AvtechTyee Thermal Testing Chamber

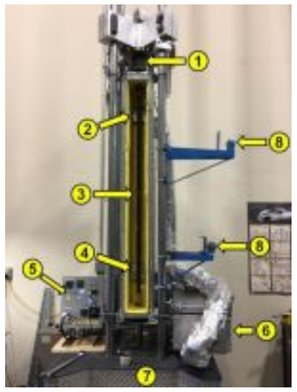
Industry Sponsor: AvtechTyee **Industry Mentors:** Matt Greenstreet & Nicolas Rafiner
Faculty Advisors: John Kramlich & Eli Patten

INTRODUCTION

AvtechTyee is an aerospace manufacturing company producing composite rods. Rods are tensile tested in a thermal chamber that sits on a load frame. Their current chamber is cumbersome to use and inefficient, bringing need for improvement

Current Chamber:

- Non-modular
- Cumbersome to use
- Limits functionality



AvtechTyee's current thermal testing chamber

PROBLEM STATEMENT

Our project designs a modular thermal testing chamber for AvtechTyee engineers to more efficiently test the structural properties of various-sized composite rods in a high-temperature environment without sacrificing performance.

CORE REQUIREMENTS

Module Body:

- Weight must be under 40lbs per module
- Viewing windows at top/bottom module to see specimen
- Interior must have ample space to work around specimen
- Insulation adequate for heat loss and not exposed
- Modular in 24" tall bodies able to stack upon each other
- Must allow side-loading capabilities

Heating System:

- Ample power to keep nominal temperature of 250F
- Must have safety features, "kill switch" to ensure heating system can be turned off
- Must monitor temperature at different points in chamber
- Must have uniform heat distribution across chamber

Usage for Load Cell:

- Attach to 110 kip and 20 kip load cells
- No major heat loss through attachment
- Modules must be stable when attached to each other

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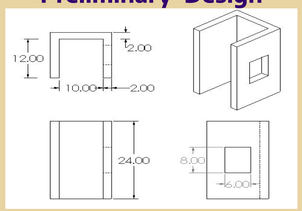
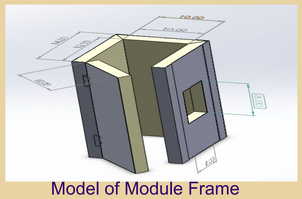
DESIGN & DEVELOPMENT

Design Approach: Subteams focused on different components were created to develop different solutions for; **Module Bodies**, **Module Interfaces**, **Heating system**, and **Temperature Control System.**

Preliminary Design

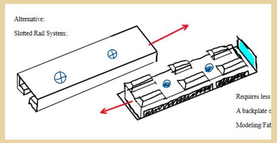



Model of Module Frame

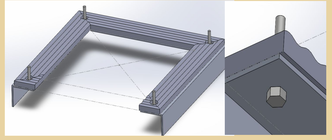
Module Bodies & Interfaces:

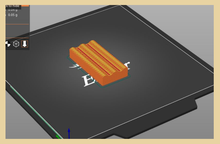
- Preliminary designs created in CAD based off sketches
- Increased chamber width by 4"
- Mineral Wool insulation was utilized to provide high R-Value
- Larger borosilicate glass viewing windows able to withstand heat
- Included steel framing on doors to improve modularity
- Interfaces must "lock" modules together and be easily assembled

Preliminary Interface Designs Considered

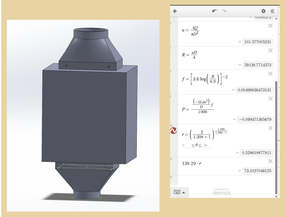


Slotted Rail Design


Alignment Pin Design


3D Printed Design

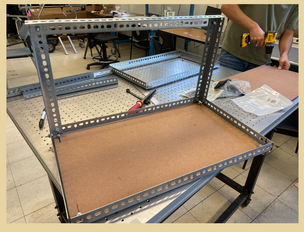
Preliminary Design


Model of Heat Box

Heating System & Temperature Control:

- Preliminary designs were modeled based off calculations and sketches.
- Redesigned the current heating system, using dryer heating elements and fans
- Arduino helped regulate temperature
- Thermocouples recorded analog readings
- Code was validated with low fidelity tests

Development


Module Body Frame


Dryer Heating Element

- Module Body fabrication & prototyping
- Heating system validation through testing
- Fix discrepancies between design and model

RESULTS/VALIDATION


Stacked Modules


Mineral Wool Insulation Attached to Chamber

Validation tests:

- Weighing the modules
- Timing the process of assembly and disassembly
- Timing how long it takes for the chamber to reach the desired temperature
- Using a thermal camera to detect any areas of major heat loss
- Validating the temperature control system

CONCLUSION

Overall, our thermal chamber improves upon AvtechTyee's current design by increasing ease-of-use, interior space, modularity, and efficiency. While there is room to improve on manufacturability and decreased heat-loss, future modules created through our design can address this.

ACKNOWLEDGEMENTS

We would like to acknowledge and thank **Matt Greenstreet, Nicolas Rafiner, the AvtechTyee team, Eli Patten**, and **John Kramlich** for their mentorship, guidance, and relentless support that made this project possible.

Mechanical Engineering Capstone Exposition
June 3rd, 2025, Husky Union Building, University of Washington, Seattle