The goal of this project is to design, fabricate, and test a pulling tractor that meets all rules and regulations of the American Society of Agricultural and Biological Engineers (ASABE) 2014 International ¼ Scale Competition (IQS). The tractor has been divided into five distinct areas: Drive Train, Frame, Electronics and Data Acquisition, Operator Station, and Exhaust.

**Design Criteria & Constraints**

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

**Drive Train**

- Objectives
  - Provide more than 2 gear selections
  - Allow for smooth shifting
  - Contain necessary reductions to achieve required operating speeds
  - Improve ease of manufacture
  - Improve maneuverability

- Solutions
  - A four speed synchromesh transmission coupled with a planetary
  - Simple mounting brackets that minimize manufacturing costs
  - A shaft brake after the CVT

**Design Tools**

- Creo model of PQS14

**PQS14 Cost Analysis**

<table>
<thead>
<tr>
<th>Section</th>
<th>Category</th>
<th>Purchased</th>
<th>Fabricated</th>
<th>Total Cost</th>
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<td><strong>$6,704.75</strong></td>
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**Specifications**

- 31 hp engine
- 7300 ft-lbs; 2800RPM
- 18 MPH max ground speed

**Best 2 and 4 Wheel Drive 1000 lb Hooks, 2013**

<table>
<thead>
<tr>
<th>Weight</th>
<th>Speed</th>
<th>Cost</th>
<th>Serviceability</th>
<th>Manoeuvrability</th>
<th>Safety</th>
<th>Efficiency</th>
<th>Reliability</th>
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</tbody>
</table>

**Decision matrix for alternative drive train solutions**

Sponsor: Dr. John Lumkes
Faculty Advisor: Dr. Bob Stwalley
Graduate Advisor: Daniel Skelton
Special thanks:
Dr. Bernie Engel, Scott Brand
Garry Williams, John Andruch

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Frame

Objectives
- Provide adequate support and mounting points for drive train and operator station components
- Provide shielding for rotating parts
- Contribute minimally to overall tractor weight
- Simplify manufacturing and reduce cost where possible

Solutions
- 14 gauge bent sheet metal frame rails
- 1/4" aluminum plate components met shielding requirements.
- FEA analysis verified component strength, and was utilized to determine ways to remove weight and material cost from components.
- Manufacturing and design changes saved nearly $70/tractor

Operator Station

Objectives
- Provide a comfortable ride and an enjoyable driving experience
- Protect operator from hazardous tractor components
- Minimize machining costs
- Make electronic interface user-friendly

Solutions
- Comfortable and well-supported seat assembly
- Aluminum firewall that adheres to ASABE Standards
- Adjustable seat slide and hydraulic steering column
- Refined fabrication process that uses fewer cuts, bends, and welds
- Easy-to-use IQAN interface

Exhaust System

Objectives
- Install a data acquisition system using low cost components
- Meet the customer’s preferences with several mechanical/electrical packages
- Output data for visual reference and use that data to evaluate the efficiency of tractor operation

Solutions
- Implemented factory exhaust with modifications
- Created shielding that allowed for maximum heat escape without operator being harmed
- Added dual walled pipe to force exhaust to exit above operator

Electronics and Data Acquisition

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
- Implemented Parker IQAN electronic components
- Utilized both electrical and mechanical components, which can be swapped on or off the tractor
- Utilized large display screens, from Parker IQAN, to display important data

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