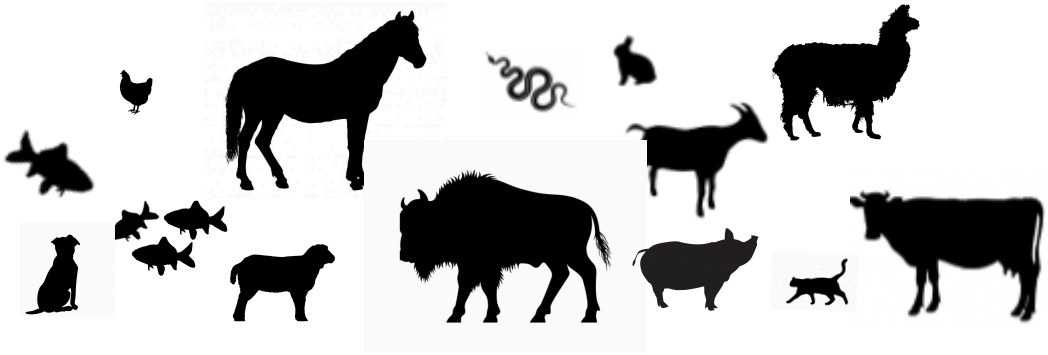
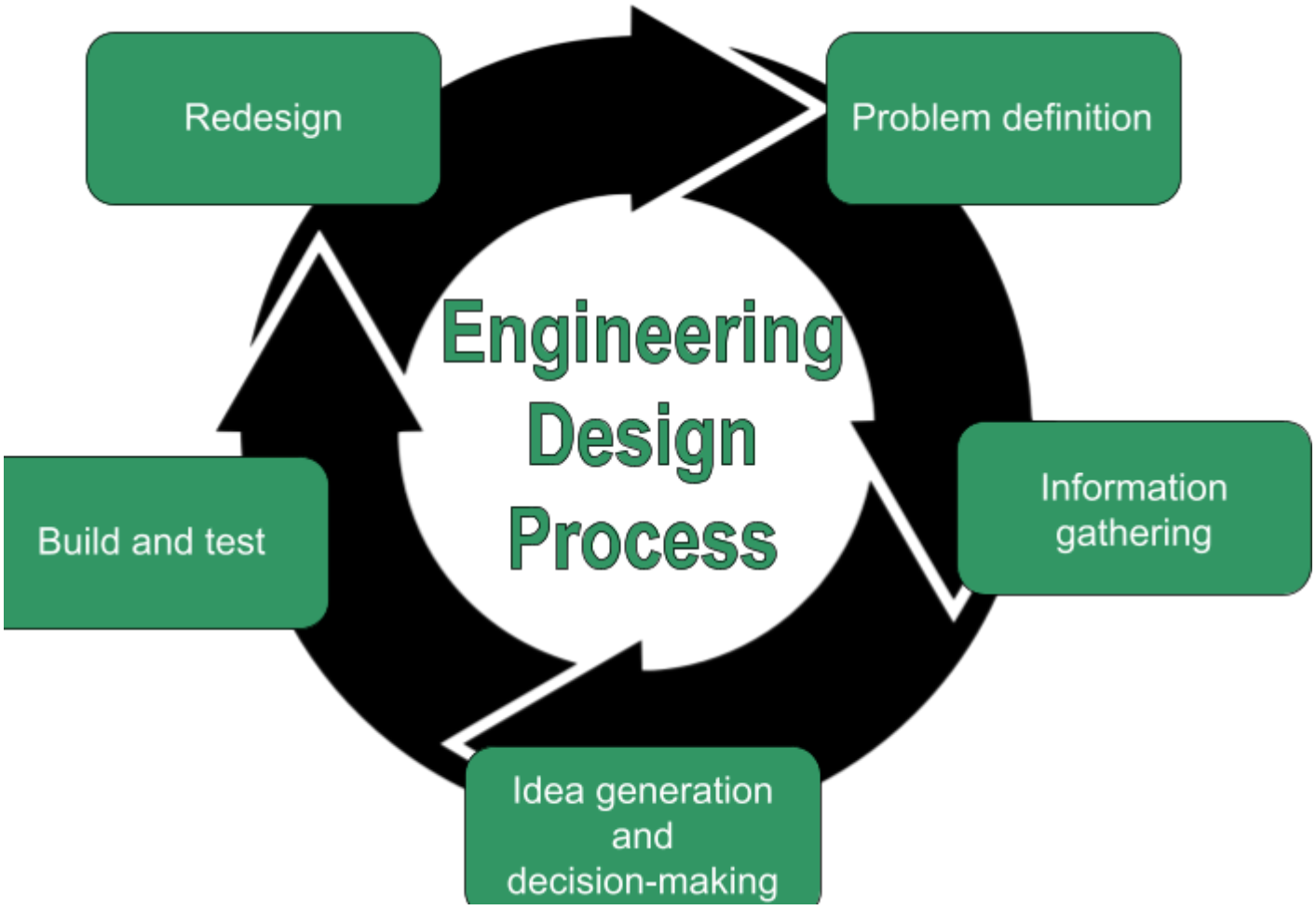


