Zero Turn Front Loader

Mechanical and Aerospace Engineering Advisor: John Liu
Tanner Bowers, Trenton Mulnix, Jordan Winebrenner, Isaac Zager

Abstract

Four MAE seniors designed and implemented a safe and functioning skid-steer style front loader on Joe Thompson's (Lab instructor) zero-turn mower. The product is designed to meet needs and requirements set by the customer.

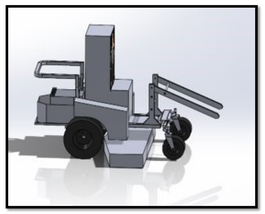
The team focused solely on the design and simulation of the loader during the fall semester. A complete SolidWorks CAD model was developed. Each part was tested on ANSYS simulation software. The dynamics and statics of the loader were verified to meet requirements in MATLAB.

During the spring semester, the team cut, welded and assembled the front loader structure and implemented systems to make the front loader compatible with the mower. As problems occurred, the team would collaborate and iterate to reach the current prototype stage.

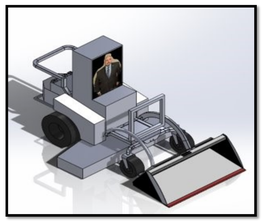
Customer Needs and Requirements

- Transport mulch, sand, dirt and gravel
- User-friendly controls
- Easy to get on and off mower
- Must be painted/finished to match mower
- Water resistant
- Ability to dump into truck bed
- Easily detachable
- Do not overload max weight of mower
- Max step height of 12'' to get on and off mower
- Lift and dump individually with 'skid steer' like controls
- Lift at least 500 lbs+ 240 lb bucket
- Minimum lift height of 50 inches
- Minimum dig height of 2" below grade
- Minimum speed of 0.5 ft/s during operation of arms/bucket
- Detachable within 30 minutes for one person
- Must be finished in orange or black to match mower
- Front Loader unit must not exceed mowers capacity of 1,500 lbs on Rear trans-axle

Concept Selection

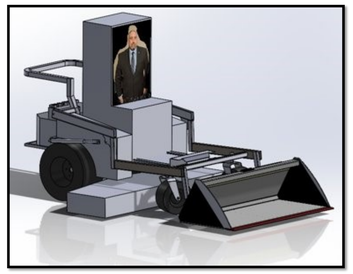


- Raised Front Mount



- Low Front Mount

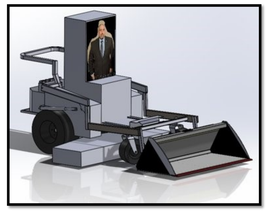
- Raised Front Mount

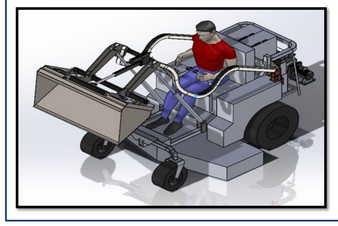


- Skid Steer Mount

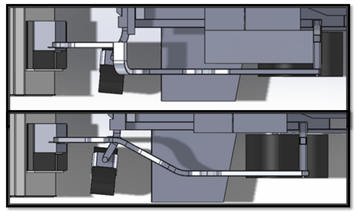
Design Solution

First Iteration
- Arms are welded together
- Stress points were not considered
- Mount at shoulders of ROPS





Second Iteration
- Arms bent inward to install quick attach
- Manufacturability not considered



Third Iteration
- Arms bent inward
- Plate added to end of arms
- Pivot point moved upward

Manufacturing

Caster Mount

- Allows extra front load capacity
- Material - ¼" A36 Mild Steel
- Two caster wheels with combined strength of 1,200 lbs

Pump Rack

- Protect and install hydraulic pump
- Material - ¼" Angle iron and expanded metal

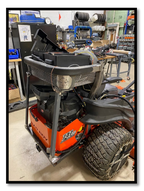
Lap Bars

- Provide clearance for lift arm movement
- Material - 6061 aluminum piping

Arms

- Complex geometry for easy accessibility
- Material - A-500 Mild Steel
- Bent using Hydraulic Tube Bender

Basket



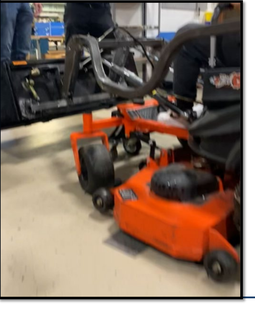
- Hold batteries
- Extra storage space
- Modified ROPS
- Material - Expanded metal and ¼" Angle iron

Final Assembly
- Complete functional loader
- Added weight – 844 lbs
- Total – 2,282 lbs

Testing and Validation

Test 1: Weight Requirement

- Add ~500 lbs of mass to bucket and lift two feet to verify functionality

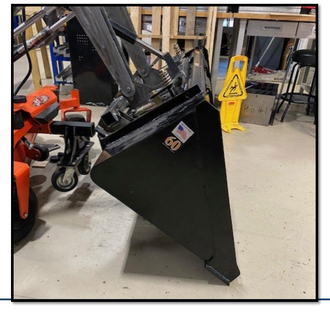


Test 2: Height Requirement

- Lift arms at 50 inches and tilt bucket up and down
- Dig two inches below grade by tilting attached bucket

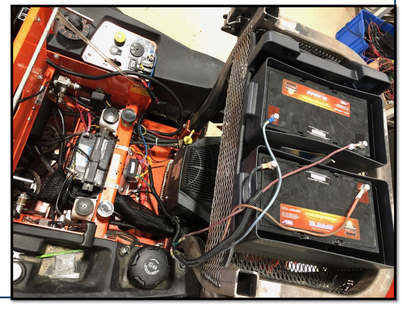
Test 3: Speed Requirement

- Under no load, extend attached cylinders fully
- Record full lift time for unloaded case



Test 4: Charge Testing

- Operate both electrical and hydraulic components
- Test combiner to verify batteries gain voltage by trickle charging



Acknowledgments

Thank you, Dr. Liu, Joe Thompson II, and the Wade Department of Mechanical and Aerospace Engineering for your contributions to this project

Thank you to our donors!
SOS Hydraulics – Hydraulic Pump and labor
Parker Hannifin – Hydraulic Cylinders
Vestil Manufacturing – Steel tubing and plate