



University of Idaho

College of Engineering

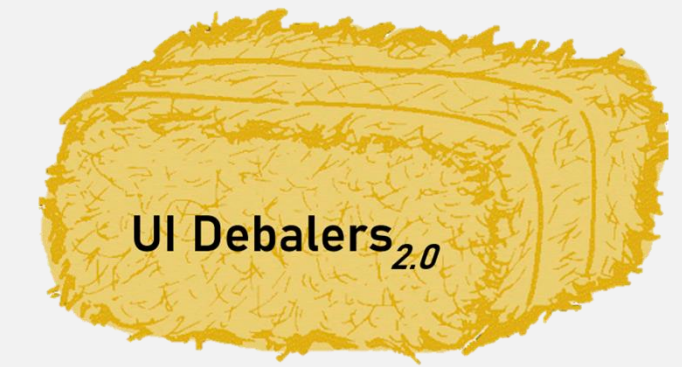
ENGINEERING EXPO

UI DEBALERS 2.0

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Zimmerman

OVERVIEW

PRESENTATION TOPICS



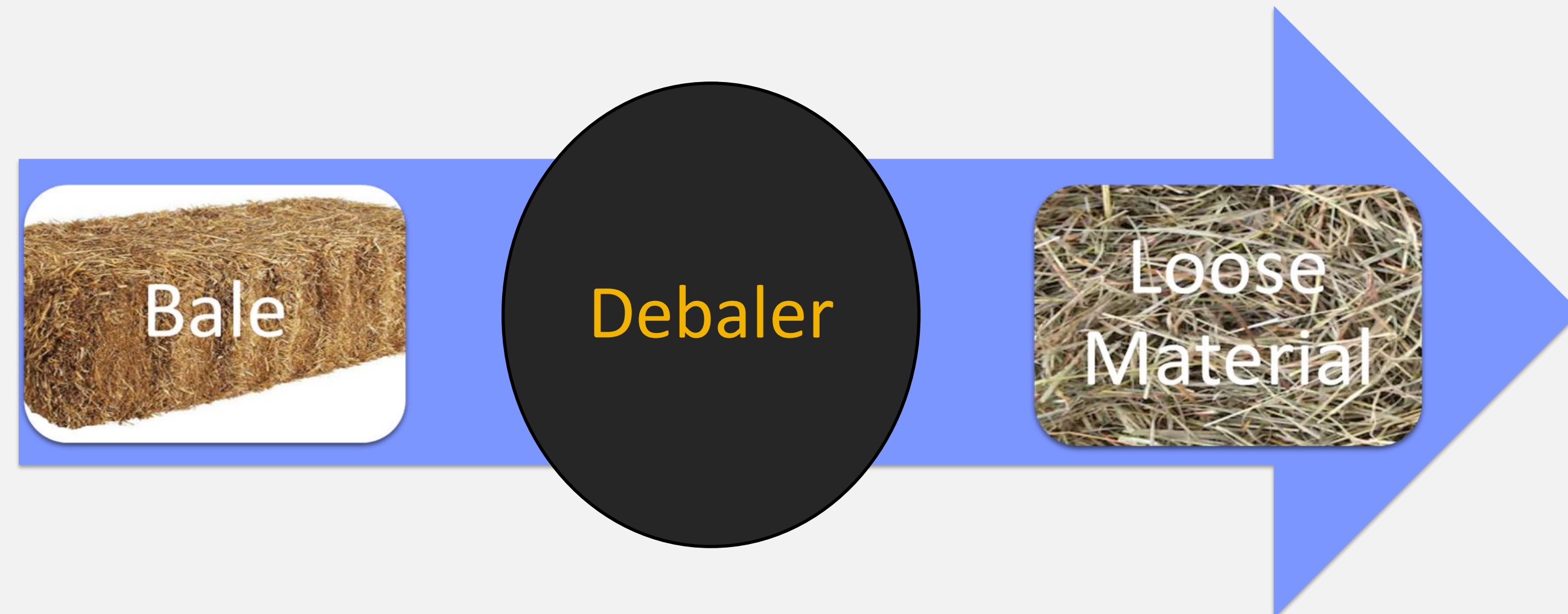
- I Background
- I Value Proposition
- I Project Objective
- I Key attributes
 - Manufacturing plan
 - Design Validation
- I Recommendations



BACKGROUND



- I There is a need to debale straw, corn stover, hemp stalks, and other baled herbaceous crops for feeding into industrial processing equipment.
- I The Fundamental Question: How can we effectively and efficiently turn baled material back into the loose material and feed it onto a conveyor for subsequent milling and processing?
- I Forest Concepts needs a debaling mechanism to break down large square bales of stover, switchgrass, and similar materials into uniform streams that can be conveyed into their Crumbler® rotary shear comminution systems.



