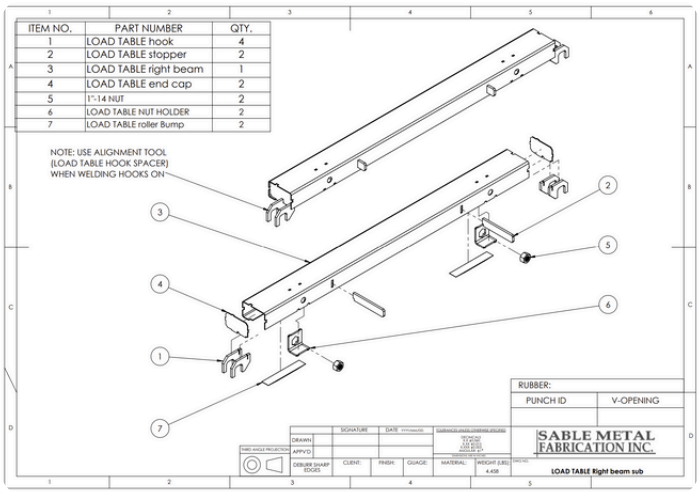
**Methods**

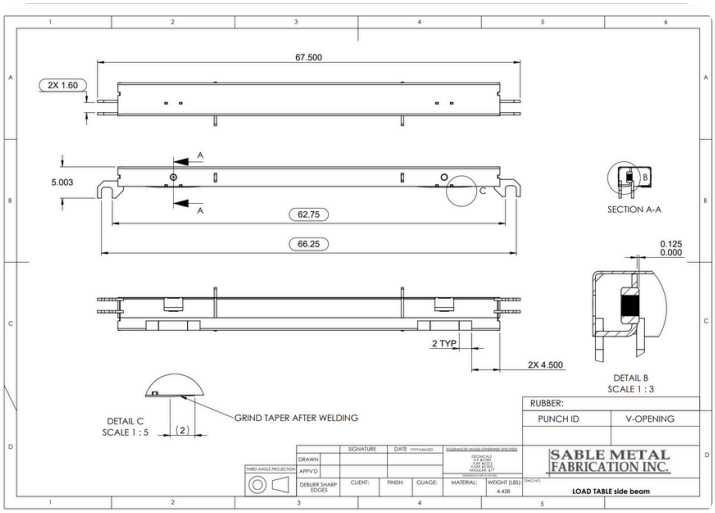
- The coupling was drafted in **AutoCAD** and this drawing was used to create a precise model of the coupling in **Inventor**

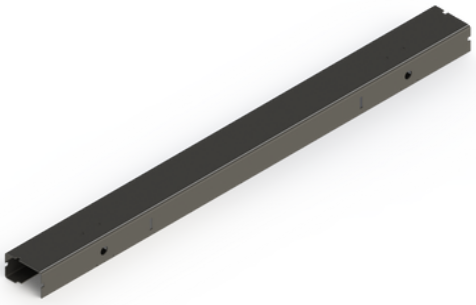
**Results**

- The drafted drawing was used to calculate the **dimensions** of a **spacer** that would be necessary during **installation**
- The new assembly model updated the old coupling in the main roller assembly

# LASER LOAD TABLE



## Goals

- Modify existing laser cutter **loading table** design to ensure proper fit of the table in the automated loading station
- Enable production of multiple tables **without** the need for post-fabrication adjustments by **grinding/welding**