4-H Engineering Design Challenge 2024

Feed the Animals

NDSU | EXTENSION

Contents



The Challenge

The fourth annual 4-H Engineering Design Challenge is to design and build a Rube Goldberg™-type contraption that **feeds an animal or group of animals by placing the food in a feeding area.**

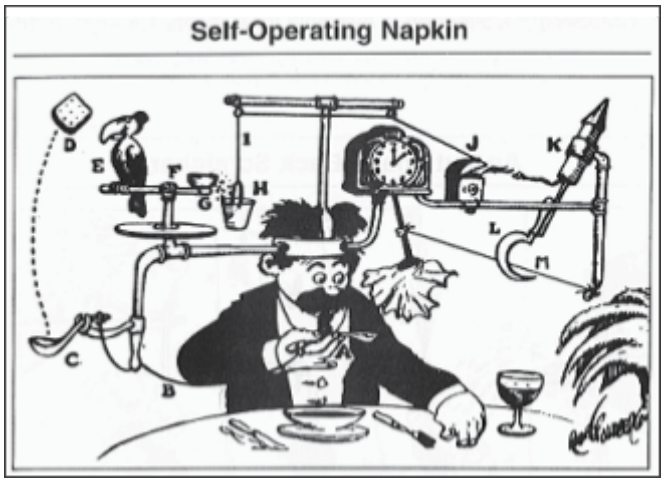
Ideally, the "food" used will be the actual food. However if that is not realistic, a model or representation of the food can be used.

The "feeding area" can be a bowl, a trough, a feed bag, a plate or even just a space that is designated or marked for feeding, as long as it is clear to the audience that the animal(s) will be fed there.

You must make sure your machine meets specifications listed on page 5.

Mission

The goal of the Engineering Design Challenge is to encourage critical thinking, creativity, innovation, problem solving and teamwork in a nontraditional learning setting and to have fun in the process. Youth who have completed 3rd through 12th grades can compete in the Engineering Design Challenge. Youth will use an engineering design process to solve problems, make a plan and design a solution.



Rube Goldberg (1883-1970) was a Pulitzer Prize-winning cartoonist who was best known for the wacky inventions that appeared in his comics. His cartoons appeared in newspapers for more than 50 years.

He created an overly complex contraption that did a simple task. The contraption used everyday items in a series of chain-reaction steps that accomplished a task.

The Engineering Design Challenge allows teams of youth to use physics, engineering, humor and storytelling while learning about simple machines and energy transfer. Teams are encouraged to create a theme for their machine and incorporate their theme in the machine components.

Teams that build a machine and complete the recordkeeping journal and a poster summarizing their work can compete or display their work at their county fair. Any team can participate in the State Fair contest; teams do not have to win a county contest to enter the 2024 State Fair challenge.

