

Engineering Notebook

Name:

Brooke Horn

Class:

E in Engineering:
Meaningful Content in
Engineering

Teachers:

Dr. Annie Arnone and Mr.
Brandon Rodriguez

School Year:

2025-2026

Project:

The Plastic Problem
Alternative Plastic
The Reusable Bag
Biodegradable Plastic
Alternative



NOTE: All Red text is not mine but part of the record keeping system of the notebook itself. I kept it for fidelity to the engineering process.

NOTES/SKETCHES/QUESTIONS/THOUGHTS

What is the Purpose of this Notebook?

This Engineering Notebook will be used to record your progress, ideas, notes, sketches questions, and thoughts. It is your evidence of the work and projects you have completed throughout the school year. This notebook has all the information you need to be successful in class. It will be kept in the classroom. If you need to take it home, you will need to remember to bring it back to class the next school day

Why an Engineering Notebook?

Engineers use an Engineering Notebook to record ideas, inventions, experimentation records, observations, and all work details. Careful attention to how they keep their Engineering Notebook can have a positive impact on the patent outcome of a pending discovery, invention, or innovation.

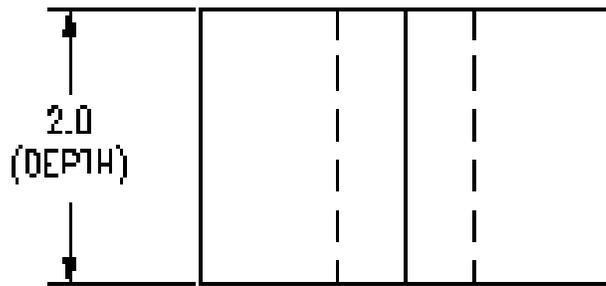
How do I keep an Engineering Notebook?

1. Write NEATLY - anyone should be able to read it.
2. Write down EVERYTHING AS IT HAPPENS.
 - If it is not documented, it did not happen
 - If you write it the next day, it did not happen.
3. Use BOTH sides of a page.
4. Date each entry in chronological order.
5. Clearly separate each day's entry by drawing a line under the entry.
6. Entries should include enough information so someone else could successfully duplicate your work.
 - Label figures and sketches. Keep sketches up-to-date – make changes as they happen.
 - Use complete sentences – a complete sentence is a complete thought that begins with capitalization and ends with a form of punctuation.
7. Draw a single line through any errors and enter the correct information nearby . . . it is o.k. to erase sketches
8. Never leave blank spaces - simply "X" out any blank spots.
9. Never, under any circumstances, remove pages from your notebook.

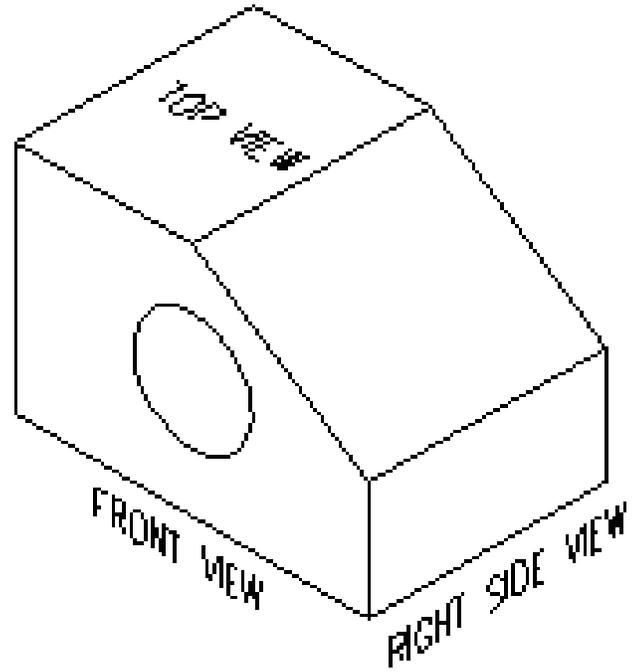
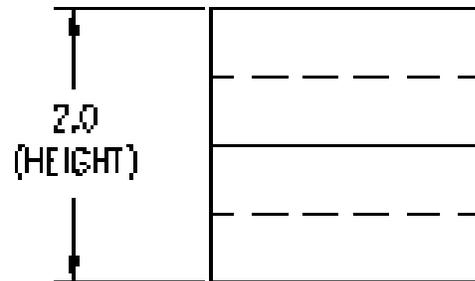
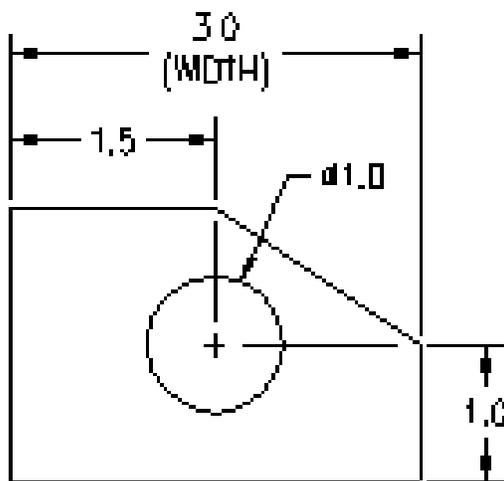
ENGINEERING DRAWING & ISOMETRIC EXAMPLE

