INTRODUCTION
The American Society of Agricultural and Biological Engineers (ASABE) hosts an annual Quarter-Scale Tractor Competition where university students design and build quarter-scale tractors that compete in a variety of events including a pull test. For the 2016 competition, the Auburn University team, the War Eagle Pullers, have elected to use a continuously variable transmission (CVT). CAT A TAC, our design team, was tasked with designing and building the actuated control system for the CVT to be implemented in the 2016 tractor.

BACKGROUND
The CVT that is to be used in this design is a rubber V-belt CVT. This system consists of two pulleys, each comprised of a stationary and movable sheave. Gear ratio is changed continuously by varying the diameter of the two pulleys. Typically, a system of flyweights in the primary pulley forces the pulley closed based on engine speed.

DESIGN OBJECTIVES
- Modify a Kawasaki KAF620 CVT and replace the flyweight system of flyweights in the primary pulley forces the pulley closed based on engine speed.
- Design and manufacture a coupling method between the linear actuator and the movable sheave of the primary pulley.
- Program a control system capable of controlling the actuator of the CVT to achieve desired performance in three distinct modes of operation: sled pull mode, sound test mode, and durability/maneuverability test mode.

QR CODES
Scan the QR codes below to learn more about:

CVT Video
Simulation Animation
Control Algorithm

DESIGN
CVT – Actuator Mount
The CVT – Actuator mount design needed to accomplish two main goals:
- Serve as a linkage between the actuator and the CVT
- Translate the pushing force of the actuator to the center of the rotating face of the CVT

A Teflon disc (Figure 2) attaches to the CVT via three existing 6mm bolt holes and serves as a wear plate and shaft collar. An aluminum thrust disc (Figure 5) can push and slip on the rotating Teflon disc.

Control System
The operator is able to input competition mode via three toggle switches. A Teflon disc (Figure 2) attaches to the CVT via three existing 6mm bolt holes and serves as a wear plate and shaft collar. An aluminum thrust disc (Figure 5) can push and slip on the rotating Teflon disc.

Cost Estimates

<table>
<thead>
<tr>
<th>Purchased Component</th>
<th>Quantity</th>
<th>Price</th>
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<tbody>
<tr>
<td>6061 Aluminum bar, 3/16” X 1”</td>
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<td>29.08</td>
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<tr>
<td>2024 Aluminum, 1/2” X 3/4”</td>
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<td>61.99</td>
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<tr>
<td>6061 Aluminum disc, 5” diam</td>
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<td>68.68</td>
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<tr>
<td>PTFE disc, 5” diam</td>
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<td>7.18</td>
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<tr>
<td>1/4” Clevis pin w/Cotter pin</td>
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<tr>
<td>1/4” Clevis pin w/retaining ring</td>
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<tr>
<td>10-32 UNC hex socket head cap screw, 40 mm length</td>
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<td>2.05</td>
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</tbody>
</table>

Total Cost = $749.63

CONTROL
CAT A TAC has developed a design to electronically control a continuously variable transmission (CVT). This design consists of a linear actuator mounted to the primary pulley of the CVT and control system. The control system allows for the extension and retraction of the actuator and was simulated in Matlab. The War Eagle Pullers (Auburn University’s Quarter Scale Tractor team) will be able to implement this design and compete in the 2016 ASABE competition.

ACKNOWLEDGEMENTS
CAT A TAC would like to thank Dr. Tim McDonald, the faculty of the Biosystems Engineering Department, and the War Eagle Pullers for their assistance on this project.