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1st Flow Feed System Failure Analysis

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Problem Statement

1st Flow is a sub company of Reicksview Farms. Reicksview Farms is a large farming operation in Northeast Iowa focusing on row crop and hog operations. The system initially was implemented solely in their own facilities. While there have been sales to several producers, Brenneman Pork has purchased the most units from 1st Flow. The system is prone to cracking and stripping however the causes of these issues are unknown. Current issues being seen are moisture being allowed in the system and causing feed to not flow correctly and the agitator not being able to turn. As a result, it is no longer marketable because of these issues. A solution for this system will allow 1st Flow to return to a lucrative market of high quality hog feed systems.

Disciplines

Bioresource and Agricultural Engineering | Industrial Technology

IOWA STATE UNIVERSITY

Department of Agricultural and Biosystems Engineering (ABE)

TSM 416 Technology Capstone Project

1st Flow Feed System Failure Analysis

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1 PROBLEM STATEMENT

Problem Statement

1st Flow is a sub company of Reicksview Farms. Reicksview Farms is a large farming operation in Northeast Iowa focusing on row crop and hog operations. The system initially was implemented solely in their own facilities. While there have been sales to several producers, Brenneman Pork has purchased the most units from 1st Flow. The system is prone to cracking and stripping however the causes of these issues are unknown. Current issues being seen are moisture being allowed in the system and causing feed to not flow correctly and the agitator not being able to turn. As a result, it is no longer marketable because of these issues. A solution for this system will allow 1st Flow to return to a lucrative market of high quality hog feed systems.

Business Case Statement

The 1st Flow system is prone to cracking and stripping making the product to not function as desired. There is no clear reasoning on why this occurs in these systems or what is causing the damage. While

this damage does not cause the system to completely fail it does cause issues with efficiency and requires more maintenance than desired. The problem is more prevalent in cases where the system is installed on a tandem bin system or any system with multiple bins. As a result of there not being a solution to the issues that the system faces, the 1st Flow system is no longer able to be marketed. 1st Flow currently has a stockpile of inventory that has not been utilized due to the problems during operation. If a solution is found, not only will existing customers be able to improve their systems, but the company will be able to begin selling them again.

2 GOAL STATEMENT

The goal of this project is to analyze the 1st Flow system and conduct a recommendations report. The root cause of this project is the 1st Flow system is having failure issues. 1st Flow needs a failure point analysis done on the systems. To do this a Failure Mode and Effect Analysis is the best option. The recommendations report will give 1st Flow a good option to increase the efficiency of the auger system while also giving them a cost analysis. There was no data collected by the company that we could analyze so we will be collecting data on failure points while we are on a company visit. For tangible results the goal is to have a low cost to fix, minimize risk by 50%, and improve performance by 50%.

- **Main Objective(s) and Specific Objectives**
    - The **main objective is to:** provide a recommendation report providing a suggested solution for the issues the 1st Flow System faces.

    Specific objectives include:
    - (1) Conduct a Failure Point Analysis using a Failure Mode and Effect Analysis (FMEA).
        - Thoroughly analyze every party of the system
        - Use knowledge from previous experiences for the probabilities of failure
        - Use observation data of broken parts for the probabilities of failure once they are obtained.
        - The client has no data for us to use for probabilities in the FMEA
        - Still haven't been able to figure out where all the broken parts are to help with the analysis.
    - (2)Determine any areas that can be improved without adding cost to the system.
    - (3)Provide a complete recommendation report stating what areas fail the most and which failures are most significant. Also report on any possible solutions and improvements to the system.
- **Rationale**
    - Upon completion of the analysis completed within this project's objectives, the client will be able to justify whether an investment should be made to solve the current design issues. The project of the 1st Flow System has been written off as not worth the time and money to resolve. Hopefully, with the data generated by this team a proven final solution for the system can be implemented.

3 PROJECT PLAN/OUTLINE

A. Methods/Approach

- **Reference Materials**
  - Researched past capstone group projects that have had the same type of project
    - A group in the past had to do a failure analysis for a project
      - (Yeggy et al., 2017)
  - CAD drawings and blueprint
  - FMEA reports
- **Data collection**
  - The data that we collected was what parts are failing, what are the conditions they are failing, and how critical each failure is to the system. Data was collected by on site visits and client testimonies to determine each failure point and cause.
- **Skills**
  - TSM 327: Animal Production Systems gives an insight on how feed systems for swine systems are designed and implemented allowing for a better understanding of the 1st Flow System.
  - Similarly to Animal Production Systems, TSM 322: Preservation of Grain Quality talks about grain movement and sizing requirements for a system.
  - TSM 477: Risk Analysis and Management gives the students the knowledge needed to analyze the systems.
  - TSM 116 and 216: Design in Technology is a 3D modeling class that helped us understand the CAD drawing and develop our own drawing.
- **Proposed Solutions**
  - Adding an electric motor to each agitator system.
    - Eliminate the extension shafts
      - Eliminates vibration and torque causing failures
  - Adding two spacers on each shaft in the agitator one at each end
    - Makes more room for feed to flow
    - Reduce back up pressure from feed above the agitator
- **Organization**
  - Team meetings were held weekly with additional meetings if necessary.
  - Initial client meeting was held with additional meetings as needed.
  - Communication with the client consisted primarily of emails sent by team members or if needed through phone calls and face-to-face meetings.
  - Major milestones for this project include: determine desired outcomes, complete product analysis, and complete Failure Mode and Effects Analysis.
  - Our planned timeline and communication processes was adjusted to meet changes in the client's needs.

