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Automated Finishing Pig Feeder Adjustment

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Problem Statement
Feed costs in the swine industry are typically 60-70% of the total swine production costs. Feeder adjustment is used to decrease feed costs. When feeders are properly adjusted, the growth rate can be improved while the wasted feed is minimized. Currently, feeders are manually monitored and adjusted by daily caretaker inspection, which is very laborious. Automated adjustment would reduce labor need and allow for the integration of precision management in the future.

Disciplines
Bioresource and Agricultural Engineering | Industrial Technology

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Department of Agricultural and Biosystems Engineering (ABE)

TSM 416 Technology Capstone Project

Automated Finishing Pig Feeder Adjustment

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1 Problem Statement

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Feed costs in the swine industry are typically 60-70% of the total swine production costs. Feeder adjustment is used to decrease feed costs. When feeders are properly adjusted, the growth rate can be improved while the wasted feed is minimized. Currently, feeders are manually monitored and adjusted by daily caretaker inspection, which is very laborious. Automated adjustment would reduce labor need and allow for the integration of precision management in the future.

Business Case Statement

Margins are tight in the swine industry, so minimizing costs in any area is important. Because feed is such a large percentage of production costs, it is an important category to address when finding ways to lower production costs. The group's solution would primarily be applied in research settings. The potential for precision allowed by the automated system would be ideal for research, as precision in feed experiments would be much easier to obtain than by hand. This could also be used by growers who want to vary the amount of feed available to pigs or who would prefer to do less frequent in-person checks of the building. The system would allow growers to adjust the feed as much as they wanted without needing anyone to physically be in the facility. Additionally, workers could focus on the pigs when doing checks, rather than having to check and adjust feeders as well.

Current technologies focus on metering the input feed rather than the feed coming out of the gate.

2 Goal Statement

Main Objective and Specific Objectives

The automated feeder system reduces the labor cost associated with manually adjusting each feeder. The improvement will be measured by comparing the cost of installing the automated system to the labor savings.

To find the labor savings, time studies were conducted to find how long it takes to adjust a feeder. This time was multiplied by the average hourly wage for workers at swine operations of various sizes.

This iteration of the project will not be implemented; the goal for this project was to fit the feeder with appropriate mechanical controls. A future project would be to add controls so that the gate system could be controlled remotely. The specific objectives of this project included:

- (1) Design of a mechanical control system that meets all client criteria and constraints:
  - Bi-directional feeder adjustment
  - Easily integrated with current commercial feeders
  - Accommodate a variety of feed (type, density, etc.)
  - The motor should be DC power
  - Simple, minimal moving parts, low maintenance
  - Withstand swine environment (gases, dust, etc.)
  - The motor should produce minimal noise
- (2) Construct a prototype of the control above system on a feeder:
  - Budget of $1,000

Rationale

Our client will be able to adjust the swine feeder gate by running a motor rather than manually. This will be beneficial, especially in research settings, because of the system's capability for precise adjustment.

3 Project Plan/Outline

A. Methods/Approach

- **Reference Material(s)**

  - Farm Journal's Pork: typical feed waste costs
  - Pork Information Gateway: information about proper feeder adjustment
  - National Pork Board: employee compensation
- **Data Collection**:
  - In order to find the necessary motor torque, the group used a torque wrench to turn the sprocket. The resulting torque was multiplied by a safety factor of 25%, and this torque was used to select an appropriate motor.
- **Skills**:
  - *TSM 116: Introduction to Design in Technology* in designing the control system and housing
  - *TSM 214: Managing Technology Projects* in project management
  - *TSM 240: Introduction to Manufacturing Processes* in manufacturing the prototype
  - *TSM 363: Electric Power and Electronics for Agriculture and Industry* in motor sizing and wiring
- **Solutions**:
  The group's designs are shown in section 8.1 of the appendix. The chosen solution is shown in Figure 3. It was evaluated based on ease of construction, as well as cost and time savings. The proposed solutions were presented to the client for input, which was considered and incorporated by the team. The necessary materials are listed in section 8.3 of the appendix. Supplier and part number are included for reference. The chosen solution directly addresses and is consistent with the project objectives and scope. The solution meets client expectations. By meeting with the client every other week, the group received constant feedback on what would and would not work with the project, in addition to any potential issues with the solution.
- **Organization:**
  The group met with Dr. Ramirez every other week, in addition to communicating via email when necessary. Major milestones for the project included creating and agreeing upon a design, getting the design approved, and building the prototype.
  - Create a design: 2/1/19
  - Agree upon design and identify necessary materials: 3/8/19
  - Build prototype: 3/29/19

  Each major milestone was broken into smaller, more frequent milestones. These can be seen in section 8.2 of the appendix.