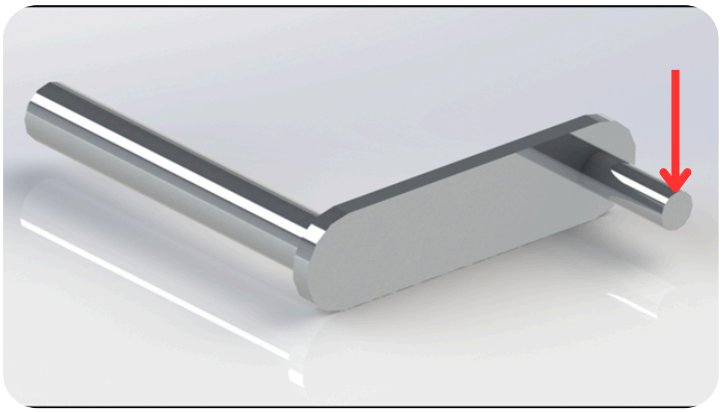
## Methods

- Used **SolidWorks** to ensure all the parts fit together without any interferences
- **Vernier calipers** were used to compare dimensions with factory built loading tables and make changes to drawings where necessary
- Communicated with welders about **critical dimensions** to be taken care while welding

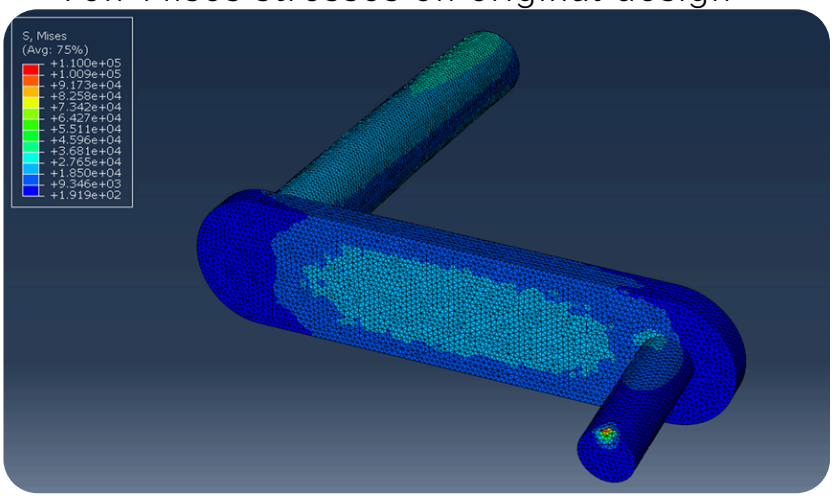
## Results

- The loading table worked perfectly with a proper fit in the automatic loading station with **greater ease** of movement within the system compared to previous build
- This design provides a foundation design which can be used to manufacture **multiple tables** at once

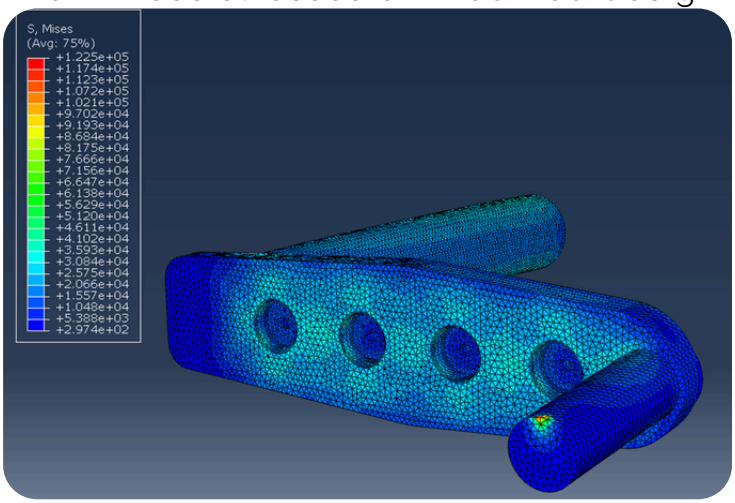
# CRANK OPTIMIZATION



Von-Mises stresses on original design




Von-Mises stresses on modified design




## Goals

- Find the **maximum point load** that can be applied on the Aluminum crank (red arrow) with the long rod considered to be fixed
- Optimize the design to **reduce** the **mass** without changing its load carrying capacity