VALUE PROPOSITION



THE PROBLEM

- I Current debaling methods used in industry do not work well for automated processes
 - Produce too large of chunks of material
 - Produce too many fines (finely ground material)



Some Current Processes

VALUE PROPOSITION (CONTINUED)



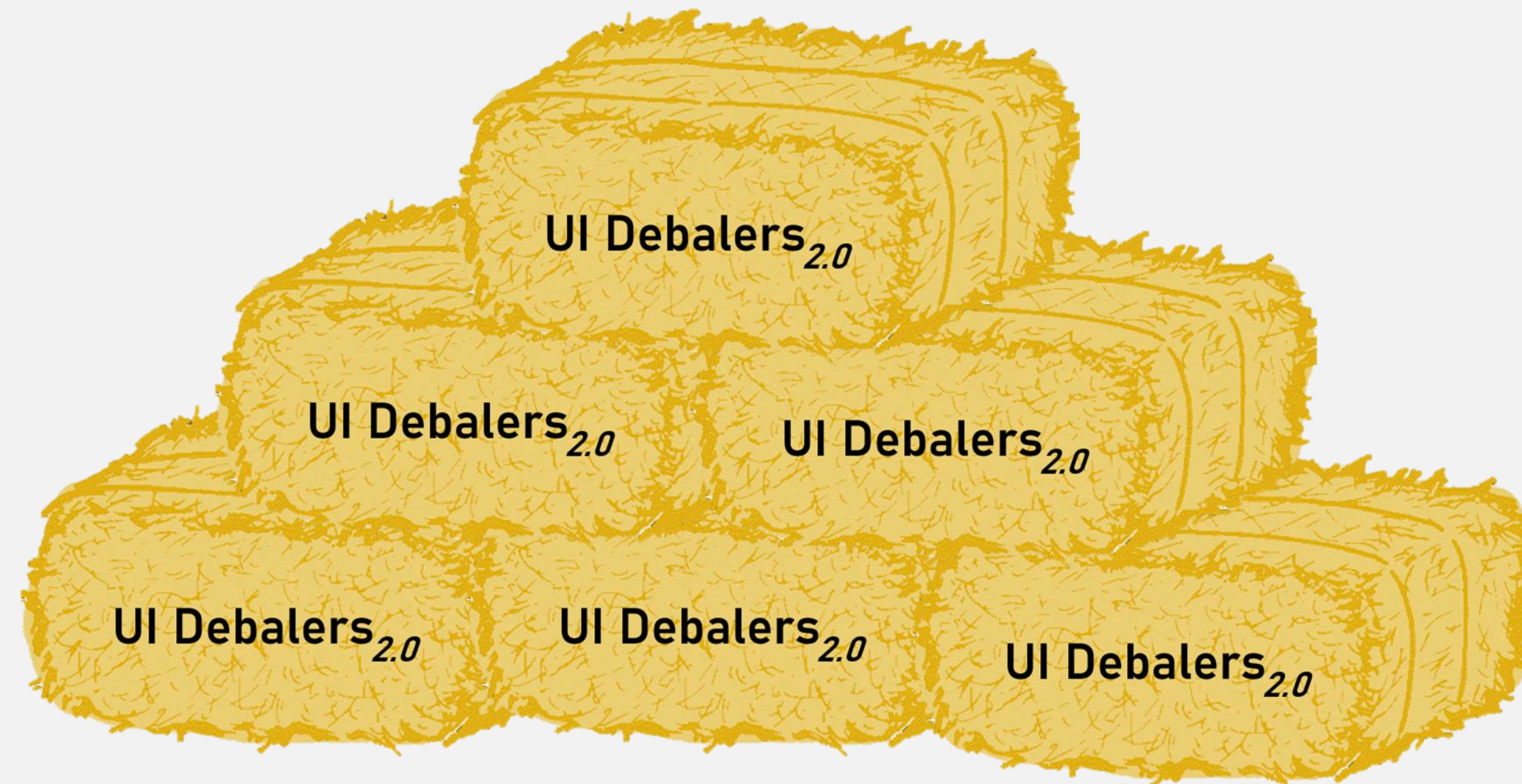
THE SOLUTION

- I Our client needs an automated debaler for their assembly line process that produces a steady/consistent flow of debaled material and requires minimal operator input.
- I By accomplishing the objective, the team will be able to:
 - Present client with working prototype along with in depth analysis of systems strengths and where it can improve
 - Present optimal running conditions for the tested materials

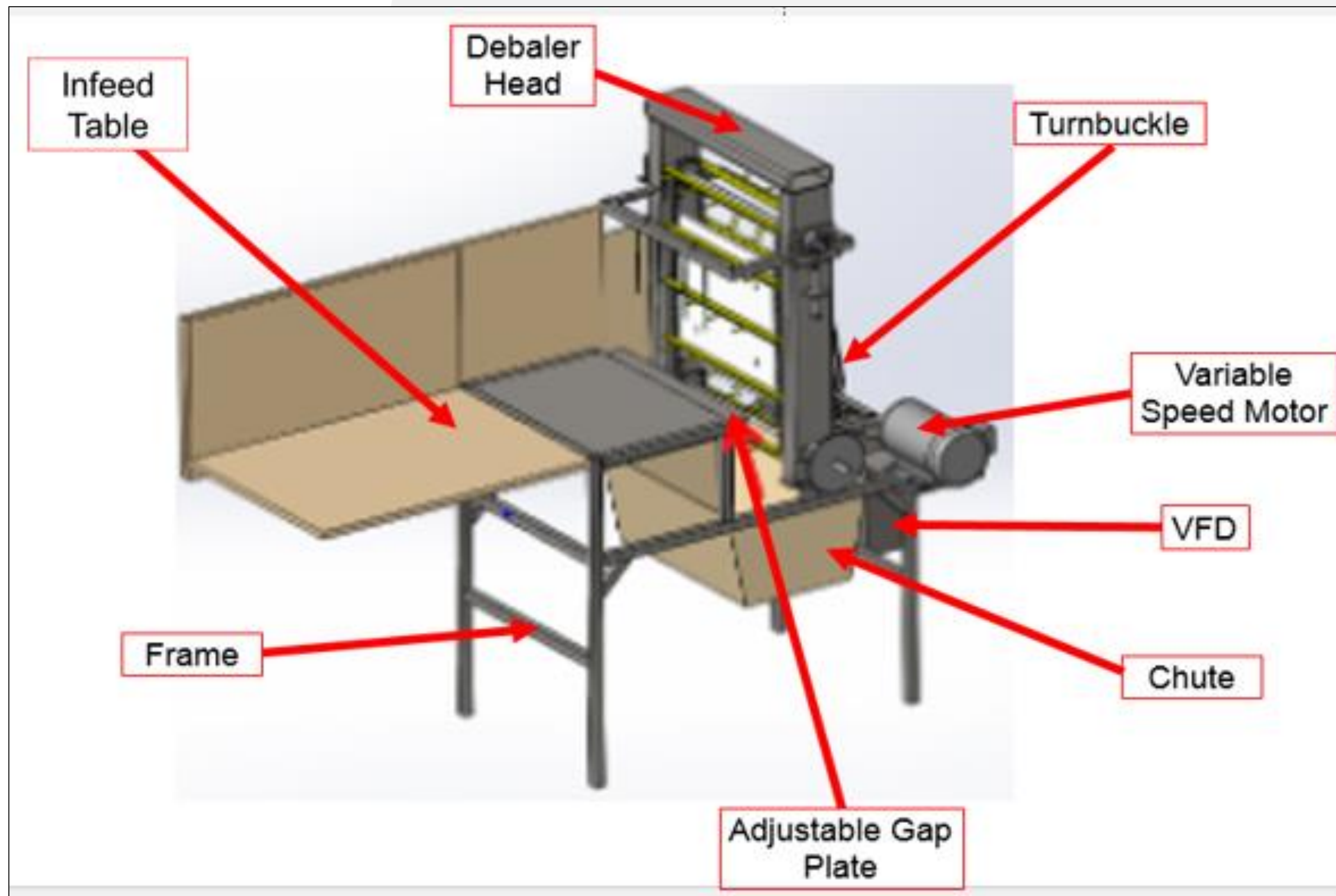
PROJECT OBJECTIVE



- I Improve current debaler prototype
- I Make the prototype fully automated
- I Add control system/algorithm to sense bale jamming and chute clogs
- I Test the final debaler prototype with different materials (Timothy hay, alfalfa, and straw) and find optimal running conditions



