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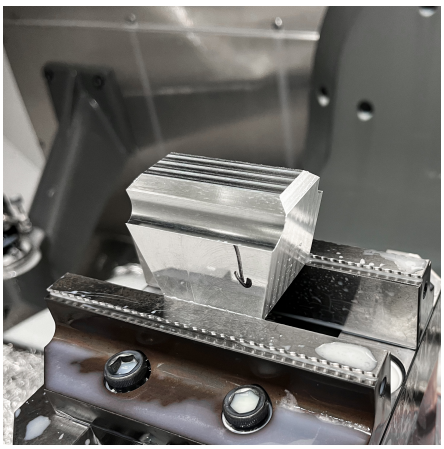
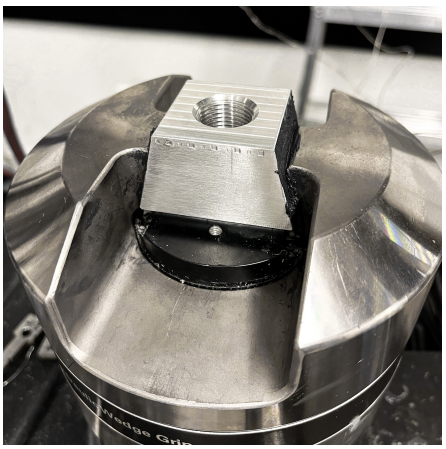
Design and Manufacturing of Tensile Tester Grip

What: A grip that fits between the hydraulic jaws of a tensile testing machine.





Why

- A custom autoclave for tensile testing under high-pressure hydrogen gas utilizes threaded connections to attach to the load frame.
- Conventional jaw and grip setups do not allow for threaded components to be tested; therefore, a new grip needed to be designed and manufactured.

How

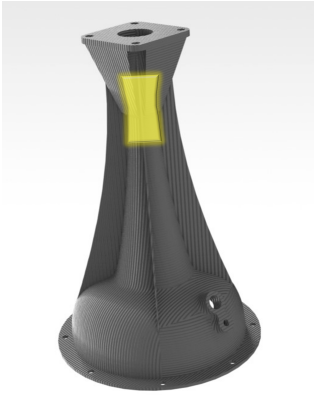
- 3D printed prototypes were used to rapidly iterate the through design and geometry validation.
- Material choice was validated through cost-benefit and strength analysis.
- 5-Axis CNC milling was used to manufacture the part in-house.

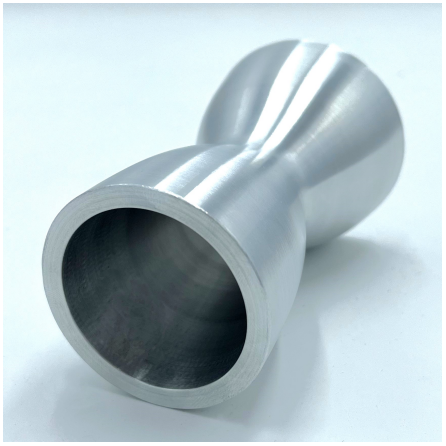
Result

- The grip is now a critical component within in-situ testing infrastructure for material testing in high-pressure hydrogen environments.
- At the jaws' maximum load, the grip maintains a safety factor of two against yielding.

Manufacturing Aluminium Restrictor for FSAE Car Intake

What: FSAE regulation requires that air moves through a 20 mm restrictor in the intake system.





Why

- Previous intakes have been 3D-printed with an undesirable surface roughness that negatively impacts airflow characteristics.
- Machined aluminum can achieve a much higher surface finish, mitigating negative surface effects.

How

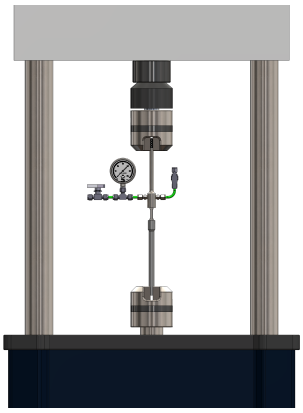
- The restrictor's inner and outer profiles were turned on a CNC lathe using CAM programs made in Fusion 360.
- A 3D-printed fixture was used (seen in black) to support the workpiece while turning the outer profile.

