Exhaust Bellow Test Stand

Overview
The goal of this project is to create a test stand test that can qualify the flexible bellows found within the exhaust system of a John Deere agricultural tractor. Currently, John Deere’s full size engine test stand cannot adapt to supplier bellow dimensions. Creating a scaled down modular test stand will allow for localized testing that can efficiently test supplier bellows. Ideally, the stand needs to support the bellow during vibration testing of maximum tractor frequencies and heating up to 600°C.

Objectives
The goal of this project is to create a test stand test that can qualify the flexible bellows, or flexible piping, found within the exhaust system of a John Deere agricultural tractor.

Approach
• The team developed a finalized list of customer needs based upon the test stand requirements specified by John Deere
• Ranked customer needs, target specifications and a Pugh scoring matrix showed that the optimal design to qualify exhaust bellows will combine a shaker table with electrical resistance
• A patent search was completed by the team to determine what products were previously created to undergo a vibration and thermal test simultaneously
• An FEA analysis confirmed the displacement and thermal expansion was minimal during operating conditions
• An alpha prototype generated 220°C of the required 600°C during heat testing
• The beta prototype was focused on generating a rigid body during vibration testing
• The gamma prototype integrated a tube furnace with a rigid vibration system
• All CAD models for the alpha, beta and gamma prototype were created using Solidworks
• By visual inspection through a slow motion video a displacement of 1.58mm was measured
• Through heat transfer calculations, it was shown that the tube furnace would need to run at 750°C

Outcomes
John Deere will benefit from the newly designed test stand in the following ways:
• The company has the ability to test supplier exhaust bellows with different dimensions
• The most efficient bellow can now be implemented with the Final Tier 4 agricultural tractor
• John Deere will significantly reduce the yearly manufacturing cost after the implementation
• The test stand has the ability to be transported if necessary