Orthographic Projection - depicts an object's, **Top**, **Front**, and **Right** side view, as well as a 3-Dimensional View called an **Isometric**.

Orthographic Projection



TOP VIEW



IDENTIFY PROBLEM

PROJECT

Identify the “Big” concept to be covered by the engineering design challenge.

Background Timeline:

2018:

The American Chemistry Council, the National Association for PET Container Resources and The Association of Plastic Recyclers calculated that 35,680 thousand tons of plastic was generated in the United States alone. Of that number: 3,090 thousand tons was actually recycled, 5,620 thousand tons was combusted through energy recovery and the remainder was sent to landfills.

March 2020:

NYS issued a plastic shopping bag ban on all major retailers. This affected not only the retailers themselves, but the consumers as well.

March 2022:

The United Nations Environmental Assembly agreed to establish a legally binding international agreement to end plastic pollution.

May 2025:

The NYS Senate voted to pass the Packaging Reduction and Recycling Infrastructure Act, which is designed to reduce packaging items in plastic by 30% incrementally over the next 12 years. By 2052 all products must meet a 75% recyclability in NYS.

June 2025:

The Act failed to pass for a second time in the NYS Assembly. It is still very much in the news. Just last week, a local radio station was interviewing protesters in upstate NY on their thoughts and feelings on the plastic and packaging act.

The Bottom Line:

Clearly, whether you are for or against the Act to pass in congress, 85% of Americans agree that plastic waste is a problem and that we as a population need to find a solution. Additionally, 91% of Americans said they were somewhat more likely to use a biodegradable plastic or environmentally friendly alternative if given the choice: knowing it would benefit the environment.

The Task:

Design, build, test, and evaluate a biodegradable polymer that functions similarly to plastic.

- This polymer will help reduce the global production and consumption of single use plastic products
- This polymer will not remain in landfills long term or pollute the oceans because it will degrade biologically.
- Group consensus:

Links:

- <https://www.epa.gov/facts-and-figures-about-materials-waste-and-recycling/plastics-material-specific-data>
- <https://dec.ny.gov/environmental-protection/recycling-composting/bag-waste-reduction-law/plastic-bag-film-plastics>

- <https://www.beyondplastics.org/press-releases/ny-packaging-passes-senate-2025>
- <https://www.beyondplastics.org/press-releases/two-years-ny-assembly-fails-packaging-reduction>
- <https://www.wamc.org/news/2025-09-15/activists-urge-nys-assembly-pass-the-packaging-reduction-recycling-infrastructure-act>
- <https://www.worldwildlife.org/pages/no-plastic-in-nature>
- Engagement Links:
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LEARNING STANDARDS

PROJECT

Research appropriate learning standards associated with the topic.

NYSSLS, ITEEA, MATH & ELA Standards

HS-PS2-6: Communicate how molecular-level structure determines macroscopic properties.

- **Science:** Understanding the relationship between atomic/molecular structure and observable material properties.
- **ITEEA:**
 - **Design (Standard 3):** understanding materials to inform engineering design
 - **The Designed World (Standard 8):** recognizing that materials and their structure impact functionality
- **Math:**
 - **HSF-IF.4:** Interpret functions in terms of context
 - **HSS-ID.6:** Represent data on two quantitative variables
 - **HSS-IC.3:** Recognize the purposes of data collection and summarize data
- **ELA:**
 - **RST.11-12.1:** Cite specific textual evidence to support analysis of science/technical texts
 - **RST.11-12.2:** Determine central ideas or conclusions of complex texts
 - **WHST.11-12.2:** Write informative/explanatory texts to examine scientific concepts
 - **SL.11-12.4:** Present information, findings, and supporting evidence clearly

HS-PS1-3: Plan and conduct an investigation to gather evidence to compare properties of substances.

