IOWA STATE UNIVERSITY

Department of Agricultural and Biosystems Engineering (ABE)

TSM 416 Technology Capstone Project

Cadman 5000 W-XL Reel Speedup

Authors: Mason Heaton [a*], Matthew Melson [b*], Tanner Calderwood [c*], Brayden Arnote [d*], Michael Anderson [e*], and Jacek A. Koziel [f*]

[a] Agricultural Systems Technology, ABE, ISU, heaton45@iastate.edu
[b] Industrial Technology, ABE, ISU, mmelson@iastate.edu
[c] Agricultural Systems Technology, ABE, ISU, tacwood@iastate.edu
[d] Industrial Technology, ABE, ISU, barnote@iastate.edu
[e] Dept. of Agricultural and Biosystems Engineering, ISU, 2358 Elings Hall, Ames, IA 50011, mea1@iastate.edu, 515-294-2129
[f] Dept. of Agricultural and Biosystems Engineering, ISU, 4350 Elings Hall, Ames, IA 50011, koziel@iastate.edu, 515-294-4206

*course instructors and corresponding authors.

Client: *CFI Customs, 2878 Highway 8 Traer, Iowa 50675*

- Contact: Michael Calderwood, Owner Operator, calderwoodm65@gmail.com, (319)-415-4623

1 PROBLEM STATEMENT

Increasing the Retrieval rate of a 2000 ft of manure application hose to decrease the downtime of the manure application system.

Problem Statement

- CFI Customs is a Family-owned and operated custom manure pumping business that specializes in liquid swine manure. They pump anywhere from 18-26 million gallons a season (but is always growing), mostly around central Iowa. Their customers vary from small 100,000-gallon sites to large 6-million-gallon sites. They apply using a Dragline system to pump 1200 GPM from the building to the application site 3.5 miles away.
- The client is looking to lower their downtime in between fields by increasing the retrieval rate of the dragline reel due to it being the slowest part of the moving process.
- The applicator is paid by the gallon for the manure application business and not the hour, as the employees are paid by the hour. So, with every minute of downtime, the applicator is losing money.
- The problem is unknown. We are unsure if anyone else is looking to solve or fix this problem because this was a rare special order set up that most manure applicators do not use.

Business Case- This initiative was started because the Cadman reel was not fast enough. This was limiting profit, so the client wanted us to come up with a solution for it. We made the reel faster but

without sacrificing its reliability. Anyone who has a specialty setup would benefit from this upgrade. This small niche would potentially be a good business opportunity.

2 MAIN OBJECTIVE

Main Objective(s) and Specific Objectives

Main Objectives:

- Increasing the speed of the Cadman reel decreases downtime between fields.
- This will be measured by the RPM on which the hose reel spins
- Total time of the roll-up process along with the number of revolutions it made per minute where all considered in this project.
- Difficult to measure results include price of the system being down

Specific Objectives:

Criteria	***Constraints***
Total costs	Reliable
Quick turnaround	Cost Efficient
Quicker Reel up speed	

Rationale

- The client is going to be able to increase profits by leaving fields quicker.
- The client will be able to accept more work per year.
- We were able to increase the efficiency of the reel by 50%.
- Saved $140 per reel up in downtime alone, which equates to $5290 per season and $10,584 per year.

The Project Scope

- This project's scope was to increase the retrieval speed of the reel to lower the downtime of the application system.
- Some boundaries were the original components of the reel, the max hydraulic flow of the tractor, and the time at which the prototype had to be implemented.
- The boundaries were put into place by the client and our team.
- The owners/operators of this business were included in this project.

3 METHODS/APPROACH

Methods/Approach

- We all had different ideas on how to solve the reel problem, so we brainstormed and did the calculations for each of our solutions. We decided that the best and most effective in solving the issues is the one we worked towards.

Data collection:

- The data collected for this project was the total time it took to roll up 2000 ft of hose.
- The cost analysis of the time saved in the reel up process.
- The amount of RPM increase we gained from the update.

Skills:

- Knowledge of a fluid power system.
- TSM 337 (Fluid Power Systems Technology) has helped us find a great solution.

Solutions:

- We did the calculations and looked at it from multiple angles to develop the best overall solution to the reel.
- The solution was to add a set of hydraulic lines to supplement the current motors to get them into their rated flowrate to run at the rated RPM.
- We implemented our solution and began testing for results.