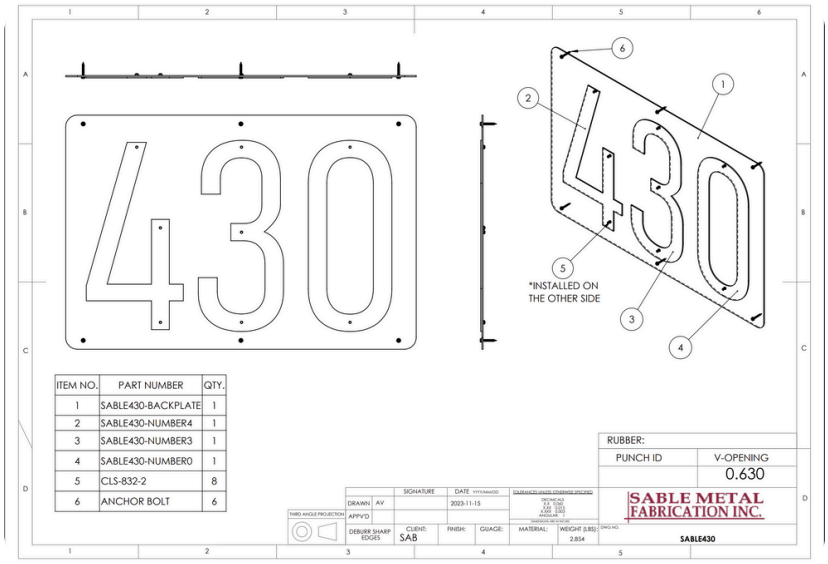
## Methods

- Used **SolidWorks** to model the crank
- Used **Abaqus** to mesh the model, create the load and boundary conditions and visualize the results
- Increasing loads were applied until a certain area observed **von-mises** stresses **greater** than the **yielding** stress
- Careful reduction in material was done in areas with **lesser von-mises** stresses

## Results

- The maximum force was found to be **208lb**
- A **11%** reduction in overall mass was achieved by creating a triangular top and bottom, and holes with a depth of half the thickness

# BUILDING NUMBER SIGN






## Goals

- Design and manufacture a building number sign that needs to be mounted on the outside wall
- Needs to be clear enough to be seen from the road

## Methods

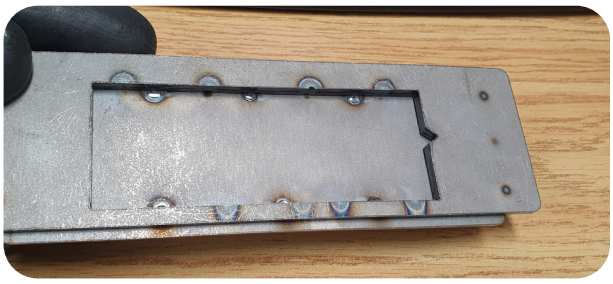
- Used **SolidWorks** to create separate numbers with a **legible font** in sheet metal
- The numbers are then mounted onto a backplate using **PEM flush head studs** for sheet metal
- The backplate is placed onto the wall using **anchor bolts**

