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Prototype Bale Trailer and Tongue Finite Element Analysis

Kirk Atwater
Iowa State University, katwater@iastate.edu

Weston Connor
Iowa State University, wpconnor@iastate.edu

Dillon Gaul
Iowa State University, dgaul@iastate.edu

Colin Vagts
Iowa State University, cvagts@iastate.edu

Joseph R. Vanstrom
Iowa State University, vanstrom@iastate.edu

See next page for additional authors

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Problem Statement

Our Client is an independent inventor located in western Iowa. The problem at hand was that our client farms on very uneven ground and have problems when loading round bales. The problem with round bales and hills is that they are prone to roll away. During the baling process, the operator tries to place bales at an angle to prevent rollaway bales. Our client has created a self-loading bale trailer that can be pulled by either a tractor or a pickup truck. The goal was to eliminate the need for a loader in the field and be able to pick up bales on the move. The trailer must pick up and haul seven bales safe and efficiently. Another feature of this trailer is when picking up corn stalk/ hay bales, the operator can drive with the rows to reduce stress on equipment.

Disciplines

Bioresource and Agricultural Engineering | Industrial Technology

Authors

Kirk Atwater, Weston Connor, Dillon Gaul, Colin Vagts, Joseph R. Vanstrom, and Jacek A. Koziel

IOWA STATE UNIVERSITY

Department of Agricultural and Biosystems Engineering (ABE)

TSM 416 Technology Capstone Project

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Kirk Atwater [a], Weston Connor [b], Dillon Gaul [c], Colin Vagts [d], Joseph R. Vanstrom [e] and Jacek A. Koziel [f]

[a] Agricultural Systems Technology, ABE, ISU, katwater@iastate.edu
[b] Agricultural Systems Technology, ABE, ISU, wpconnor@iastate.edu
[c] Agricultural Systems Technology, Industrial Technology, ABE, ISU, dgaul@iastate.edu
[d] Agricultural Systems Technology, Industrial Technology, ABE, ISU, cvagts@iastate.edu
[e] Dept. of Agricultural and Biosystems Engineering, ISU, 2321 Elings Hall, Ames, IA 50011, vanstrom@iastate.edu, 515-294-9955
[f] Dept. of Agricultural and Biosystems Engineering, ISU, 4350 Elings Hall, Ames, IA 50011, koziel@iastate.edu, 515-294-4206

*course instructors and corresponding authors.

Client: Independent Inventor, 39212 Hwy 3, Le Mars, Iowa, 51037

- Joe Ludwig, Independent Inventor, joejludwig@gmail.com

1 PROBLEM STATEMENT

Our Client is an independent inventor located in western Iowa. The problem at hand was that our client farms on very uneven ground and have problems when loading round bales. The problem with round bales and hills is that they are prone to roll away. During the baling process, the operator tries to place bales at an angle to prevent rollaway bales. Our client has created a self-loading bale trailer that can be pulled by either a tractor or a pickup truck. The goal was to eliminate the need for a loader in the field and be able to pick up bales on the move. The trailer must pick up and haul seven bales safe and efficiently. Another feature of this trailer is when picking up corn stalk/ hay bales, the operator can drive with the rows to reduce stress on equipment.

Business Case Statement

- We started with a basic plastic prototype, provided by our client. We have recreated the initial design with the use of SolidWorks CAD software. We then designed the trailer tongue and completed a Finite element analysis (FEA) test on our design to ensure the strength and safety.
- The tongue is a very critical part of the trailer; if it fails, we cannot successfully load and transport bales to and from the field.

- This problem occurs on uneven farm ground during the summer when making hay. Then during the fall when making corn stalk bales.
- The opportunity here was not to recreate the wheel, but to improve on a process that can be very time-consuming. The goal was to be able to drive with the rows to reduce stress on equipment.
- People who will benefit from this product are smaller farming operations who do not make as many bales or farm on uneven ground.

2 GOAL STATEMENT

An Improvement was required because our client and other hill farmers face this problem every year. A roll away bale can be a dangerous thing to the farmer, his/her land or pass by vehicle. In the mind of a farmer the faster, you can get a job done the better. The goal here is to load bales with the rows while you are still moving to eliminate time spent sitting still waiting to be loaded. Another factor to this is if the trailer can load itself then the farmer will only need one loader tractor back at the farm to stack bales for storage over the winter.

Improvement on this process can be measured in time saved. Either from driving back and forth from the field with the loader or in time spent in the field loading bales. Time = Money on the farm so the more efficient a farmer can be the better it is for his/her bottom line.

Our goal was to improve on this existing process by making this trailer as efficient as possible and as user-friendly as possible. This will be accomplished by both time and money saved by the farmer.

- **Main Objective**
  - The main goal was to fully design the initial prototype bale trailer our client had provided us, then run a Finite element analysis (FEA) test on the trailer tongue system.

- **Objective and Constraints**
  - Created CAD model of bale trailer
  - Completed FEA test on trailer tongue
  - Must be able to load when moving while driving with the rows
  - Ability to load and haul 7 bales safely, when in the field and on the road
- **Rationale**
  - Reduce average time for loading and unloading bales in the field and at the storage site
  - Eliminate need for a loader in the field
  - Reduce cost of operation for the farmer

3 PROJECT PLAN/OUTLINE

A. Methods/Approach

- Reference Material(s)
  - ASABE Standard Tubing sizes
  - SolidWorks CAD Software

- Patents on existing self-loading trailers
- Iowa State University faculty members

- **Data collection**:
  - We collected our data upon completion of our FEA test results
  - We then reported our results to our client on if our tongue design is plausible
- **Skills:**
  - We used SolidWorks CAD software for prototype and FEA testing
  - Statics of materials and strengths
  - Time and project management
  - Proper professional business communication with faculty and our client
- **Solutions**:
  - Upon completion of our FEA test of the trailer tongue. We evaluated our design to see if it will hold up to the stress, it will face out in the field
  - Our original design was not strong enough, we then went back and added supports and strengthened the weak points of the tongue
  - We presented our client with our findings and our proposed possible tongue design
- **Organization:**
  - Our team had weekly meetings from 2-4 on Mondays
  - We attempted to make contact with our client weekly if not every other
  - We stayed on task by filling out an excel sheet to track our time spent working
  - Our major milestones were completing the 3D model, FEA test, and final report

B. Results/Deliverables

- FEA test results on trailer tongue system
- 3D CAD model of bale trailer
- Final report with part drawings

4 BROADER OPPORTUNITY STATEMENT

- Our project appeals to the average farmer who produces hay or corn stalks every year
- Our product helps feed the world. Hay is a critical feed ingredient for livestock industry
- Our product will only be sold in the Ag market to farmers who produce bales
- It is designed to pick up forage bales.
- Self-loading bale trailers already exist but not for pickup trucks. Our goal is to make one on a smaller scale to be more affordable for the smaller farming operations.

5 PROJECT SCOPE

The goal of our project was to design and test a trailer tongue for a self-loading bale trailer our client is designing. Our client is an independent inventor/ farmer. We started with our client's initial prototype trailer and designed our tongue system to withstand all the forces it will face out in the field. Upon the completion of the 3D CAD model and FEA test, we contacted our client with our results. If more work was required to fix the problem, we then redesign and fixed the wrong parts of the trailer.

6 GRAPHICAL ABSTRACT

Trailer design is still patent-pending.