Developed:

- The evaluation metric was developed by seeing the problem at hand and joining together the client and our input on increasing the system's efficiency.
- This solution has been developed by checking all the components and seeing what they were capable of before implementing our results.
- Our solution was a 50% increase in the original reel speed.
- The results were quantified into money saved per reel up, the RPM of the reel, and the total time it took to retrieve the hose.
- Our solution of adding additional flow to the hydraulic motors where able to keep it within the projects scope of decreasing the down time of the system.
- This solution was right in line with the project's scope by being significantly below the budget, using common parts that could be purchased almost anywhere, and increasing the efficiency of the teardown process.
- Our solution was able to meet the client's expectations by decreasing the time it took to reel up this application hose and allowing the operator to aid in the rest of the teardown procedure.

Organization:

- We stayed organized by setting up recurring meetings and discussing things we needed to get done each week.
- The major milestones for our project were implementing our calculated solution to the field and running the system.
- The reel broke on us during testing, which setback our timeline.

Timeline

- Prototypes need to be done before November 25th to run the test over winter break and before the ground freezes.

4 RESULTS

Results/Deliverables

- Increased the speed of the hose retrieval process.

- Stayed under the budget.
- It was installed and tested promptly.
- User serviceable parts were used.
- It remained within the client's expectations and delivered the results.
- This project was completed and was tested sooner than we had planned, which allowed us to test the system more.

Recommendations

- Adding this solution to fit all types of reels could be a successful business venture.

5 BROADER OPPORTUNITY STATEMENT

This problem is an exceedingly small niche. With technology improving every day, the reel could keep on being improved. The limiting factor for us was the amount our client wanted to spend and the reliability of the reel. If the budget was greater, we could have made it even faster. However, that would involve higher spending and an intensive modification to the reel itself.

6 GRAPHICAL ABSTRACT

The hydraulics on the Cadman reel were modified to give more hydraulic flow to the motors.

7 REFERENCES

MLHV 800	48.91	250 RPM	300 High side RPM	16650	18650	57	64.4	2320	2610	52.8	63.4 GPM

These are the motors that are run on this reel. There are 2 of them, and these are the motor specifications for them.

RPMS might be an issue, but since the motors are not getting the full flow, they should not be at the full

https://www.ms-hydraulic.com/index.php?option=com_k2&view=item&id=77:mlhv&lang=en

Text

Fluid Power Designers Lighting Reference Handbook (TSM 337 Fluid power system Handbook)

8 APPENDIXES

Fixed Data

- Price: $2000
- Serviceable parts

Relevant Coursework

- TSM 337 Fluid Power Systems
- ENGL 302 Business Communication

Actual Cost

	Cost ($)	# of items	Total ($)
196” x ¾" Hydraulic Hose	73.93	2	147.86
Pioneer Fittings	9.25	2	18.50
T JIC-fittings	10.90	2	21.80
90-degree JIC fittings	8.45	2	16.90

Total Cost of Modification = $205.06

Amount of Money Saved:

- **The industry standard charge is $0.015 per gallon**
- **This system, while running, runs at 1200 gpm**

Calculation:

1200* .015= $18 * 60= $1080 per hour in potential loss

3 Hired hands working at $20.00 per hour = $60 per hour

Cost of System Down:

- **The reel has 66 revolutions per retrieval.**
- **The original reel speed is 3 rpm.**

Calculations:

66/3= 22 min

(22min/60min)*(60+1080)=$418.00

New Cost of System Down:

- **New reel speed is 4.5 rpm**

Calculations:

66/4.5=14.67 min

(14.67/60min)*(60+1080) =

$278.73

Difference in Cost:

418-278.73=

$139.27 Saved per roll up

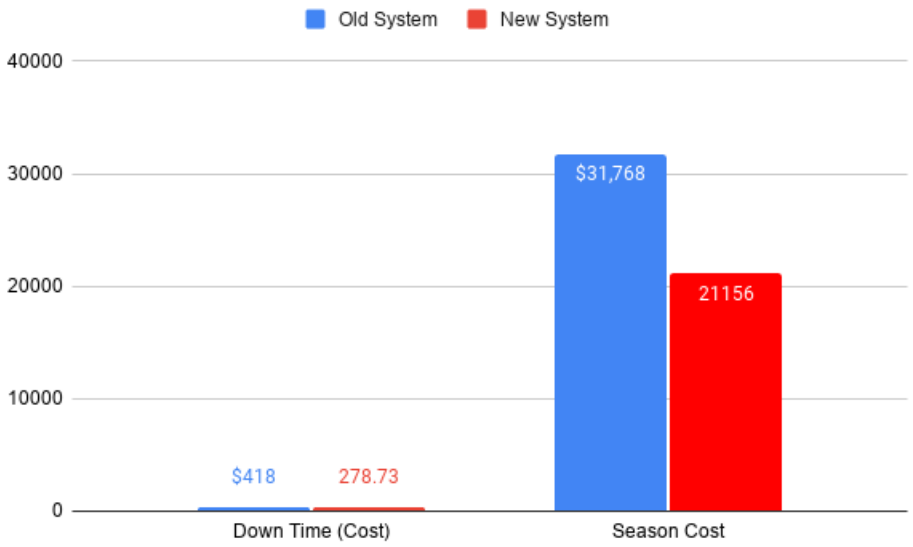
Per Season:

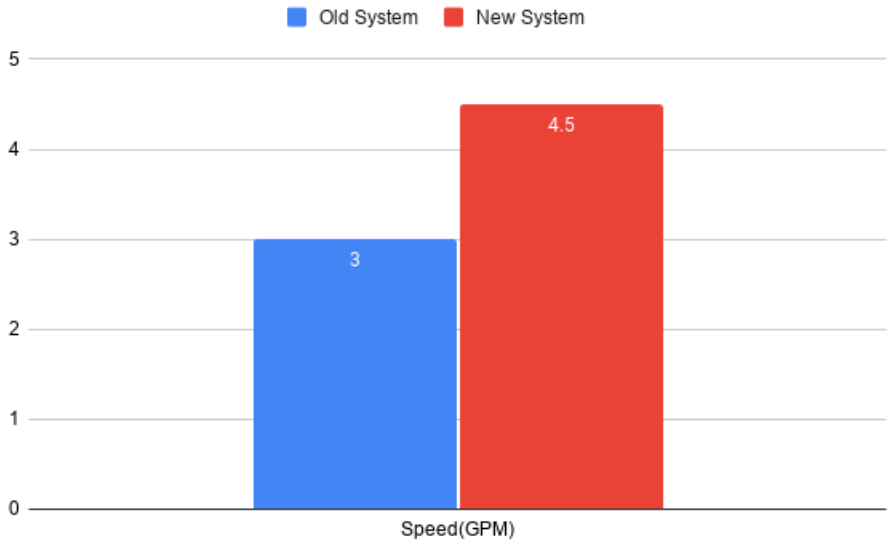
38 retrievals per season*139.27=

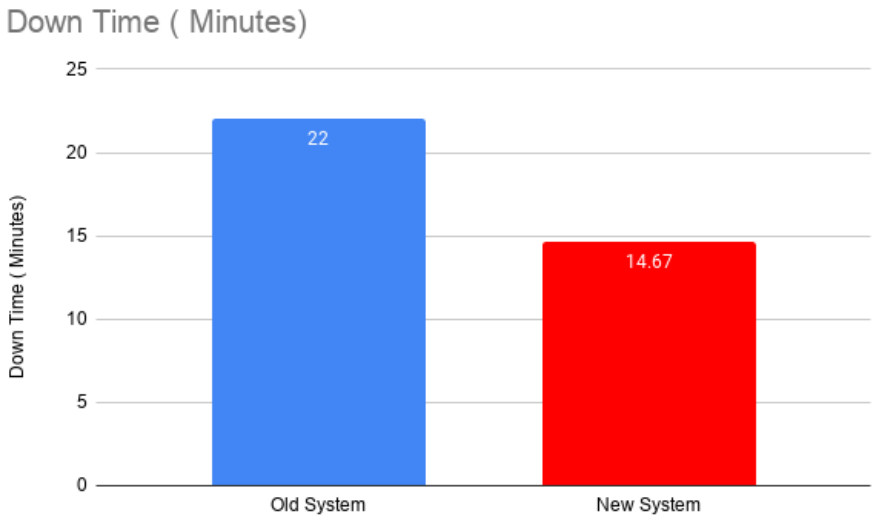
$5292.26 per season savings

Per year Savings:

$5292.26*2= **$10,584.52 per year**


Old System
New System
40000
30000
20000
10000
0
$31,768
21156
$418
278.73
Down Time (Cost)
Season Cost


Old System
New System
5
4
3
2
1
0
4.5
3
Speed(GPM)


Down Time (Minutes)
25
20
15
10
5
0
Down Time (Minutes)
22
14.67
Old System
New System