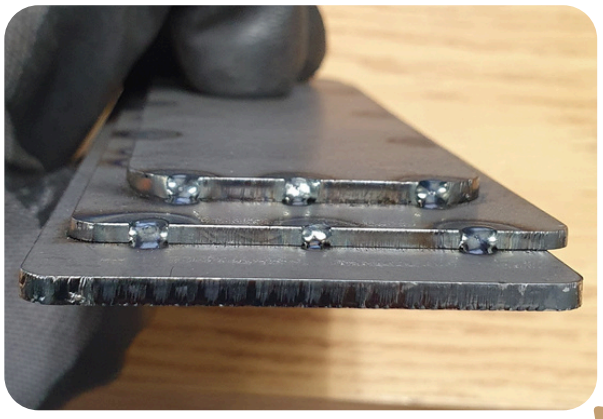
## Results

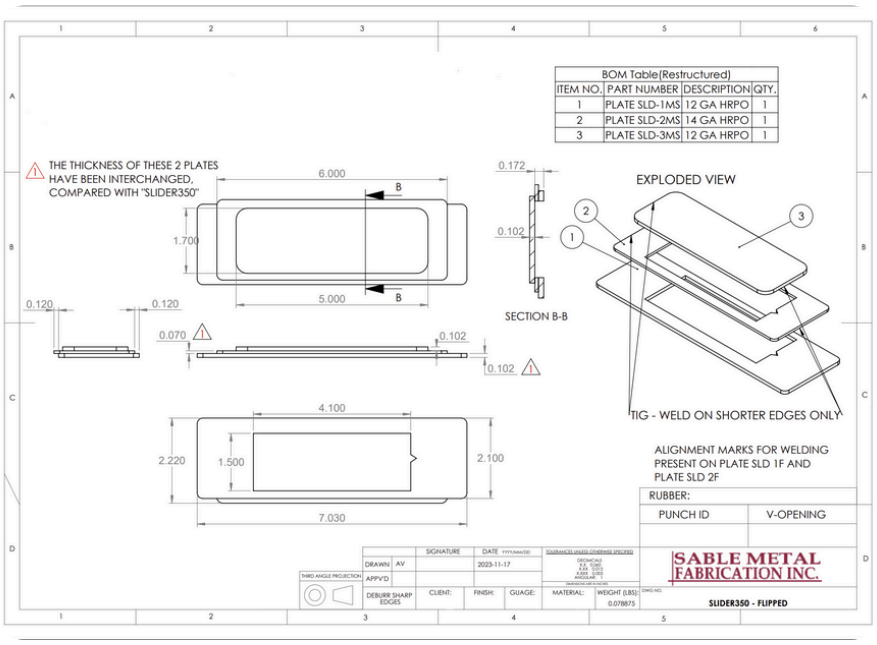
- The building sign was a success due to its ease of installation and stylistic design

# DOOR CLOSER - INTERNAL COMPONENT

SABLE

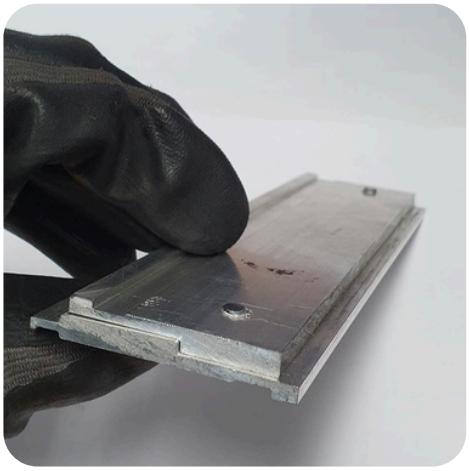







New Design

Old Design



## Goals

- Redesign an existing **internal component** of a door closer to be manufactured using sheet metal
- Ensure the part can **slide** through the aluminum extrusion
- Fabricate a **prototype** to show proof of concept