4 RESULTS

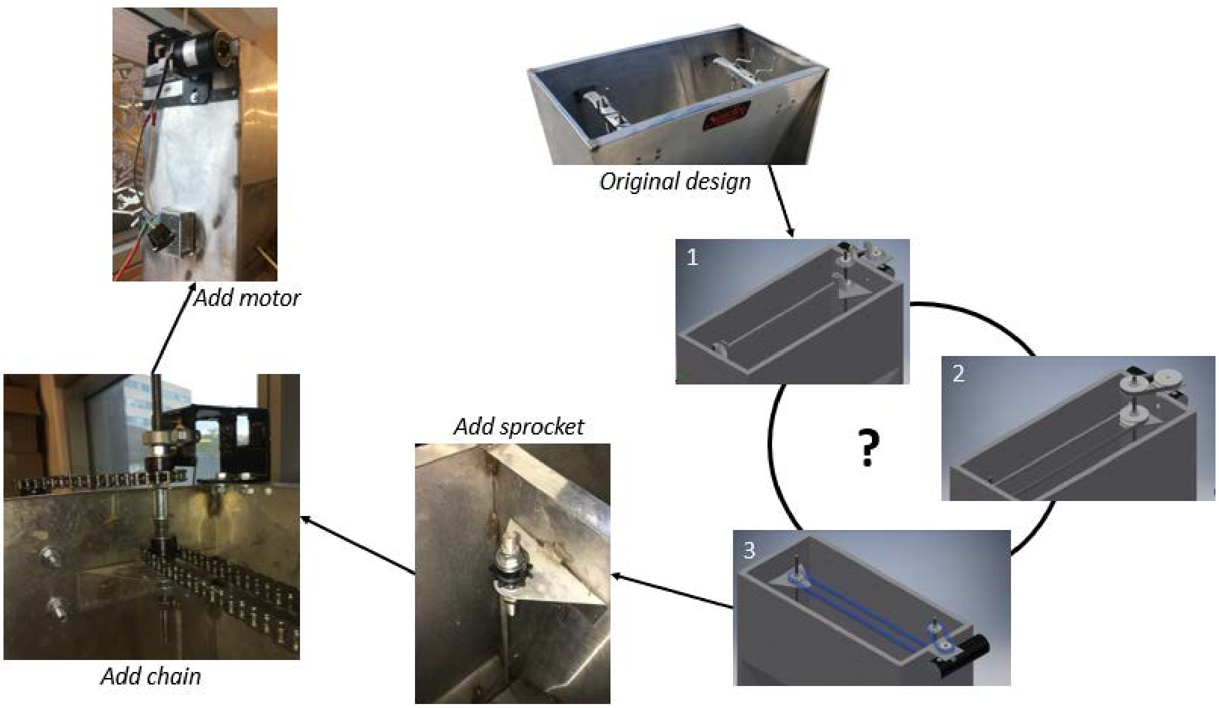
Results/Deliverables

The main deliverables for our project are the prototype design and the prototype feeder. The project was completed as planned. The next step for the project is to wire the system and create software so that the feeder can be adjusted remotely. After this, the feeder could be installed in a hog facility to test it in real conditions.

5 Broader Opportunity Statement

This system provides swine producers and researchers with a way to adjust swine feeders without setting a foot in confinement. This could be used for other livestock, such as cattle. Another method of addressing this issue is controlling the amount of feed that is released from the central holding area, which is used with other livestock.

6 Graphical Abstract



7 References

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Time for New Feeders? (2012, March 9). In *Farm Journal's Pork*. Retrieved from https://www.porkbusiness.com/article/time-new-feeders

8 APPENDIXES

8.1 Design

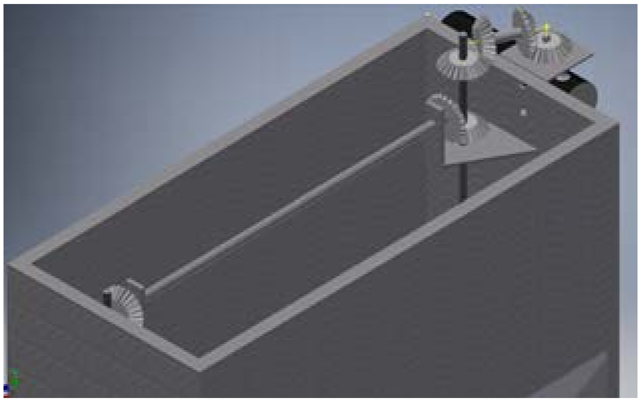

Figure 1. Proposed Solution: bevel gears and rod. This solution was not chosen because of the many moving parts required. The torque requirements for a motor would also be high compared to other solutions. The parts involved in making this solution are also very expensive.

