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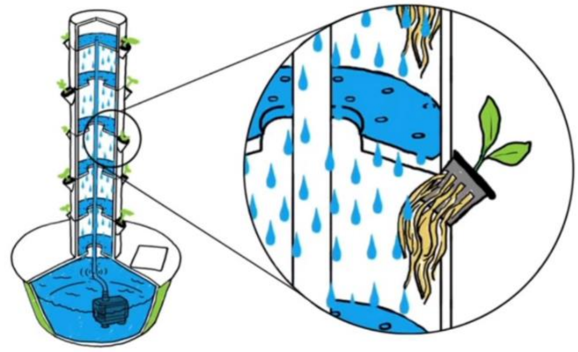
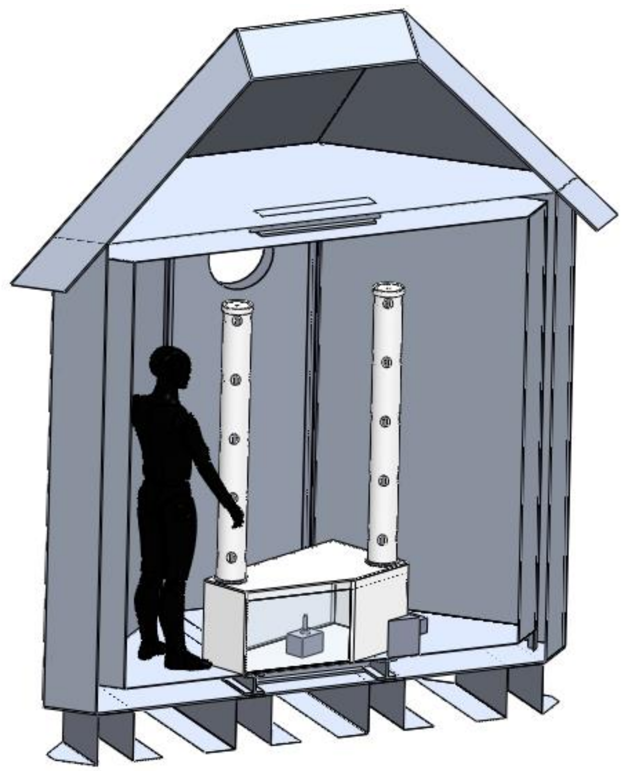
PINGA: ARCTIC AEROPONICS SYSTEM

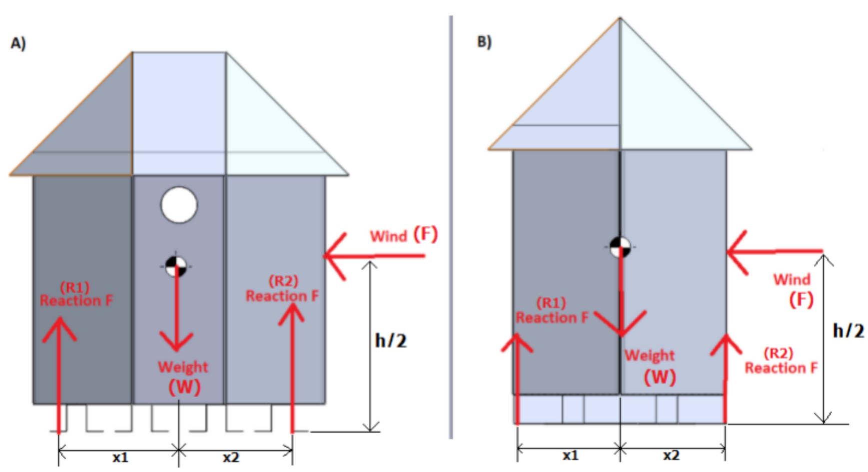
- Remote northern Canadian communities suffer from food insecurity.
- Created a system to allow growing produce and fight food insecurity in remote arctic communities as my fourth-year design project.
- Chose aeroponics system because it very efficient system that uses the least amount of energy and water compared to traditional and hydroponic method. A depiction of aeroponics system is given on the right.
- Conducted a rudimentary study to find that cylindrical growth structure allows the highest number of plants per volume.