Machine Steps

Each machine has to include a minimum number of "steps." A step in the machine is a transfer of energy from one action to another action. The minimum number of steps for this challenge is seven.

- Example 1: A ball rolls down a ramp. This equals one transfer of energy step (ball rolling along a surface).
- Example 2: A ball rolls down a ramp and causes a row of dominoes to fall over. This is two transfers of energy (ball rolling along a surface and dominoes falling over.)
- Example 3: A ball rolls down a ramp, hits a row of dominoes, the dominoes trigger a mousetrap. This is three transfers of energy (ball rolling along a surface, dominoes falling over and a mousetrap being triggered.)

Identical transfers of energy in succession are only counted as one step. For example, a line of dominos hitting each other only counts as one step. Counting 100 dominoes as 100 steps does not meet the guidelines.

Who Can be on an Engineering Design Challenge Team?

- A team must have at least two youth team members but no more than 10.
- Youth who will have completed 3rd through 12th grades by the end of the 2023-2024 school year are eligible to be on a team. Youth who have completed any grade beyond 12 are not eligible to be on a team, but they may act as youth mentors. Youth mentors do not replace the adult volunteer leaders.
- The challenge will not have a junior and senior division for the 2024 contest. A youth team can be made up of any members that are in grades 3 through 12.
- In addition to the 2 to 10 youth, each team must have at least one adult volunteer leader. Each volunteer must complete the 4-H volunteer screening process. One volunteer must be present at the State Fair competition for the team to compete.
- All team members (youth and adult) must be enrolled in 4-H before the team registers for the contest.

Registration

A. Team sign-up: This sign-up serves as a notice to the state leaders that you have signed up as a team. This will allow the state staff to estimate contest participation and also email updates to teams.

   a. You can find this registration on FairEntry under “Engineering Design Challenge.” Adults have to register before any youth team members can register.

   b. After the adult volunteers have registered, we will list the team in FairEntry and notify the adult volunteers that their youth team members can register. Notifying the adult volunteers that their team can register may take a couple of days.

   c. If you have any questions about this process, please contact Holly at 701-231-7259.

Sign-up Deadline

Teams should sign up as early as possible so we can be prepared for the State Fair. Teams must sign up by June 30.

B. County Fair Registration: If a team decides to show its machine at its county fair, registration for the county fair will be at the county level and carried out through the county fair registration process.

C. State Fair Registration: Teams who would like to compete at the State Fair will sign up through the State Fair registration process facilitated by the county 4-H agent.

Machine Specifications

Machine Specification	Requirements or Limitations
Complete the official task (for example, put a quarter in a piggy bank)	Required
Safe for participants and observers	Required
Written list of all steps in your machine; can be in your journal and part of your presentation	Required
Number of steps	Minimum: 7; maximum: unlimited
Physical size of machine	Minimum: no minimum size Maximum: 6 feet by 6 feet by 6 feet
Single run time to complete the task	Minimum: None Maximum: 2 minutes
Reset time (time required to set your machine up again after a run)	Maximum: 20 minutes
AC or DC power cords running to the machine	Maximum: 1 cord
Use of air compressors	Not allowed
Objects flying beyond machine boundaries	Objects must stay within overall maximum boundary of 6 feet by 6 feet by 6 feet
Corporate logos	Allowed with written permission from the logo owner
Use of live animals	Not allowed
Hazardous (toxic, noxious, dangerous) materials, explosives or flames	Not allowed
Combustion engines	Not allowed (No gasoline or other combustible fluid may be a part of the machine)
Use of profane, indecent or lewd expressions, offensive symbols or graphics	Not allowed

Theme and Story

While developing the design for your machine, each team should start to develop a theme. The theme and story should be a fun part of creating your machine and might even make the design process easier.

As a team, decide how you will share your story. Your team will have a chance to tell the audiences and judges about your machine story and theme. Videos should not be used as a presentation technique during the contest.

