Mechanical Engineering Design Portfolio

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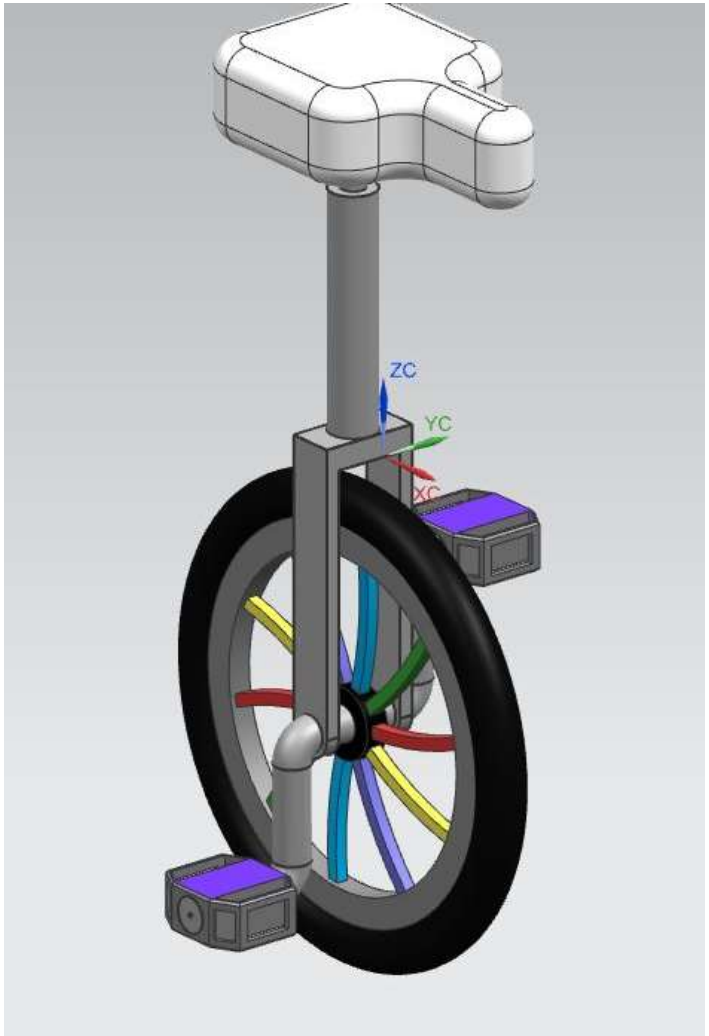
Welcome, and thank you for taking the time to view my portfolio. The goal of this portfolio is to give you a deeper insight into my experiences and skills I have gained over my recent history.

It is my hope that this will allow you to better assess how my skills can be applied to your company.

I would be happy to talk in more detail and can be reached using the contact information on the previous page.

Project 1

Unicycle Project



- Role: Mechanical Design and Manufacturing Student
- Date: April 2019 – June 2019
- Skills: Mechanical Design, CAD (Siemens NX)

Unicycle Project

- Aim: You are a chief designer of a sports equipment company. Your company is planning to present a concept design of its next generation unicycle next month. You are asked to design a new wheel, seat and pedals and finally assemble them into a unicycle.

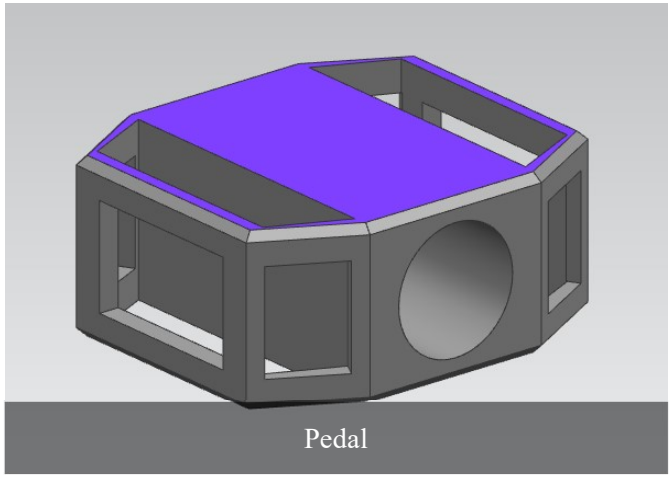
  Requirements:

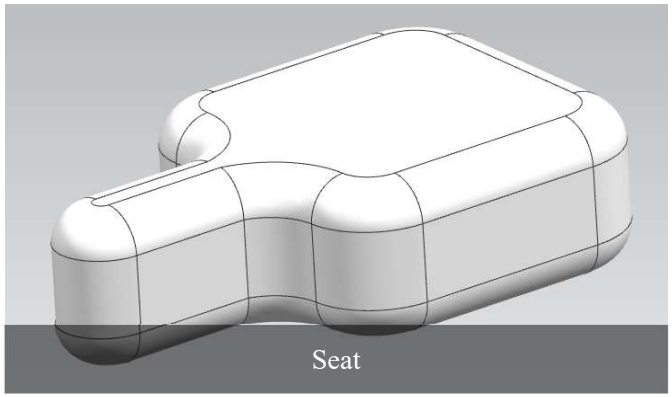
  1. All part files must be a single solid body
  2. All sketches/drawings must be fully defined
  3. Assemblies must have degrees of freedom corresponding to real world conditions
  4. Style is important. Parts must be practical have a color assigned, other than the default

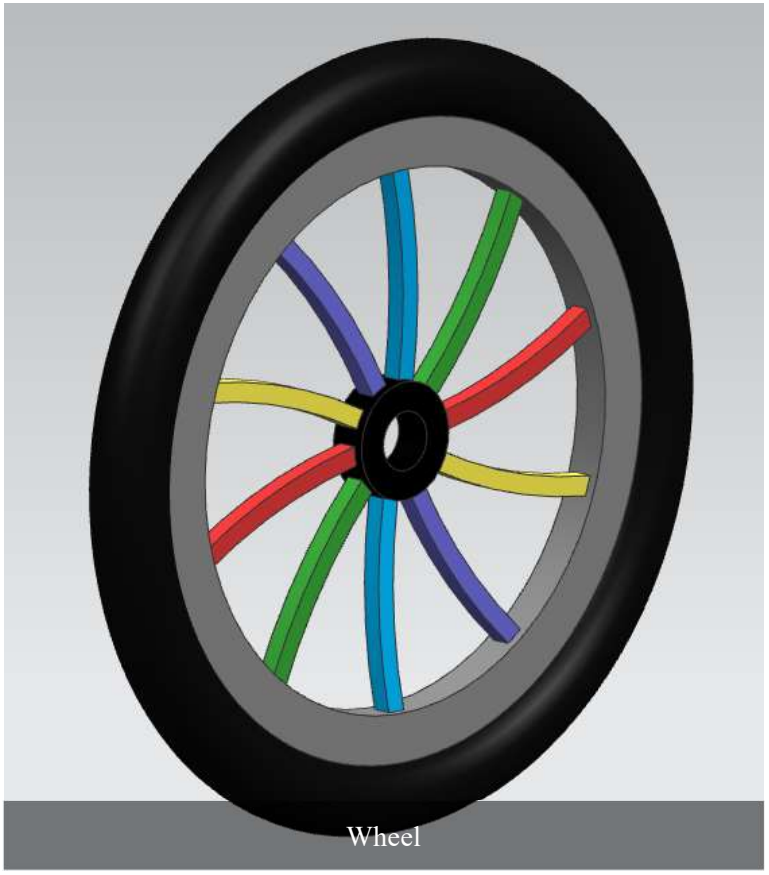
- Result: Modeled three different aspects of a unicycle and then combined them all into an assembly which obeyed real world conditions