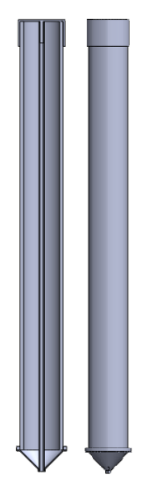


- I was responsible for the structural design and mechanical testing.
- Directed mechanical design process to create 50+ parts and assemblies, using SolidWorks, while enforcing DFM and DFA principles
- Design was altered through various iterations to meet the requirements and constraints.
- Biggest considerations were wind force, heat loss, price and reliability.
- The design on the right was the final design that met all of the requirements.



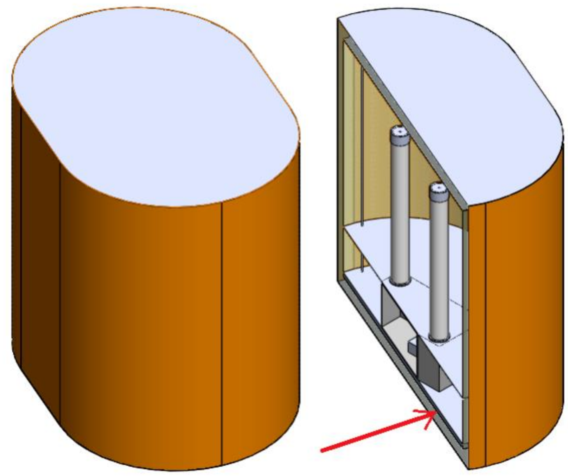
- Conducted tests to ensure reliability in extreme weather conditions of northern Canada. (-58 deg F and 84 mph wind)
- Analyzed the structure of the systems at 3 wind conditions, increasing the force needed to tip over the system by 20%.
- The tipping calculation was conducted as seen below with the wind speed was assumed to be 135 km/h or roughly 84 mph.
  - The highest recorded wind speed in Nunavut.
- Achieved a factor of safety of 2 for 84 mph wind.

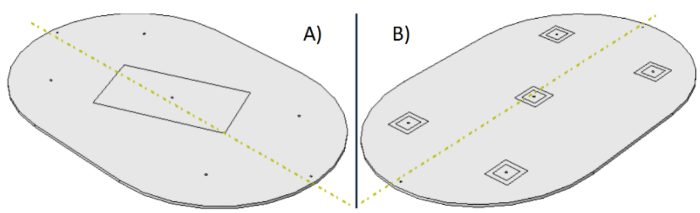


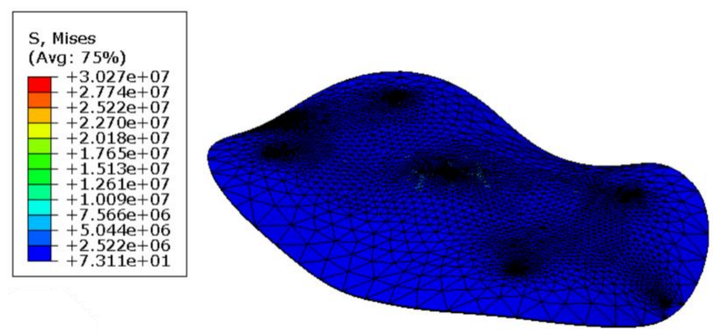


CABLE MANAGEMENT SYSTEM

- The Arctic Aeroponics System's bottom base is subject to severe loading conditions including the weight of 6-gallon water tank.
- As the mechanical lead for this project, I identified the need to analyse stress levels in the bottom base early in the design process. I led and designed the stress study.
- The initial design of the cable management system is given on the right.
- Here, the bottom base, pointed to by the red arrow on the right, is held up by 5 feet support which raises the system above the ground to give it a layer of air as insulation from the permafrost ground.