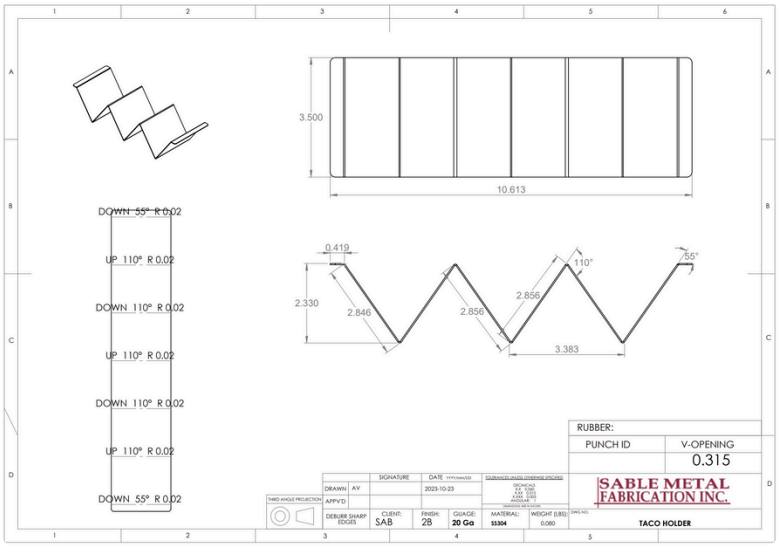
## Methods

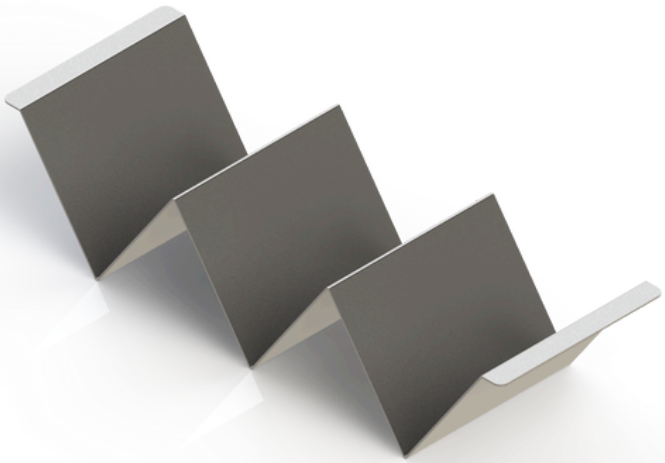
- Used **SolidWorks** sheet metal to design 3 separate mild steel plates with **specfic thickness** to ensure the part fits in the slots of the extrusion
- The 3 plates are **TIG welded** on the shorted edges and in the inside cavity
- The weld was performed by carefully ensuring that the plates **do not bend** during welding, which can severely effect the sliding motion

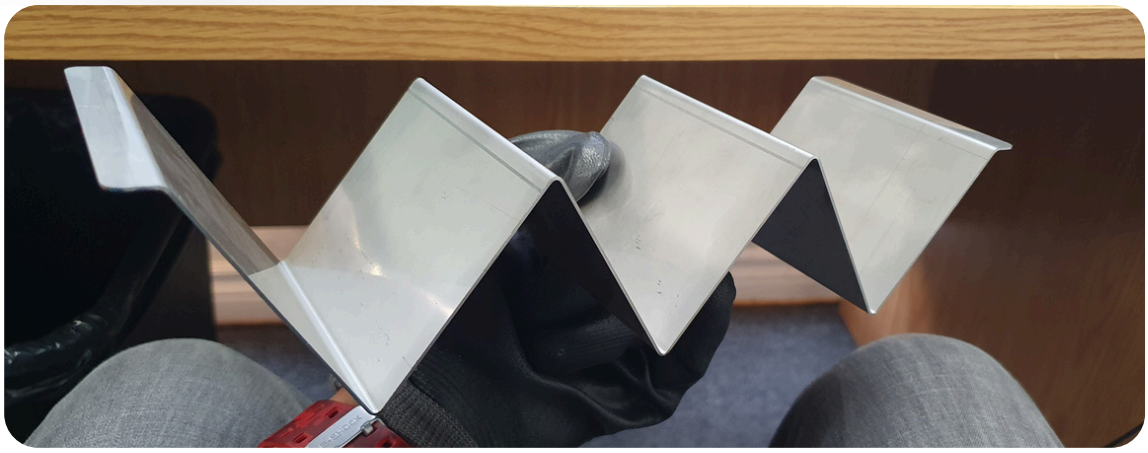
## Results

- The prototype was able to perform the sliding motion as intended with **sufficient friction** between it and the extrusion, to prevent the part from sliding on its own
- Incorporation of **welding consideration** in the design of the parts such as laser engravings for alignment, tab cutout for more accurate alignment made welding easier and more accurate

# TACO HOLDER





## Goals

- To model and manufacture a taco holder from a picture of an existing one
- Must be able to hold **3 tacos**
- **Safe** for children to handle

