Teams 11 & 12: Gunimix Pro

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Background

Gunite is a concrete product used to make custom pool structures by spraying a dry mix of sand and cement onto steel rebar with water added at the nozzle. Gunite pools are Blue Water Pools' core business, and improvements on their existing gunite trailer were strongly desired.

Figure 1. 634 Mix-Elvator (BWP Original Equipment)

Objectives

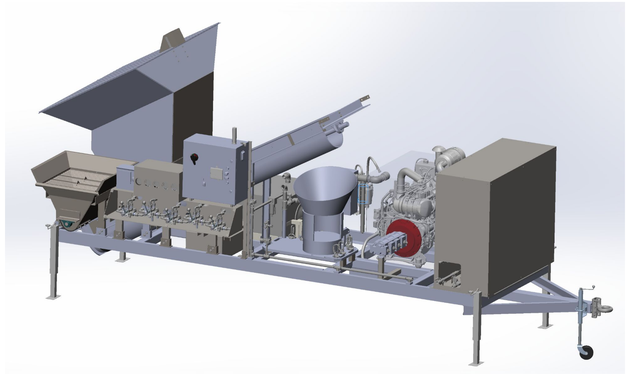
- Increase control of cement-sand ratio
- Improve monitoring of hopper levels, auger speeds, and material output
- Accommodation for future auxiliary hopper system
- Increase life of replaceable components
- Reduce material loss during operation
- Reduce required operators

Key Specifications

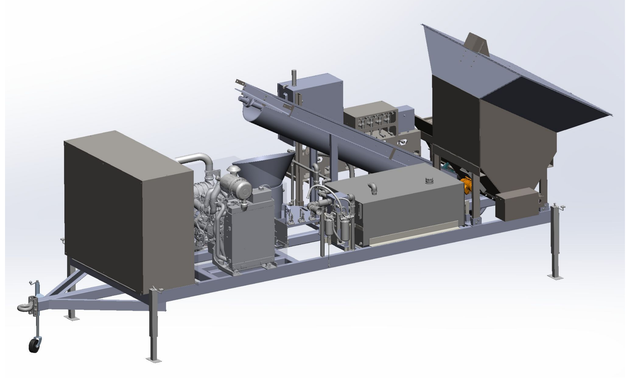
- Must fit into a bounding box of 21 ft x 8 ft x 13.5 ft (L x W x H)
- Sand hopper must have a volume of at least 35 cu. ft
- Cement hopper must have a volume of at least 4 cu. ft
- Life of main auger must be at least 960 hours (~2 years)
- Overall system life must be at least 14,400 hours (~20 years)
- Engine must be rated to support the trailer load, plus the load of one additional feed auger
- Actual mix ratio must be within ±15% of the set point
- Must require no more than 3 operators

Design Approach

A Micro Logix PLC was used alongside induction sensors, radar sensors, and solenoid valves to improve the control and monitoring of material within the system. The hardness of the auger blades was increased by approximately 200% and the size of the blades was reduced to allow for a ½" gap between the flight and the troughs to reduce wear. All systems were designed with components that meet or exceed the current system's life expectancy of 14,400 hours. Any components that cannot meet the system life are commercially available and were designed to be accessible for regular maintenance. A canopy was added around the C-10 Rotary Gun in order to reduce material lost to wind during operation. All user interfaces were centrally located so that the number of critical operators could be minimized.



(a) Right View



(b) Left View

Figure 2. 3D CAD Model of Final Design

Notable Challenges

- Learning new CAD methodologies (chain paths, sheet metal, weldments, configurations, etc.)
- Learning how to design and validate a hydraulic system
- Integrating large subassemblies in Solidworks
  - Maintaining links between parts
  - Combining different modeling schemes effectively
- Management of over 800 unique part files
- Development of specialized drawings (weldments, sheet metal bending, hydraulic/pneumatic schematics, etc.)
- Working on a 12-person team with sub-groups (controls, trailer, fluids, hoppers/augers)
- Fabrication of custom components utilizing welding, milling, plasma cutting, etc.
- PLC enclosure design and manufacturing

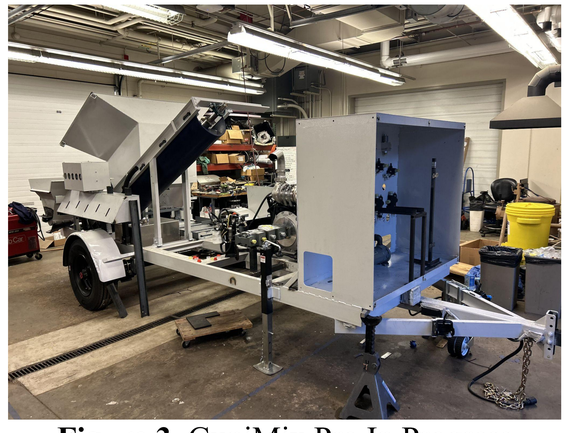


Figure 3. GuniMix Pro In Progress

Business Case

The 634 Mix-Elvator caters to pool manufacturers in lower demand areas, like Michigan, that can't justify a larger dry-mix machine, which can cost near $250,000. However, this machine presents some operational issues, and is no longer manufactured. This leaves a gap in the market for the GuniMix Pro, making gunite pools more widely accessible while also improving upon issues with current market solutions.

Thank you to Michael and Chris at Blue Water Pools, and thank you to our faculty advisors, Drs. Reffeor and Pung, for their guidance and aid throughout the design process.