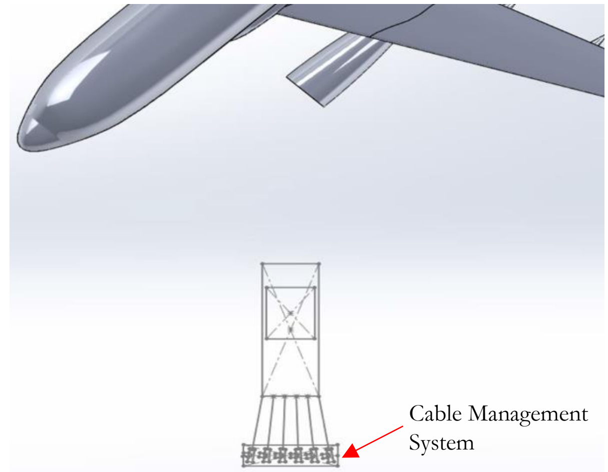


- The Finite Element Analysis (FEA) study was conducted on the early version of the system.
- During the study, no symmetry was identified in the system. To reduce computational load, critical zones were identified (as seen in above), which were given lower mesh sizes compared to rest of the body.
- Conducted H-refinement and P-refinement to select the mesh size of 50 mm for the critical zones, and to select quadratic elements for the analysis.
- Decreased the thickness from 2" to 3/16" reducing the weight by 90% which increased the stress level by 2291.45%. But the stress was only 20.62% of the yield stress. The initial thickness was found to be too big.

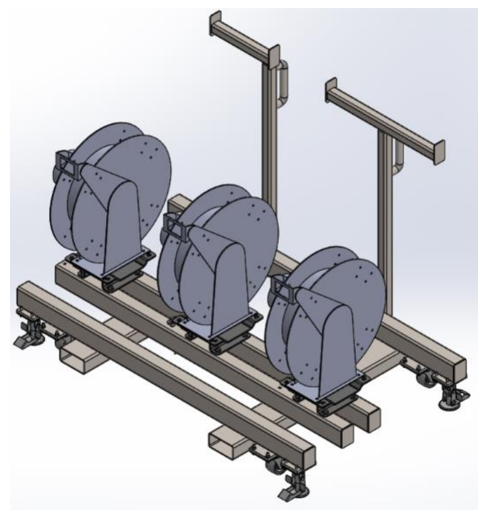
- After the system was updated to better meet the DFM and DFA principles, the team lost access to Abaqus CAE software due to technical difficulties with University of Waterloo's remote desktop network.
- Considered options such as using hand calculations (beam analysis), ANSYS, SolidWorks Simulations, and MATLAB.
- However, due to the 3D geometry of the problem, loss of access of ANSYS, size of the model, and complexity of the task, the options were deemed unsatisfactory, respectively.
- Therefore, as the first test on the initial version was very good, we decided to grandfather the system as satisfactory.

