

# **Key factors in designing a robust biorefinery feedstock preprocessing system**

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Yancey

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# ***Key factors in designing a robust biorefinery feedstock preprocessing system***

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William Smith, and Neal Yancey**

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## *Outline of presentation*

- Why a robust Feedstock Preprocessing is necessary for Biorefinery
- What are the major Biomass Feedstock Handling Issues in a Biorefinery
- How are these issues can be resolved to design a robust feedstock preprocessing system



POET-DSM Cellulosic Ethanol Plant



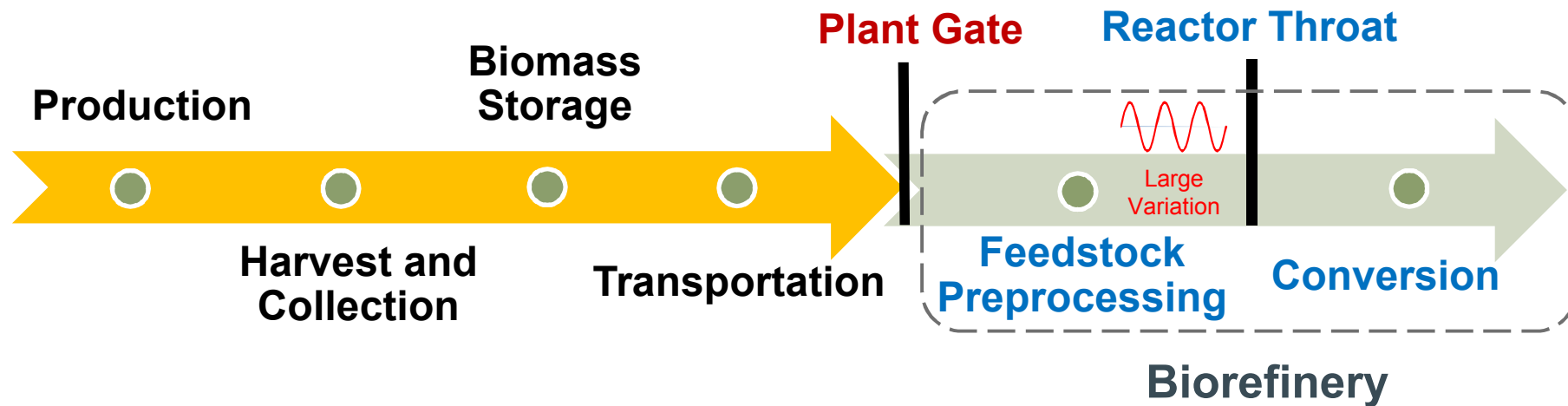
DuPont Cellulosic Ethanol Plant



Abengoa Cellulosic Ethanol Plant

## What is Feedstock Preprocessing

- Feedstock preprocessing converts raw biomass into a uniform feedstock format that can be fed into a conversion reactor



- Feedstock preprocessing should be de-coupled from biorefinery to improve the operational reliability of both plants



## Major Types of Feedstock Logistics

- Baling logistics
  - Common in agricultural residue (corn stover, straw)
  - Multi-pass (cut, shred, rake, windrow, bale)
  - High soil contamination
  - Single-pass and double pass technology are available but not commonly used
  - Microbial degradation can cause significant changes in properties and chemical composition during storage
- One-pass harvest and chop logistics
  - Common in energy crops (herbaceous and woody biomass)
  - Low soil contaminant
  - Suitable for ensiled storage which results in lower dry matter loss



Baling logistics



One-pass harvest & chop logistics

## ***Characteristics of a Robust Feedstock Preprocessing***

- A robust feedstock preprocessing system will:
  - Have the capability to handle variability of biomass properties to ensure high operational reliability and throughput
  - Produce consistent quality feedstock (e.g., particle size, moisture content, ash content) that meets the conversion specifications to ensure high product yield
  - Minimize feedstock losses during preprocessing (e.g., not generating too much fines)



Hammer milled Corn Stover



One-pass Harvest Chopped Biomass Sorghum



## Common Feedstock Handling Problems

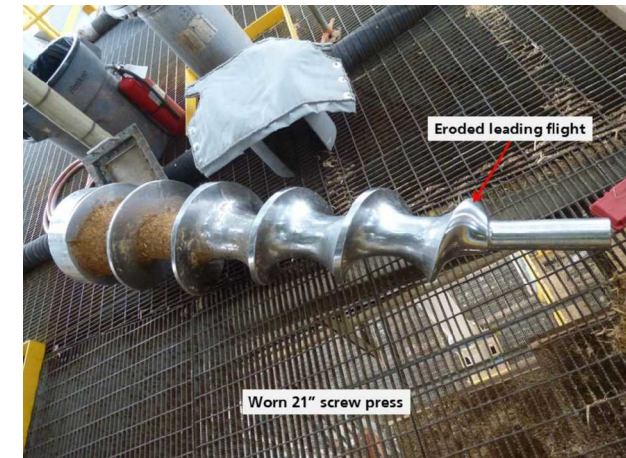
- High moisture biomass causes plugging of hammer mill, screw conveyors, and bins
- High ash content accelerates wear of equipment
- Degraded biomass leads to high content of fines which can cause plugging of reactor feeder
- Variability of biomass properties can cause surge in flows which lead to equipment pluggage and process upset