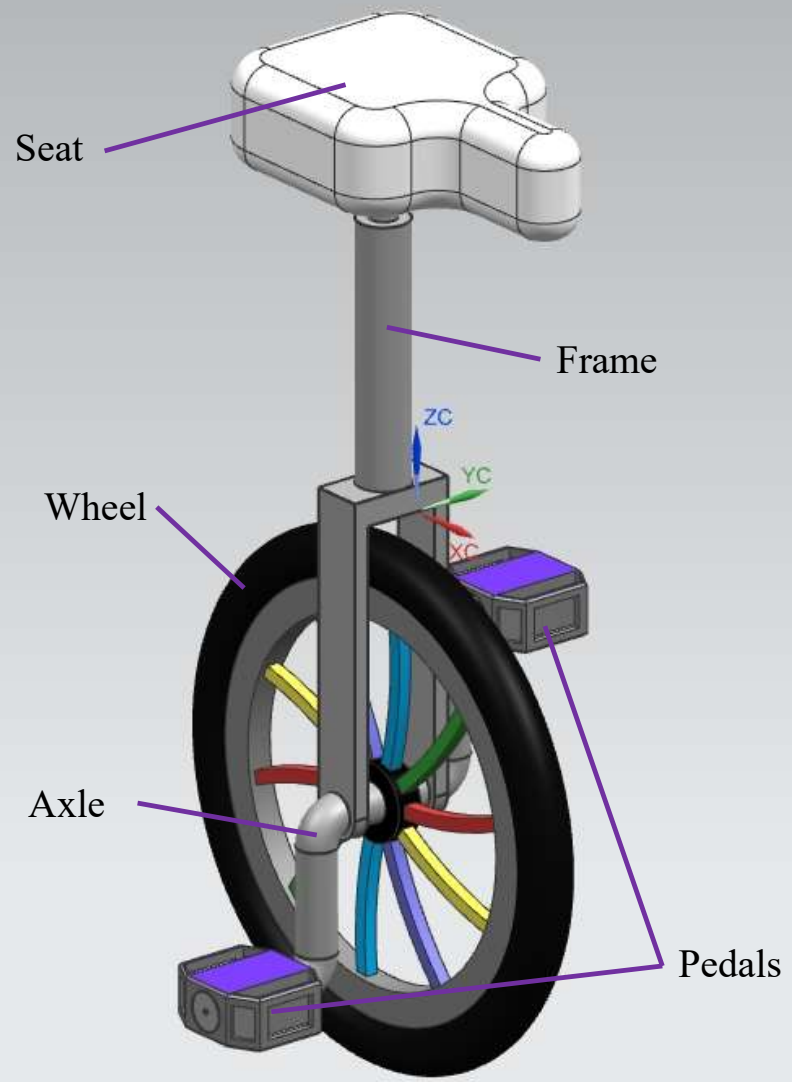
Unicycle Project

Part Files


Pedal


Seat


Wheel



Unicycle Project

- Full CAD Assembly with:
  - Seat
  - Axle
  - Frame
  - Pedals
  - Wheel

Project 2

Bike Project

Role: Personal Project

Date: July 2021

Skills: Mechanical Design, CAD (SOLIDWORKS)

Bike Project

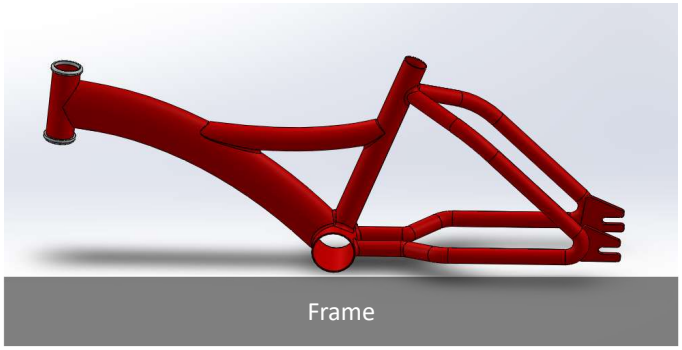
- Aim: Prove how my CAD skills have improved since my first introduction to CAD in the Unicycle Project

- Result: Successfully designed 8 different bicycle parts and combined them into a single assembly with accurate degrees of freedom

Bike Project

Part Files

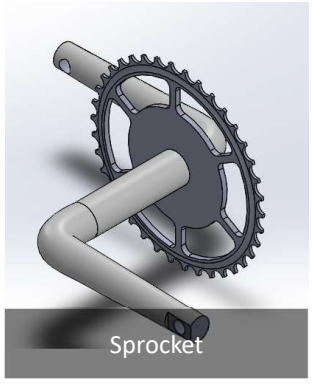

Steering Fork


Frame

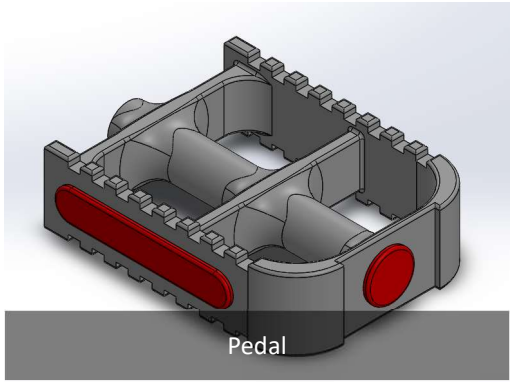

Rear Wheel


Front Wheel


Seat


Sprocket


Chain


Pedal

Bicycle Project

Full CAD Assembly with:

- Front Wheel
- Rear Wheel
- Steering Fork
- Frame
- Pedals
- Seat
- Sprocket
- Chain

