SENIOR CAPSTONE/
SENIOR DESIGN EXPERIENCE
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Overhead Grain Bin Unloading

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Executive Summary

The objective of the overall solution to this project is to automate the overhead grain bin at Purdue's Agronomy Farm which is used to load grain trucks in order to haul grain to sell. Automation of the overhead grain bin is done by improving the method of opening and closing the bin door, a system that helps the driver more clearly see the grain being loaded, and a way to know how much grain is in the bin at any given time. The solution that was come up with was an electric motor mounted on a mount and recommended camera and load cell system.

Background Research

Through background research, the team found multiple commercial products that are used on overhead grain bins for the purposes needed. However, these commercial products can be very costly. Along with that there are very minimal commercial load cell kits that are made for overhead grain bins. Most kits are made for small agricultural feed bins which hold much less weight than the overhead bin which limits commercial product use for load cells.

Project Characteristics

Constraints:
- Cost: Must stay under budget
- Must work using electricity already at the bin site
- Solution must utilize only one person to load grain
- Bin door must close in under 4 seconds, or at same speed as current method
- Must be able to quantify grain amount in bin
- Must not reduce flow capacity from current state
- Must be compatible with current bin system

Criteria:
- Cost: Lower cost is more favorable
- Ease of installation
- Gate operation time
- Weight determination accuracy
- Product warranties/maintenance

Deliverables: Selection of method to remotely open and close bin door, Camera system for viewing grain being loaded, Weight system that can determine amount of grain in the overhead bin.

Solution Proposal & Selection

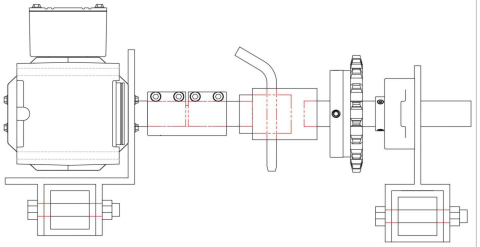
Soultion 1.1: Electric motor mounted to operate overhead bin door.
Solution 1.2: Linear actuator to open and close bin door.
Solution 2.1: Mounted camera setup with monitor for viewing grain being loaded.
Solution 2.2: Mirror setup mounted around bin superstructure where driver can view for moving truck.
Solution 3.1: Thru-hole load cells beneath bin legs to determine weight of grain in overhead bin.
Solution 3.2: Timing of grain to estimate bushels/hour and convert to weight based on test weight.

Value Proposition

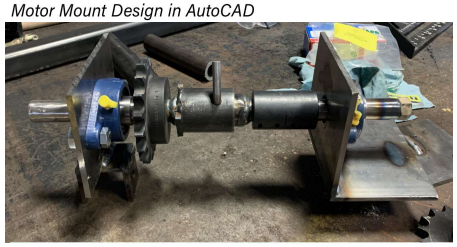
The main value of this project is to improve and automate the unloading of grain within the overhead grain bin. The main group that benefits is the Agronomy Farm and their employees while also other farms that want to utilize the solution ideas.

Project Design & Construction

- Motor mount for electric motor designed and built
  - Shaft coupler connects motor to failsafe and sprocket
- Motor mount failsafe
  - Failsafe pin can be pulled to allow free spin of sprocket if motor fails
- Other pieces of solution will be recommended and installed on new grain bin setup being built
  - Agriculture camera system recommended
  - Thru-hole load cells recommended to be placed under bin legs



Motor Mount Design in AutoCAD



Completed Motor Mount: One side using additional shaft and welded on nut for testing purposes.

Prototype Testing

As the motor mount for the overhead grain bin door was the only piece that had to be designed and constructed, that is the only piece that was able to be tested. A chain was used on the sprockets of the motor mount and bin door. An impact was used to turn the shaft on the mount in order to properly simulate the torque and speed of the electric motor. The failsafe was also tested and performed properly.

Testing of Motor Mount on Overhead Grain Bin

Maximizing Impact

The goal of testing of the motor mount was to have a solution that worked as efficiently and effectively as the current method of operating the bin door, which was successful. After installation of the motor mount the Agronomy Farm will successfully be able to operate the overhead grain bin door safely and effectively.

For the other pieces of the solution, an agricultural camera system was recommended to be installed around the overhead bin in order to safely view the grain being loaded. Thru-hole load cells were also recommended to be put under the overhead grain bin legs. Both of which will be installed at a later date by the Agronomy Farm.

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