Performance Task:

Feed the Chicks

Grade Level: 11 - 12

Referencing Vermont Proficiency-Based Graduation Requirements for Informed and Integrative Thinking and Science (Engineering)

Authors: Vermont Agency of Education and Great Schools Partnership

Contributors: This task was developed from materials created by Amy Anthony of Windham Regional Career Center in Brattleboro, VT. Additional contributions were made by Jim Dirmaier of the Essex Center for Technology in Essex, VT, Lisa King of Otter Valley Union High School in Brandon, VT, and Liz Mirra, Springfield High School in Springfield, VT

Table of Contents

Sample Task

Overview/Standards and Learning Targets....3

Big Ideas/Enduring Understanding/Focus Questions....4

Culminating Task: Content/Sources/Materials....4

Opportunities for Formative Assessment....6

Task Instruction: Presentation Expectations, Directions and Instructional Supports....6

Instructional Activities & Other Resources

Instructional Activity: Chick Feeder Project – The Problem....7

Instructional Activity: Chick Feeder Project – Background Research....8

Instructional Activity: Chick Feeder Activity – The Brainstorm....9

Instructional Activity: Chick Feeder Activity – The Plan....10

Instructional Activity: Chick Feeder Activity – The Design....11

Instructional Activity: Chick Feeder Activity – Test and Refine....11

Instructional Activity: Check Feeder Activity – The Presentation....12

Overview

This task asks students to design a solution for a unique scenario. A poultry producer has started to raise a new breed of genetically modified chicken. The problem is that these genetically modified chickens have no instinct that helps them stop eating when they are full, so they will eat constantly. If they are allowed to do this, eventually their legs will not be able to support their weight and they will collapse and suffer injury or death. Currently, the poultry producer is using a trough system that provides food constantly under the assumption that the birds will stop eating when they are full. However, now that they are raising the new breed of chicken, they need a system that will automatically regulate the amount of food available and provide the chickens with access to food during the weekend when human intervention is not available.

Standards and Learning Targets

The following content standards, transferable skills and connected learning targets will be demonstrated and assessed in the culminating task. All of the instructional activities that are included relate to these standards.

TRANSFERABLE SKILLS

Transferable Skill 5: Informed and Integrative Thinking

a. Apply knowledge from various disciplines and contexts to real life situations.
b. Analyze, evaluate, and synthesize information from multiple sources to build on knowledge.
c. Apply systems thinking to understand the interaction and influence of related parts on each other, and on outcomes.
d. Use evidence and reasoning to justify claims.
e. Develop and use models to explain phenomena.
f. Use technology to support and enhance the critical thinking process.

SCIENCE--Next Generation Science Standards

HS PS3-3 --Energy

Design, build and refine a device that works within given constraints to convert one form of energy into another form of energy.

- Disciplinary Core Idea—Definitions of Energy
- Science and Engineering Practices—Developing and Using Models, Constructing Explanations and Designing Solutions
- Crosscutting Concepts—Energy and Matter, Systems and System Models

HS-ETS1-2 Engineering Design

- Design a solution to a complex real world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

HS-ETS1-3 Engineering Design

- Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.

Big Ideas/Enduring Understanding

- A system's total energy is conserved, even though energy can be converted from one form to another within a system.
- The efficiency of a device can be determined by testing the device and analyzing the data.

Focus Questions

What are the overarching and guiding questions students will answer in order to develop these enduring understandings?

- What are the essential steps to designing a product or service to solve an issue, or enhancing a design that already exists?
- How can we design an unmanned system to accomplish a task?
- How is energy transferred and conserved within a system?

Culminating Task

Each student, individually, must produce a formal presentation justifying the design of their product and its development process for the 'client.' This presentation can be in the form of a written evaluation with graphics or an annotated set of slides. The document or slides must address each of the following criteria:

1. Make a claim about why the Design Team solution is an effective one to solve this problem, and support that claim with evidence and reasoning. This evidence should be drawn from the testing of the group design as well as from any research that has been done about products that address similar problems
2. Describe/show the device you designed, including a diagram or a model that illustrates how the product will work.
3. Explain how the parts of the system interact effectively to achieve the desired effect (how the criteria and constraints were met).
4. Explain how any parts of this device converted energy one form into another.
5. Include justification for the tradeoffs made in this design to benefit the system.
6. At the end of your presentation, include an annotated list of resources that describes the sources of information or inspiration that you used while developing the design ideas, with explanation of how each source contributed to the final design.