INITIAL DEBALER PROTOTYPE



PRODUCT REQUIREMENTS



OUR PROTOTYPE REQUIREMENTS

- I Convert 40lb – 140lb bales into loose material
- I Make system require minimal operator input
- I Infeed Conveyor shall safely uphold a static force of 300lbs
- I Sense bale jams
- I System will operate on 120V
- I System will break down into two main parts (processing head and infeed conveyor)
- I System shall not exceed a total weight of 1000lbs
- I The system shall have a maximum volume of 220 ft³ (8ft X 5ft X 5.5ft)
- I Transportable by common over the highway equipment

KEY ATTRIBUTES

I Processing Head

I Infeed Conveyor

I Control Algorithm



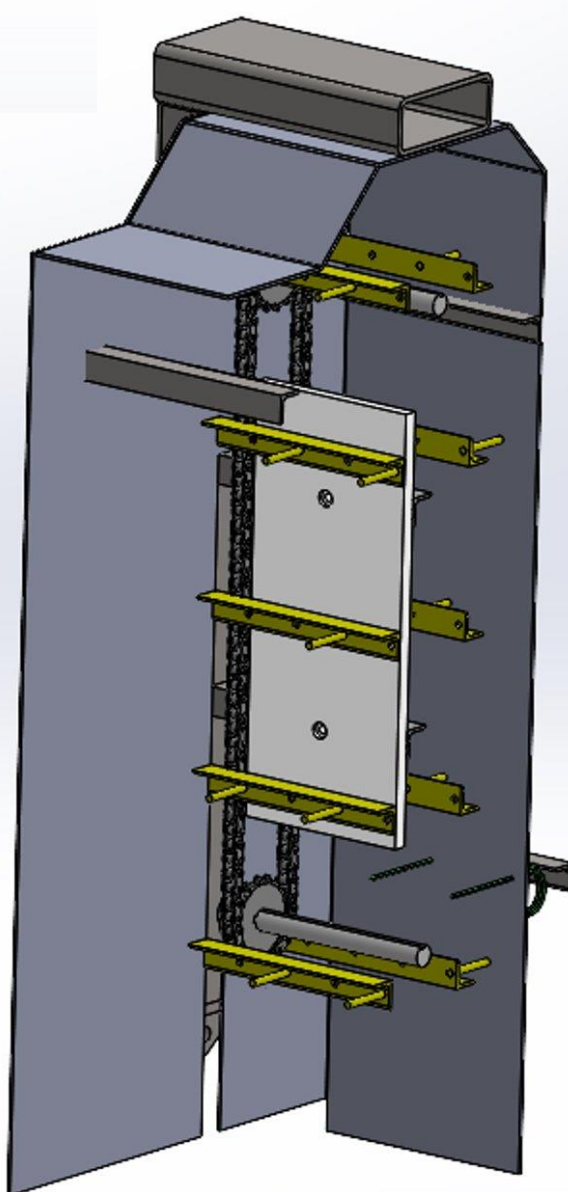
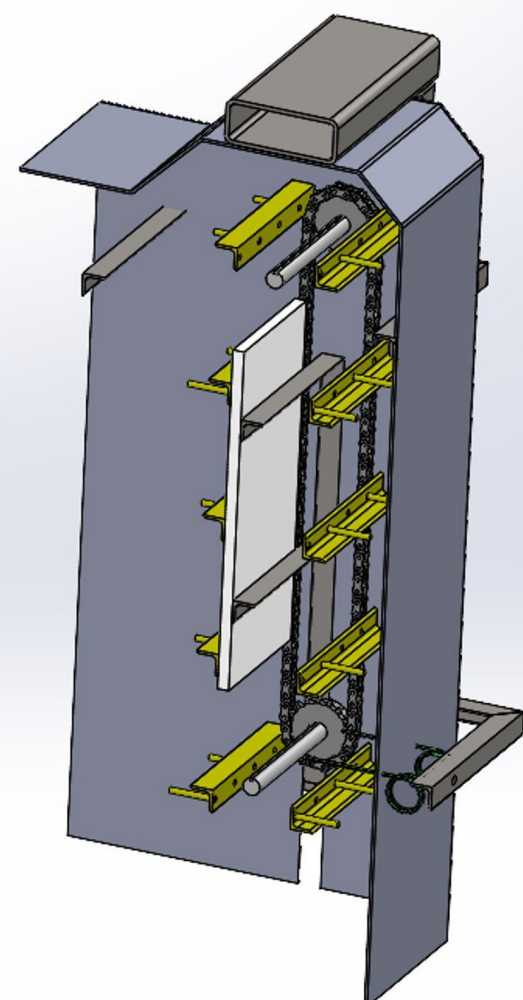
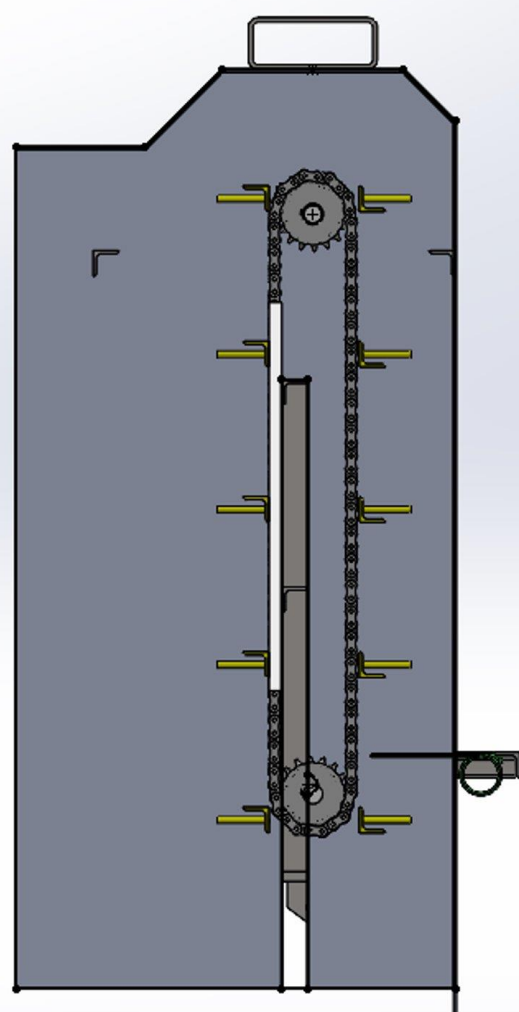
IMPROVEMENTS TO PROCESSING HEAD



