



University of Idaho

College of Engineering

Debaling Agricultural Materials

UI-Debalers
Expo Presentation

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Objective

To design and test a device that will efficiently debale agricultural material for secondary processing. The debaler will produce a consistent outfeed of material without creating fines.



Value Proposition

Agricultural feed stocks for bio-based products and biofuels:

- Biomass materials need to be baled for transport from the fields
- Need for increased productivity of various facilities (dairies, ethanol plants) by providing effective method of debaling material
- Meet the increasing demand for precision based feedstocks, biofuels and biobased products



Product Requirements

Specifications:

- Mechanical device to pull apart agricultural materials
- Less unusable particles than a traditional hammer mill
- Prototype withstand 100 lb bales
- Full scale withstand 2,000 lb bales
- Consistent outfeed
- Control material outfeed to conveyor



Testing Forces Needed to Debale a Bale



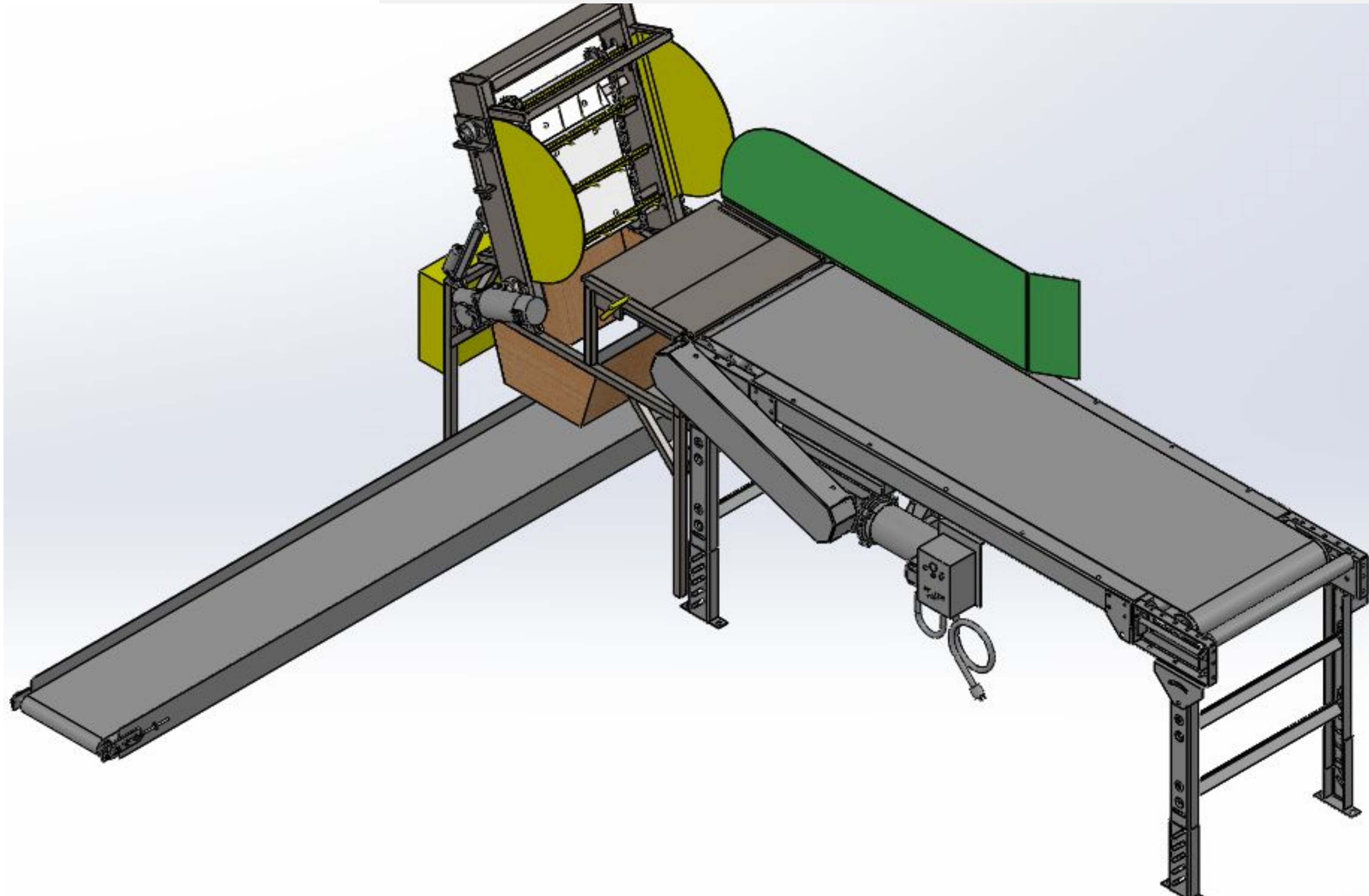
1st testing was with a pitchfork and fish scale.

2nd testing was with a “cross bar” and fish scale.

Proof of Concept testing with a digital torque adapter.



