Automated Pipe OD Measurement Device

Overview
Team “Snakes in 2 Planes” was asked by Air Products Inc. to design and build a device capable of measuring and storing/transmitting the outer diameter (OD) of pipes in a natural gas reforming plant. The data will be used to study creep effects over the operating life of the pipes to prevent catastrophic failure.

Objectives
Snakes in 2 Plane’s objective is to create a device that is able to crawl along a 1.5” nominal pipe while taking measurements every inch. This data must then be formatted in a way that allows for easy access and processing on most computers.

Approach
• First, the team visited the customer at Air Products headquarters in Allentown, PA to gather customer needs and fully understand the purpose of the project
• The team generated concepts during a brainstorming session
• Concepts scored using Analytical Hierarchy Process, highest scoring concept was selected
• Patents were examined to prevent infringement, results showed no similar device or process
• A simplified, proof-of-concept device was 3D modelled and fabricated using wood
• The prototype design was created in Solidworks to plan overall spacing and basic component types
• Further refinement proceeded in Solidworks, with accompanying analysis of potential sources of measurement error
• Components were selected by analysis of performance and tolerances, and subsequently added into the model by downloading 3D models provided by the component manufacturer
• Once the model reflected the full assembly and fabrication process, including holes, hole tolerances, thread specifications, fillets, and chamfers, stock materials and specified components were ordered
• Machining and assembly was performed in the learning factory
• The chassis was cut out of a plate of stock 3/8” 6061 Aluminum Plate using the water jet machine
• Control functionality was finalized in parallel, including reading of calipers and control of motors
• Electrical components were then integrated to the device
• A brief testing period confirmed the device could run on a pipe and take measurements, but due to time constraints, detailed analysis of results were cut short

Outcomes
• Prototype delivered on-time and under-budget
• Accurate readings of pipe OD demonstrated
• Functioning prototype provides a starting point for further development of a robust measurement platform
• Air products will have more detailed data on the creep damage at their HYCO plants