B. Results/Deliverables

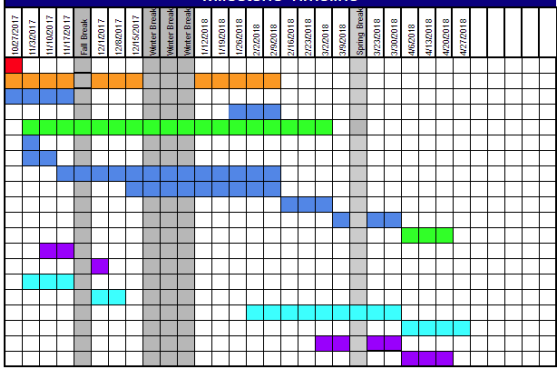
- Our deliverables are the solutions we have proposed above for 1st Flow to implement if the choose to do so or they can have a future capstone group continue this project and test our proposed solutions.

C. Timeline

Milestone Performance

Major Project Milestones	Time Required	Completion Date	Actual % Complete	On / Off Schedule
Determine Desired Outcomes	1 week	10/27/2017	100%	On
Complete product analysis	13 weeks	11/24/2017	100%	On
Communicate with client customers to determine product failure points	4 weeks	11/17/2017	100%	On
Schedule site visit and physical analysis of product	3 weeks	2/2/2018	100%	On
Failure Mode and Effects Analysis (FMEA)	18 weeks	3/2/2018	100%	On
FMEA Set Up	1 week	11/3/2017	100%	On
Risk Assessment Matrix (RAM) Construciton	2 weeks	11/10/2017	100%	On
Determine Targets, Probabilities, Severities, and Risk Codes	13 weeks	2/9/2018	100%	On
Determine Counter Measures for FMEA	9 weeks	2/9/2018	100%	On
Determine new Probabilities, Severities, and Risk Codes after countermeasures	3 week	3/2/2018	100%	On
Cost Analysis on Potential Solutions	3 weeks	4/6/2018	66%	On
Recomendation Report	3 weeks	4/20/2018	33%	On
Draft Poster Presentation	2 weeks	11/17/2017	100%	On
Final Poster Presentation	1 week	11/27/2017	100%	On
Draft Report Fall	3 weeks	11/17/2017	100%	On
Final Report Fall	2 weeks	12/8/2017	100%	On
Draft Report Spring	9 weeks	3/30/2018	100%	On
Final Report Spring	4 weeks	4/27/2018	50%	On
Draft Oral Presentation	4 weeks	4/6/2018	50%	On
Final Oral Presentation	3 weeks	4/20/2018	75%	On

Milestone Timeline



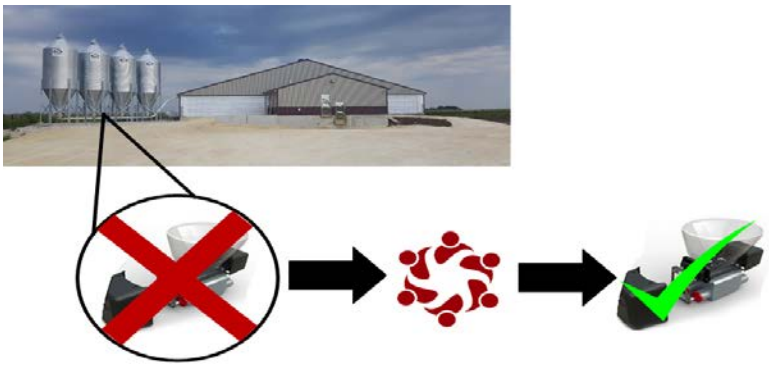
4 BROADER OPPORTUNITY STATEMENT

There are 6,300 hog farms in the state of Iowa that raise 49 million hogs at any given time. Each one of these hogs farms need to have some sort of feeding system to be able to feed that many animals. In retrospect the amount of feed needed for the hogs is 16 million tons of feed which is enough feed to cover the city of Ames in one foot of feed. The 1st Flow system can help improve feed flow from the feed bin to the hog when working properly. If we can improve feeding efficiency and lower the cost to feed hogs and will increase profits for each of those 6,300 farms. There is a huge market for this type of product and it will impact anyone who will consume pork products.

5 PROJECT SCOPE

The scope of this project is to analyze component failures of the 1st Flow System and develop a recommendation report on how to improve the system efficiency and durability. The starting step of this process was to determine desired outcomes with the client and use analysis systems to get to the outcomes. The finishing step of the scope is to develop the recommendation report with a cost analysis for the client.