## Methods

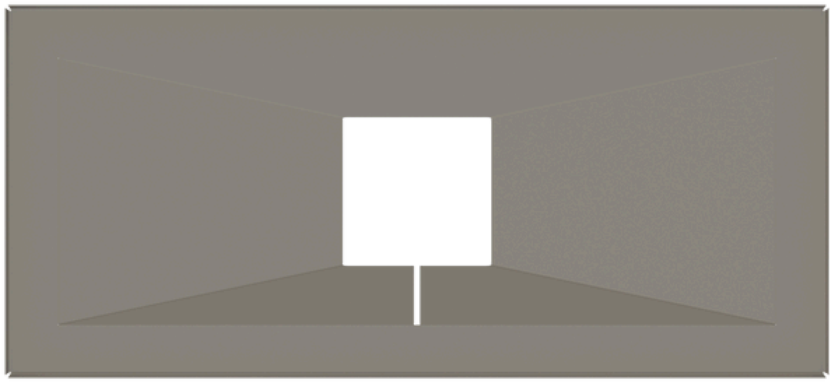
- Designed the part in **SolidWorks** by calculating required **bend angles** using geometry from known angles
- Manufactured in-house

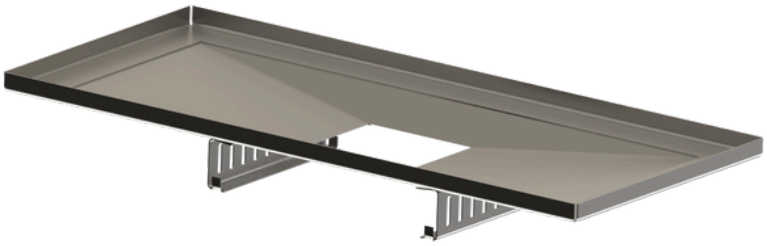
## Results

- The taco holder was able to be **fabricated easily** without any problems with the multiple bends and met all necessary requirements

# BARBECUE GREASE TRAY

SABLE





## Goals

- Design a barbecue grease tray using sheet metal by **reverese engineering** an old rusted grease tray
- **Minimize** the number of separate parts that need to be welded