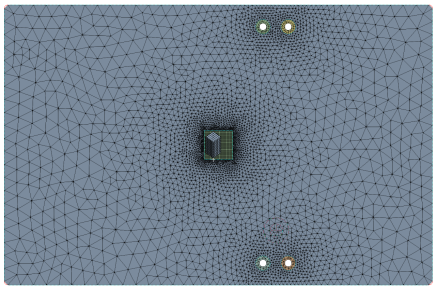
Result

- The aluminum restrictor was machined to a polished surface finish, greatly reducing negative surface effects.
- This restrictor was then welded within other intake components and sealed using two-part epoxy.

Safety shield for Tensile Testing Pressurized Samples.

What: A safety shield designed to contain pressure system failures up to 2400 psi.





Why

- To protect users when breaking internally-pressurized tensile samples on a tensile testing machine.
- A solution was needed that was cost-effective, easy to manufacture, and could easily be integrated into the existing test apparatus.

How

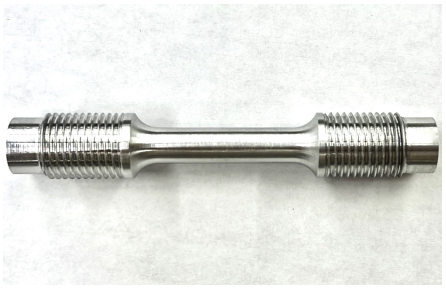
- The safety shield is made of a 1/4" thick polycarbonate. The required sheet thickness was determined using an array of impact and force calculations in Excel and then was further validated using an FEA simulation.
- The safety shield was fabricated on-site using a waterjet, hydraulic bender, and welder.

Result

- The safety shield design was approved by UBC's School of Engineering and is now in operation.
- The safety shield can easily be attached or removed using wingnuts.
- The shield was manufactured at minimal cost and took advantage of on-site materials for quick fabrication.

Hollow Cylindrical Tensile Samples (HCTS) for Material Testing in Gaseous Environments

What: Hydrogen can negatively impact material properties, HCTS were made to measure this effect.



Why

- To test the effects of hydrogen on pipeline steels, the material testing must be done in hydrogen-rich environments (in situ).
- The hollow cylindrical geometry, originally developed by Bool et al provides a way of hydrogen testing without an autoclave setup.

How

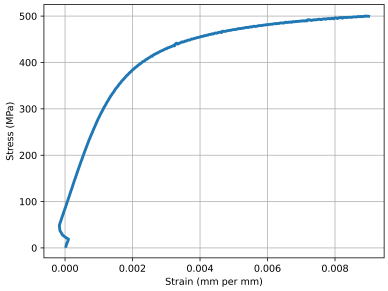
- To create this geometry, pipe sections were torch cut in quarters, milled flat on a CNC mill, waterjet into strips, turned into round bars on a lathe, drilled hollow on a CNC mill, and then turned to their final geometry on a CNC lathe.
- A major challenge with this is deep-drilling straight 1/8" holes to 24 x diameter. This was accomplished with well-refined CAM programming on a CNC mill.

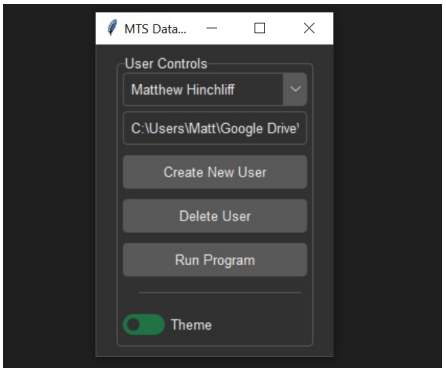
Result

- Samples were successfully manufactured using a repeatable process.
- The samples produced consistent test results and allowed for the continued study of hydrogen embrittlement in pipeline steels.