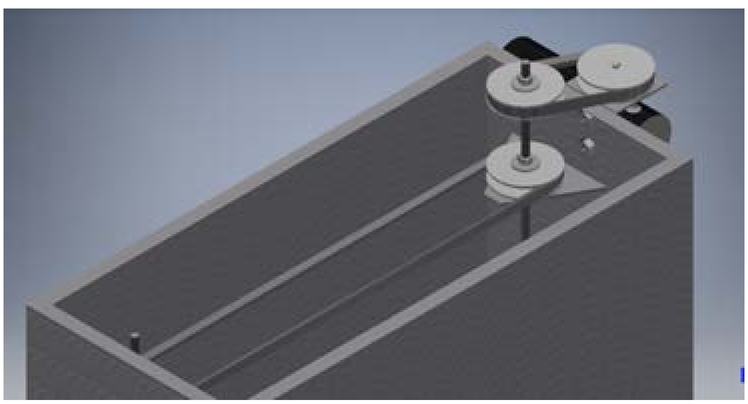

Figure 2. Proposed Solution 2: belt and pulleys. This design was not chosen because of the high chance of the belts slipping and being inefficient in transmitting power. Belts also become brittle over time.

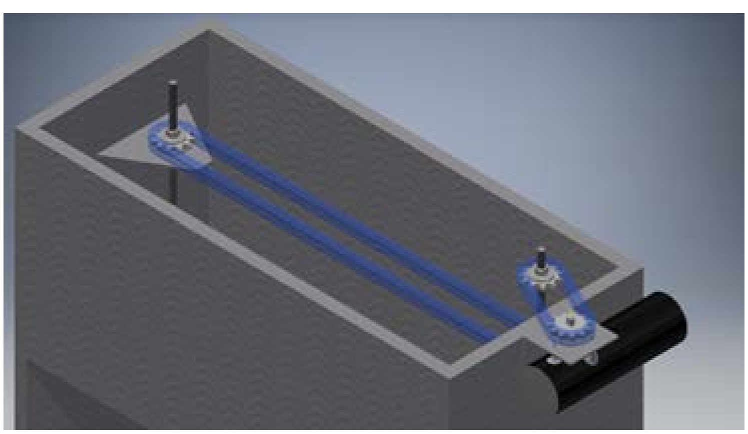

Figure 3. Proposed Solution 3: sprockets and chain. This solution was the most cost-effective way of transferring power from the motor to the shafts. The low amount of moving parts was also another factor in making this the choice solution.

