SENIOR CAPSTONE/
SENIOR DESIGN EXPERIENCE

2025

Power Assisted Front Axle Demonstrator

[1]Ryan Liebermann, [2]Sam Plumer, [3]Alex Hokey, [4]Tyler Ziehm

[1]Agriculture Systems Management; [2]Agriculture Systems Management;
[3]Agriculture Systems Management; [4]Agriculture Systems Management

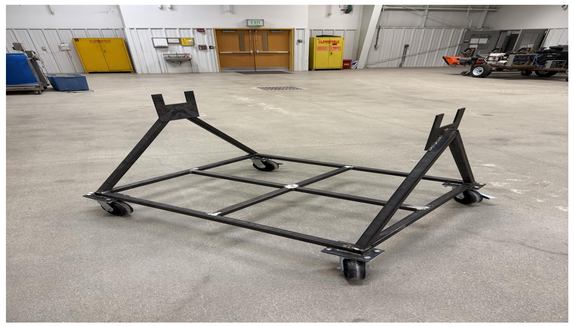
PURDUE UNIVERSITY
Agricultural and Biological Engineering

Objective

The objective of this project is to design and construct a fully operational, mobile front axle demonstrator using a Case IH Puma axle to enhance hands on learning within Purdue's Agricultural and Biological Engineering department. The demonstrator will showcase key components such as the planetary gears, differentials, and hydraulic systems, providing students and faculty with a functional teaching tool to support instruction in power trains, hydraulics, and mechanical systems relevant to modern agricultural machinery.

Problem

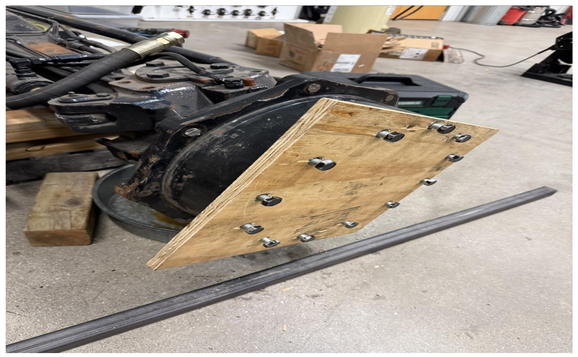
ABE faculty are currently lacking interactive planetary gear demonstrators to use for teaching aids and exhibits for departmental recruitment events, which limits hands-on learning opportunities, student engagement, and the department's ability to showcase innovative technologies to prospective students and visitors



Initial Frame Design

The initial frame that was designed had the goal of successfully supporting the weight of the axle as well as the hydraulic components that would sit under the axle.

- Cross Members were added to better support the bottom of the frame
- A Steel plate was plasma cut to be made into holders for the axle to sit in



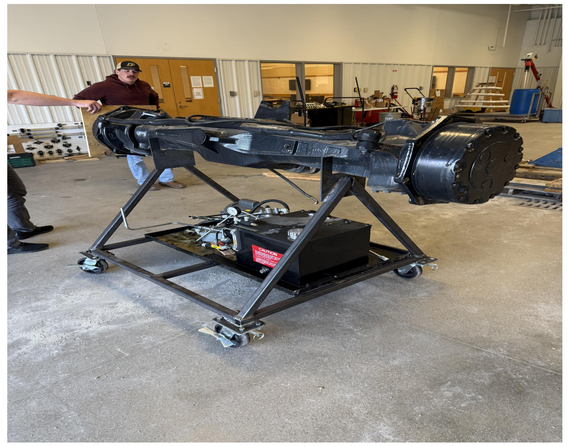
Final Drive Testing

The team used a piece of plywood to model a piece of clear ½" plexiglass to test to :

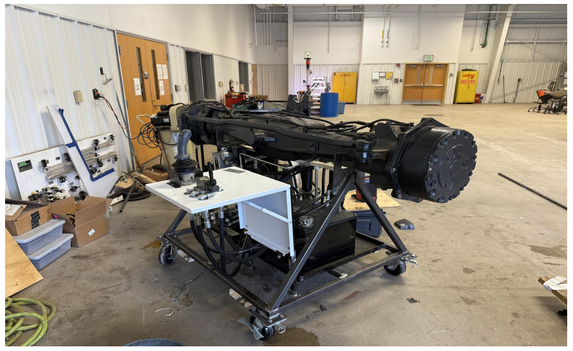
- Ensure planetary gears stayed in place
- Ensure all holes would line up and bolts would thread before cutting plexiglass
- Ensure needled bearings would stay within their housings

Project Research and Context

Research focused on three key areas: structural integrity, hands-on learning effectiveness, planetary gears, and hydraulic functionality. Steel tubing was selected for strength and safety, and MIG welding ensured durable construction. Studies support hands-on learning, which guided the inclusion of interactive controls. The hydraulic system was designed using manufacturer schematics and complies with NFPA 70E, ISO 4413, and ISO 12100 safety standards. USPTO searches confirmed no conflicting patents. This research shaped a safe, functional demonstrator that provides students with a clearer understanding of drivetrain systems and supports Purdue ABE's commitment to active, industry-relevant instruction.



Axle sitting on the stand for the first time under the support of only the stand without other support mechanisms.



Final Design

The Final Design of this project featured :

- A completely operational demonstrator
- Forward and reverse motion of the planetaries
- Side to side motion of the planetaries (steering)
- Interactive hydraulic control station

Project Impact/Conclusion

This demonstrator strengthens Purdue ABE's hands-on learning by giving students a functional model to explore axle mechanics and hydraulic systems. It improves classroom engagement, supports recruitment, and prepares students for careers in ag equipment and machinery diagnostics.

•Enhances instruction in ASM 345 and ABE 545
•Showcases key systems: steering, gears, and hydraulics
•Aids recruitment with an eye-catching, mobile display
•Promotes safer, interactive lab experiences
•Built for long-term use and easy updates

The team would like to give a special thank you to our Sponsor Dr. Stwalley and Advisor Dr. Lumkes