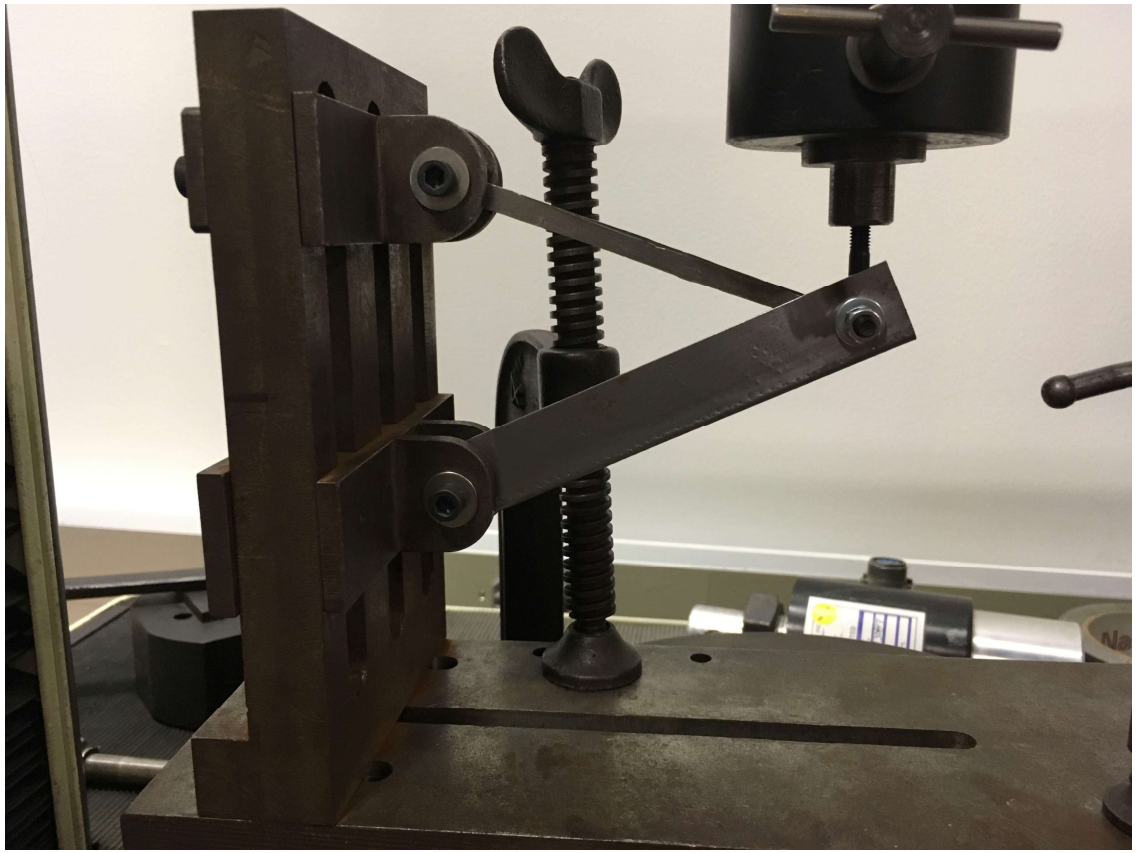
Project 3

Mechanical Bracket Project

Role: Mechanical Design and Manufacturing Student

Date: April 2019 – June 2019

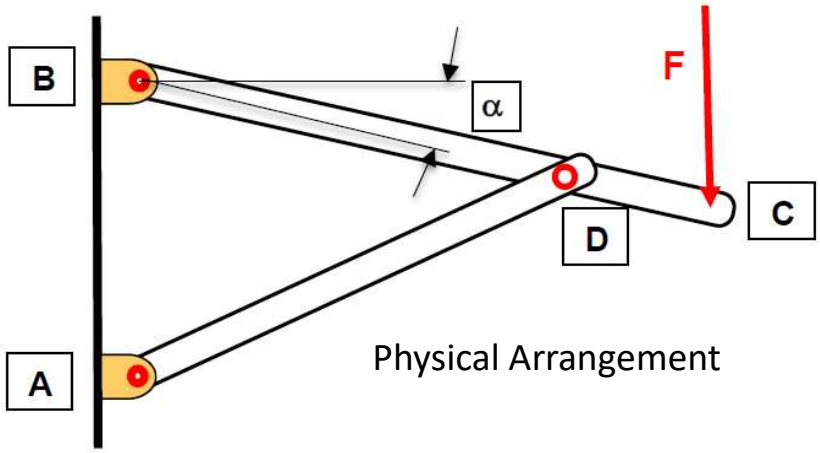
Skills: Mechanical Design, CAD (Siemens NX), Manufacturing, GD&T, Strength of Materials



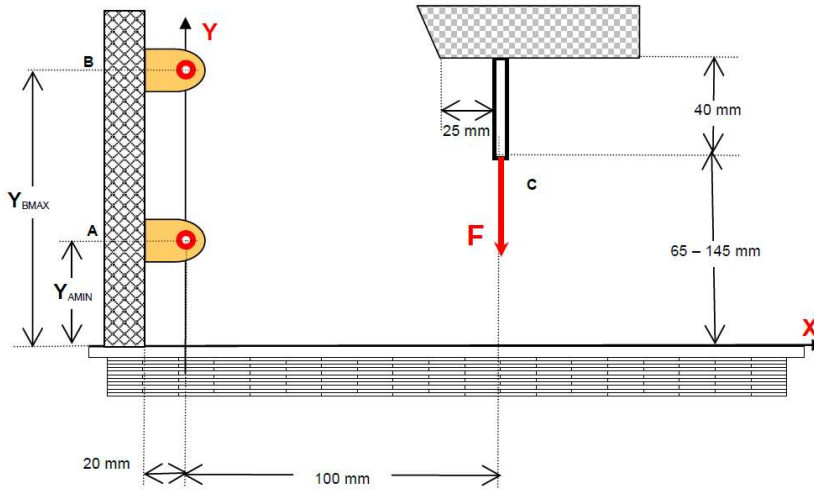
Mechanical Bracket Project

- Aim: Design a sheet-metal bracket/truss to support a steady downward acting load of F = 1,500 ~ 1,800 N at point C. It will be fixed at points A and B with pins to the corresponding supports. The bracket/truss must consist of two separate members AC and BD, suitably joined at point D, where joint D should be a pin connection. The choice of the shape and material of the members and the location of the point at which they are joined, point D, is your design decision. The inclination angle of member BC must be at least equal to $\alpha = 15°$.

