SENIOR CAPSTONE/
SENIOR DESIGN EXPERIENCE

2025

PQS Operation Station

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Executive Summary

This project focused on fixing the operator controls on the quarter scale tractor. The shifter on the tractor to change gears was relocated to allow easier operation, alter joystick steering, and improving the throttle system. With a successful project, the tractor design was significantly improved, and the operation is much easier. The focus of this project allows the remaining Quarter Scale team more time to improve the other aspects of the tractor in time for the June competition.

Key Dates

- Project Path Selection – 8/30/2024
- Find Solution Possibilities – 10/11/2024
- Solution Decision – 11/15/2024
- Prototype Design – 3/07/2025
- Prototype Completion – 4/11/2025

Background Research

The design of the team's shifting mechanisms must align with the ASABE rules for competition as well as outside codes and standards. Last year's tractor utilized a mechanical linkage that rested underneath the seat which proved difficult to shift. To improve the performance and ergonomics, the design will focus on repositioning the mechanism to improve accessibility during operation.

Project Characteristics

Constraints:
- Cost: Must stay under budget
- Control: Must be locked out unless there is an operator to control the machine (IQS 6.13)
- Integration: Must be integrated with the cub scout transaxle
- Shifting: Must be able to shift from armrest

Criteria:
- Cost: Lower cost is more favorable
- Serviceability: Easy to service in case of malfunction
- Ergonomics: Comfortability and ease of use is key
- Weight: Least amount of extra weight is favorable

Deliverables: Design drawings and CAD models for all required shifter parts for the assembly. Operational prototype with usable shifter. Improved ergonomics of shifting mechanism.

Codes/ Standards: IQS Rulebook 4.3, 5.6, 6.13, ASABE S538, ASABE/ISO 15077

Solution Proposal & Selection

Solution 1.1: Mechanical Shifting
Solution 1.2: Cable Shifting
Solution 1.3: Electrical Shifting with Linear Actuators
Solution 1.4: Pneumatic Shifting

Value Proposition

Ergonomics is an integral part of the Testing and Development section as it is responsible for 70/350 points available. Last year, the Purdue Quarter Scale team placed 7th/21 in the ergonomics criteria with a score of 53.8/70. The Top 5 scores for the ergonomics section included scores of 57.2, 57.0, 56.0, 55.4, and 55.4. This directly affected the overall score of the competition as the team was less than 1 point away from 4th place. Pursuing a better score in ergonomics would greatly benefit the team in better overall placing

Project Design & Construction

- The project design is made up of two linear actuators and a shifting linkage to change gears in the tractor's transaxle, shown in figure 1.
- The actuators will be controlled with a second joystick installed on the tractor's armrest. The buttons on the joystick will determine actuator movement for gear selection.
- Most of the design itself was cut out from simple carbon steel sheets and should be very easy to mass produce. The assembled shifter mechanism is shown in figure 2.

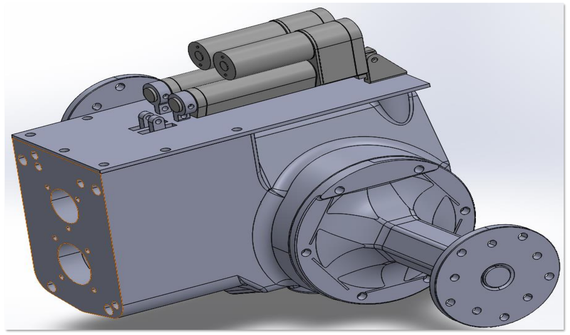

Figure 1: Shifter CAD Model Mounted to Transaxle

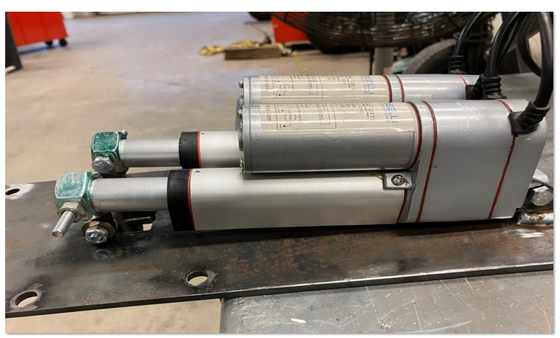

Figure 2: Completed Shifter Design

Prototype Testing

Shown in figure 3, the prototype was mounted to the tractor transaxle. The actuator was then extended and retracted to shift into each gear twenty times to ensure the design worked as intended without hiccups. The key purpose of this testing was to check if the actuators could not provide enough force to enter each gear, if there were other design flaws

Figure 3: Prototype Assembly Attached to transaxle for testing

Maximizing Impact

The goal of testing the gear shifting was to have a solution that worked efficiently and effectively as the current method of shifting is inconvenient with its current position. The current shifting method also has the tendency to not want to go into gear. With the testing of the new method for shifting. There is a lower chance to break something in the transaxle. With the new shifting method the team can program the linear actuators to stop if there is an overload of force involved.

Sponsor: Dr. John Evans & PQS Team
Instructor: Dr. John Evans

References: ASABE Codes/Standards- https://elibrary.asabe.org/standards.asp
ASABE Quarter Scale Tractor Competition Rules-
2025_IQS_ATeamRules_2024_v03.pdf

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