Specific Challenge Specifications

The food must be physically moved into the feeding area. Ideally, the "food" used will be the actual food, however a model or representation of the food can be used.

The "feeding area" can be a bowl, a trough, a feed bag, a plate or even just a space that is designated or marked for feeding, as long as it is clear to the audience that the animal(s) will be fed there.

Engineering Design Process Stages

The engineering design process has five stages:

1. **Problem definition**
2. **Information gathering**
3. **Idea generation and decision-making**
4. **Build and test**
5. **Redesign**

Reflecting on Your Process

Problem definition:

- What is one problem that your team ran into today?

Information gathering:

- What did your team know already that helped you think of a solution?
- What more does your team need to know to help you think of a solution?
- How does your team plan to gather the information that you need?

Idea generation and decision-making:

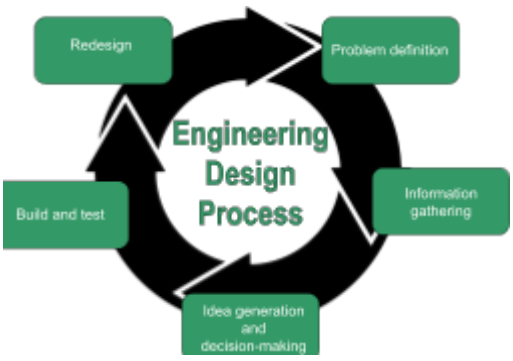
- List the ideas that your team came up with for solving the problem.
- How did your team decide which of these ideas to test?

Build and test:

- Create your design. Did it work? If yes, how? If not, what more did your team do to solve the problem?
- Write down the information/date that your team collects from testing to help you make a decision/solve the problem.

Redesign:

- What did your team do to improve your design/or solve the problem?



Recordkeeping

One of the most important parts of the Engineering Design Challenge is reflecting on and recording one's learning as the team designs the machine. Each team should have a notebook (journal) documenting the design and building process.

The team also should prepare a presentation that summarizes its work outlined in the journal. The recordkeeping requirements must be completed by the time the machine is judged at the county fair. The completed notebook will be judged with the machine.

Team Notebook Specifics

The team notebook or journal should be a record of the team's ideas, progress, setbacks and accomplishments throughout the design and building of the machine. The notebook should be accessible to all the team members and everyone should have the opportunity to make entries and record information.

The notebook should contain writings and drawings. If an idea is not used or if something does not work, do not scribble it out or erase the information. Instead, go into detail about why the idea did not work or wasn't used. The team can write in the notebook throughout its meeting or the team could designate the last 10 to 15 minutes of the meeting to write in the notebook.

Suggestions of what to record: the location, date and length of time the team worked on the machine. Record who was present at each of the sessions; document what was tried. Explain if the trial worked or did not work and why.

*An example journal template is included at the end of the rulebook but teams are welcome to use any format that works for them.

The purpose of the notebook is to give the team members a way to reflect on what they learned and accomplished each time they met. The notebook also provides documentation to the fair judges of the team's work, including research, successes, setbacks and progress. The five stages of the design process may help the team record its meeting entries.

Frequently Asked Questions

Questions About the Contest

Question: What is a step?

Answer: A step in the machine is a transfer of energy from one action to another action. Identical transfers of energy in succession should be counted as one step.

Example: A sequence of dominos hitting each other counts as one step. Counting 100 dominoes as 100 steps is not a different transfer of energy.

Question: Can programmable logic controllers or microcontrollers be used?

Answer: Yes, but their use must fit within the definition of a step. Steps that use controllers should be clearly stated in the written step list and include detailed information on how the transfer of energy is accomplished.

Example: A ball falls onto a switch connected to a controller that turns on a motor.

Question: What is meant by human intervention?

Answer: Once the first step in your machine takes place, (a team member can physically start the machine), the machine should function all the way to the end without a person touching it. If the machine fails before it completes the task, starting it again from the point where it failed may be necessary.