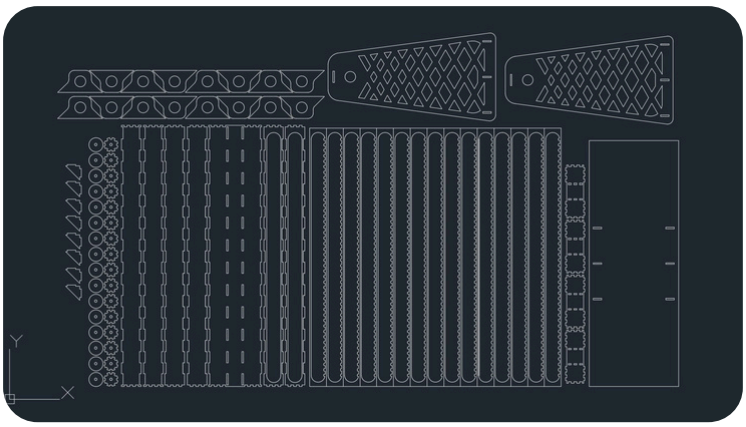
## Methods

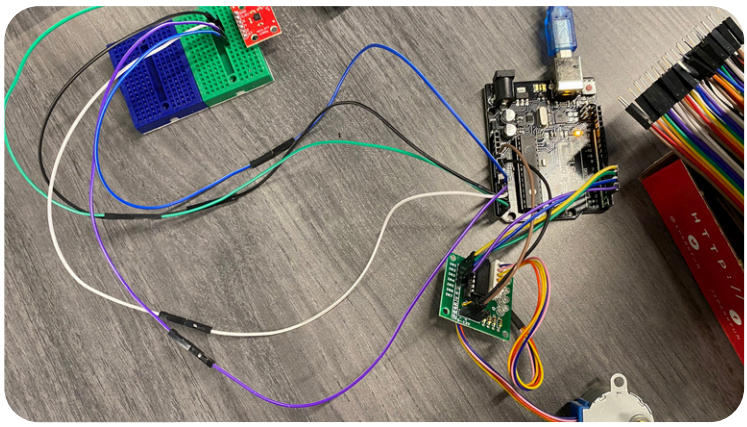
- Used **SolidWorks** sheet metal to design **4 separate parts**: Tray, Frame and two Sliding Racks
- Took accurate measurements of old grease tray using **vernier caliper** and **protractor**

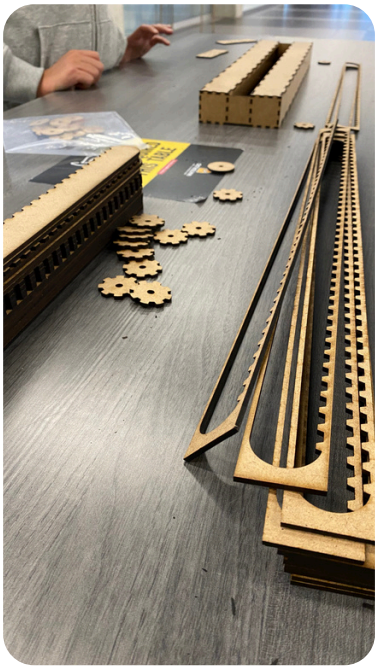
## Results

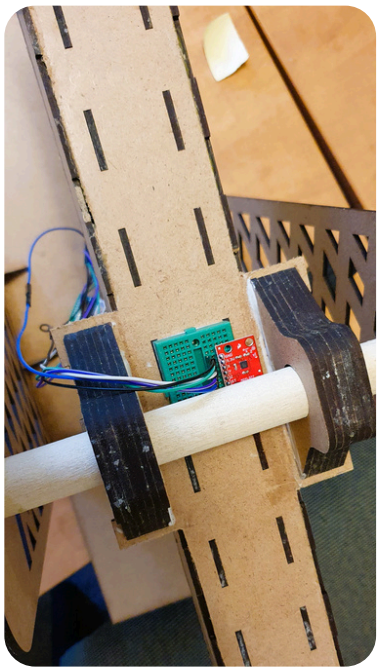
- The design met all expectations and the reduced number of parts needing welding, **decreased risks** of problems with fitting

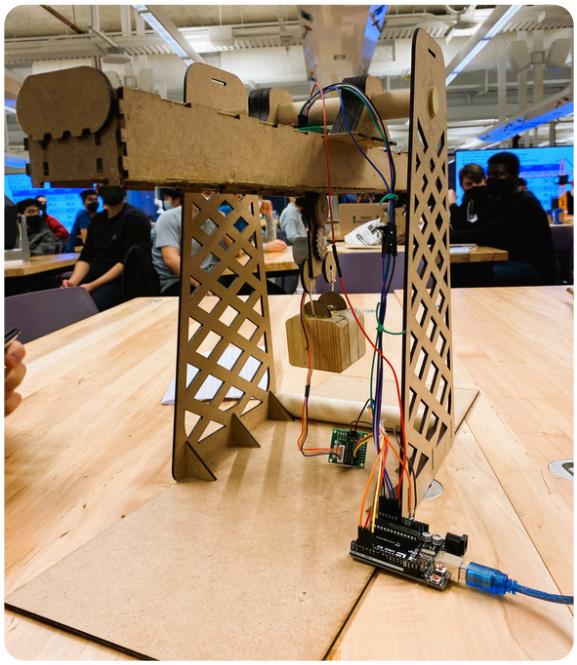
# BALANCE MONKEY TOY











## Goals

- Design and prototype a toy whose main goal is to balance the beam by using pieces of wood, while the monkey moves and unbalances it
- Primarily responsible for all the electronics used in this project
- Designed few of the CAD drawings
- Was one of two members who was tasked with assembling the different components and final refinements

