’24 – ’25 Campus Service Vehicle (CSV)

Mechanical and Aerospace Engineering

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Advisors: Dr. Rizakan Sarikaya and Mr. Joe Thompson | Customer: Trine University Campus Operations Team

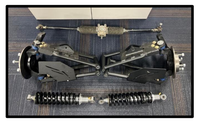
Abstract

The goal of this year’s Campus Service Vehicle team was to create a hydro-vacuum excavation vehicle for the Campus Operations team at Trine. These vehicles use pressurized water and a vacuum system to safely and efficiently excavate soil, without damaging underground utilities. The key changes and additions made to the vehicle are as follows: a new front end for safer travel, a strong vacuum and pressure washer system to perform hydro-excavation, an improved steering system for better maneuverability, a 50-gallon freshwater tank for operation in remote areas, and 4 new lithium-ion batteries for improved runtime. This vehicle provides the campus ops team a safer and more efficient way to maintain underground utilities.

Customer Needs and Requirements

Customer Needs	Customer Requirements
Dig holes (hydro vacuum) with pressure washer	Capable of digging a 4’ deep by 1’ wide hole
Vacuum dirt/water into tanks & dump	Minimum capacity for slurry from 2, 4’ x 1’ holes, bypass small debris, 8ft minimum vacuum/drain hose
Lift/remove drain covers and manholes	Min. 500lb initial hit from hoist
Run full workday	8hr workday, 5-mile range
Safe to operate	4 wheels, 10mph max speed, comply with common OSHA regulations, Zero lab safety violations
Transport full capacity	½ mile to dumpsite with full load, frame strength requirements (safety factor of 1.5)
Outside storage + operational in rain	Weatherproof – protect water sensitive areas
Ergonomical	Replicate standard practices found in off-highway vehicles, e.g. John Deere Gator

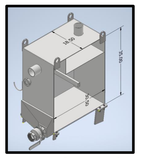
Concept Selection



New Front End

48V Lithium-Ion Batteries

Roots URAI-59 PD-Blower

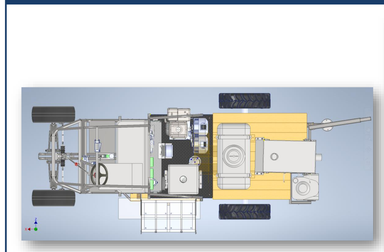


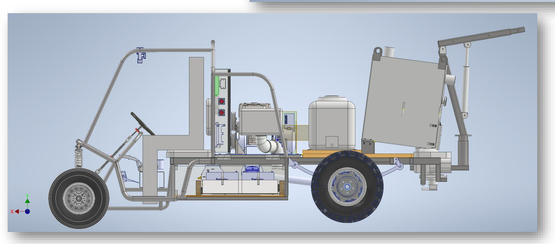
Manufactured Slurry Tank

150V 70A Charge Controller

- 4X 48V DC LiFePO4 Batteries
- 5kW Drive Motor
- 3kW PD-Blower Motor
- 10.7 hp Honda GX340 Engine
- Victron 150|70 Solar Charge Controller
- Honda GCV 190 Pressure Washer
- Manufactured Steel Slurry Tank
- Rank and Pinion Steering
- Landmaster UTV Wheel hubs
- Enclosed Electrical Cabinet
- Front End Shock Suspension
- New front end of chassis
- 50-gallon freshwater tank

Design Solution





Manufacturing

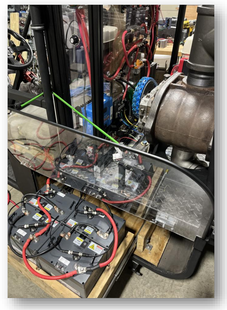
Frame Revisions

Frame revisions to accommodate the new front end and roll cage, making it 4 wheels for stability due to increased payload

New Slurry Tank

Manufactured completely custom, vacuum rated steel slurry tank to store mud-water slurry with the help of the team at IC&E

Electrical Cabinet + Battery Storage



Improved electrical cabinet, watertight, 48V circuit that powers whole vehicle

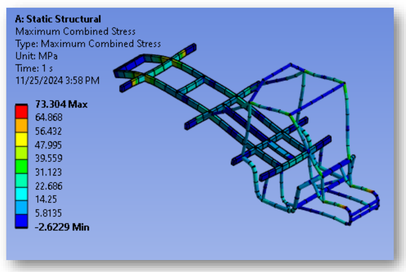
Bed Layout Optimization

Optimized positioning of each subsystem for the vehicle’s new application

Testing and Validation

Frame Integrity Test

- Simulation Testing done on frame under maximum expected load
- Found Safety Factor to be 2.73 when under Dynamic Loading

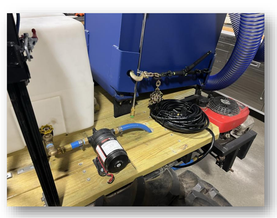


PD-Blower Testing

- Maintenance performed to clean parts and optimize performance
- Found blower to be 90% of manufactured vacuum and CFM rating after maintenance

Pressure Washer Testing

- Flow rate setup test to ensure 5gpm achieved
- Test failed, so team implemented new 12V DC RV Pump to pressurize water



Final Assembly!

Acknowledgments

LANDMASTER

Nidec All for dreams

C&E INDUSTRIAL CONTRACTING & ENGINEERING

FUTURE SOLUTIONS

CORE MECHANICAL SERVICES

Vermeer Midwest

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