Question: Can I enter a machine that previously was built and posted online?

Answer: No. All entries must be new machines created and built for entry in this competition.

Question: Does our machine have to fill the whole 6- by 6- by 6-foot space?

Answer: No. Your machine can be smaller than the maximum allowed dimensions; it just can't be larger.

Question: Can you tell me more about the theme and the story?

Answer: This year's task is to feed an animal or group of animals by placing the food in a designated feeding area. You could select a theme that ties in with the animal(s) you are feeding. Once you think of your theme, the story will begin to take shape.

Question: What sources can we use for research?

Answer: You already may know some of the information you use to build your machine before you start the design process. However, you probably won't know everything. You can use the library, your teachers, the Internet, your family or 4-H volunteers. Talking to an engineer if you know one might be a good idea.

Lessons on simple machines, transfers of energy and building a simple machine that were developed to supplement the contest are available. The lessons can be found on the Center for 4-H website.

Question: If we show our machine at our county fair and decide to show the machine at the State Fair, can we make changes to our machine, records and presentation between the time we show at our county fair and the State Fair?

Answer: Yes. The engineering design process encourages us to learn from experience and redesign to improve the machine.

Questions About the Teams

Question: Can a team be made up of youth from different school grades?

Answer: Yes. A team can be made up of more than one grade as long as all members are between 3rd and 12th grades.

Question: If our team decides to attend the State Fair, but not all of our members are able to attend the State Fair, is it still OK for some of us to show our machine?

Answer: Yes, you can show your machine even if you are missing a team member. However, make sure that you have enough team members to transport, assemble, demonstrate and disassemble the machine.

Exhibiting Your Machine at County and State Fairs

Be sure to read the information in the registration section about registering to compete at your county fair or at the State Fair.

Presentation at the Fair

Each team will demonstrate how their machine runs.The purpose of the presentation is to assist the team in describing its experience, theme and journal during the judging at the fair. Each member of the Engineering Design Challenge team should have a role in the presentation.

Teams can use pictures, posters and their journal as part of their presentation. The presentation should be less than five minutes in length. The journal helps the team think about the entire process in small steps; the presentation highlights the lessons learned, the big moments, the fun and frustrations the team had from the beginning to end.

Transporting and Storing Your Machine

County Fair

Space differs from one county fair to the next. Teams must contact their county Extension staff regarding their plans to exhibit their machine at the county fair. The staff will be able to give you guidelines on whether you will be able to drive right up to the exhibit space at your county fair to unload your machine or whether it can be stored at the fairgrounds before or after the fair takes place.

State Fair

Teams attending the State Fair should plan on bringing their machine to the fair on the day of their judging and taking the machine back to their home county after judging. Some exceptions may be made for teams traveling a long distance. Any such arrangements must be made ahead of time with the North Dakota 4-H State Fair staff.

4-H staff will do their best to accommodate teams and their machines. In the past, teams have been allowed to park near the State Fair building for 15 minutes to unload/load their machine. We have no guarantee that we will be allowed to do this for the 2024 contest; however, helpers and carts may be available to help transport the machine onto the fairgrounds. The assistance North Dakota 4-H is allowed to provide will be communicated to teams shortly before the State Fair contest.

Fair Judging

All entries will be judged using the conference judging process in which a team meets with the judges at the fair and talks with them about their machine, including developing the design, building it, solving problems, identifying lessons learned and how they worked as a team. Final ribbon placement will be based 50% on the team members' knowledge of that process and 50% on the machine itself.

Ribbon placements will be purple, blue, red or white.