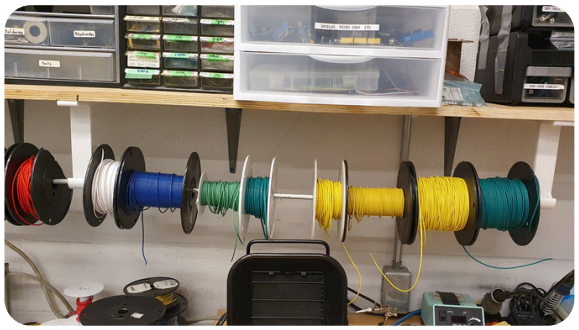
## Methods

- Used **AutoCAD** to design the side supports which were then laser cutted
- Used **Arduino** to control stepper motors and an accelerometer to check balance
- The monkey (woodblock) moves by a rack and pinion system

## Results

- The toy was a success resulting in our team being one of the few teams having a successfully completed prototype
- It can be further improved by implementing better cable management, using more powerful DC motors

## WIRE SPOOL RACK UWAFT



**Goals**

- Design a new wire spool rack for the UWAFT Vehicle Garage that enables easier access and replacement of spools when needed

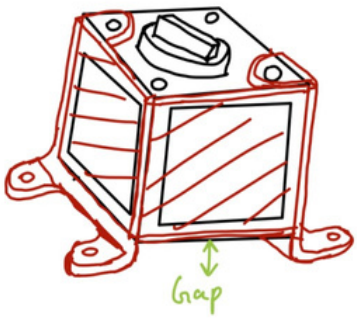
**Methods**

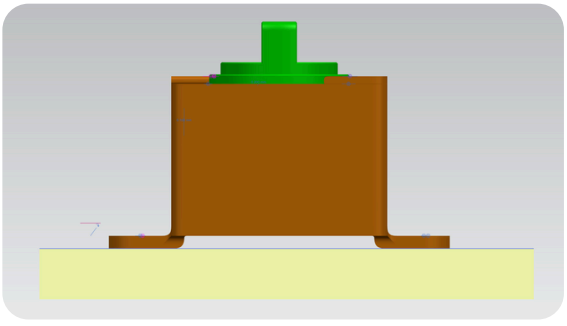
- Used **SolidWorks** to model the individual hooks for the rack
- A SolidWorks Assembly was made to check the fit of all the components
- Hooks were 3D printed in PLA using an in-house Ender 3 printer
- Aluminum rod was passed through the spools to hold it in place

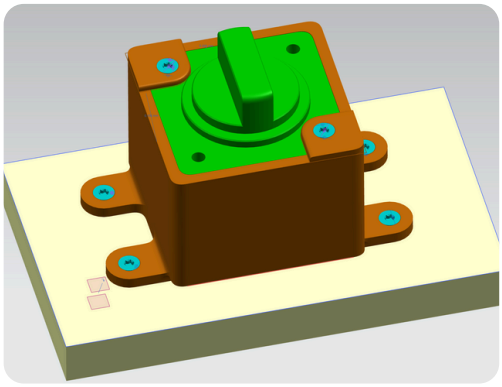
**Results**

- This design allows the Aluminum rod to be lifted from the support hooks easily when the spools need to be replaced
- Spools can be spun about the rod when wire needs to be taken for use
- Storing wire spools in such a way keeps them organized

## SWITCH MOUNT UWAFT





**Goals**

- Being a University of Waterloo EcoCAR Team (UWAFT) member, I was asked to design a mount for a switch as part of a CAD challenge
- The mount must enclose the open panels
- Should be able to manufacture it in a cost efficient way.

**Methods**

- Used **Siemens NX** to model the mount
- Suggested **3D printing** as the best way to manufacture this enclosure

**Results**

- Provided a solution that offered good structural support while at the same time minimized screw usage