Bridging in Feedstock Bin



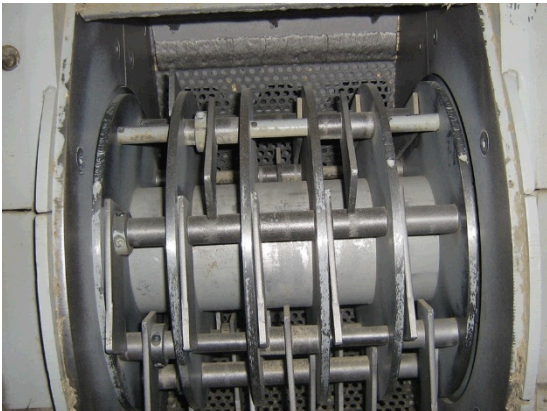
Plugging of Grinder Screen



Worn Screw Press

## ***Main Causes of Biomass Feedstock Handling Problems***

- Variability in biomass properties which is caused by:
  - Heterogeneous properties of biomass such as corn stover, logging residues
  - Harvesting and collection methods & equipment can lead to variable amount of contaminants such as gravel dirt and dirt
  - Storage methods can lead to variable extent of degradation which affect the fiber integrity, moisture content, and composition of biomass
- Lack of knowledge of performance characteristics of equipment which leads to improper selection or operation of equipment
- Lack of proper control of integrated equipment



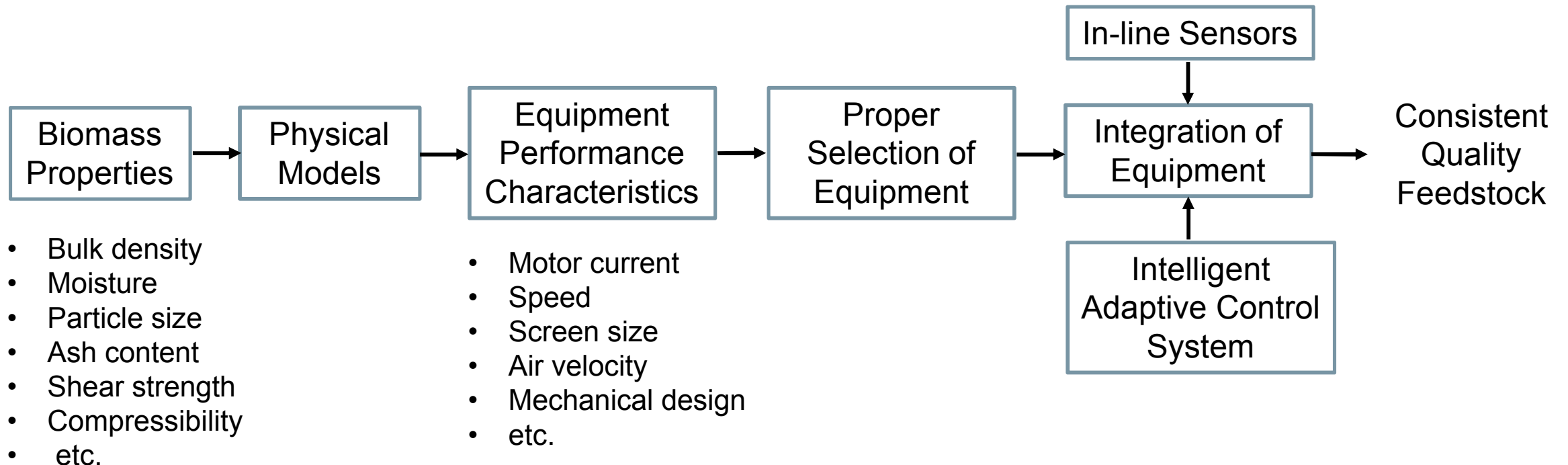
Hammer Mill is not suitable for fine grinding high-moisture biomass