What the Ribbon Colors Mean

- Purple: The exhibit meets all standards. The team has shown complete understanding of what, how and why the exhibit was done, and has a thorough knowledge of the subject. The exhibit and workmanship are extraordinary and need no improvement.
- Blue: The exhibit meets most standards. The team can explain what, how and why the exhibit was done and has a good knowledge of the subject. The exhibit is well organized and well done.
- Red: The exhibit meets some standards. The team can somewhat explain what, how and why the exhibit was done and has a fair knowledge of the subject. Some improvements may be needed on the exhibit.
- White: The exhibit meets few standards and lacks the quality of other exhibits. The team cannot adequately explain the what, how and why of the exhibit. Possibly they have overlooked a safety flaw. Improvement is needed in the exhibit, the knowledge of the subject, or both.

Judging Process

- Teams should refer to the judging guidelines on the following page to prepare for their judging experience.
- The team will participate in a public presentation and conference judging style experience. Each team member should present for a portion of the theme/story/journal presentation and machine demonstration.
- Teams will share their journals during conference judging and review the process for the design and construction of their machine.
- Team members will share with the judge their individual contributions to the construction of the machine.
- The team will demonstrate its machine for the judge and the public.
- Teams who complete the judging process will be awarded a purple, blue, red or white ribbon at county and state fairs.

Judging Guidelines

	Worthy	Good	Excellent
Task completed	Task not completed OR Task completed with multiple human interventions outside of the specified time constraints	Task completed with multiple human interventions in the specified time constraints OR Task completed with 2 human interventions in the specified time constraints	Task completed with one human intervention in the specified time constraints OR Task completed with no human intervention in the specified time constraints
Fits criteria (simple task completed in complicated manner), sequence of steps are clear and described, energy transfer is described, simple machines are identified	Does not meet machine specification requirements and there was not discussion of the sequence of steps, energy transfer or simple machines	In written or verbal presentation one of these criteria were not described clearly: • sequence of steps are clearly described • energy transfer is described • simple machines are identified	• Meets machine specification requirements and limitations • In written or in verbal presentation the sequence of steps are clearly described, energy transfer is described, simple machines are identified
Degree of complication	Simple transfers of energy with little degree of difficulty or complication	Less than half of the steps demonstrated a difficult and precise transfer of energy	Over half of the steps demonstrated a difficult and precise transfer of energy
Degree of innovation	None identified	Less than half of the steps demonstrate an innovative, different, creative use of tools	Over half of the steps demonstrate an innovative, different, creative use of tools (tools/machines are repurposed)
Worked as a team	No teamwork identified	Team was dominated by one or more members; unequal distribution of workload or opportunity for input OR Roles were not clearly articulated	Each team member had a clearly defined role that was articulated or demonstrated to the evaluators in some method
Ways that problems were solved are described using examples and demonstrating perseverance	None identified	Problem solving was evident by not clearly described	Team was able to describe how one or more problems were solved using examples; demonstrated perseverance to get through problems

4-H Engineering Design Challenge Judging Form

Date:_____ Grade range of team members:_____

Name of county team _____

❑ Purple ❑ Blue ❑ Red ❑ White

	Much improvement needed	Some improvement needed	Very good
Machine • Theme or story about machine • Sequences of steps are clear and described; energy transfer is described; simple machines are identified • Understanding and use of: mechanical simple machines • Degree of innovation, creative use of everyday items in new ways • Degree of human intervention			
Conference Judging • Worked as a team, role of each team member is identified and described • Discovered ways problems were solved and described using examples; demonstrates perseverance • Identified "lessons" learned and how they apply beyond engineering design • Conducted research (sought information and knowledge) • Elements of the design process stages are evident • Provided a record or journal that documents the process of building the machine			

Machine Specifications	Specifications met	Specifications not met
Number of steps (minimum of 7)		
Task completed		
Objects leaving the machine		
Machine does not exceed size requirement		
Machine meets rule safety requirements		

Engineering and Design Journal

Team Name:

Location:

Date:

Length of meeting time:

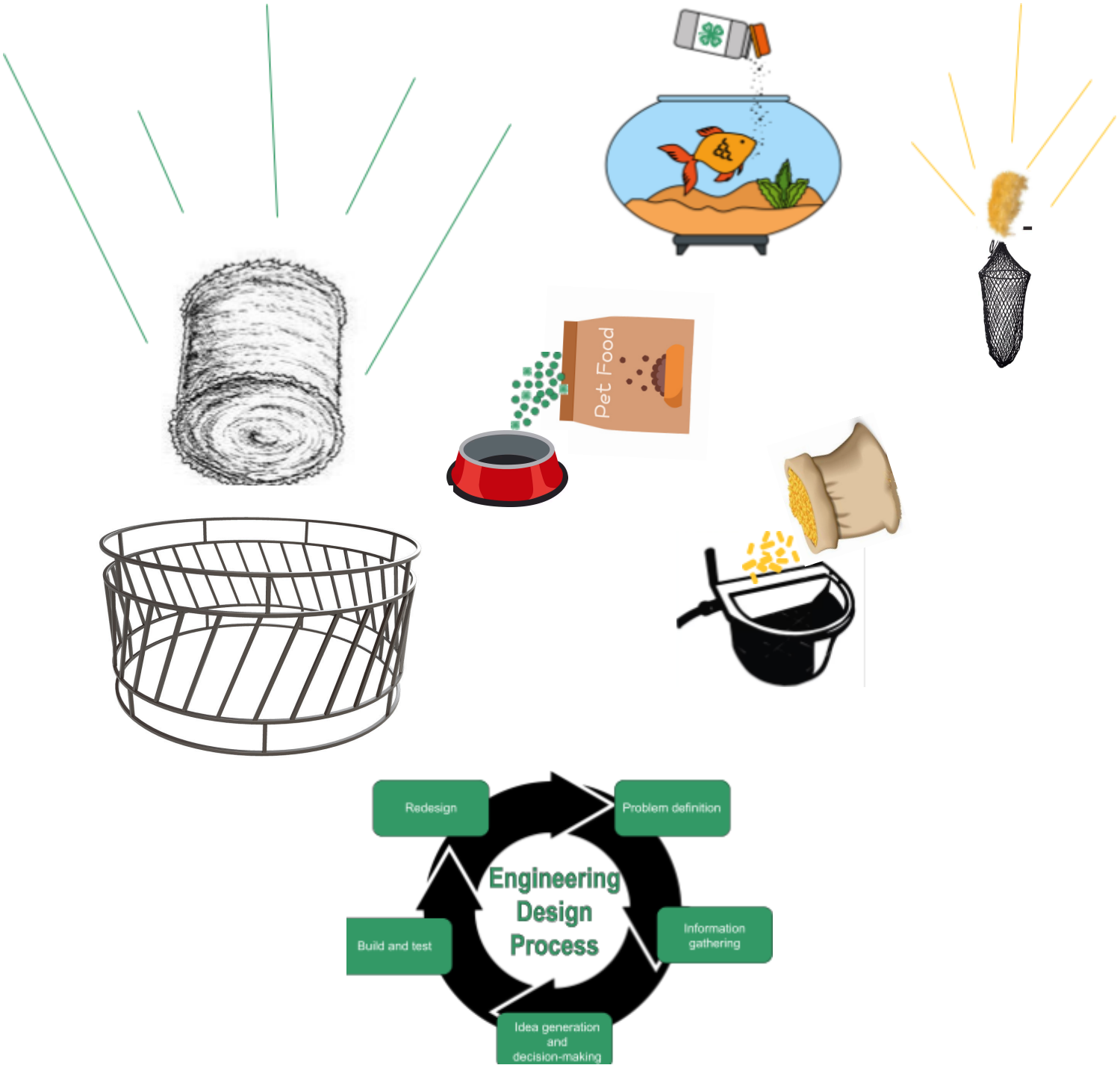
Team members present:

Draw or write about ideas that your team came up with during your meeting:

What is one problem that your team ran into today?

Did you resolve the problem? Why or why not? How?

Describe the progress of your machine:



For more information on this and other topics, see www.ndsu.edu/extension