I Processing Head Shroud

- Sheet metal enclosure
- Integral chute





IMPROVEMENTS TO PROCESSING HEAD

OUTFEED CHUTE



HEADER SHROUD



FLAKE HOLDING MECHANISM

- Adjustable bar
 - Accommodate different sized bales
- Flexible holder



INFEEED CONVEYOR



I Old Hay elevator

- Powered by Motor w/ VFD



INFEEED CONVEYOR

- I Gap adjustment plate
 - Help prevent flaking
- I Chain cover for motor
 - Safety consideration
 - Prevent hay from catching in the chain



Chain cover



Gap plate

INFEEED CONVEYOR

- Conveyor chain dragging on the support table
 - Attach a chain guide



CONTROL SYSTEM DESIGN

Components of System:

Hitachi 2hp VFD (Header)

KB VFD (Conveyor)

$\frac{3}{4}$ hp Sew-Eurodrive motor
(Conveyor)

1 $\frac{1}{2}$ hp Ironhorse Motor

Double pole Double throw switch



MANUFACTURING PROCESS



- I Cut and welded infeed conveyor
- I Welded stand for infeed conveyor
- I Fabricated sheet metal shroud enclosure and chain cover



OPERATION



DESIGN VALIDATION



Requirement	Test	Test Subject	Complete & Passed
Maximum weight of system shall not exceed the target weight of 1000lbs (4448.2 Newtons).	Weigh the conveyor and processing head (the two parts of the system) on the scale in JML.	Fully functional prototype	
Maximum Volume of the Final prototype shall not exceed 220 ft^3 (8ft X 5ft X 5.5ft).	Use a tape measure to calculate the maximum length, width, and height dimensions of the prototype.	Fully functional prototype	
The Infeed Conveyor shall be able to uphold a static force of 300 lbs.	Place 300 lbs on the Infeed Conveyor and make sure the system can hold the static load.	Fully functional Infeed Conveyor	
Conveyor shall move two 140 lb bales to the processing head during operation, as well as two 40 lb bales.	Place two 140 lb bales on the conveyor and run the system. Make sure the bales are transformed into loose material without operator intervention.	Fully functional prototype	
Test the control algorithm during operation.	Make sure that when a bale jam or chute clog occurs the system responds the way it is designed to. This may require manual bale jamming/chute clogging created by operator.	Fully functional prototype	
Control input locations on the prototype shall be approximately 3 ft away from the processing head.	Use a tape measure to find the distance between the control panel and the processing head.	Fully functional prototype	
The final prototype shall process the following materials: alfalfa, straw, and timothy hay.	Obtain the listed materials and run them through the system. During testing, record optimal motor speeds for some desired flow rates.	Fully functional prototype	Grass Hay
The final prototype shall have a self-containing shroud to capture all loose material and funnel it into outfeed chute.	Process a few bales and ensure that the tines are free of loose material after operation.	Fully functional prototype	

