

Keith Brown (ASM), Paul Hellwarth (ASM), Phil Root (MSE)

## Problem Statement

The goal of this project is to design, fabricate, and test an operator station, exhaust system, and electronics and data acquisition system for the quarter scale pulling tractor that meets all rules and regulations of the American Society of Agricultural and Biological Engineers (ASABE) 2015 International ¼ Scale Competition (IQS). The competition gives student engineers a chance to participate in a real design, test, and build opportunity, and to receive feedback from engineers working in industry.

## Design Criteria & Constraints

- Weight limit of 800 lbs.
- Must be easily manufactured with low overhead costs
- Operator station must be safe and comfortable
- Sound produced by tractor must be less than 91 dB
- Electronics must be reliable and versatile



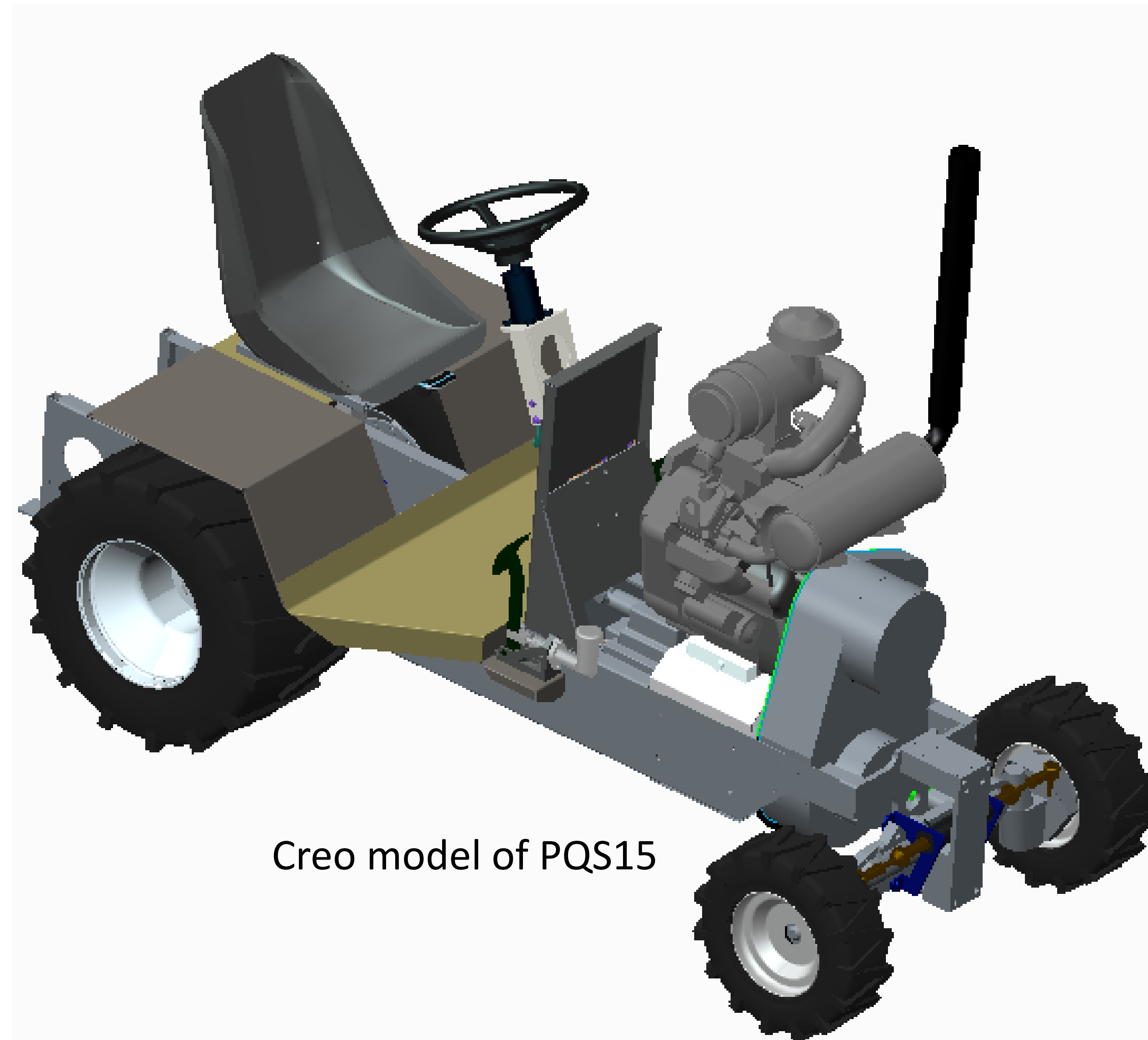
## PQS Design Evolution

- 2011 – Single engine, simplified driveline
- 2012 – Improved driveability
- 2013 – Improved operator experience
- 2014 – Serviceability, versatility
- 2015 – Manufacturability, data

## Design Tools

Software Packages Utilized:

- Creo Parametric (3D CAD)
- Microsoft Excel
- Creo Simulate (FEA)
- MathWorks MATLAB
- ANSYS Workbench (FEA)
- ETS – National Instruments (Dynamometer Software)



Creo model of PQS15

## 2015 PQSo15 Cost Analysis

Section	Category	Purchased	Fabricated	Total Cost
1	Engine System	\$ 1,422.61	\$ 8.15	\$ 1,430.76
2	Transmission/Transaxle	\$ 1,565.00	\$ -	\$ 1,565.00
3	Drive Train	\$ 625.58	\$ 141.88	\$ 767.46
4	Tires & Wheels	\$ 265.84	\$ -	\$ 265.84
5	Steering	\$ 343.47	\$ 16.83	\$ 360.31
6	Frame	\$ -	\$ 534.09	\$ 534.09
7	Body	\$ 36.79	\$ 123.29	\$ 160.09
8	Brake System	\$ 222.89	\$ 34.89	\$ 257.78
