PURDUE UNIVERSITY

CAPSTONE/DESIGN EXPERIENCE 2016

Ergonomic Trailer Hopper Opener

Agricultural & Biological ENGINEERING

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Objective/ Problem Statement:

Using traditional hopper openers on hopper bottom trailers can be ergonomically unsafe and create a safety hazard when this task is performed multiple times per day.

Background:

- Grain industry trend towards hopper bottom trailers for the transportation of commodities.
- The current hand operated design has the potential to cause operator fatigue and injury.
- During peak delivery times of the year, an operator can open several hundred hoppers per day.
- The low height of the trailer door causes strain on operator's back through the bending motion.

Constraints:

- Minimize or reduce fatigue/injury to employees.
- Hot work permit required everyday for electrical tools.
- Assume no electric or pneumatic power available at dumps.
- Adaptable to multiple trailer opening designs.
- All parties involved approve of the use of the opener.
- Keep the customer's trailer damage free during operation.

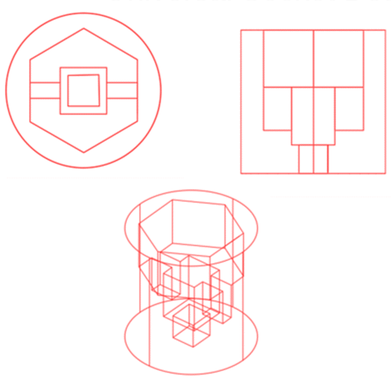
Compressed Air Feasibility Report

Parts	Info	Price
Air Compressor	80 gal Stationary, 6.6 CFM	$ 959.20
Steel Piping	10' 3/8"sticks $8.58/stick-15	$ 128.70
Fittings		
90	$1.54/fitting -5	$ 7.70
Females	$1.54/fitting-10	$ 15.40
T	$1.97/fitting-4	$ 7.88
Wall Clamps	$.25/clamp-20 clamps	$ 5.00
Hose Reel With Hose	3/8 in -50 ft hose	$ 89.99
Air Impact		$ 393.75
Labor	20 hours $20/hour plant empolyee	$ 400.00
Total		$2,007.62
Potential upcharge	20%	$2,409.14

Potential Alternative Solutions:

- Manual Crank
- Electrical
  - Corded
  - Wireless
- Hydraulic
- Pneumatic

Universal Socket Design



Recommendations/ Research Design:

For this project, the recommended power solution is to use pneumatic driven tools. The specifics of the pneumatic system will have to be set up so as to make the workplace safe and free of trip hazards. Therefore the air supply line will be suspended off the ground to avoid being in contact with the employee and equipment. The compressor and storage tank will also need to be housed in building or control room to contain the potential risk of electrical spark from the air compressor.

Pneumatic components: Many different components will be needed to operate a pneumatic driven opener. The system will consist of:

- Air compressor
- High pressure air lines
- Retractable air hose reel
- Flexible air hose
- Variable torque impact wrench

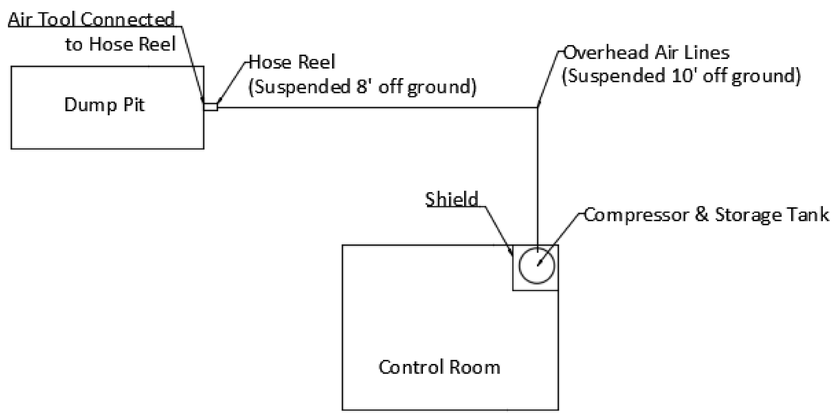
Torque: The impact wrench will have to be able to produce at least 55 ft.-lb. of torque, but it should not exceed 80 ft.-lb. to prevent damage to trailer components.

Compressor requirements: The opening of the hoppers with the impact will require 3.75 cubic feet per minute of air from the compressor. The compressor that has been suggested can yield up to 6.6 cubic feet per minute to allow for a reduced workload. This compressor will only be able to run a single unloading pit, therefore a larger unit would be required for operation of multiple unloading pits.

Universal Socket Specifics: Chrome molybdenum should be the material used for the socket due to it is more ductile and less likely to shatter from torque or vibration.

Trailers: The one half inch drive universal socket is able to open multiple trailer brands like: Wilson; Tempte; Merritt; Maurer; Neville; Jet; and possible others. The socket consists of a 1.75" internal hex, a 0.75" internal square, and a 0.375" keyway milled into the internal square.

Final System Design



Sustainability/ Impact on Industry

The ramifications of this project have the potential to change the way an industry operates in terms of customer service and grain movement. With around 300,000 farms and 14,000 commercial elevators that store grain, there is a large market that could benefit. If the industry had an easy and safe way to open hoppers for customers, the efficiency of the process as a whole would be increased as well as fewer days lost to accidents and fewer long term injuries could also be recorded. This increase efficiency can be translated into being good for the environment by reducing the time that grain trucks are sitting at idle just burning fuel. Powered and assisted opening devices already exist in the rail hopper market, if the technology and ideas could be scaled down to a more manageable size for semi trailers, the effects throughout the industry could be significant.

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