- **Science:** Designing experiments, collecting and analyzing data, and comparing materials.
- **ITEEA:**
 - **Abilities for a Technological World (Standard 7):** Conducting experiments and investigations safely.
 - **Design (Standard 3):** understanding materials to inform engineering design
- **Math:**
 - **HSF-IF.4:** Interpret functions in terms of context
 - **HSS-ID.6:** Represent data on two quantitative variables
 - **HSS-IC.3:** Recognize the purposes of data collection and summarize data
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 - **RST.11-12.1:** Cite specific textual evidence to support analysis of science/technical texts.
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- **WHST.11-12.2:** Write informative/explanatory texts to examine scientific concepts.
- **SL.11-12.4:** Present information, findings, and supporting evidence clearly.

HS-ETS1-1: Analyze a global challenge (plastic pollution) and specify criteria/constraints for a solution.

PROBLEM SOLVING

PROJECT

Identify and discuss the different types of problem solving and declarative/procedure knowledge needed:

Principles of Problem Solving:

- Cognitive but from inferred behavior
- Results in behavior that leads to a solution
- Manipulation of our operations on previous knowledge
 - These include the ability of the student to be able to:
 - Analyze the question/topic (identify the problem)
 - Communicate effectively within their group to accomplish the task (teamwork)
 - Display emotional intelligence
 - Redefine resilience against the problem (explore solutions and test them)
 - Be creative
 - Be adaptable
 - Evaluate result and determine whether it is satisfactory

Declarative knowledge: context knowledge to teach problem solving in authentic situations.

- This is the chemistry and sustainability concepts to needed to interpret results:
 - Polymers: long chains of repeating molecules
 - Difference between natural polymers and synthetic plastic
 - Role of each ingredient:
 - Starch - rigidity, strength
 - Gelatin - adds protein based polymer chains
 - Glycerol - acts as a plasticizer for flexibility
 - How molecular structure relates to macroscopic properties (H-bonding, polarity)
 - Why plastics are an environmental problem (non-biodegradable)
 - Engineering design process
 - Safety rules in chemistry lab

Procedural knowledge: knowledge exercised in performance of some task.

- This is the lab skills and testing/design process
 - Measure and mix ingredients
 - Heat mixtures safely
 - Follow experimental set-ups
 - Collect data systematically
 - Test materials for strength
 - Record and analyze results
 - Revise a design (based on results)
 - Communicate results in oral and pictorial formats

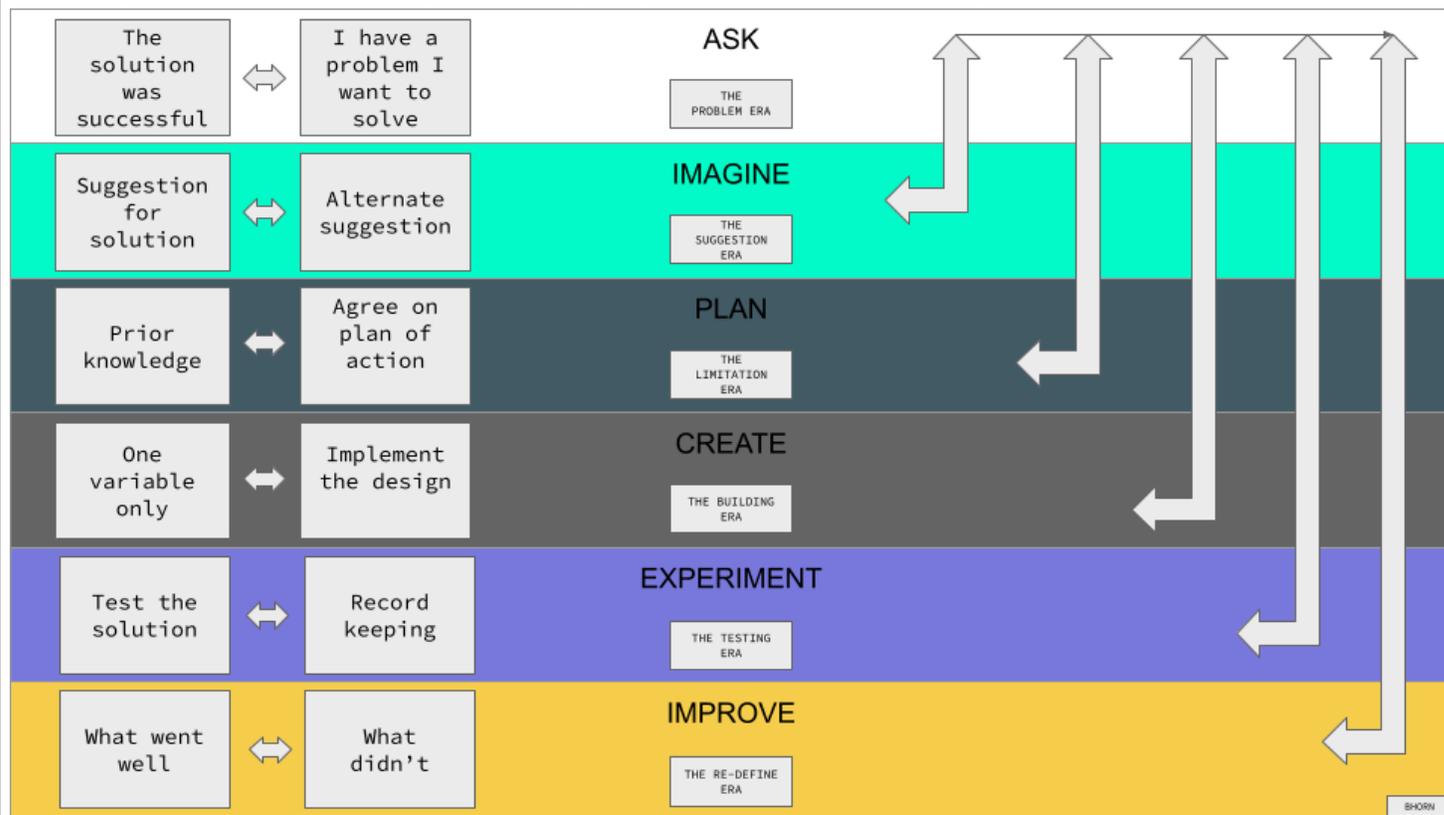
LEARNING OBJECTIVES:

Explore objectives and ancillary concepts/content covered by the project.

Students will be able to:

1. Explain how polymer structure and intermolecular forces influence physical properties.
2. Plan and conduct an investigation to compare mechanical and chemical properties of different biopolymer formulas.
3. Apply the engineering design process to design and optimize a sustainable plastic alternative.
4. Evaluate their design against constraints and a global challenge.
5. Communicate findings with evidence-based reasoning.

ENGINEERING DESIGN PROCESS



IMPLEMENTATION TIMELINE

PROJECT:

Date(s) October 2025

LINKS

Lesson 1: ASK

Introduce the Plastic Problem with various infographics (websites/readings/videos) surrounding plastic and how it is impacting our bodies. Set up a problem for students to solve.

Lesson 2: IMAGINE

Explain design criteria and constraints. Students start to brainstorm ideas for possible suggestions to modify the amount of plastic pollution on the planet. In theory, the less plastic polluted, the less which should end up in our bodies. Students will sketch potential biopolymer design and predict how amounts will affect biopolymer design.

Lesson 3 and 4: PLAN/CREATE

Students make a plan on what variable to manipulate and who will run each experiment. It is decided that students will manipulate the amount of gelatin and test the gelatin's water resistance and elasticity; two key aspects of what make plastic, plastic. If this biopolymer can be used as an alternative to plastic, then it should not be able to be dissolved by water and should have minimal elasticity (return to its normal shape after pulling).

Lesson 5: EXPERIMENT

Students create the biopolymer. See lab activity attached below.

This had to be completed over multiple days because the polymer had to dry before the students could run testing on the plastic polymers.

Lesson 6: IMPROVE

Students believed that adding more gelatin made the substance more plastic-like. Not food dyeing it (keeping it clear) also made it look more like plastic (in comparison to those which were food dyed). All three variations made were water resistant. The least elastic was the one with the greatest amount of gelatin.

[SLIDESHOW FOR STUDENTS](#)