Final Design Concept



- 1- Ability to adjust infeed gap.
- 2- Ease of changing attack angle.
- 3- Simple speed control.
- 4- Constructed with pre-existing components for cost savings.

Final Design Prototype



Final Design Attributes

Red arrow indicates the sliding plate to adjust infeed gap.

Yellow arrow shows the large coarse thread turnbuckle to obtain optimal attack angle.



VFD for easy speed control.



Manufacturing



- SolidWorks was used to model the design
- The use of a drill press for more precise drilling.
- Bearing slots were made with the drill press and cut-off wheels
- The frame and head were welded together.
- Grade 5 fasteners used throughout the full assembly
- The largest challenges faced during the manufacturing was finding a location that had the equipment needed
- We want to thank **Dianna Olsen** for allowing us to use her shop and equipment to construct and test our project!



Debaler Walk Through



Debaler Operating



Testing



Observations and Possible Alterations

- Clearance gap is vital between cross-bars and material
 - Several different gaps were tested in both proof of concept and prototype
 - A 4" Gap was optimal for the material we were testing
- RPM has a large effect
 - Hand Crank was around 60 RPM
 - Prototype had a range from 70-176 RPM ~ 770-1,940 in/min
 - Diminishing returns at higher RPM
- Angle of attack
 - Prototype tested 4 different angles. 0, -5, -10, -17
 - With more angle stalling/plugging decreased
- Brush needed
 - Testing showed material did not come off teeth as expected
 - Prototype used a spring tines on backside of machine
- Needs larger funnel
 - Should be from back of support frame to infeed



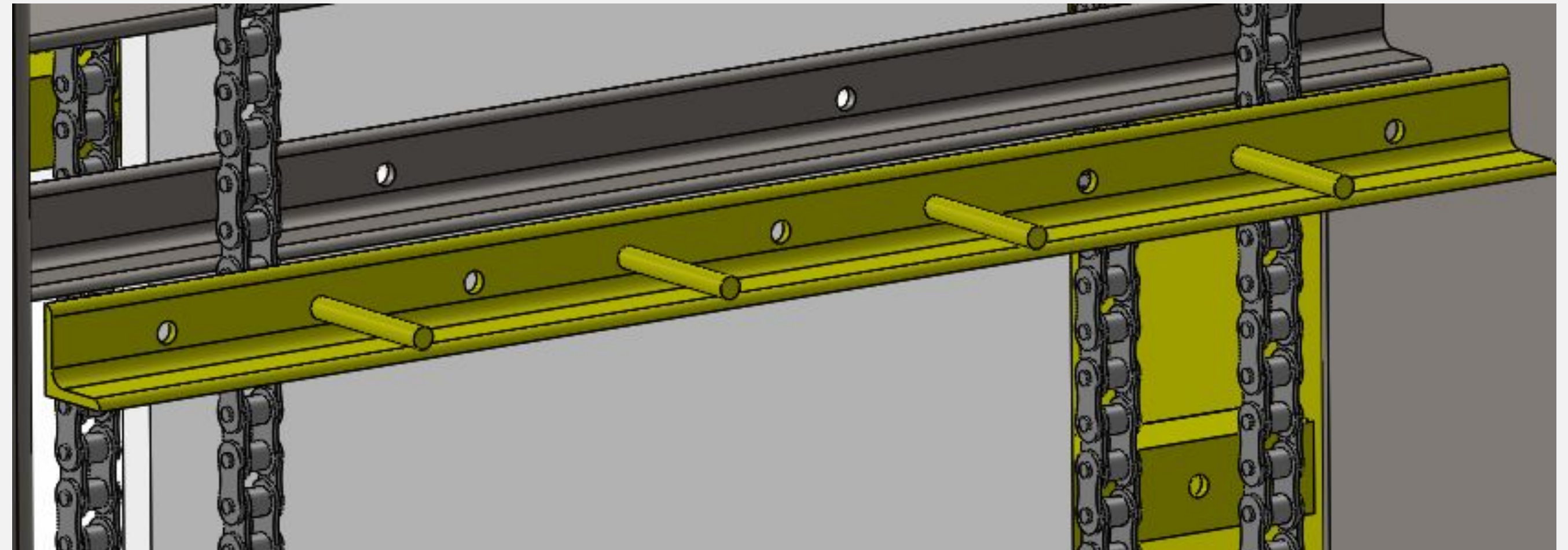
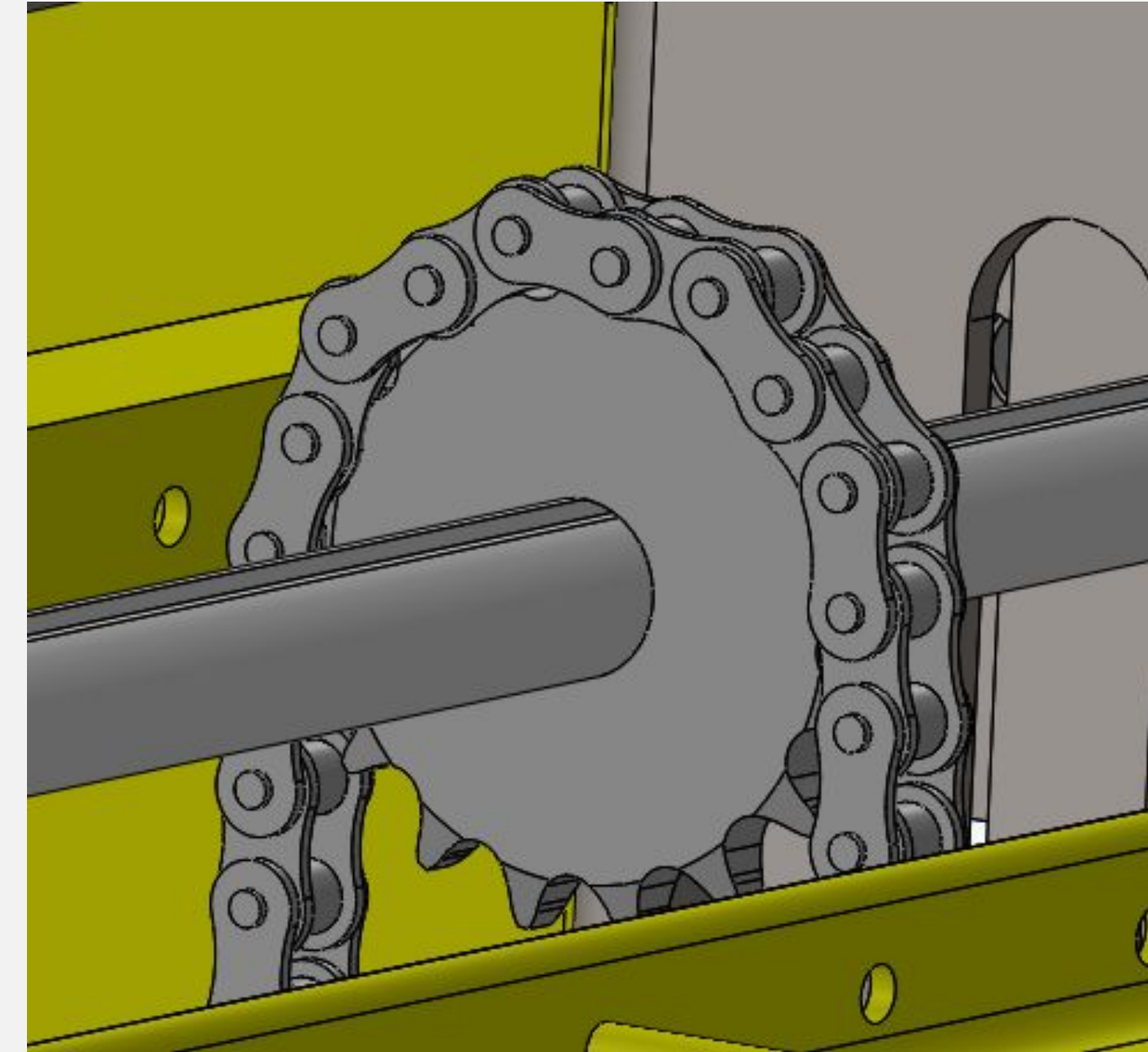
Validation of Prototype