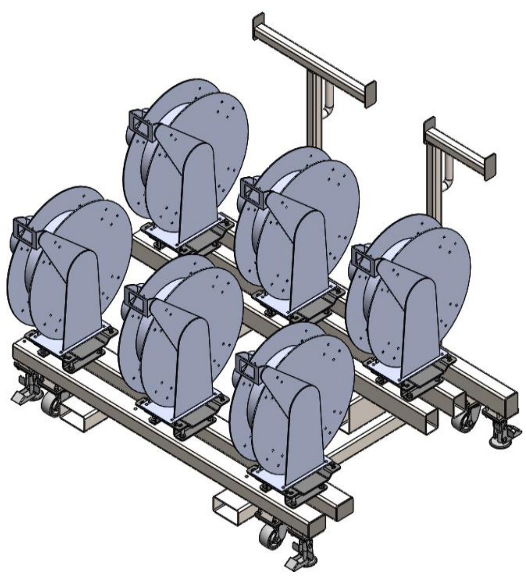
CABLE MANAGEMENT SYSTEM

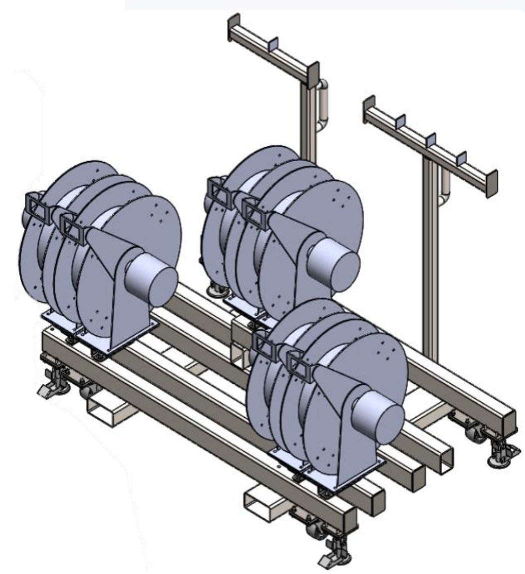
- Besnovo was developing a fully automated laser de-coating solution for aerospace, automotive, advanced manufacturing and other sectors.
- The system had to be mobile to go around vehicles.
- To provide this mobility an intermediary mobile platform was needed to house cable reels on it to supply cables with to the system from a stationary power source: the cable management system



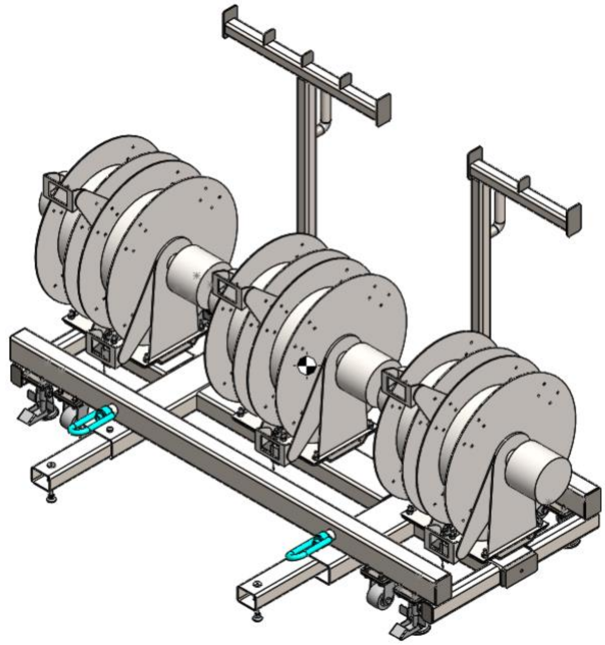
- The existing design had a capacity of 3 UEA 8000 series self-retracting cable reels.
- A new system must have a capacity of 6 cable reels.
- The initial design is given on the right.
- Created a few designs in the initial design phase as depicted below.