Content/Sources/Materials

Equipment Needed:

Availability of tools for preparing Chicken Feeder materials, on-line access to research sources, computer lab to create presentation materials, printer, multi-meters, force sensors.

Materials Needed (per Team):

Controllers, servo and continuous motors, wires, lexan sheets, wood, fasteners (screws, etc.), LEDs, batteries, wires, timer, chickens coop, pulleys, cord, timer, PVC pipe, glue, feed and access to chicks to test the product, science notebooks.

Texts/Other Materials Needed

Students will need access to computers on which they can compose their presentations. Students will need materials to devise this Chicken Feeder device

The Engineering Design Process:

The instructor will need to ensure that students understand Engineering Design. This diagram could provide the basis of that instruction.

- Teacher Resources
  - (How to Teach Engineering Design Grade 6-8)
  - NGSS High School Engineering Design (Fact Sheet)
  - Design Squad Examples

From: Engineering Everywhere—Engineering Design

Anchoring Phenomenon:

DO THIS **before** you distribute the Student Task instructions to the students.
Teacher provides students with the picture of two genetically modified chickens (Anchoring Phenomenon) and asks individual students to answer the following questions in their science notebooks:

- **Describe what this photo conveys about how poultry growth has changed in the last 50 years.**
- **Identify the implications of this situation for a poultry farmer.**
  - Students will share their thinking with entire class about what they have observed and recorded in their notebooks.

1. **The Problem:** *(Identify)*
   - Teacher will present the following situation to the class and poses the problem students are asked to solve.
   - Students will gather in Design Team groups (2-3 students.)
   - Students will consider the Criteria and Constraints of the problem and complete **Chart #1**in their Design Teams. **See 'The Problem' in Student Task below.**

2. **Background Research:** *(Investigate)*
   - Students, as a class or other group, will brainstorm and together clarify the problem.
     - Students will identify questions they may have.
   - Then in Design Teams, they will research/jigsaw information and share that information with the class. (Different class groups can each address one of the topics below.) **See 'Background Research' in Student Task below.**
   - Design Groups will organize what they learned in Chart #1 and share information with the larger group.

3. **The Brainstorm** *(Imagine)*
   - Students will discuss and devise Theoretical Solution—through Class Discussion
     - Revisit the Research
     - What might we need to do?
     - Record answers to questions on Wall Chart. **See 'The Brainstorm' in Student Task below.**

4. The Plan *(Plan)*

- Each Design Team discusses the brainstorm ideas and devises a Theoretical Solution to the Problem.
- Students consult notes and identify and prioritize Criteria and Constraints for the proposed Design
- Teams discuss how they will overcome the obstacles and sketch a model of the circuitry for the Feeder.
- Each Design Team creates a design for the Feeder, including details of the circuitry for the regulating device and records a Sketch--Feeder Circuit Model.
- Then each Design Team develops a Sketch-Overall Design Model for their Feeder. **See 'The Plan' in Student Task below.**

5. The Design *(Create/Build)*

- Design Teams build a prototype for their Chicken Feeder that meets the identified criteria. **See 'The Design' in Student Task below.**
- Students revisit constraints in **Chart #1** and put an "✗" in the box for each constraint that the design satisfies.

6. Test and Refine *(Test and Improve)*

- Students Test and Evaluate the performance of their design.
- They REVISE their design and re-evaluate Results. **See 'Test and Refine' in Student Task below.**

7. The Presentation *(Communicate)*

- After finding the optimal design to accomplish the requests of the Client, students will prepare their presentation. **See 'The Presentation' in Student Task below.**
    - Distribute the project rubric and review expectations with the students.

Opportunities for Formative Assessment

Written documentation illustrating

1. Problem identification
2. Brainstorming
3. Design selection of three possible ideas to investigate
4. Design refinement/research
5. Matrix for design selection
6. Prototyping/testing
7. Design selection
8. Building
9. Implementing/presenting

(Materials for these formative assessments can be found within the Student Task.)

Task Instruction: Presentation Expectations:

As students plan their presentation they will need to include each of the items in the following checklist. Then they can use these notes to help build a complete presentation. All of the categories listed here must be addressed.

☐ *Make a claim about why your design and solution to the Problem is effective and support that claim with evidence and reasoning.*
- This evidence can come from the tests performed by you and from your research using outside sources.
- You must present and explain at least three pieces of evidence or data that support your position.

☐ *Describe/show the device you designed, including a diagram or a model that shows how the parts of your system will interact to achieve the desired effect.*
- Your diagram or model can be 2 or 3-dimensional; if it is 3-dimensional, include photographs in your final presentation.