Data Management Python Program

What: A user-friendly Python program takes raw data and yields relevant engineering parameters.





Why

- Tensile testing data is not output in a useful format. The sample metadata, plots, and various engineering parameters have to be accessed or calculated after data acquisition .
- Time can be saved and human error can be prevented when the process is automated.

How

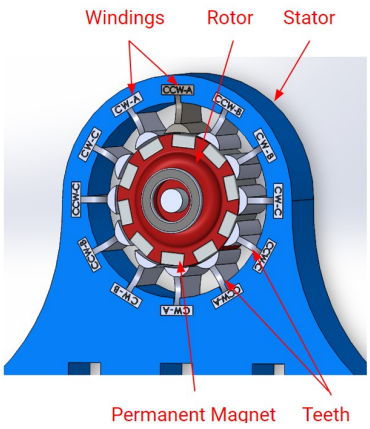
- A graphical user interface was made using Tkinter to allow different users to access and store data from different directories.
- The Python program relies heavily on Pandas data frames for data handling and manipulation; however, it also reads and writes to various Excel sheets to carry out further calculations and display data to the user.

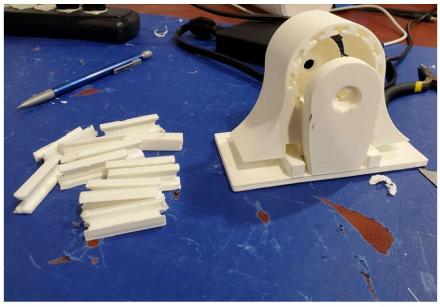
Result

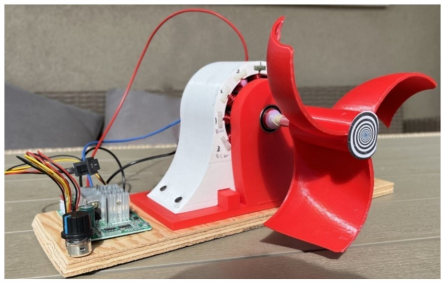
- The program reads in raw data, updates file names, organizes data into new folders to match sample designations and calculates ultimate tensile stress, yield stress, and maximum force.
- In addition to results from individual samples, a summary of testing conditions, sample material, geometric information, and calculated results is output into a single sheet for easy comparison between results and test parameters.

Brushless Motor

What: A serviceable brushless motor manufactured using 3D printed components.







Why

- The motor was created to apply theoretical knowledge about electromagnetic circuits in a practical project.
- The goal of the design was to utilize first principles thinking to build a motor capable of spinning a fan.

How

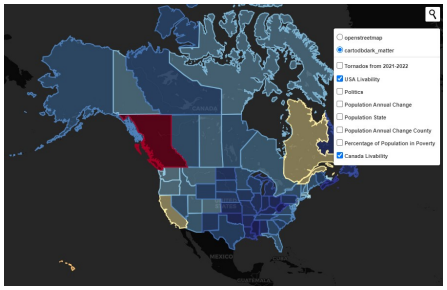
- Motor design parameters such as wire diameter, winding configuration, and number of winding turns were determined through theoretical knowledge and literature review.
- The motor was rapidly prototyped at a smaller scale to determine the 3D printer's dimensional tolerance and to validate design decisions.

Result

- The motor was capable of spinning a fan at 1600+ rpm on a 3A supply.
- The motor is displayed in UBC's "maker space" for students to learn about the capabilities of additive manufacturing.

North America Livability Map

What: An interactive map that allows users to look at livability data by state or province.



Why

- The goal of this map is to use data to determine the most livable states and provinces in the USA and Canada for mechanical engineers.

How

- The map was made using Python and various packages including geopandas, pandas, and folium.

Result

- The map allows users to interactively view various datasets using filters and provides a unique perspective on the livability of different regions in North America.
- Link to Interactive Map.