PURDUE UNIVERSITY

CAPSTONE DESIGN EXPERIENCE 2016

Quarter Scale Tractor

Agricultural & Biological ENGINEERING

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(All are graduating with degrees in Agricultural Engineering-Machine Systems)

Background

The ASABE holds the International ¼ Scale Tractor Student Design Competition that provides students with a 360-degree workplace experience. The Purdue Quarter Scale (PQS) team works year long, concentrating on innovative designs for drivetrain, manufacturability, serviceability, maneuverability, safety, performance improvements, data acquisition, and ergonomics.

Project Goals

The team set out at the beginning of the year to accomplish four goals:

- Real time feedback
- Drivetrain durability
- Operator safety and serviceability
- CVT tuning with dynamometer

Design Constraints

Design engineers were constrained by the requirements of the ASABE competition. These design criteria were:

- Weight – Tractor may not exceed 800 lbs. maximum gross vehicle weight
- Length – No part of the tractor may protrude further forward than 96 inches from the center of the rear axle
- Width – No part of the tractor may be wider than 72 inches

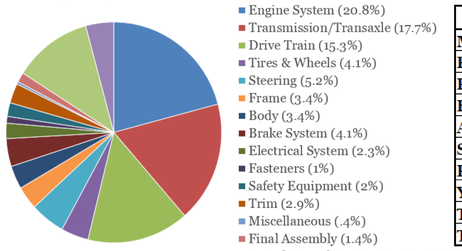
There are several other limitations and rules that the team must meet to qualify for the competition, regarding component design, safety, noise, etc.

Impact and Sustainability

- New designs were chosen to reduce material used and wasted
  - Simplified frame, wheelie bars, and hitch mount
- Fluid drainage tubes to ensure oil makes it into the drainage bucket
- Light weight, 4x4 drivetrain reduces soil compaction and yard damage.

Economics

- Priced per ASABE competition rules
- 3.5% reduction in adjusted manufacturing cost from 2015 tractor
- Engine, transmission, and drivetrain account for 53% of costs



HammerDown Series III Cost Summary		
Manufacturing Variable Cost	$	5,836.61
Period Manufacturing Cost (14%)	$	817.13
Research & Development (5%)	$	291.83
Estimated Full Production Units		3000
Adjusted Manufacturing Cost	$	6,945.56
Suggested List Price	$	7,695.00
Profit Margin		10%
Yearly Net Profit	$	2,248,310.00
Total Number of Parts		201
Tractor Weight		720 lbs

Customer Requirements

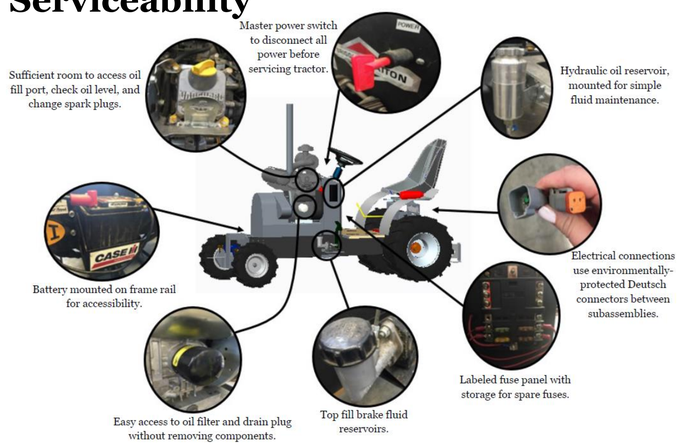
Competitive tractor pullers

- High performance product
- Serviceable
- Safe

Hobby farmers and Landscapers

- Work 5 acres of land
- Handle variable field conditions
- Implement Utilization
- Ergonomic operator's area

Serviceability



Manufacturability

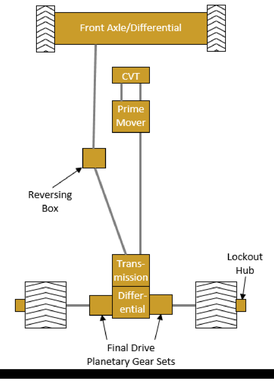
- Common Materials
- CNC plasma cutter, press brake, and powder coating
- Production by an assembly line with subassembly branches

Drivetrain

Objective: Increase reliability.

- 3 main components:
  - Integrated transmission, transfer case, final drives, and locking differential
  - Continuously variable transmission (CVT)
  - Front axle
- 3 forward speeds for ratios ranging from 1:1 up to 3:1
- 27% weight reduction

Alternative designs: 2WD, single planetary, custom transmission, electronic locking differential

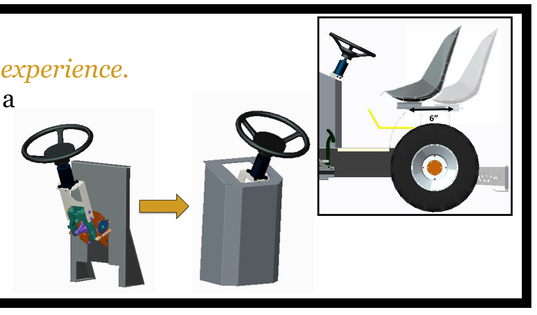


Operator's Station

Objective: Improved operator experience.

- Adjustment to accommodate a 95th percentile operator
- Eliminate pinch points
- Attention to operator zone of comfort

Alternative designs: swivel seat, steering adjustment

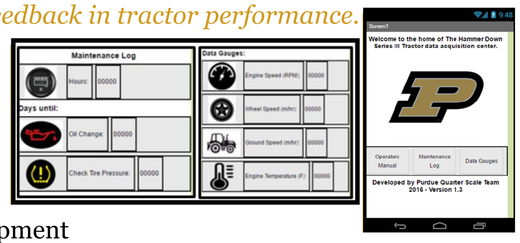


Data Acquisition

Objective: Provide real time feedback in tractor performance.

- Real time feedback
- Measure performance
  - Engine RPM
  - Shaft RPM after the CVT
  - Ground speed
- Competitive advantage
- Phone application in development

Alternative designs: IQAN, tractor ballasting recommendations, gear display

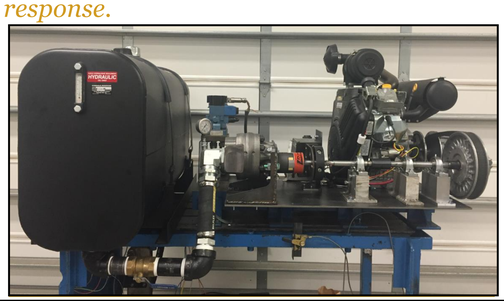


CVT Dynamometer

Objective: Optimize drivetrain response.

- Platform that allows PQS to determine the best setup for their CVT
- Receive full range of actuation from CVT
- Easy access to CVT weights and springs

Alternative designs: various layouts, two-stage pump



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