- a. What went well with the engineering design challenge?
 - b. What did not go well with the engineering design challenge?
 - c. What concepts were covered (list standards and topics where appropriate)
 - d. How did the ED process help teach the science and mathematics concepts?
 - e. Did I choose an appropriate engineering design process? Should I simplify or make it more complex?
 - f. How can I improve this activity to use with future students?
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- A. The engineering design challenge left my students really impressed with themselves and a solution to a real-world problem that is affecting them in their lives. I was even surprised with how impressed they were with the finished material. I don't think it truly sank in until they were able to fold the biopolymer and run water over it - that they did it. They created something similar to plastic, which in theory, could break down, rather than accumulating in our brains and blood.
 - B. Since I ran it with a smaller class, the students were not always together to complete the assignment. We needed to let it sit for 3 days, instead of 2, as originally planned (because of a day off for students). Food dyeing the biopolymer seemed cool for the students at first, but, when one student did not food dye it - it actually looked like plastic and I think the other students wished they made it look more like plastic.
 - C. Please reference the learning standards section of this document.
 - D. The engineering design process helped the students learn math and science because they need to apply those skills in order to complete the task. Additionally, it provides context and relevance for the task at hand.
 - E. The class that I chose to run the engineering design activity was originally chemistry, however, I did not end up having the opportunity to do so. Instead, I took a different approach to this activity. I also teach a class called 'Why am I sick?' and thus turned this challenge into a fun hands-on activity for those students. We first learned about the sicknesses related to accumulation of plastic in our bodies and then thought about potential solutions to this problem. Ultimately landing on synthesizing a plastic which could break down naturally. For this course, I think the level of complexity was perfect because it is an elective, meaning, I have students across multiple academic levels completing the activity.
 - F. To improve this activity in the future, I could add more ways to test the biopolymer - to see if it would be like a plastic we would like to use. (Can it carry weight? Can it hold a sandwich?)

Name: M.G.

Bioplastic Alternative Lab - WAIS

Background/Purpose:

As people have increasingly used plastics, we have also seen an increased number of microplastics build up in human organs, stressing the need for a change to the plastic industry. The purpose of this lab is to create a biodegradable plastic that can function in a similar way to non-biodegradable plastics. It is known that people rely heavily on plastic for food based needs such as cutting boards, food storage, and water filtration. All of these lead to microplastics in our bodies due to consumption and our goal is to find a way to replace these toxic plastics in a way that people may accept.

Safety:

1. Safety goggles
2. Monitor hot plate for temperature
3. Gloves
4. Do not consume any materials

Materials:

- Gelatin (unflavored)
- Glycerol (food grade)
- Distilled Water
- Food coloring (optional)
- Watch glass
- Beakers

- Stirring sticks
- Timer / stopwatch
- Safety gear: goggles, gloves, apron
- Weighboat
- Graduated cylinder
- Ruler

Procedure:

Record mixing observations (viscosity, color, smell) in data table.

1. The teacher labeled watch glasses with student initials (for molds).
2. Measure 5 g gelatin in a weighboat.
3. Add 30 mL cold water, pour in gelatin and stir — allow to **bloom** 3–5 minutes.
4. On the hot plate, heated 30 ml of water until hot, not boiled, and add to bloomed gelatin while stirring until fully dissolved (mixture should be bubbly/grainy).
5. Measure glycerol (6.66 g) and add to the beaker with gelatin and water. *Add food coloring if desired.* Stir thoroughly.
6. Heat solution for 30–60 s to ensure homogeneity (do not boil).
7. Pour solution onto watch glass and allow to cool to room temp, then place in the drying area.
8. Record observations.
9. Run water resistance and elasticity testing
 - a. Elasticity:
 - i. Pull on the bioplastic in the compass directions east to west. If bioplastic is flexible, it will return to its original shape
 - b. Water Resistance:
 - i. Pour 15 ml of water on the bioplastic. If bioplastic is water resistant, it should not dissolve

I poured the hot water

I added blue and green food dye

Looked like snot (chunky)

After pouring, part of the surface was smooth while the rest was bumpy

Keily's was red and liquidy (looked like cough syrup)

She used less gelatin

Data:

Data Table 1:

Sample	Ingredients and Ratios	Drying Time (hours)
1 (KC)	2 g gelatin, 6.66 g glycerol, 60 ml water	72 hrs
2 (MG)	5g gelatin, 6.66g glycerol, 60 ml water	72 hrs
3 (MP)	8g gelatin, 6.66g glycerol, 60 ml water	72 hrs

Data Table 2:

Sample	Observations (Procedural)
1 (KC)	More liquidy, "cough syrup"
2 (MG)	Looked kind of chunky, pouring was not smooth
3 (MP)	Mixture was chunky and grainy

Data Table 3:

Sample	Water Resistance	Elasticity
1 (KC)	Was water resistant	Was elastic
2 (MG)	Held water. Didn't melt it. Kind of	Relatively elastic

	slippery afterwards.	
3 (MP)	Water resistant	Was elastic

Data Table 4:

Sample	Design Iterations/Changes
1(KC)	More gelatin
2 (MG)	More gelatin but not bad
3 (MP)	Possibly 1 more gram of gelatin and more drying time

PHOTOS BELOW:













