Cryogenic Check Valve

Overview
Cryogenic check valves utilize a spring to fully open and close in order to prevent unwanted fluid flow. The spring on the valve fails due to cyclic loading after approximately five years. The cost of replacing a check valve is upwards of $100,000.

Objectives
The purpose of this project is to redesign the existing cryogenic check valve for a retrofit, extend the service life beyond 10 years, and function properly without utilizing a spring.

Approach
- Visited the Solutionwerks site and defined the customer needs and specifications
- Conducted a patent search and listed potential check valve designs: rotating spherical design, dual sliding check valve, and dual hinge design from the previous group
- Modified the existing design in order to meet the required specifications
- Developed volumetric flow simulations in Solidworks to justify and analyze the modified valve design
- 3D printed 2” and 4” prototypes to assist with visualization and recognizing issues
- Finalized our design by 3D printing an 8” valve that had to be partitioned and dovetailed together due to cost and limited resources at Penn State
- Performed test on 8” 3D printed check valve using our partially assembled test rig (four leaf blowers fed through 8” PVC pipe with a tee section for pressure release) in which the plastic flap fully opened
- Manufactured a flap and hinge out of T304 stainless steel, we chose the material due to low cost, high strength, and good machinability/weldability
- Performed second round of testing using the final prototype and completely assembled test rig
- This consisted of a series of tests; checking the rig’s max pressure and testing the valve with varying weights as the counterweight
- Recorded videos of tests and played them back to gather results

Outcomes
- Completed model of a functioning check valve without a spring
- Built test rig to simulate flow through the prototype valve
- During testing, the valve opened more than ⅔ of the way without a counterweight and ⅓ with max counterweight
- The valve closes completely with max counterweight
- Created a patentable dual hinge check valve that can be used in pre-existing plants