- Result: Successfully designed a sheet-metal bracket with the correct geometry to support the necessary weight



Physical Arrangement

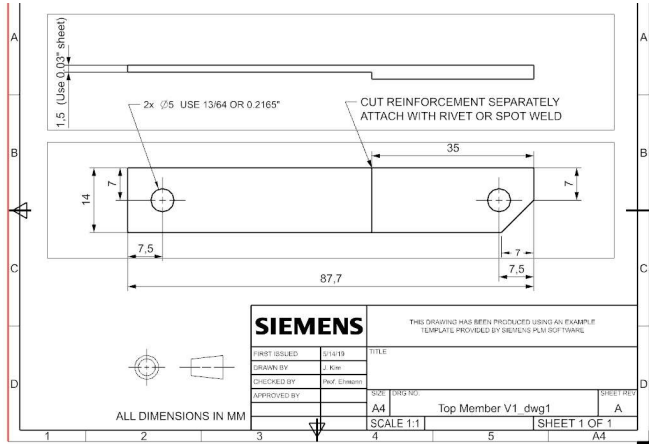


Load Application and Restraints

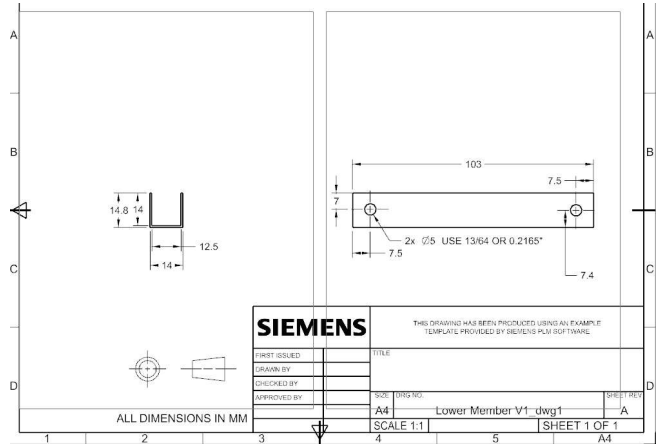
Version 1

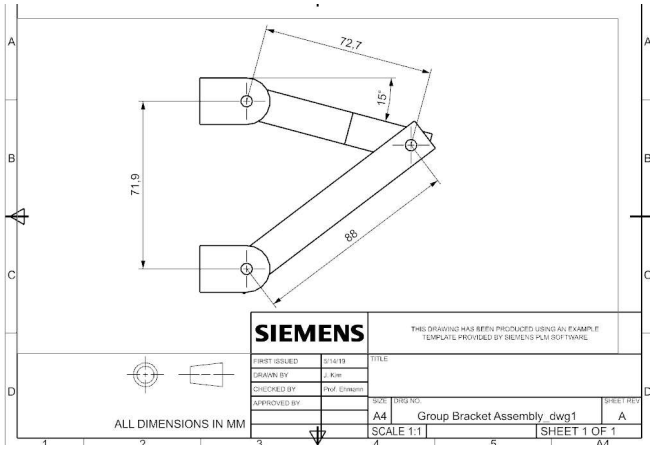
- Design consists of one, flat top member and a U-shaped bottom member.
- Attachment point at end to eliminate bending in the top member
- Top member designed to be a flat beam because it only experiences tension stress
- The bottom member utilizes a U-shape to prevent buckling under the compressive load.
- The result of the loading test was a bolt hole tearout in which the pin connection of the top member could not support the load given by the testing machine

Top Member Drawing



Bottom Member Drawing

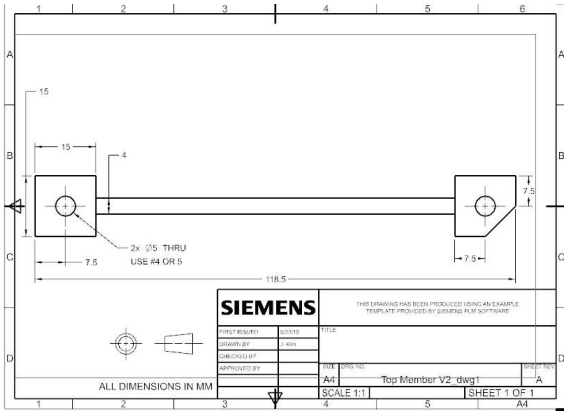




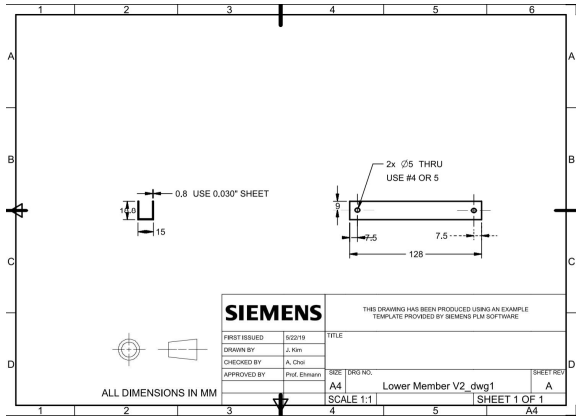
Assembly Drawing

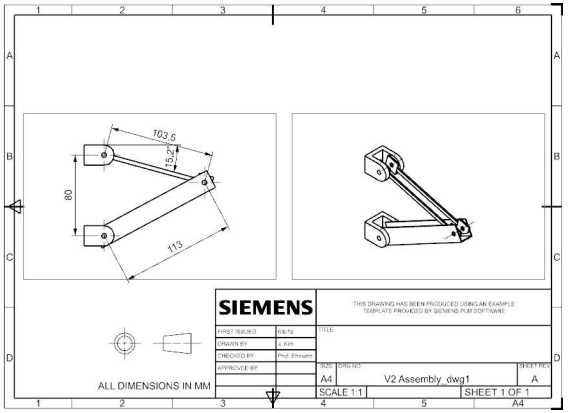
Testing Results

Top Member Drawing



Bottom Member Drawing





Assembly Drawing

Testing Results

Version 2

- Design consists of two top, flat beam members to make sure there was no bending moment in the bottom member.
- Strengthened the overall bracket, especially the point where the bracket failed during the first test.
- Area around the holes was increased to improve the strength of the pin supports.
- The result of the loading test was that the bracket was only slightly deformed as seen in the bottom right
- There was no obvious visible deformation in either of the top pieces, and it's clear the addition of the second top piece mitigated loads at the top bolt holes to prevent failure and tearout there.
- Version 1 problem was solved, and the bracket was able to fully support the load