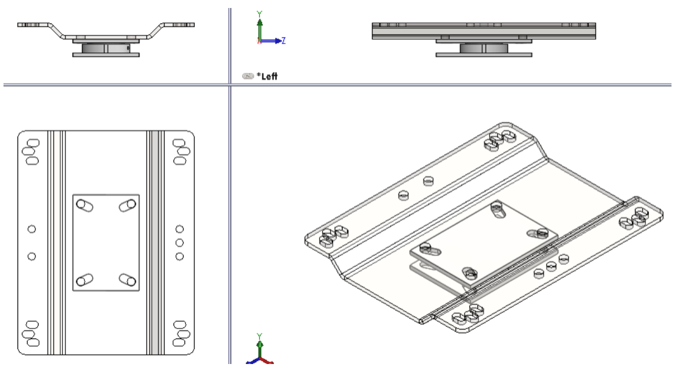


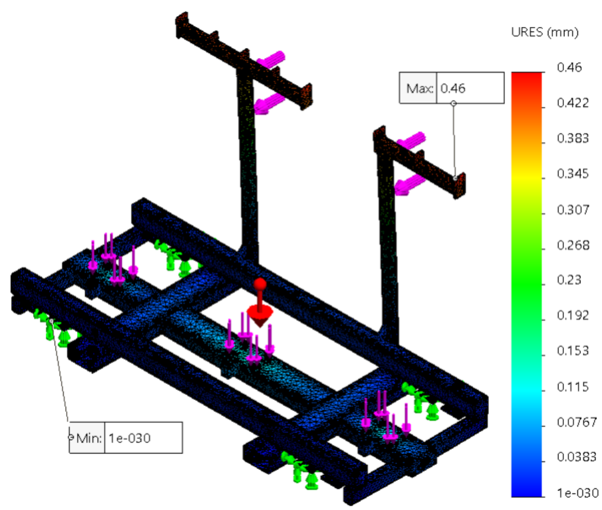


CABLE MANAGEMENT SYSTEM

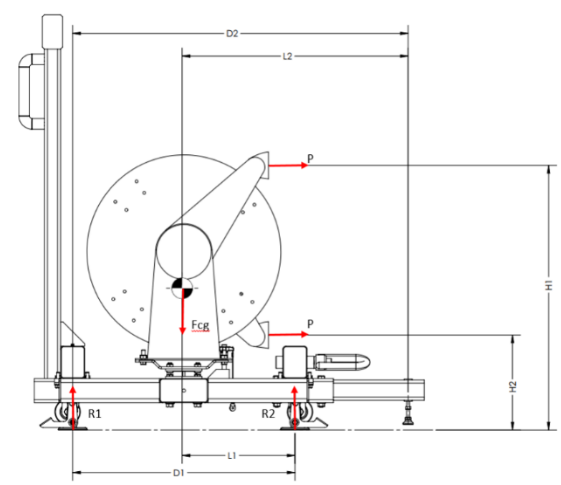


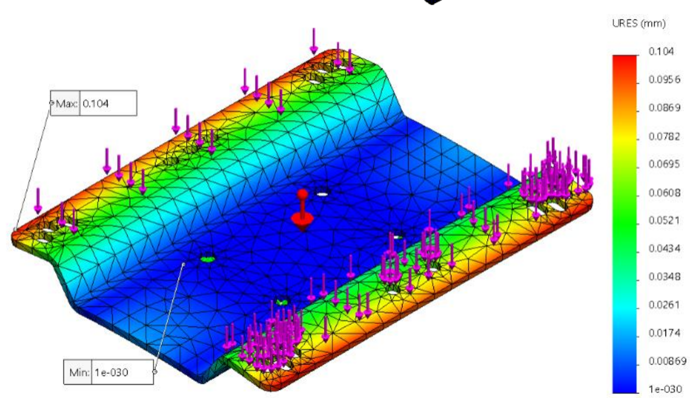
- Design was altered to meet requirements and constraints.
- The design on the right was the final design that met all of the requirements.
- Created a few extra parts to make the design more compact like the swivel base depicted below.



