In a 2012 study by the United States Department of Agriculture (USDA), there were 42,226 broiler (meat-bird) poultry farms located within the United States (USDA, 2012). These types of farms depend on several pieces of equipment to stay operational, one of the most important being a tractor. Farmers can spend up to eight hours a day operating a tractor. Therefore, minimizing time spent driving will improve the efficiency of the farm. P&A's tractor design incorporates hydraulic steering along with a hydraulic powertrain assembly to help minimizing drive time. The figure below demonstrates P&A’s proposed tractor design in relation to a common poultry house.

### DESIGN OBJECTIVES

1. Develop a hydraulically actuated steering system, with a max pressure of 1800 psi, which will achieve an 11 ft. turning radius with a 14 ft. implement attached.
2. Configure a powertrain capable of producing a total of 1800 lbs. of towing force and a maximum speed of 20 mph.
3. Design a tractor having a low-profile frame with an overall length of 7.5 ft., width of 5 ft., and height of 5 ft.

### DESIGN COMPONENTS

- **Hydraulic Control System**
  - Bidirectional Pedal
  - Display Screen / Computer Control

  This system controls the speed of the hydraulic pump and allows for quick change of flow direction. This is important to make maneuverability easy for the user.

- **Drivetrain Assembly**
  - Hydraulic gear motor
  - Displacement: 1.95 in³/rev
  - Max Pressure: 4000 psi
  - Planetary gearhead
  - 7:1 gear ratio

  With a towing force of 3600 lbs., this tractor is capable of pulling any typical attachment used in the poultry industry. In addition, the tractor has a maximum speed of 20 mph, making it easy to travel around the farm in an efficient manner.

- **Steering Valve**
  - Displacement: 3.30 in³/rev
  - Operating Pressure: 1800 psi
  - Flow: 8 gpm

  This hydraulic steering valve provides easy turning (<1 lb. force) for the operator, reducing fatigue while increasing productivity. Lock to lock turning is achievable in two steering wheel revolutions using this valve.

- **Cast Front Suspension**
  - Double acting hydraulic cylinder
  - Turning force: 700 lbs.

  This is beneficial to an operator constantly making turns with an implement within a poultry house.

### COST ANALYSIS

<table>
<thead>
<tr>
<th>Category</th>
<th>Purchased</th>
<th>Fabrication</th>
<th>Manufacturing Price</th>
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<tbody>
<tr>
<td>Engine System</td>
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<tr>
<td>Drivetrain Assembly</td>
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<tr>
<td>Miscellaneous</td>
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<td><strong>Total</strong></td>
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<td>$9,551.63</td>
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P&A’s tractor design will cater to the specific needs of the poultry industry by utilizing a hydraulic powered steering system and drivetrain. This combination of design components and the low-profile frame of the tractor improves efficiency by reducing wasted motion. In order to make this an good investment for the farmer the retail price will be listed as $13,000. This results in a profit margin of 23%.

P&A would also like to thank the following people for their contributions throughout the design process:
- Dr. Timothy McDonald – Professor, Auburn University
- Dr. Jeremiah Davis – Associate Professor, Auburn University

The common commercial poultry house has a width of 40 ft. A turning simulation was performed to demonstrate the achievable turning radius of P&A’s proposed tractor design. This schematic shows the low-profile tractor pulling a 14 ft. long, 500 gallon capacity, poultry house washer through an 180° turn. The tractor was capable of performing this turn within an 11 ft. radius. This turning radius allows the poultry farmer to efficiently use their time driving within the poultry house by minimizing wasted movement. This is a result of P&A’s hydraulically actuated steering system.