☐ *Explain how the parts of your system will interact effectively to achieve the desired effect (how the criteria and constraints were met).*

☐ *Explain how any parts of this device converted energy from one form into another.*
- The science of the energy transfers must be explained.

☐ *Explain the tradeoffs that you made in this design and explain your justification for each one.*

☐ *Include an explanation of the tools or technology you used, with a discussion of what worked well and what did not work well.*

☐ *At the end of your presentation, include a list of source used during this project.*
- Describe the sources of information or inspiration that you consulted while developing your design ideas, with explanation of how each source contributed to the final design.
- Each entry must be accompanied by a sentence explaining why this source meets your criteria for being valid and reliable.

Student Task

- Describe what this photo of genetically modified chickens tells us about how poultry growth has changed in the last 50 years.
- Identify the implications of this situation for a poultry farmer.

1. The Problem: *(Identify)*

Introduction: This task asks you to design a solution for an unusual scenario. A poultry producer has started to raise a new breed of genetically modified chicken. Because these genetically modified chickens have no instinct that helps them stop eating when they are full, they will eat constantly. If they are allowed to do this, eventually their legs will not be able to support their weight and they will collapse and suffer injury or death.

Your client raises these genetically modified chickens that are ready for harvesting in sixty days. During the sixty days, the client encountered several problems, including chickens' overeating. The client provides fresh water and food to the chickens daily. The first year of this project the client

realized evening and weekends were difficult for him to tend to the birds. To prevent the chickens' overeating, the client traveled to and from the chicken coop several times a day during the weekend and stayed late during week to remove the access to the food. This year the client hopes to implement a system that will automatically regulate the amount of food available and limit the when food will be available to these chickens. Because the chicken coop does not have access to power for running a Feeder, you need to devise a system that provides energy to the Feeder without connection to a power grid.

Problem: A client has contacted your Engineering Company with the following request: "How can you design an automated system to feed my chickens so that they do not overeat? The producer would like the chickens' access to feed to be regulated so that the producer will not have to visit the coop on the weekends and so the chickens would not have constant access to feed during each day." The system does not have access to power for running the feeder.

It is important to note the chicken coop holds twenty chickens and is located away from any building and any power source. The chicken feeder weighs approximately 30 lbs. when filled.

- In your Design Team discuss the Criteria and Constraints that this Problem presents.
- Record the Criteria and Constraints in **Chart #1** below.
- Record your reasons for these Criteria and Constraints in your Notebook.

CHART #1

Criteria and Constraints

Criteria	Constraints
•	•
•	•
•	•
•	•
•	•
•	•

2. Background Research *(Investigate)*

- As a class you will Brainstorm your ideas about the Problem. Record ideas in your Notebook.
- In Design Teams of 2-3 students you will research information to share with classmates.
  - Chicken Foraging/feeding behavior
    - Normal Chick Feeding Behavior (article)
    - A Behavioral Approach to Feeding Broilers (article—you may want to provide only appropriate excerpts)
      - Chicken Foraging Behavior (article)
      - Poultry Behavior (article)

- Chicken feeder designs *(For the Teacher: These resources provide a variety of feeder designs that will help students to solve this problem.)*
  - DIY Chick Feeders (YouTube)
  - Backyard Chicken Lady—DIY Feeder (blog)
- Different ways of automating chicken food delivery
  - Chick Feeder (You Tube)
  - Automatic Chicken Feeder (You Tube)
- Other sources to answer questions. (Group Choice)

- Design Teams will organize what they learned from research in **Chart #2** and share information with the class.

CHART #2

Know	Need to Know

3. The Brainstorm *(Imagine)*

- Discuss, with the class, what your Team discovered and share possible solutions to the Problem.

Brainstorm Guidelines

Consider your response to these questions:

- How may we restrict the feed from the chicks during a 24-hour period?
- How may we provide sufficient food for the chicks during the weekend?

1. Record as many ideas as possible.
2. Be visual, sketches if needed.
3. Quick concepts one-word description.
4. Everyone shares.
5. Be positive, encouraging, any idea is ok.
6. Build on others ideas.
7. Stay on topic.
8. Consider crazy ideas.

- Revisit the Research, if necessary.
- Consider what else you may need to do to gather sufficient information.
- Individually record important ideas from the Class Discussion into your Notebook.

4. The Plan *(Plan)*

- Discuss the brainstorm ideas with your Design Team.
- Consult your notes and **revisit** the Criteria and Constraints in **Chart #1**.
- Record revisions to your plan in your Notebook.

