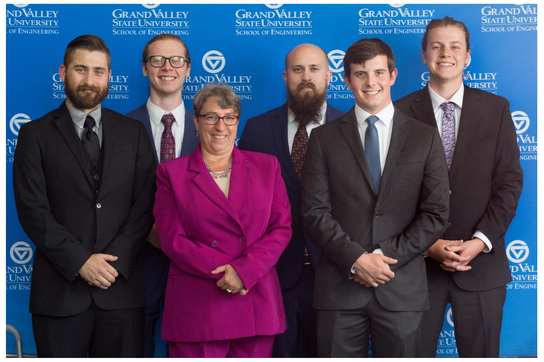
Vacuum Oven

Team Members: Jordan Cooper, Seth Gibson, Dylan Howcroft, Drew Siegersma, Micah Whittle

Faculty Advisors: Dr. Reffeor & Dr. Bakora

Technical Advisors: Dr. Stevens & Dr. Jafari



Sponsor: Woodward Inc.

Sponsor Contact: Logan Tenwalde

Project Description

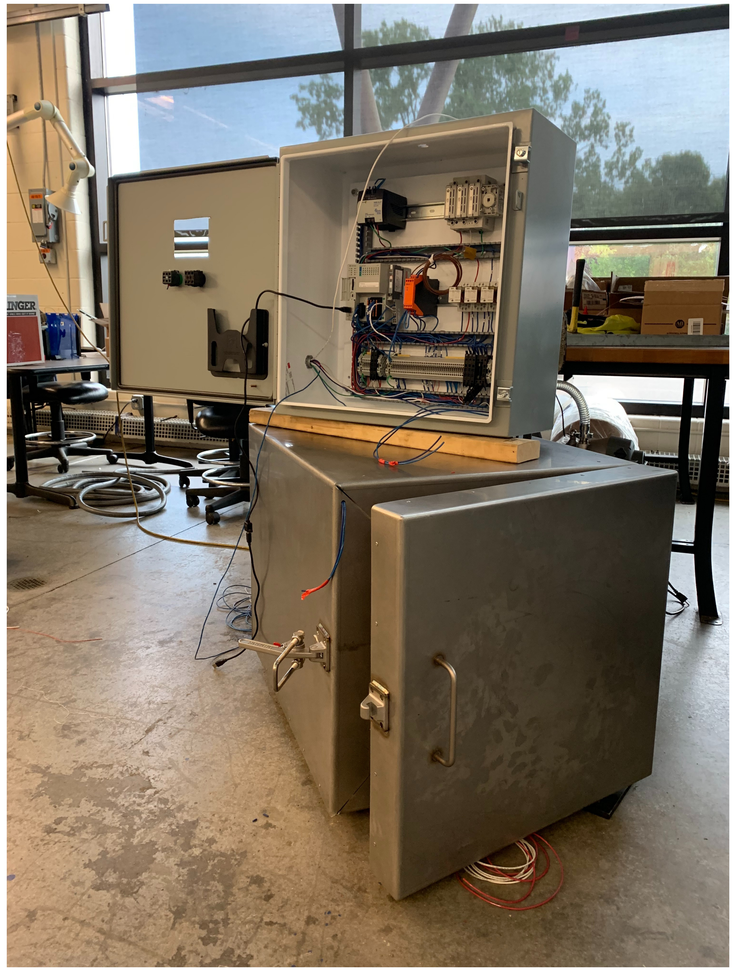
The purpose of this project was to design and build a vacuum oven that will be used to dry a part dipped in a water solution

Background

Woodward Inc. is an independent designer, manufacturer, and service provider of energy control and optimization solutions for aerospace and industrial markets. For some of their products, a drying process is necessary, in which they currently use a thirty-year-old convection oven.

Key Specifications

- Interior enclosure dimensions must be 18" x 18" x 27"
- The designed vacuum oven must fit on the *Uline* tables at Woodward Inc.
- The vacuum oven enclosure must be made of stainless steel alloy, due to their anti-corrosive properties
- The vacuum oven must be able to reach a temperature of 250 °F within 30 minutes
- The vacuum oven must have a maximum temperature of 300°F
- Must be able to pump down to 1 Torr above absolute zero
- The vacuum oven must run off a 120 Volt power circuit



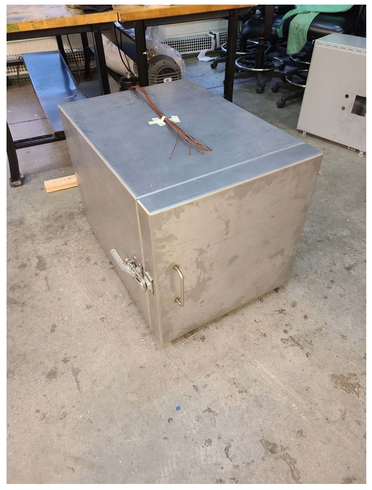
Design Process

During the design process, five critical functions were identified for the vacuum oven to meet its design criterion:

- Heating of 250 °F within 30 minutes, and a maximum of 300°F
- Vacuum down to 1 Torr absolute pressure
- Ergonomic vacuum oven enclosure, that has a sealed opening to maintain a vacuum, and meets dimension specifications
- PLC control system that operates the vacuum oven and its components
- The vacuum oven must have an HMI (Human Machine Interface)

Main Design Features

The vacuum oven consists of four main design features, the enclosure, the heating element, the vacuum pump, and the controls:

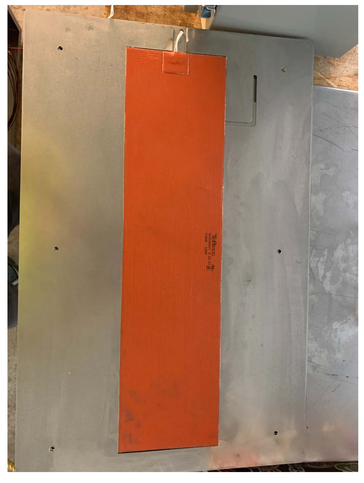


Vacuum Enclosure

Due to the corrosive environment, the vacuum oven enclosure is made of 11 gauge 304 Stainless Steel sheet metal. Thick sheet metal and bracing are used to ensure the enclosure could handle the stress caused by the vacuum during operation. Additionally, ceramic thermal insulation is used between the exterior and interior enclosures of the oven to retain the oven's heat

Heating Element

Since the air of the interior enclosure will be pumped out to create the vacuum environment, normal convective heating could not be used. Therefore, to reach the specified heating constraints, a conductive heating will be used via a heated shelf with a *Tempco* SHS80431 silicone rubber heating pad connected to it



Vacuum Pump

To ensure the interior enclosure will have a pressure of 1 Torr absolute, an *Edwards* nXDS6i dry scroll vacuum pump will be used. With an evacuation rate of 6.8 cubic meters per hour, the pump should be able to evacuate the air in the enclosure in 9.21 minutes

Vacuum Oven Controls

To reliably control the components and operations of the vacuum oven, the vacuum oven will have a control system consisting of an *Allen Bradley* PanelView Plus 7 HMI and an *Allen Bradley* CompactLogix PLC. The HMI will display real-time process conditions of the vacuum oven and provide access to various vacuum oven functions.