- Ran 23 tests to optimize output by adjusting variables:
 - Gap width
 - Motor speed
 - Attack angle
- Produced consistent outfeed on multiple tests
 - No flakes were seen in the outfeed
 - Consistent height of material along conveyor



DFMEA

- 23 entries
- Drive chain skipping or snapping
 - (RPN score of 16)
- Cross bar failure
 - (RPN score of 12)
- 3 Phase motor/VFD
 - (RPN score of 12)





Budget

Currently well under budget

U I - Debalers											
Project: Debaling Machine											
Last Updated 9/20/2019											
Expense Items	Year								Item Total		
	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr			
Travel:											
(Travel Unlikely)	\$ -								\$ -		
Supplies / Parts / Services:											
Feed Bales, 2		\$ 14							\$ 14		
Spence					\$ 4				\$ 4		
MBS					\$ 23				\$ 23		
Pacific Steel							\$ 9		\$ 9		
Fastenall, hardware							\$ 19		\$ 19		
Spence hardware							\$ 6	\$ 43	\$ 49		
Hay Bale							\$ 7		\$ 7		
Amazon, bearings, switch, electrical box							\$ 64		\$ 64		
Fastenall, shaft							\$ 69	\$ 19	\$ 88		
Pacific Steel, materials							\$ 207		\$ 207		
North 40, hardware						\$ 9	\$ 46	\$ 23	\$ 78		
VFD							\$ 194		\$ 194		
									\$ -		Expenses
									\$ 756		Subtotal
Shop Usage (est. Hrs):											
Keying nut						1			1		
									0		
									\$ -		including fringe
									\$ -		
									\$ 38		5% of all expenses
									\$ 794	\$ 1,241	\$ 447
										Budget	Excess

- Total Spent \$800
- Total Remaining \$400
- Major costs
 - VFD
 - Steel
 - Shaft Material



Questions?

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