9	Electrical System	\$ 772.88	\$ -	\$ 772.88
10	Fasteners	\$ 90.00	\$ -	\$ 90.00
11	Safety Equipment	\$ 17.00	\$ 120.04	\$ 137.04
12	Trim	\$ 46.00	\$ 150.00	\$ 196.00
13	Miscellaneous	\$ 13.00	\$ -	\$ 13.00
14	Final Assembly	\$ -	\$ 50.63	\$ 91.13
<b>TOTAL</b>		<b>\$ 5,421.06</b>	<b>\$ 1,179.81</b>	<b>\$ 6,641.38</b>

## Global Impact

The International ¼ Scale Competition gives future engineers experience that has real-world impact. Students who participate in the competition learn what it is like to work with a team of peers and being assigned small, specific project goals in order to accomplish a much larger goal. Being involved as a student results in better engineers entering the workforce.

## Sustainability

Participating in the IQS produces engineers who are more passionate about what they do, are more capable to act on their passions, and who have a large network of peers. Many IQS alumni, now working in industry, continue to contribute to the event by acting as judges, and donate to the competition or individual schools. This serves to further student interest, and leads to them reinvesting their resources as alumni.

Keith Brown (ASM), Paul Hellwarth (ASM), Phil Root (MSE)

## Exhaust System



Collecting decibel levels



Double - walled pipe exhaust

### Objectives

- Provide an exhaust system that decreases noise without adversely reducing power
- Shield hot surfaces properly to avoid operator injury
- Divert exhaust emissions away from operator

### Solutions

- Begin with previous year's design and improve
- Created shielding that allowed for maximum heat escape without operator being harmed
- Utilization of aluminum over steel to lower weight and increase heat dissipation
- Installed sound insulating foam for outer pipe to dampen exhaust sound.