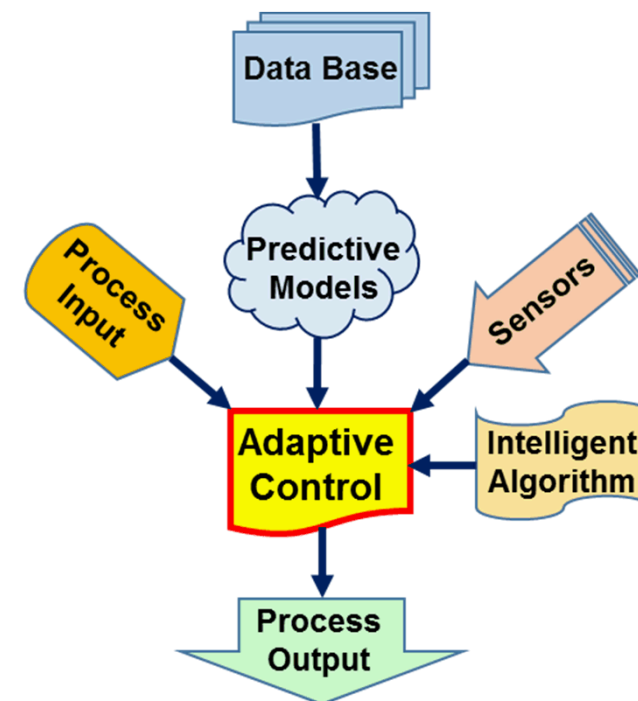
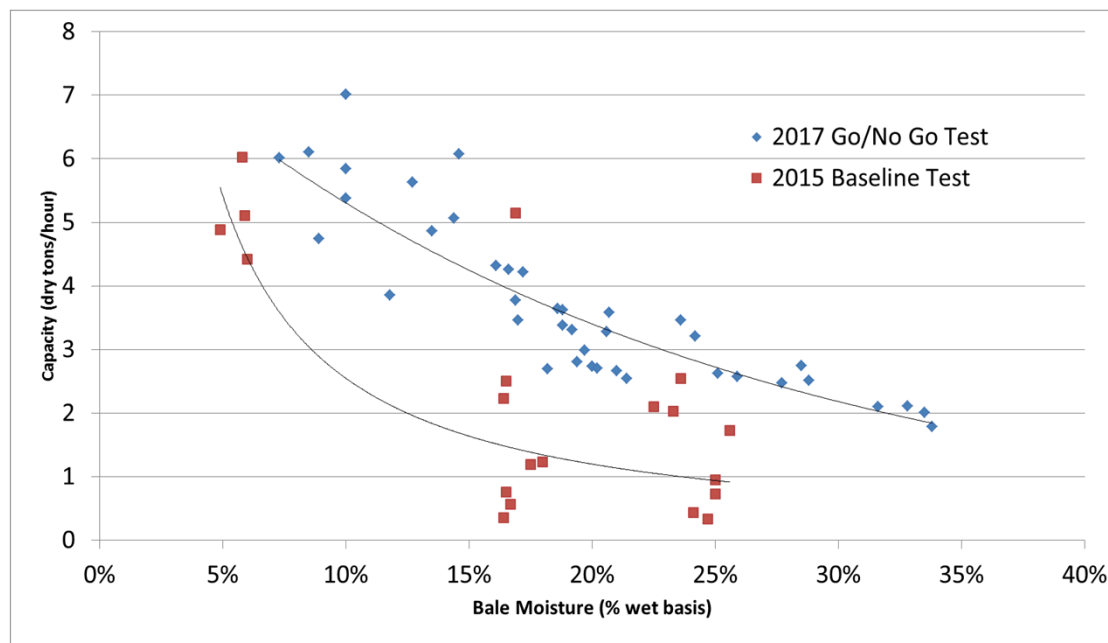
Shredder is suitable for fine grinding high-moisture biomass

## ***Factors contributing to a robust feedstock preprocessing system***

- Measure physical and mechanical properties of biomass and develop physical models predicting how these properties impact the performance of equipment
- Know the performance characteristics of equipment to select proper equipment
- Develop in-line sensors to measure biomass properties and facilitate optimal equipment operation
- Develop effective control system for integrated equipment operation



# Adaptive Control System improves throughput of 2-stage grinding high-moisture corn stover



Adaptive Control System achieves 96% operational reliability  
 Feedback Control System achieves 63% operational reliability



## ***Biomass Feedstock National User Facility***

- Fully integrated pilot plant with commercial scale processing equipment
- Modular design allows the insertion of third-party equipment
- Extensive material characterization and data collection
- Offering
  - Toll processing/piloting
  - Toll characterization
  - 3<sup>rd</sup> party testing & validation
  - Process development
  - Feedstock preprocessing R&D



## ***Acknowledgement***

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# Questions?