RECOMMENDATIONS

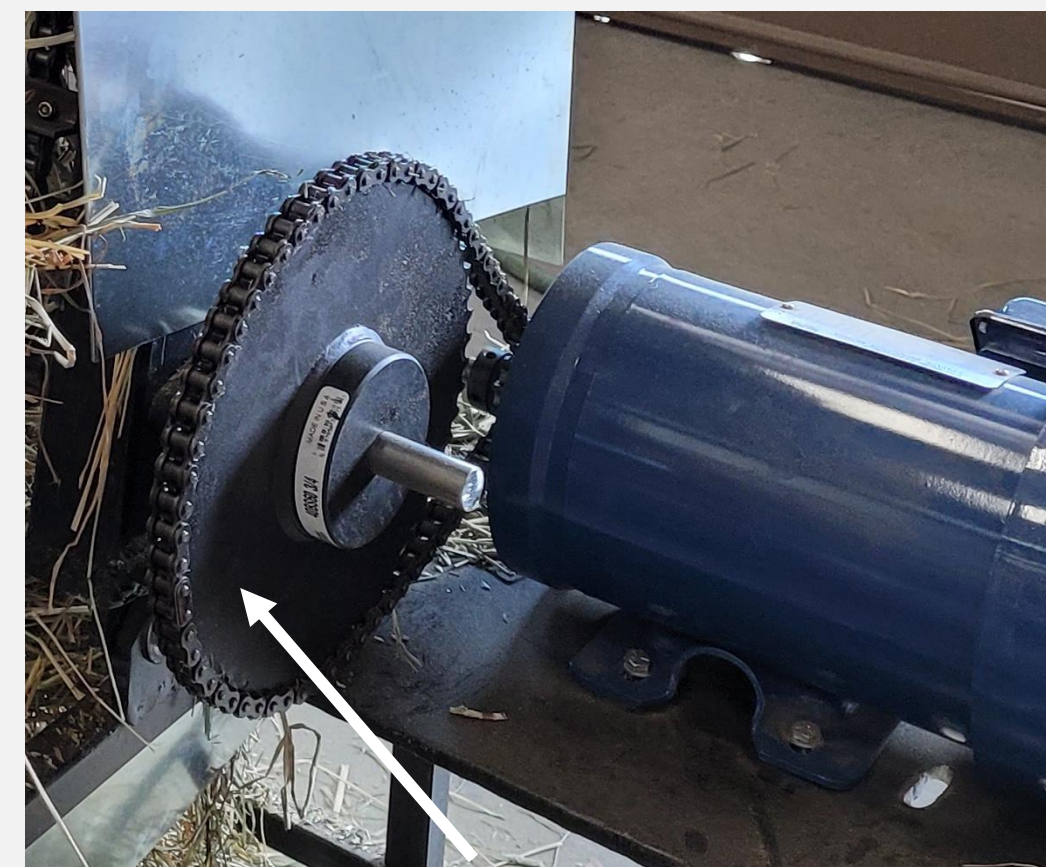


I Mount Header motor to Header

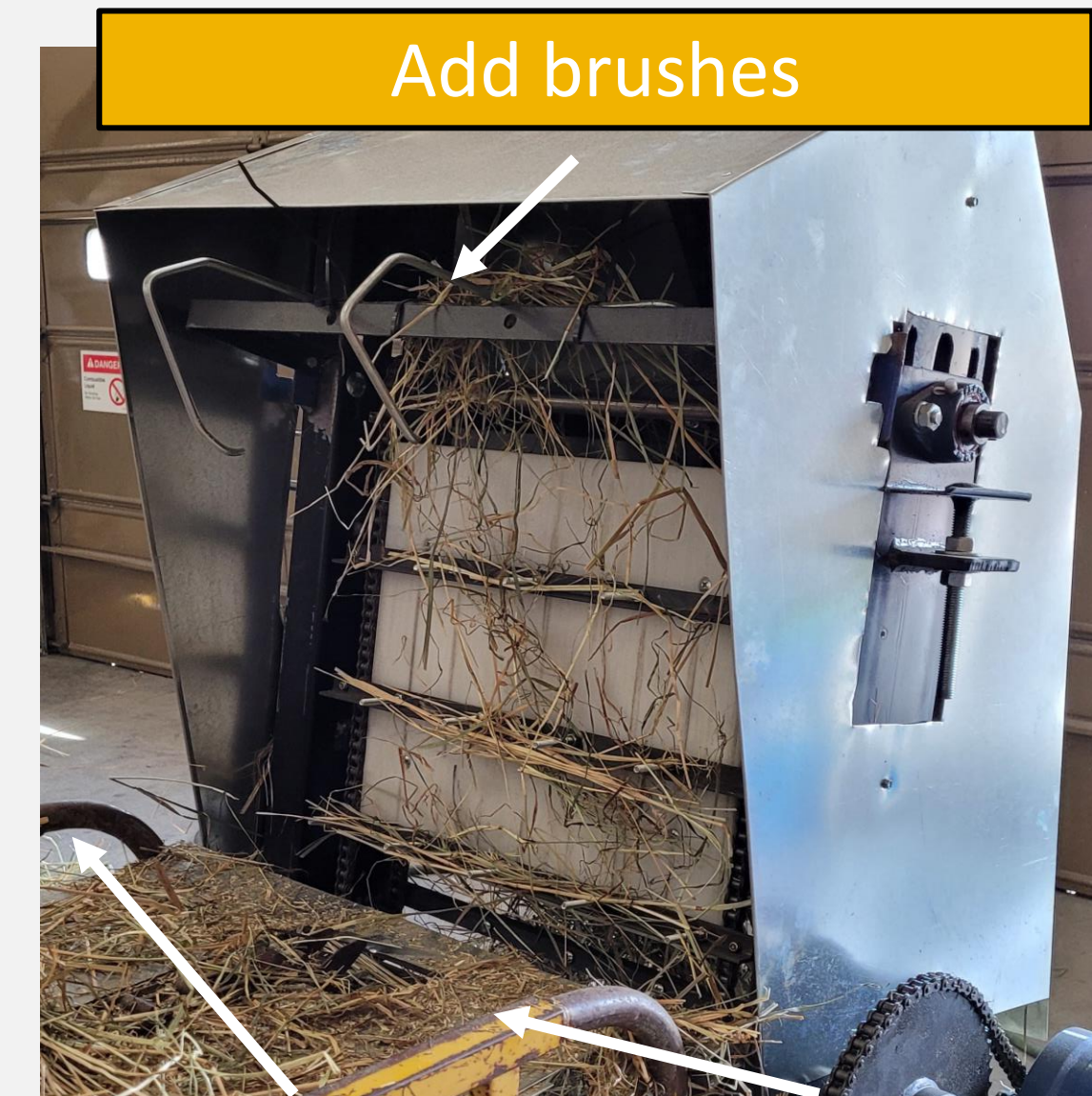
- Change Header motor drive system
- Add Brushes to top bar
- Add side Funnel plates
- Increase Finger length on processing Head
- Create Feedback loop to control system
- Set plate gap to 2"



Increase gap



Change to pulley and belt



Add brushes



Add side plates



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QUESTIONS?