**Design**

PQ505 was designed with the goal to meet all of our objectives as efficiently as possible. Below are the subassemblies of the tractor along with the key features of each system.

**Parallel Path Driveline:**

For high rearward maneuverability and reverse, PQ505 incorporates a compact, independent hydrostatic powerpath.

**Specifications:**
- *Two-track drive forward speed: 174 mph of horizontal motive force.*
- *Frontal control of vehicle motion.*

---

**Calculations and Analyses**

**Loading Conditions for Frame FEA**

<table>
<thead>
<tr>
<th>Frame</th>
<th>x-comp</th>
<th>y-comp</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engine</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td>Lift</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td>Exhaust</td>
<td>-950.0</td>
<td>-330.9</td>
</tr>
<tr>
<td>Interior</td>
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<td>0.000</td>
</tr>
<tr>
<td>Chain</td>
<td>52.4</td>
<td>-52.4</td>
</tr>
<tr>
<td>Sedan</td>
<td>-11.0</td>
<td>-58.5</td>
</tr>
<tr>
<td>Mass (lbs)</td>
<td>0.000</td>
<td>0.000</td>
</tr>
</tbody>
</table>

**Front Axle FEA**

1000 lb load acts downward in middle of front frame rail. One bracket is hidden to better show stress distribution.

**Turning Radius**

*Steering optimized with 107.5° Ackerman.*

**Hydraulic System**

**Driveline Components**

*Percent of Chain Tensile Strength: 2190 ft-lb, 174 mph, 41% - 3795 ft-lb, 174 mph, 48%*

*Minimum Required Rotation: 1.8 mph, 2.5 ft-lb, 1.2 mph, 174 mph, 5 ft-lb, 1000 psi*
Quarter Scale Tractor Design

Problem statement:
Completely design and build a pulling tractor to compete against other teams at the International 1/4 Scale Tractor Student Design Competition from May 29th to June 1st.

Performance is Judged by:
• Sled pulls
• Maneuverability Course

Design is Judged by:
• Manufacturability
• Serviceability
• Ergonomics
• Safety
• Sound Quality

Design Objectives:
• Move Forward Rapidly for Pulling
• Hold the Weight of the Engines
• Move Forward and Rearward Slowly
• Stop and Steer Motion
• Allow the Operator to Control and Monitor the Tractor
• Hold the Operator Comfortably and Keep them Safe

Novelty and Purpose of Project:
We are fine tuning our own engineering skills, creating new innovative solutions to problems, introducing underclassmen to hands-on engineering design, and promoting Purdue ABE.

Design Features
1. Six engines
2. Two wheel drive
3. Light-weight tubular frame
4. Composite body components
5. Electronic steering and throttle
6. Parallel drive system
Implementation
Building of the tractor began with sourcing materials and parts. Some parts were reused from previous years to save money and design time. Rear wheels and tires, brake disks and calipers, the rear differential and wheel hubs, and the front actuator were all components from the previous year. These components were shown from previous performance to be capable of handling the job. Many new components such as front wheels, clutches, and hydraulic components were sized and purchased.

Driveline Shielding
• Purchased 31" x 4" and 41" x 6.5" of ¼" 5052 aluminum plate
• Purchased 71.5" x 22.125" of ¼" 6061 T6 aluminum plate
• Plasma cut 6061 into flat shields and 5052 into bent strengthening ribs
• Welded into three identical shields

Frame
• Purchased 60 feet of 1" x 1" x 0.049" chrome molybdenum steel alloy (4130) square tube
• Cut tube to length and assembled in jig for welding

Rear Axle
• CV shafts customized to fabricate new involute splined rear axle shafts
• Axle tubes constructed using 4130 round tube with customized ends to hold bearing

Composite Seat and Hood
• Created negative mold for seat and hood
• Will lay fiberglass sheets with foam structural inserts

Drive Shaft
• Purchased 1" diameter splined 2024 T4 aluminum shaft
• Customized sprockets for quick-change utility

Front Axle
• Purchased 36 inches of 5" x 1" x 0.125" 6063 T5 aluminum rectangle tube
• Fabricated spindle tubes and center sleeve from 6061 T6 aluminum tubes
• Welded parts together

Testing
Common Shaft Speed Sensor
The Hall Effect speed sensor was used on previous tractors but never worked correctly. The testing revealed that the frequency to voltage converters needed a zero cross of the signal. A zero cross signal is obtained by using a differencing amplifier. Testing also showed that the previous tractor sensors would have never worked because they didn’t have a zero cross signal.

Weightless Engine RPM Sensors
The alternators are used as engine RPM sensors on the 07 tractor. The testing revealed the need for a differencing amplifier to protect the frequency to voltage converter.

Proportional H-Bridge
H-bridge being used on test bed and on retrofitted ‘07 tractor. Proportional H-Bridge proved to offer better controllability.

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Purdue ASABE Club
Team Sponsors