Concept Sketching: Circuit Model – Use a schematic/model to show how motors, batteries, wires, controller and simple machines could work together to control feed access. Make calculations or determine estimations for controlled amount of feed released and time interval.

- Create a design for the circuitry of the Feeder, including details needed for the regulating the device.
- Use a schematic to show how motors, batteries, wires, controller and simple machines could work together to control feed access.
- Make calculations or estimates for the weight, time and forces needed.

Your Sketch--Feeder Circuit Model

Concept Sketching: Overall Design Model – Now show a model for your integrated system. Include the location of the circuitry described above. Use labels to describe the different parts and functions. Draw the project from different perspectives and angles, if necessary, to show important details or assembly.

Your Sketch--Overall Design Model

5. The Design *(Create/Build)*

- With your Design Team create and build a Chicken Feeder that meets the identified criteria and constraints.
    - Build the proposed design. Look over your constraints in **Chart #1** and put an "✗" in the box for each constraint that your design satisfies.

6. Test and Refine *(Test and Improve)*

Original Design Test:

- Test the effectiveness of your designed feeder system. This functioning model of the feeder system is your prototype.
- Results:
    - Gather data around the effectiveness of the Feeder and record in your Notebook.
        - Amount of food dispensed (weight/volume)
        - Timing of food release
    - In your Notebook identify and record 'tradeoffs' might be necessary in the development of your design.
    - Describe any differences between your expected results and the prototype results. If your system did not work, explain the reason why.
    - Optimize: Describe how you would modify your design to improve its efficiency.

Revised Design Test:

- Design: Teams build and test the revised model of your system.
- Results:
    - Data are gathered and recorded in notebooks around the effectiveness of the redesigned Feeder.
        - Amount of food dispensed (weight/volume)
        - Timing of food release

        - In your Notebook identify and record 'tradeoffs' necessary in the development of your design.
    - Describe any differences between your expected results and the prototype results. If your system did not work, explain the reason why.
    - Optimize: Describe how you would modify your design to improve its efficiency.

7. The Presentation *(Communicate)*

- You have brainstormed, sketched ideas, tested designs, revised, and finalized your product. In this final piece of work, you will present your ideas to the client.
- Each student, individually, must produce a formal presentation justifying the design of their product and its development process for the 'client.' This presentation can be in the form of a written evaluation with graphics or an annotated set of slides. The document or slides must address each of the following criteria:
    1. Make a claim about why the Design Team solution is an effective one to solve this problem, and support that claim with evidence and reasoning. This evidence should be drawn from the testing of the group design as well as from any research that has been gathered about products that address similar problems.
    2. Describe/show the device you designed, including a diagram or a model that illustrates how the product will work.
    3. Explain how the parts of the system interact effectively to achieve the desired effect (how the criteria and constraints were met).
    4. Explain how any parts of this device converted energy from one form into another.
    5. Include justification for the tradeoffs made in this design to benefit the system.
    6. At the end of your presentation, include an annotated list of resources that describes the sources of information or inspiration that you used while developing the design ideas, with explanation of how each source contributed to the final design.

The audience for this presentation is your client.

A Few Resources to support the development of your Presentation:

- SWAY (a one page multi-media presentation mode)
- PREZI
- How to create a Power point
- 10 Tips for making a Presentation
- See Presentation Checklist.

Presentation Checklist:

As you plan your presentation be sure to include each of the items in the following checklist. Then use these notes to help you build a complete presentation. All of the categories listed here must be addressed.

☐ *Make a claim about why your design and solution to the Problem is effective and support that claim with evidence and reasoning.*

- This evidence can come from the tests performed by you and from your research using outside sources.
- You must present and explain at least three pieces of evidence or data that support your position.

☐ *Describe/show the device you designed, including a diagram or a model that shows how the parts of your system will interact to achieve the desired effect.*
- Your diagram or model can be 2 or 3-dimensional; if it is 3-dimensional, include photographs in your final presentation.

☐ *Explain how the parts of your system will interact effectively to achieve the desired effect (how the criteria and constraints were met).*

☐ *Explain how any parts of this device converted energy from one form into another.*

☐ *Explain the tradeoffs that you made in this design and explain your justification for each one.*

☐ *Include an explanation of the tools or technology you used, with a discussion of what worked well and what did not work well.*

☐ *At the end of your presentation, include a list of source used during this project.*
- Describe the sources of information or inspiration that you consulted while developing your design ideas, with explanation of how each source contributed to the final design.
- Each entry must be accompanied by a sentence explaining why this source meets your criteria for being valid and reliable**.**