### Alternative Solutions

- Motorcycle Exhaust
- Previous Years Exhaust

## Electronics and Data Acquisition

### Objectives

- Design a mechatronic system using low-cost components
- Flexible data acquisition system that will serve as a base for subsequent models to expand upon
- Maximize tractor performance at competition

### Solutions

- LabJack T7-Pro module for data acquisition and electronics control
- 2-axis electric joystick for control of multiple throttle modes, including a cruise control for durability event

### Alternative Solutions

- Parker-Hannifin IQAN
- Use of inexpensive optical flow sensor for ground speed

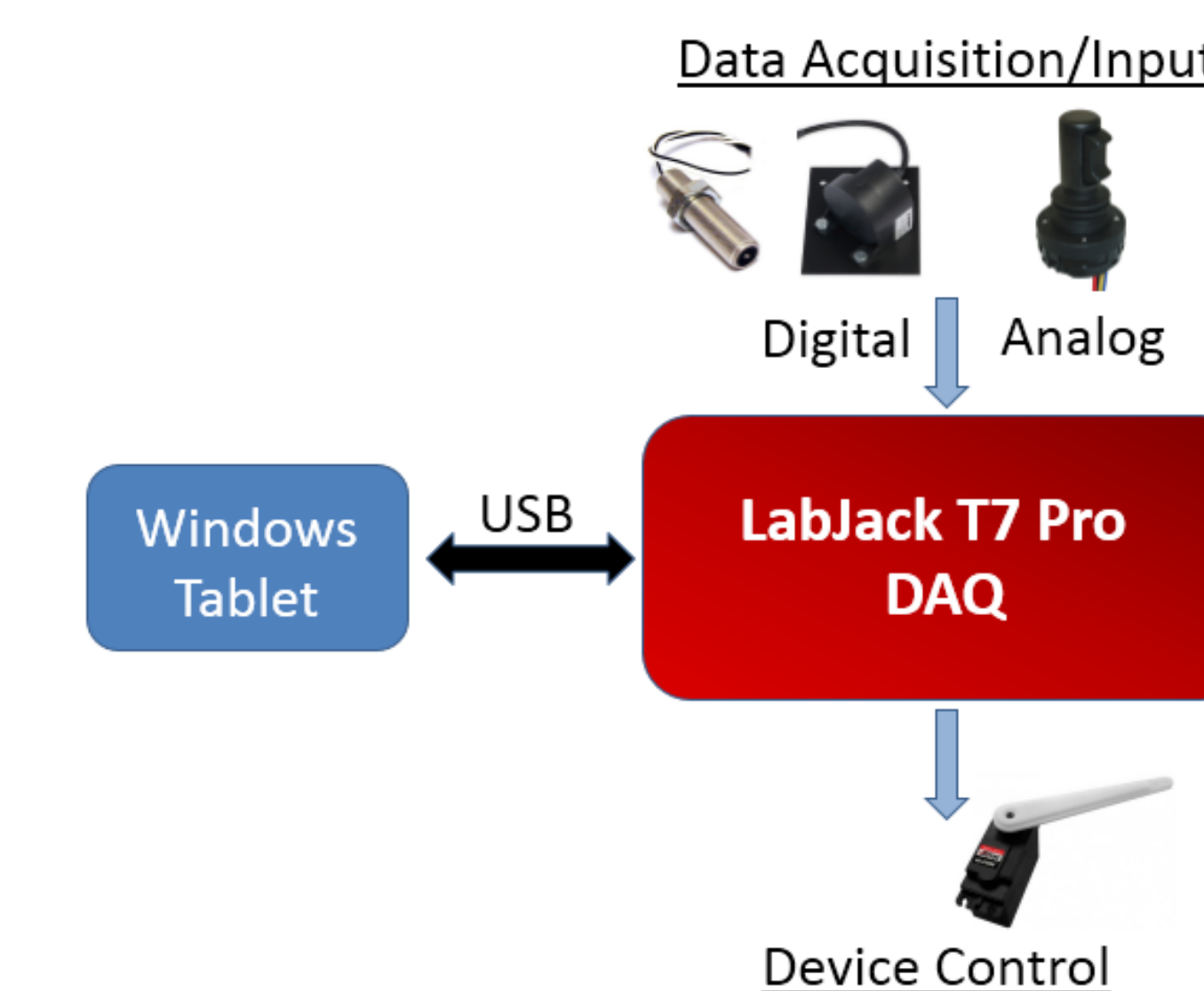