8.2 Timeline

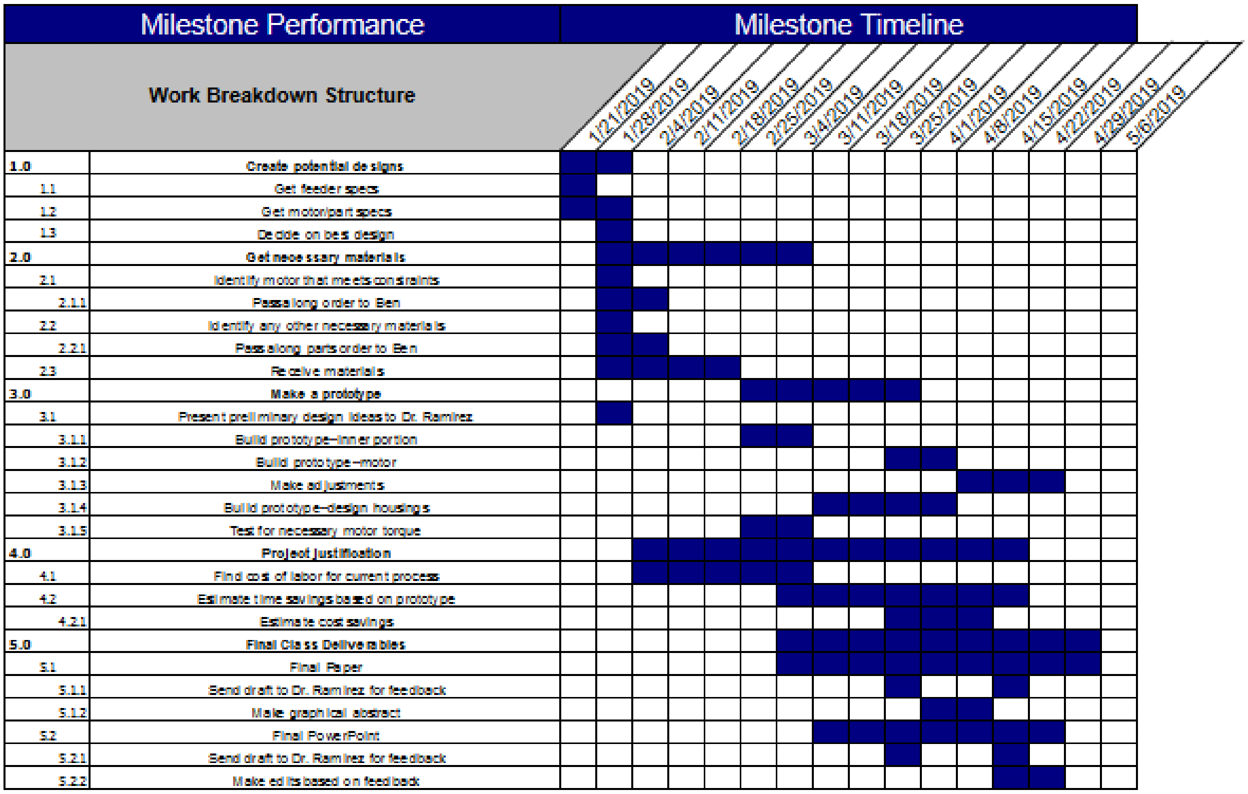

Figure 4. Project Timeline

8.3 Bill of Materials

Supplier	Part Number	Part Name	Cost	Amount	Cost/Amount (ft, pc)	Amount Used	Cost of Amount Used
Grainger	2W092	Tsubaki Chain, Carbon Steel, width 0.5, 35 size chain	$35.53	10	$3.55	4	$14.21
Grainger	36GF19	11 tooth sprocket, 3/8 inner, 1.496 outer	$10.26	1	$10.26	4	$41.04
Grainger	21YN63	3/8"-16x12 ft,. Threaded Rod, Stainless Steel, 316, Plain	$47.18	12	$3.93	0.875	$3.44
Lowe's	56107	Hillman 3/8-in Zinc-Plated Standard (SAE) Hex Nut	$6.98	50	$0.14	14	$1.95
Lowe's	409468	Hillman 3/8-in Stainless Steel Standard (SAE) Flat Washer	$2.08	36	$0.06	5	$0.29
Lowe's	68884	Hillman Fender Washer Zinc 3/8x1-1/2	$0.26	1	$0.26	2	$0.52
Amazon	PN01007-38	Makermotor 3/8" D Shaft 12V DC Reversible Electric Gear Motor 50 RPM	$69.00	1	$69.00	1	$69.00
Grainger	2YEA5	Dayton Carbon Steel, Single Strand Connecting Link	$5.09	5	$1.02	2	$2.04
Lowe's	755516	Hillman 6mmx16mm Pillips-Drive Machine Screws	$1.98	6	$0.33	3	$0.99
Lowe's	755515	Hillman 6mmx12mm Phillips-Drive Machine Screws	$1.98	6	$0.33		$0.00
Lowe's	64735	National Hardware 6" Steel Zinc-Plated Corner Brace	$0.98	1	$0.98	1	$0.98
Lowe's	63306	Hillman 1/4" Zinc-Plated Standard (SAE) Flat Washer	$0.13	1	$0.13	1	$0.13
McMaster-Carr	5912K3	Oil-Embedded Mounted Sleeve Bearing for 3/8" Shaft Diameter	$9.83	1	$9.83	1	$9.83
Lowe's	880417	Hillman 0.375-in x 1/2-in Plain Steel Standard (SAE) Flat Washer	$1.20	1	$1.20	1	$1.20
Lowe's	61827	Hillman 5/16-in x 3/4-in Zinc-Plated Coarse Thread Hex Bolt	$0.17	1	$0.17	2	$0.34
Lowe's	55817	Hillman 1/4-in x 3/4-in Zinc-Plated Coarse Thread Hex Bolt	$0.12	1	$0.12	2	$0.24
Lowe's	63301	Hillman 1 Count 1/4-in Zinc-Plated Standard (SAE) Hex Nut	$0.07	1	$0.07	2	$0.14
Lowe's	63306	Hillman 1/4-in Zinc-Plated Standard (SAE) Flat Washer	$0.13	1	$0.13	4	$0.52
Lowe's	63302	Hillman 1 Count 5/16-in Zinc-Plated Standard (SAE) Hex Nut	$0.12	1	$0.12	2	$0.24
Lowe's	63307	Hillman1 Count 5/16 Zinc-Plated Standard (SAE) Hex Nut	$0.14	1	$0.14	4	$0.56
Lowe's	61815	Hillman 1 Count 5/16-in Standard (SAE) Split Lock Washer	$0.21	1	$0.21	2	$0.42
Lowe's	61814	Hillman 1 Count 1/4-in Standard (SAE) Split Lock Washer	0.19	1	0.19	2	0.38
Grainger	6L778	Fixed Bore Roller Chain Sprocket, For Industry Chain Size: 35, 11 Number of Teeth	17.43	1	17.43	1	17.43
						Total Cost	**$165.89**

Figure 5. Bill of Materials