PURDUE UNIVERSITY | Agricultural and Biological Engineering

CAPSTONE/SENIOR DESIGN EXPERIENCE 2020

Title: PUP-4: Multi-Crop Thresher

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Problem Statement:

Mobile Agricultural Power Solutions is in need of a thresher capable of threshing multiple crops, including, but not limited to, corn and soybeans for use by smallholder farmers in developing nations. Current manual threshing methods in developing nations are inefficient, and similar threshers are expensive, difficult to obtain, and usually are only designed to be process one kind of crop. The goal is to create a thresher that has a simple design, consists only of materials sourced in-country, and is inexpensive.

Background Information:

The Purdue Utility Project (PUP) has been focused on developing vehicle platforms to provide smallholder farmers with the tools necessary to help mechanize their operations. Many other groups around the world have similar teams, but threshing has remained relatively untouched.

Agriculture in Africa:

- Largely manual
- 55% women, 51% men, 85% child laborers
- Small scale

Threshing in Africa

- Manual methods are common
- Threshing is the pinch point, increased field loss
- Requires lots of hired labor

Multi-Crop Thresher Built by David Wilson in 2015

This is the first iteration of a thresher built in conjunction with PUP. It served as inspiration for our design.

Design Constraints and Criteria

Criteria

- Easy integration with current PUP/Mini-PUP vehicles
- Higher threshing efficiency than previous iterations, as well as other current methods used in developing nations

Constraints

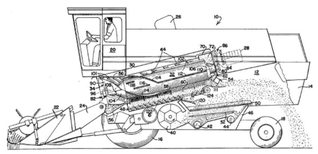
- Must conform to safety standards in-country
- Threshing unit must cost less than $750

Alternative Solutions

The team had to make several design decisions. The main decision the team needed to make was the threshing configuration. There were three possible options:

1. Axial Feed-Axial Flow
2. Tangential Feed-Tangential Flow
3. Tangential Feed-Axial Flow

1



2

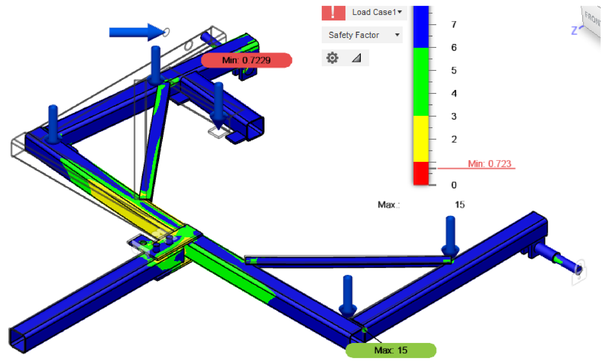
3

Final Solution:

Threshing Configuration: **Tangential Feed-Axial Flow**
Sieve Configuration: **Simple perforated sheet**
Chassis Configuration: **Trailed configuration**
Rotor Configuration: **Combination Peg Type and Rasp Bar Type**
Chute Design: **Simple Angled Chute**

Analysis of Cart Design:

- Weight of the thresher was distributed across the 6 mounting tabs
- One axle is fixed
- One axle has 300 lb loads applied in the X, Y, and Z directions

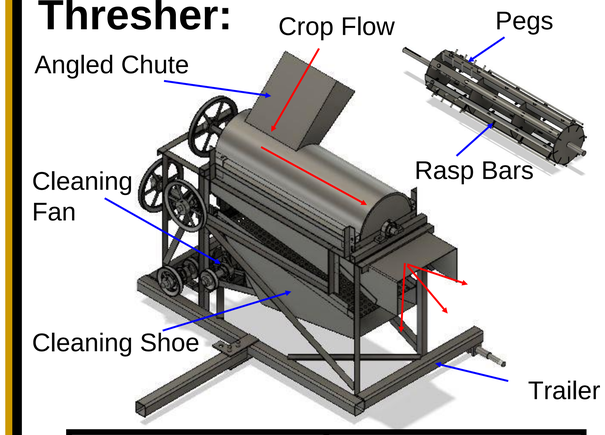


This was a static analysis of the worst case scenario of an impact on the wheel from a collision. The weakest point is at the spindle. Since the frame is strong enough to handle this worst case scenario, it will be strong enough to handle day-to-day use.

Testing Plan:

To test the machine, 25 lbs of corn and 10 lbs of soybeans should be processed. Then the masses of MOG and grain in the thresher, in the grain bin, and on the ground should be measured. These values should be compared to the baseline test performed on Wilson's model to check for an improvement in threshing efficiency.

CAD Model of Complete Thresher:



Weight:	392 lbs
Overall dimensions:	55"x62"x49"

Economic Analysis:

- Input Costs
  - Threshing Unit costs: $750
  - Cart option costs: $125
  - Labor: $125
  - Total cost: $1,000
- Monetary Return on Investment (ROI):
  - Cost for a 90 kg bag of corn (Kenya, 2018): $22.26
  - Payment needed ROI: 45 bags
  - Total threshed bags for ROI (payment is usually 1 bag for every 10 threshed): 450 bags
- Time for ROI:
  - Estimated bags threshed/day: 9 bags
  - Estimated threshing days for return on investment: 50 days
  - Length of harvest season: ~60 days

Project Implementation:

Due to the events surrounding the COVID-19 outbreak, the manufacture and testing of the machine could not occur. Instead, a manufacturing and assembly manual has been created by the team to guide MAPS and other non-government organizations (NGOs) in manufacturing the thresher. The guide features technical drawings and image-based assembly instructions. The guide serves as a rough draft, and will need to be edited once full construction has been completed.

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