Project 4

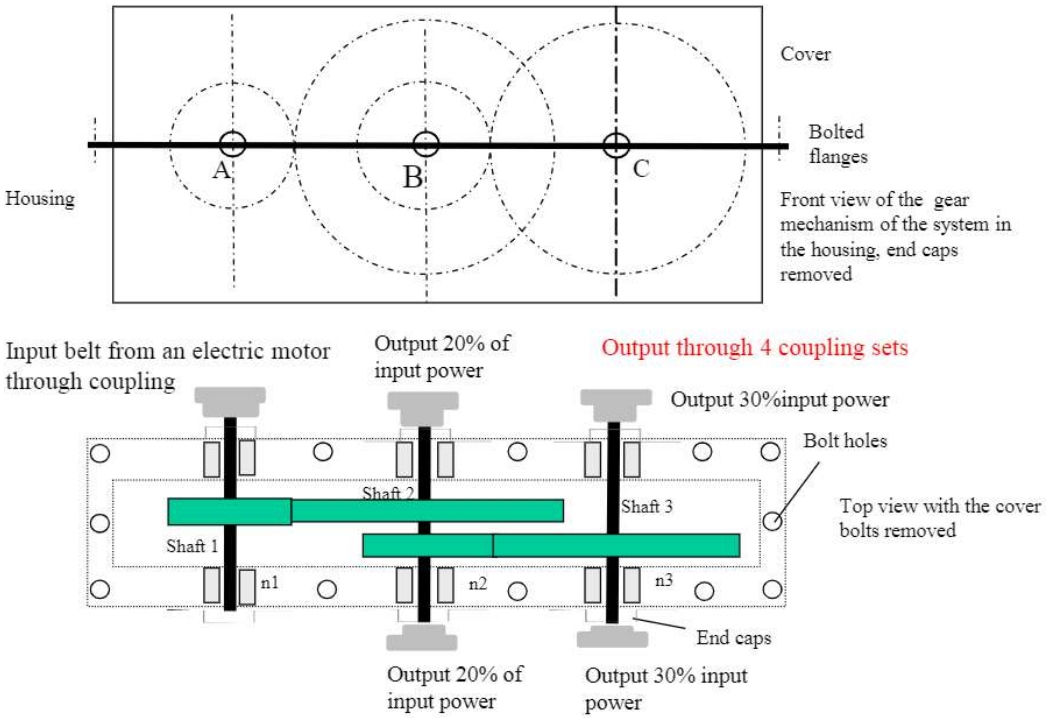
Gear Box Design

- Role: Mechanical Design and Manufacturing Student
- Date: April 2019 – June 2019
- Skills: Mechanical Design, CAD (Siemens NX), Manufacturing, GD&T, Strength of Materials

Gear Box Design

- Aim: Design the three-shaft gear-train system in a housing separated at the plane of shaft centerlines. The transmission is expected to work for at least 5 years (5 days a week, 52weeks a year, and 8 hours a day)

- Result: Successfully designed one shaft of a complete three-stage gear box including the assembly and part drawings and analyzed the safety of the overall system



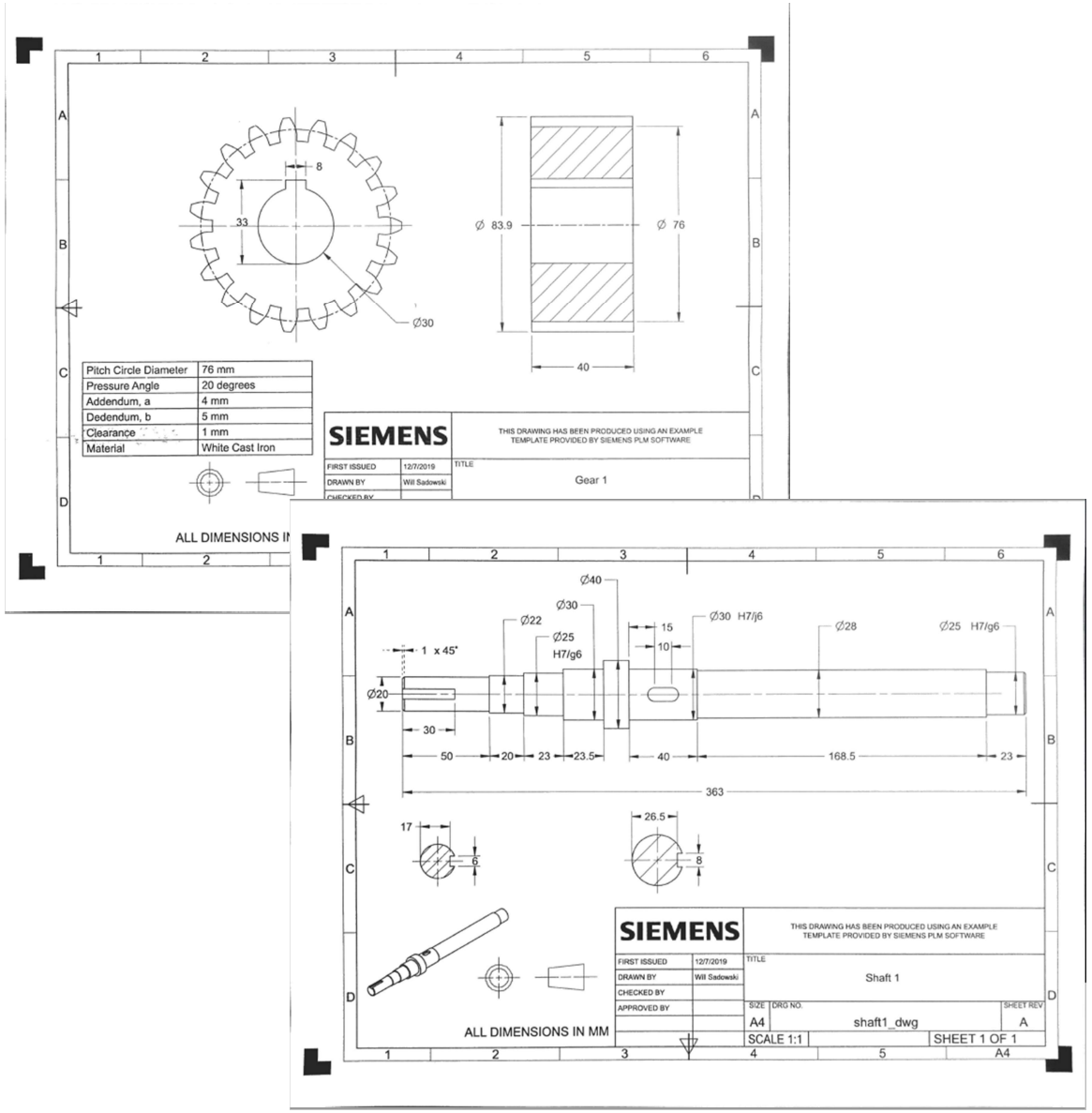
Part Drawings

Gear Parameters

Speed	**Module**	**No. of Teeth**	**Pressure angle (°)**
2800 rpm	4 mm	19 teeth	20
Face width	**Addendum**	**Dedendum**	**Tooth depth**
40 mm	4 mm	5 mm	9 mm
Clearance	**Pitch Cir Dia**	**Base Cir Dia**	**Material**
1 mm	76 mm	71.4 mm	White Cast Iron
Transmission Error	**Center Dis**	**Safety Factors**	**Hardness (HB)**
0	150 mm	$n_b = 3.29$ $n_c = 1.72$	528