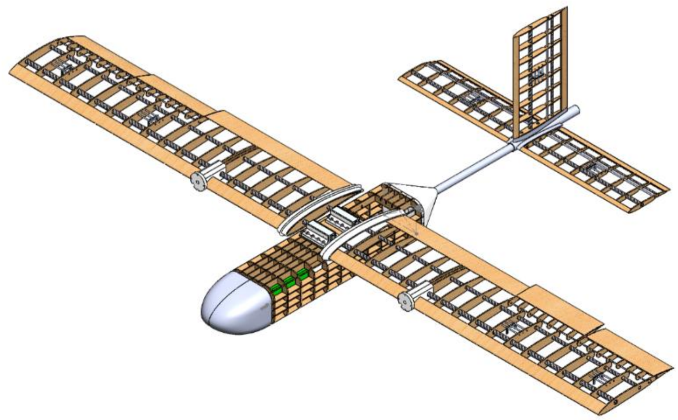


- Conducted a few tests to verify design specifications:
  - Finite Element Analysis tests
    - Weight load
    - Weight load + cable tension load
    - Weight load + load from being pushed around
    - Weight load on intermediary plate
  - Tipping calculation to make sure the system can handle the tension load from the cables.
- The tests are depicted below.
- New design was 25% cheaper, 50% smaller and 40% lighter, with a 100% increase in the cable capacity.

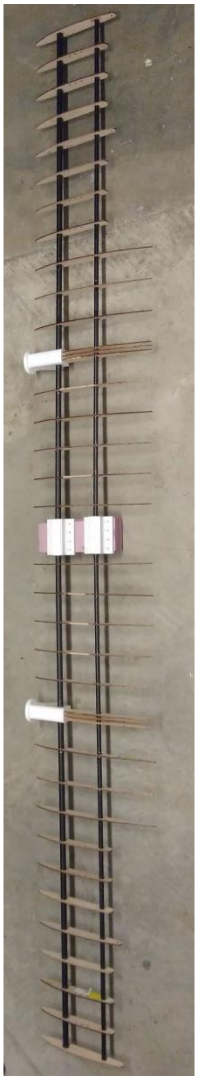




PROJECT BOREAS



- Project Boreas was an Unmanned Aerial Vehicle project I worked on at University of Waterloo.
- I was primarily responsible for designing mounts and critical joints for motors and sensors, and wing and tail assemblies, respectively. I was also responsible for designing the wing modules.
- I independently drove the design process to at an accelerated pace, expediting the project by 2 months.
- Developed and implemented tests to verify the parts met design specifications I identified earlier in the design process. Examples:
    - Tests to study the radial deflection of the carbon fiber support tube while connected to the wing joint.
- Conducted FEA studies to optimize stress and weight in the connection parts, decreasing the weight by up to 15%.
- I was also responsible for fabrication and integration of the system.
- DFM and DFA for materials: PET thermoplastic, 6061 Aluminum, rubber, and carbon fiber; using fabrication methods: laser cutting, machining and, FFF/FDM and SLA 3D printing.



CELLPHONE STAND PROJECT

- I carried out the cellphone stand project as a 3D Print Centre Engineering Assistant using the Stratasys Fortus 360mc industrial FDM 3D printers.

- Pre-production phase:
- Provided lectures to 400+ students and 10 TAs about FDM 3D printing process and efficient ways of 3D printing to limit the amount of support material used in a 3D print.
- Identified the necessary infrastructures needed to successfully execute the project with the University of Waterloo's IT department and professors including risk mitigation plans and necessary software.
- Performed pre-production diagnostic tests on the Stratasys Fortus 360mc FDM 3D printers.

- Production phase:
- Lost 50% of the total production capacity during production initiation.
- Ensured project success by executing the risk mitigation plan by directing a team of 10+ which included professors, IT department, a 3rd party diagnostic team, and teaching assistants.
- Printed all of the 400+ parts within the week maintaining the project expectations. One batch of production depicted below.

CELLPHONE STAND PROJECT

- Designed a predictive model for 3D Printing material using print settings through Machine Learning.
- The model design is given below as a flowchart.
- Used numpy, scikit-learn, and pandas python library.
- Performed data pre-processing:
  - Converted categorical data with object datatype to integers datatype.
  - Used mean normalization to for feature scaling.
  - Split data into training (60%), cross validation (20%), and testing dataset (20%).
- Trained and validated Linear Regression and Decision Tree Regression models in order to choose the best model.
- Implemented the Linear Regression model, resulting in the model predicting the validation set with an accuracy of 94.4%.