6 GRAPHICAL ABSTRACT



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7 REFERENCES

Bret Yeggy, Cody Allen, Rob Davis, Chad Dolphin, Joseph R. Vanstrom and Jacek A. Koziel. Modular Hydraulic Test Bench. Final Report. TSM 416 Technology Capstone Project, April 28, 2017.

8 APPENDIXES

Appendix A

Failure Modes and Effects Analysis

Failure Mode and Effects Analysis (FMEA)												
					(RAM)					(RAM)		
ID: #	Failure Mode	Failure Cause	Failure Effect	Target	Severity	Probability	Risk Code	Counter Measure	Severity	Probability	Risk Code	
#1	Sprocket bending causing the chain to come off.	The tension from the auger chain and the pressure from the weight of the grain.	Aggitators do not turn.		1	B	Unacceptable	See appendix for countermeasure solutions.	1	E	Acceptable	
#2	Rubber seals compress leaving room for feed to leak through.	Weathering and vibrations from system causing the material to gain develop memory.	Feed leaks through creating a loss of feed and allows moisture through.		3	A	Acceptable w/waiver	See appendix for countermeasure solutions.	3	C	Acceptable	
#3	Extension shafts disconnect and/or twist.	Pressure is overwhelming for the system.	No way to turn the extension aggitators.		1	B	Unacceptable	See appendix for countermeasure solutions.	NA	NA	Acceptable	
#4	Grain flow due to aggitator teeth.	To many teeth and not leaving enough room for grain flow.	Restricting flow of the grain.		2	A	Unacceptable	See appendix for countermeasure solutions.	2	D	Acceptable	

Appendix B

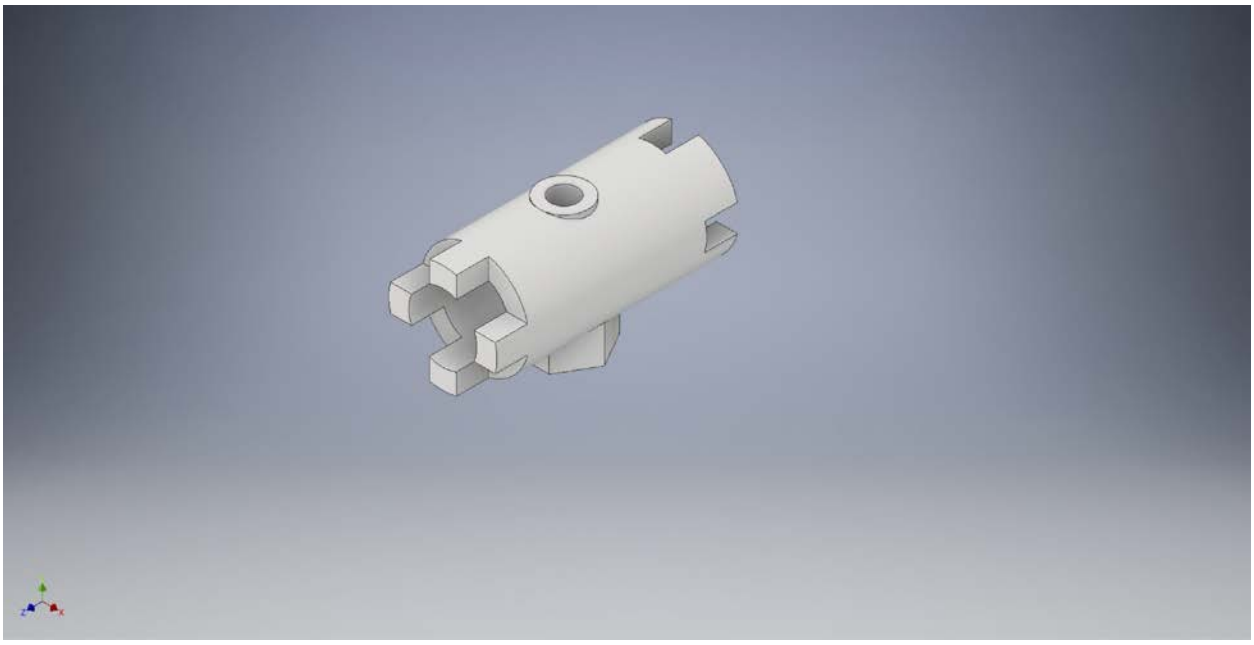
Risk Assessment Matrix

Risk Assessment Matrix (RAM)					
		Severity			
		Catastrophic (1)	Critical (2)	Marginal (3)	Negligable (4)
Probability	Frequent (A)	High	High	Moderate	Moderate
	Probable (B)	High	Moderate	Moderate	Low
	Occasional (C)	Moderate	Moderate	Low	Low
	Remote (D)	Moderate	Low	Low	Low
	Improbable (E)	Low	Low	Low	Low

Appendix C

Countermeasures

Adding spacer will lower the probability of failure four in the FMEA from an A to a D. This is due to less teeth being in the agitator allowing for more flow of feed.



Adding a motor to each of the systems will lower the probabilities of failure one and two and completely eliminate failure three in the FMEA. The probability of failure one will go from B to E and of failure two will go from A to C. This is due to motor relieving torque and vibration by eliminating the extension shafts.