PURDUE UNIVERSITY

Agricultural and Biological Engineering

CAPSTONE/SENIOR DESIGN EXPERIENCE 2020

JD-1 Grain Quality Sampling

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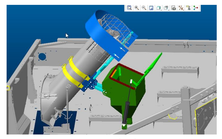
Introduction

John Deere's Global Combine Development Center has been trying to come up with a solution that will help them with collecting grain samples from the harvester grain tank

- Current situation:
  - Person climbing into tank
  - Collecting ½ gal. to 5 gal. samples
  - Climbing out
- This causes safety and efficiency issues

R&D trip to JD HQ. JD-1 team with Deere team.

Iowa State senior design.



Deere internal design.

Problem Statement

Design a system to automatically collect and transport grain samples on late model John Deere combines

Background

- **2012** – Iowa State senior design
  - Swinging container arm just under the clean grain auger with a vacuum tube solution
  - Covered too quickly and become inanimate
- **2016** – Deere internal design
  - Container just below the clean grain auger with a moving door to open and close the container
  - Covering the container and getting stuck with pressure
- **2019 Research & Development Trip** – November 15th to John Deere HQ
  - Conference meeting with validation and verification process team about what they wanted the design to look like and operate

John Deere S790 Grain Tank

Deliverables

- Design a mechanism that allows grain samples to flow from the clean grain auger to outside the grain tank.
- Video of testing that the gravity flow and vacuum will operate.
- Rough layout of storage platform above the left-hand front tires.
- Design files with build sheet & parts list so Deere can continue development.

John Deere S790 Grain Tank clean grain auger bearing

PVC pipe placement in grain tank.

Final Solution Specifications

Table1. Pipe Capacities.

Pipe Dia. x Length	Bushel Equivalent
4"x72"	0.42
5"x72"	0.66
6"x72"	0.95

Fountain Auger Extension *(1/8" rolled steel)*
PVC Pipe *(table 1)*
Fernco PVC Couplers

Components
Slide Gates
Shop Vacuum
5-gal. Bucket Cyclone

5-gal. bucket cyclone and shop vacuum photos.

Fountain Auger Extension – gives proper angle of repose for gravity flow of grain
PVC Pipe – effectively meters sample size & contains sample from outside contaminants
Fernco PVC Couplers – helps ease installment of pipes
Slide Gates – open pipe for grain to flow
Shop Vacuum – powers the grain collection system
5-gal. Bucket Cyclone – separates grain & foreign material from air in vacuum system

Factors/Impacts

- Global & Economical
  - Increased efficiency
  - Better grain quality
  - No negative impacts
  - Less yield loss
  - Autonomy

Constraints

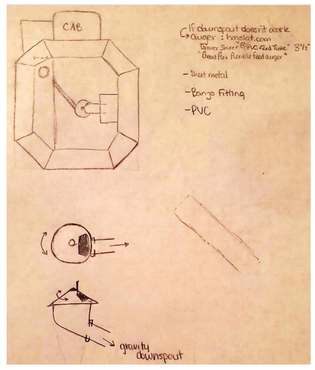
- Compatible with late John Deere models
- Does **NOT** interfere with filling the grain tank
- Ability to be shipped on pallets or in containers

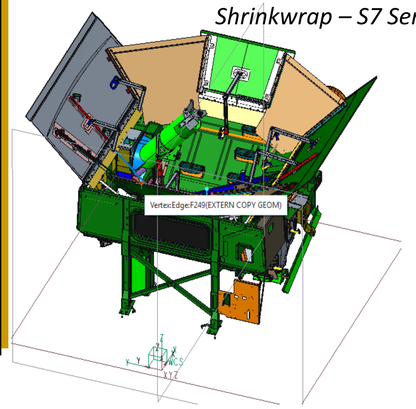
Criteria

- Ease of:
  - Operation
  - Installment
- Cost
- Storage capacity
- Ability for varying sample sizes
- Follow industry standards

Alternative Solutions

- Option 1 – collection bucket, twist top to gravity downspout
  - Flaws: twist top would get stuck after too much pressure; bucket would get covered
- Option 2 – slide gate & gravity tube straight from clean grain auger
  - Flaws: can't damage the combine itself
- Option 3 – extension on clean grain auger with slide gate & gravity tube





John Deere's Grain Tank Shrinkwrap – S7 Series

Product Implementation

Economic Analysis

- Cost – $1,000
- Labor – saves approx. 4.5 man hrs. per testing day

IVAC 4" ProBlast Slide Gate

Dustopper 5 gal. Bucket Shop Vacuum Cyclone

Testing Plans

Test 1 – extension & filling the PVC pipe
- 4" auger provided by ADM to simulate grain flow through fountain auger & extension
- Desired Outcome: time it takes to fill; issues by density variance in grain

Test 2 – vacuum collection system *(picture below)*
- Desired Outcome: could vacuum handle grain; time to empty PVC pipe; effectiveness of cyclone

Table1. Test2 – vacuum collection.

Capacity (bushel)	Time to Empty (seconds) [moisture tested: 13.1% YSB, 16% YC]
1/4	30 sec
1/2	60 sec
3/4	90 sec
1	120 sec

Test2 – vacuum collection system simulation.

Sponsor:
JOHN DEERE
Main Contacts: Derek Franke
Tyler Smith
Chad Borkgren

Instructors:
Dr. John Evans

Technical Advisor:
Dr. Shawn Ehlers

Standards:
ANSI/ASAE S343.4
Terminology for Combines and Grain Harvesting
ASAE D274.1
Flow of Grain and Seeds Through Orifices

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