Diagram of DAQ communication



LabJack T7 Pro

## Testing

### Objectives

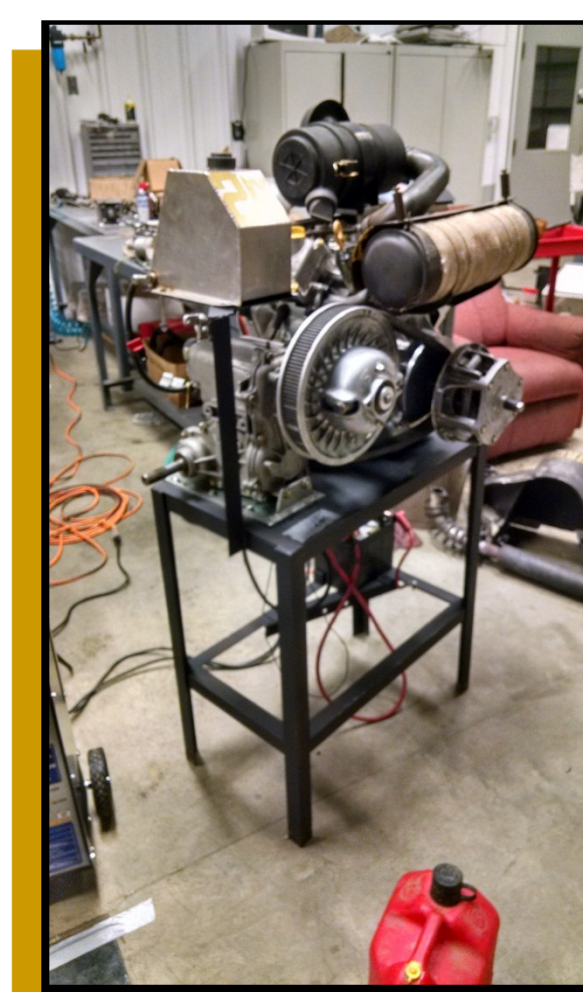
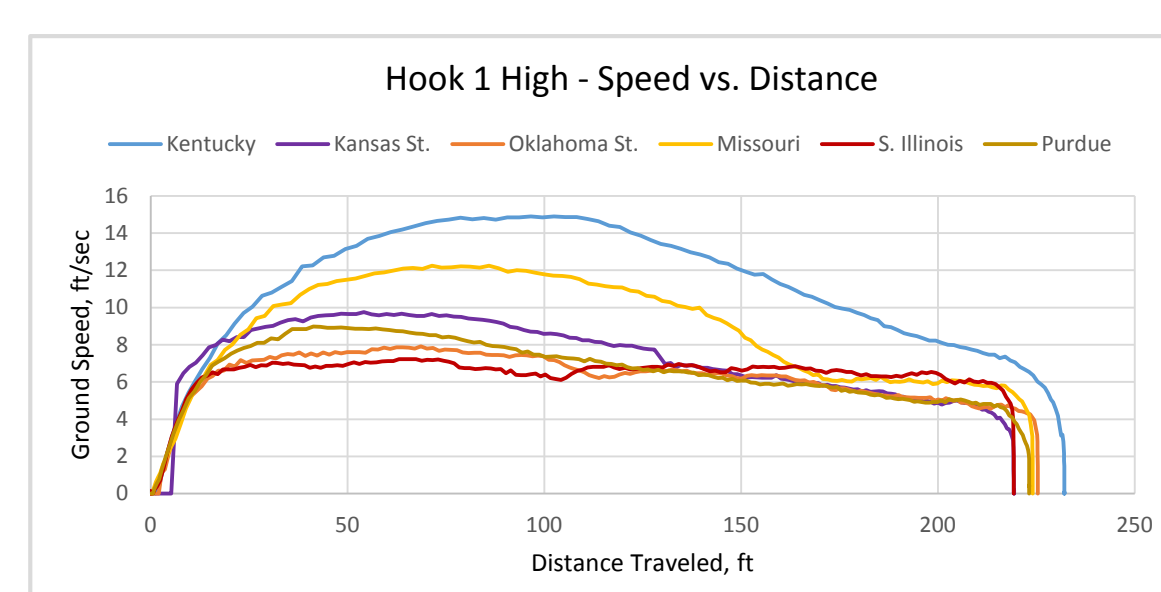
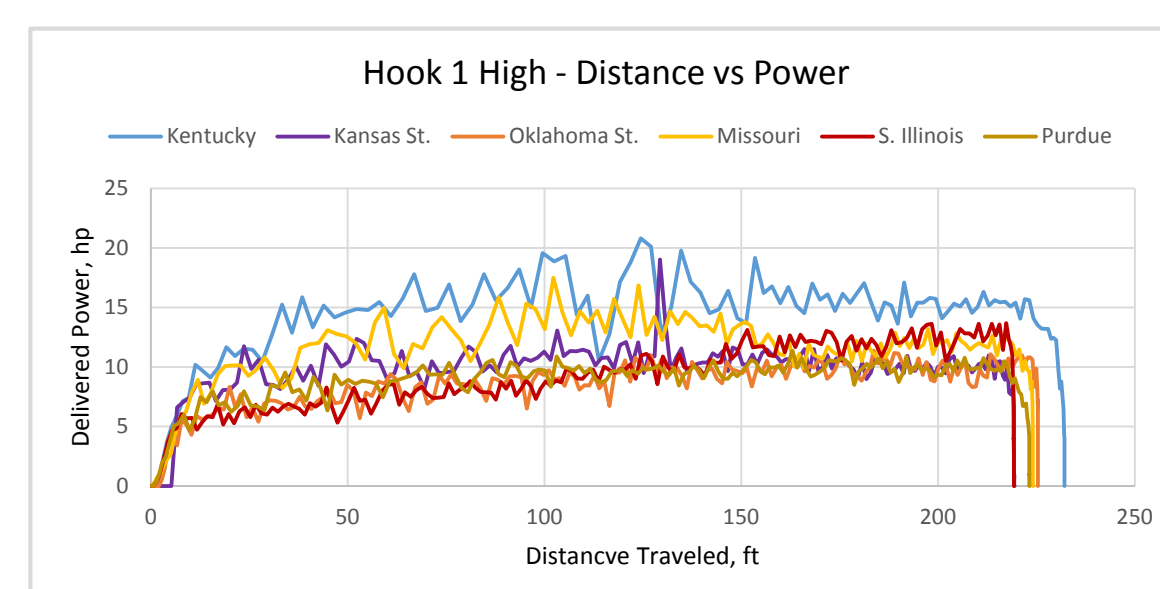
- Obtain current horsepower and torque readings
- Compare horsepower and torque to last year's tractor
- Ensure new parts work as intended
- Obtain and use wagon for durability test

### Solutions

- Engine dynamometer for horsepower and torque readings
- Test CVT weights and springs to get best output
- Potato harvester frame was used for Durability Cart

### Alternative Solutions

- Wheeled Dynamometer testing
- Tuning
- Compare pull times and distances



Engine and CVT on dynamometer stand



Durability wagon at the sand pit

## Operator Station

### Objectives

- Provide an improved design to reduce manufacturing and assembly costs
- An integrated design to reduce number of parts and fasteners needed
- Reduce type of materials used to minimize required inventory

### Solutions

- Combined functional and support components to reduce number of parts by > 50%
- Reduced number of fasteners required by > 50%
- Uses only 14 gauge and 16 gauge sheet steel

### Alternative Solutions

- Use of spot welds or clinch joining to further reduce costs
- Develop a lighter and more easily manufactured steering column