Shaft Parameters

Material	**Crit X-sec**	**Factors of Safety**	**Life Exp**
AISI 1080 Steel	C, at Gear 1	ns = 2.11 (fatigue) ns = 5.05 (yield)	5 years



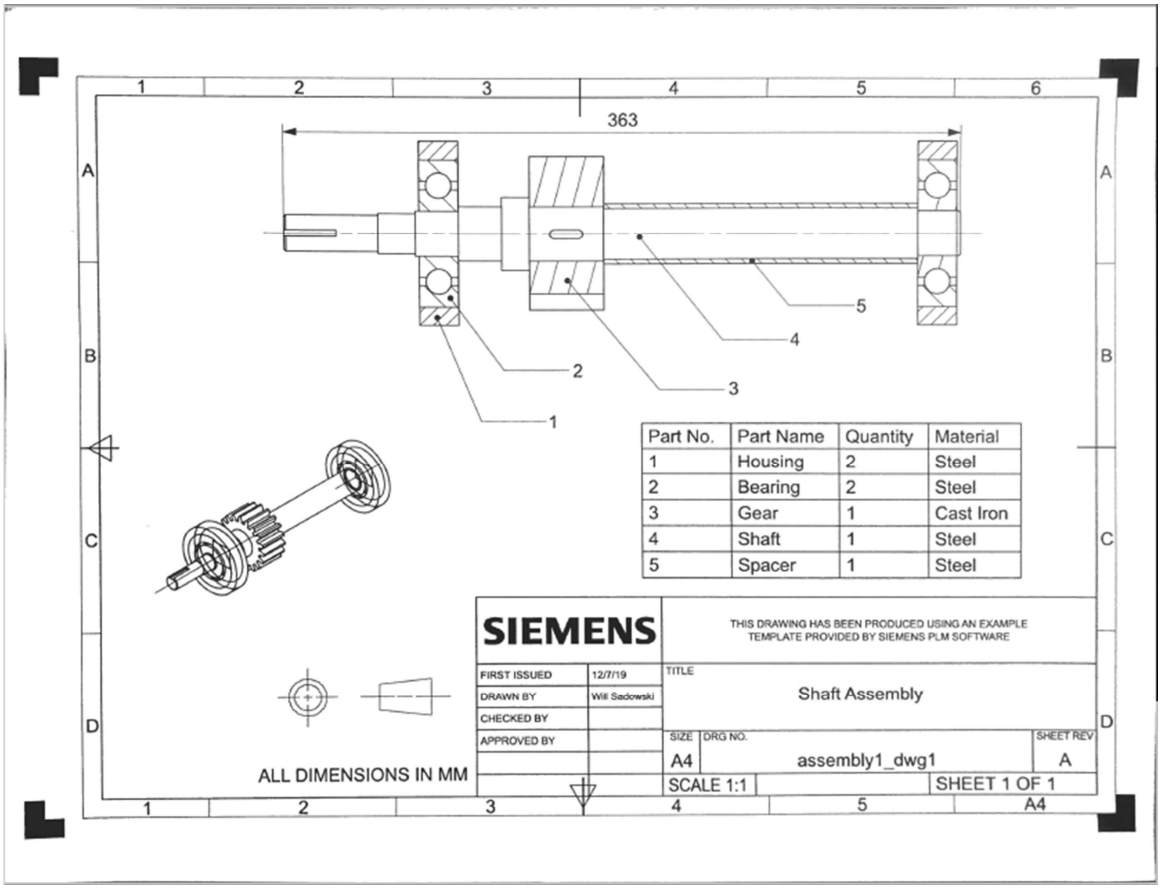
Assembly Drawing

Bearing Parameters

Bearing Set	**Bearing Designation**	**Inside Diameter**	**Outside Diameter**	**Width**
1	SKF 6405	25 mm	80 mm	21 mm
	C	**C_0**	**L_{10} life**	**Service Change Necessary?**
1	35800 N	19300 N	1747.2 millions of cycles	No

Transmission Parameters

Overall Safety Factor	Expected Life	Maintenance Needs
n_s= 1.15	5 years	None



Capstone Project

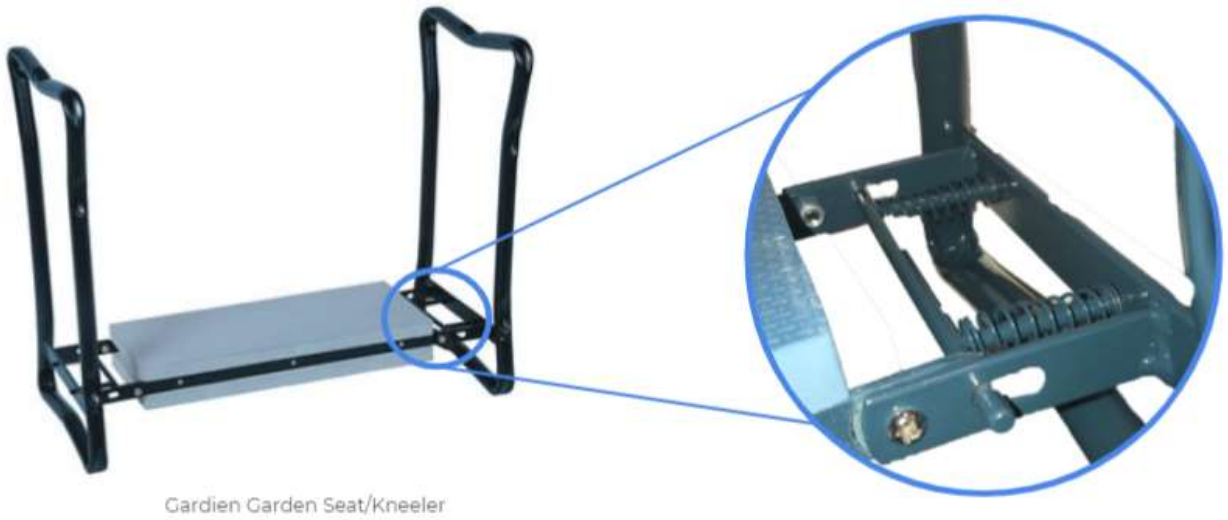
Garden Seat/Kneeler Re-Design

Role: Project Manager and Safety Lead

Date: September 2020 – March 2021

Skills: Mechanical Design, CAD (SOLIDWORKS & Siemens NX), Research, Prototyping, Manufacturing, FEA

