R&D Furnace Door Safety System

Overview
A small research furnace at Alcoa’s facility in Lancaster, Pennsylvania is used to test metal samples for new products and quality control and is used about twice a week in cycles of 9-12 hours. During operation, the vertical door of the research furnace is opened and closed using a pneumatic pump and chain system. In the event of pneumatic failure, there is no safety system in place to prevent the door from falling, posing a serious safety risk to the operators.

Objectives
The objective of this project is to improve the safety of the furnace by designing and implementing a door stop system prototype to prevent the door from falling to protect the operators in the event of pneumatic failure. As the main customers, the operators want the system to be strong enough to hold the door, easy to use, quick to operate from start to finish, and reliably safe.

Approach
- During the site visit with the sponsor, the team gathered required information about the furnace and the R&D facility while establishing objectives, customer needs, and deliverables
- The team scheduled weekly conference calls with the sponsor to discuss project progress and receive feedback
- Concepts were generated for three main subsystems: anchoring location, stopping mechanism, and movement method
- Final concepts were selected utilizing weighted concept screening and concept scoring matrices
- Final design utilized a bolt-action system located on the side of the furnace, allowing the operator full access to the furnace
- CAD models were designed in SolidWorks to create a graphic representation of the system
- Computer-aided finite element analysis and hand calculations were completed to prove structural components of the system could withstand the applied forces without failing
- The team machined and welded steel components to create a safety system prototype
- Prototype was tested by applying a downwards force on the bolt with a come-along and a hydraulic scale, which simulated the weight of the furnace door

Outcomes
- The team’s prototype was functional and met all desired customer needs and design requirements
- Prototype held a weight of 800 pounds, twice the weight of the furnace door
- System provides safer operation of furnace facility