Project Background



Gardien Garden Seat/Kneeler

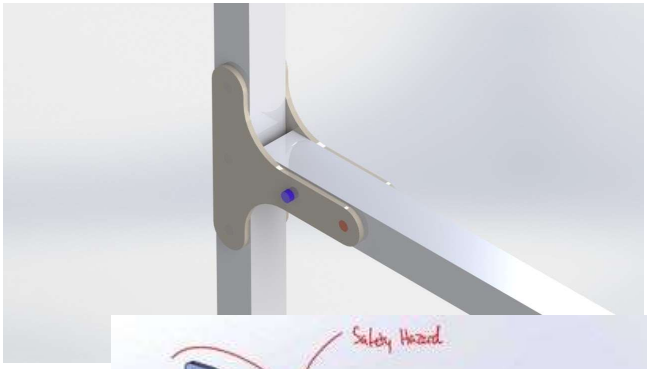
- Aim: Improve the design of the *Gardien* Garden Seat/Kneeler to assist users of advanced age in continuing to garden in a safe and comfortable manner. The current issue with this device is its wobbliness and overall poor stability, which comes from the highlighted section of the folding and locking mechanism, shown to the left

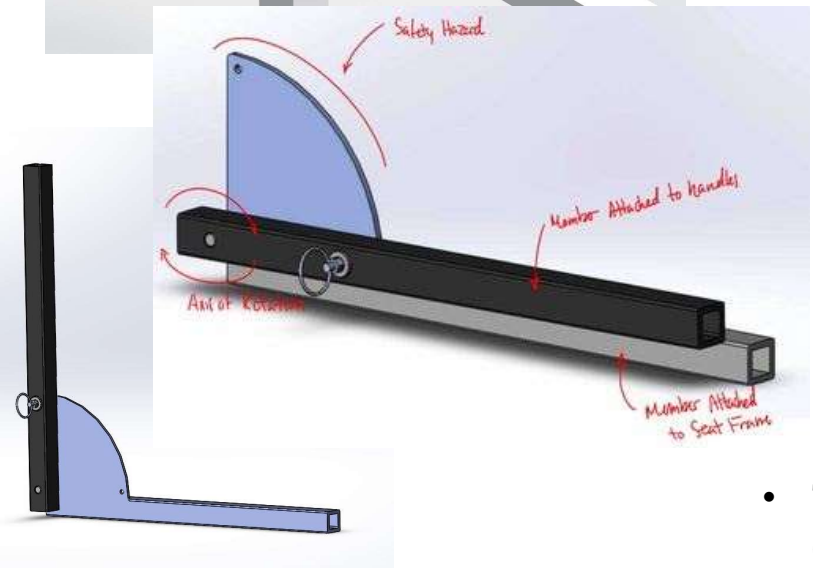
- Result: Researched, designed, and constructed a fully functional prototype with new, innovative folding and locking mechanism to provide stable support that users are confident of as they approach the ground to sit or kneel, and then assist them is rising again while also increasing ease of use, comfort, and affordability

Concept Generation and Prototyping

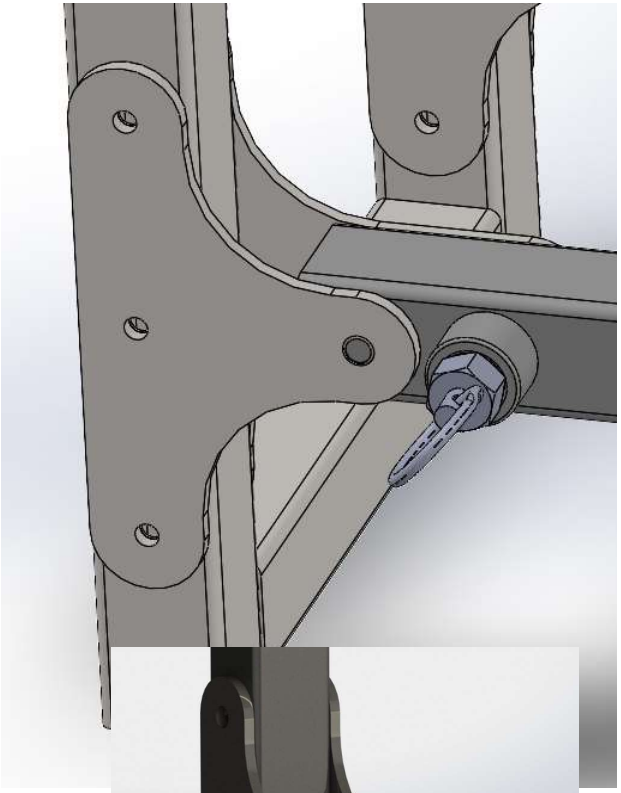
- After completing research into both competitive products and intellectual property and defining product specifications, my team came together for a brainstorming session to generate ideas for fabrication
- We then voted on ideas and took the most popular ones to begin prototyping our solution
- Each design was first modeled in CAD, evaluated based on engineering analysis, and then constructed and tested for feasibility
- After multiple iterations of the most successful designs, we arrived at our final alpha level prototype…

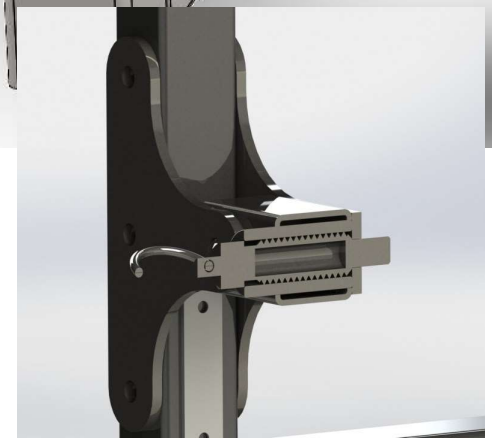
Initial Prototypes in CAD



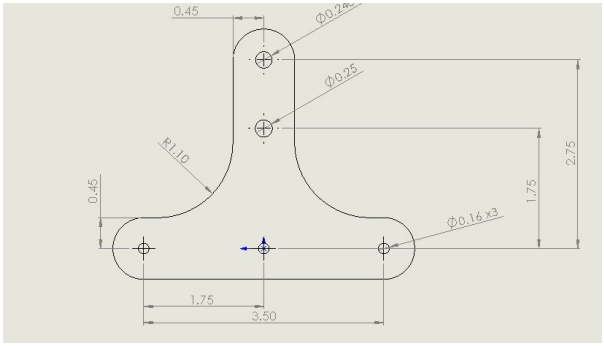


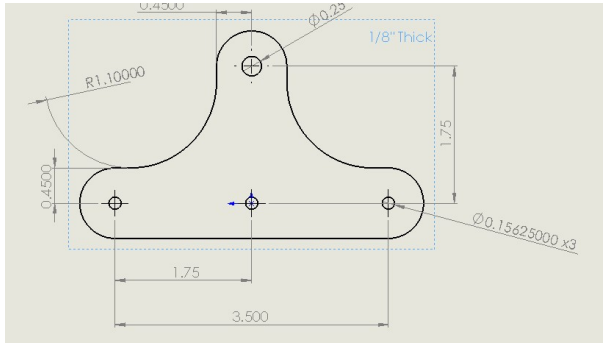
- The first promising design (top left) featured a bracket and a detent pin, similar to the design of crutches
  - It was found to be simple and intuitive but difficult to actuate
  - The second design (bottom left) utilizes a spring plunger retractable pin
  - It was found to be easy to actuate but posed a safety hazard when folded
- These two designs were combined (right) to eliminate the safety hazard while still increasing ease of use

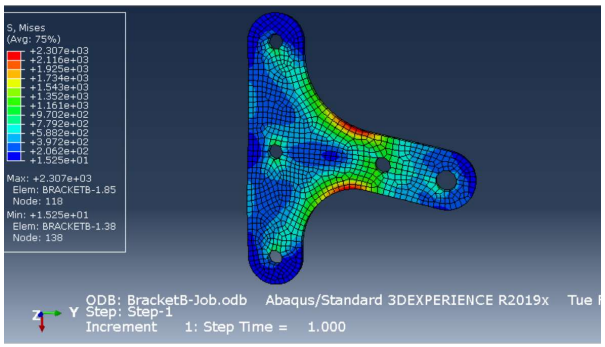


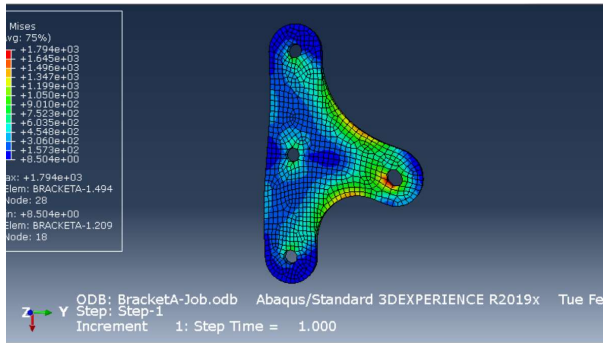


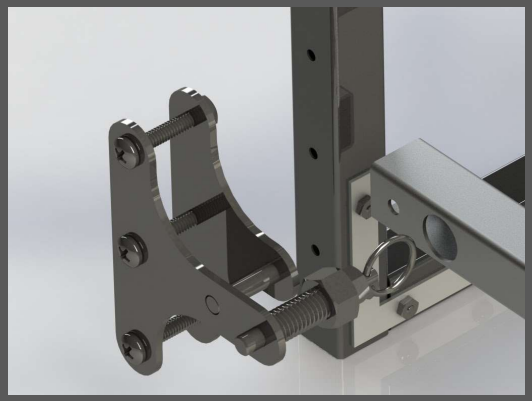
Bracket Design & Analysis







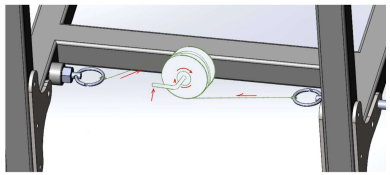


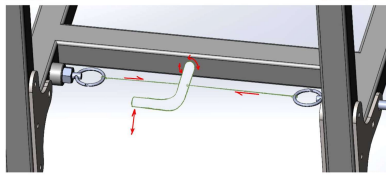


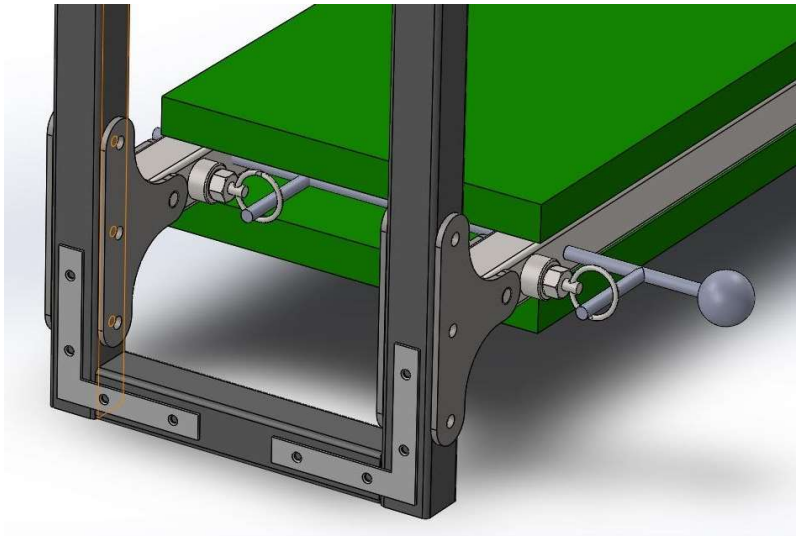
- Finite Element Analysis (FEA) was performed on the new bracket designs to determine if the load bearing capabilities of the components were confirmed to meet the specified needs
- The load used was the maximum target user weight, around 300 lbs
- Different materials were tested and compared for overall performance and cost

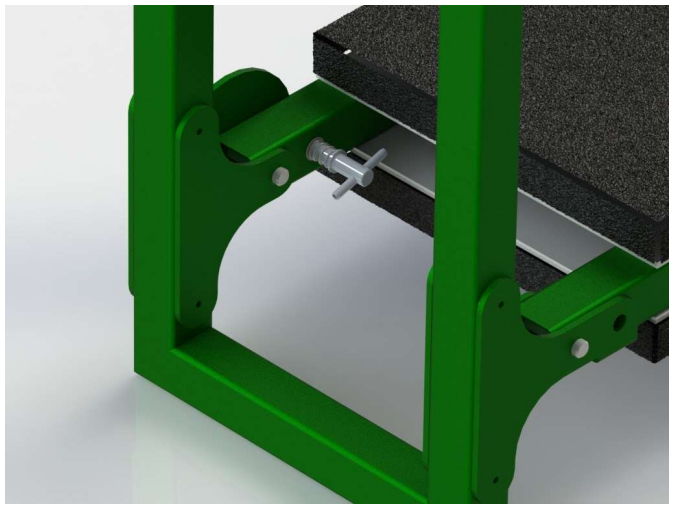
Functional Prototype in CAD

- After incorporating the spring plunger design, we moved to modeling an actuation system in order to release the pins on the same side
- The first design used linear actuation, connecting the two spring plungers through direct linkage
- The second design used rotational actuation, translating the user's rotational input into lateral displacement
- Both these designs were constructed and tested but ultimately eliminated due to cost considerations









Final Prototype – Square Tube

Features a hand-actuated locking and folding mechanism, comfortable kneeling/sitting surface, and welded, rigid frame for support

Final Prototype – Round Tube

- Towards the end of the project, cost considerations began to be more heavily stressed by the client
- The client expressed interest in using round tubing as it is cheaper and easier to manufacture
- As a result, the spring plunger and bracket designs were modified to interface with round tubing