Unit Overview – Socially Responsible Engineering & Technology (POS)

Course: Y1U1

Unit Title: Got Design? (Introduction to the Engineering Design Process)

Approximate Length of Unit: 5-6 Weeks (based on five day weeks; 45 minute periods each day)

Unit Summary

This unit will begin by raising student interest in the Engineering Design Process and the designed world. Our society has been greatly transformed by technological innovations since the dawn of time, most noticeably in the past century. We now take for granted many great advances that did not exist even a generation ago and the rate of innovation is not expected to slow in the future. We as a society are just at the beginning stages of many new innovations in areas such as autonomous robots, nano-technology, and biotechnology, among others.

At the beginning of this unit, students will learn about the Engineering Design Process, lab procedures, natural vs. designed world, and the resources of technology. This will be accomplished by providing them with a process (the Engineering Design Process), a context (the Problem), and the design brief (Specifications and Constraints) to work within.

Throughout the unit, students will acquire the ability to apply the Engineering Design Process to create a viable solution to a problem while acquiring technical skills and demonstrating the application of math and science principles. Students will be presented with the following problems:

Using the **TSA Structural Engineering Design Brief** and the Engineering Design Process, students will design, fabricate, and test a structure that must hold a specific amount of weight.

Using the **Sweet Project Design Brief** and the Engineering Design Process, teams of 2-3 students will design, name and create a prototype candy bar. A theme will be development to market the candy bar that will relate to the shape and texture of the bar as well as the packaging.

The first design challenge is meant for the teacher/instructor to walk the students through each step of the Engineering Design Process while giving instruction on the skills necessary to complete each step. The second design challenge is meant for the students to practice the Engineering Design Process. Throughout the second design challenge, further instruction will be provided to further refine their skills needed for each step.

Primary Interdisciplinary Connections: *The use of Mathematics (NJCCCS 4.2), Science (NJCCCS 5.1), Technological Literacy (8.2), 21st Century Life Skills (9.1), Career and Technical Education (9.4), and English Language Arts (Common Core).*

21st Century Themes:

Global Awareness – *students must consider the global impact of technology*

Problem Solving *– students will solve design problems using the Engineering Design Process*

Collaboration *– students will work with fellow students to solve problems using the Engineering Design Process*

Critical Thinking – *students will think critically about the problems posed in the design briefs*

Unit Rationale

Today, it is important for students to have a basic foundation of technological literacy in order to be successful decision makers in such a technologically advanced world. This unit will allow students to apply the concepts of design and begin to gain an understanding the cultural, social, economic and political impacts of technology and innovation. These foundations will be built upon in other units and courses within the framework.

There is also a strong demand for engineers, as is demonstrated by professional engineering associations, to collaborate with education, in order encourage students to take career paths in engineering. The Bureau of Labor Statistics – Occupational Outlook Handbook projects that engineering careers as a whole are expected to grow at an average rate through 2018. However, some engineering specialties such as Biomedical, Civil, Environmental and Industrial engineers are expected to grow at rates of up to 72% within decade.

Suggested Materials:

TSA Structural Engineering

- Refer to TSA Handbook

Sweet Project

- Rigid Foam
- White Glue
- Paper
- Hot Glue

(Optional Thermoforming Plastic)

Suggested Tools/Machines:

TSA Structural Engineering

- Please refer to the TSA Handbook for Structural Engineering

Sweet Project Design Brief

- Sandpaper
- Hand Tools
- Hot Glue Guns
- Scroll Saw/ Bandsaw
- Drill
- Rotary Tool (such as a Dremel)
- Sander(s)
- (Optional: Hot wire cutter and vacuum former)

Learning Targets

Math (NJCCCS 4)

4.2 Units of Measurement: Measurement helps describe our world using numbers. An understanding of how we attach numbers to real-world phenomena, familiarity with common measurement units (e.g., inches, liters, and miles per hours), and a practical knowledge of measurement tools and techniques are critical for students' understanding of the world around them.

CPI #	Cumulative Progress Indicator (CPI)
4.2.12.D.2	Choose appropriate tools and techniques to achieve the specified degree of precision and error needed in a situation.

Science (NJCCCS 5)

5.1 Science Practices: All students will understand that science is both a body of knowledge and an evidence-based, model-building enterprise that continually extends, refines, and revises knowledge and reasoning skills that students must acquire to be proficient in science.

CPI #	Cumulative Progress Indicator (CPI)
5.1.12.C.1	Reflect on and revise understandings as new evidence emerges.

Engineering and Technological Literacy (NJCCCS 8.2)

8.2 Technology Education, Engineering, and Design: All students will develop an understanding of the nature and impact of technology, engineering, technological design, and the designed world, as they relate to the individual, global society, and the environment.

CPI #	Cumulative Progress Indicator (CPI)
8.2.12.B.3	Analyze the full costs, benefits, trade-offs and risks related to the use of technologies in a potential career path.
8.2.12.C.2	Evaluate the ethical considerations regarding resources used for the design, creation, maintenance and sustainability of a chosen product.
8.2.12.F.1	Determine and use the appropriate application of resources in the design, development, and creation of a technological product or system.

21st Century Skills (NJCCCS 9.1)

9.1 21st-Century Life & Career Skills: All students will demonstrate the creative, critical thinking, collaboration, and problem-solving skills needed to function successfully as both global citizens and workers in diverse ethnic and organizational cultures.

CPI #	Cumulative Progress Indicator (CPI)
9.1.12.A.1	Apply critical thinking and problem-solving strategies during structured learning experiences.
9.1.12.B.3	Assist in the development of innovative solutions to an onsite problem by incorporating multiple perspectives and applying effective problem-solving strategies during structured learning experiences, service learning, or volunteering.

9.4 Career and Technical Education: All students who complete a career and technical education program will acquire academic and technical skills for careers in emerging and established professions that lead to technical skill proficiency, credentials, certificates, licenses, and/or degrees.

CPI #	Cumulative Progress Indicator (CPI)
9.4.12.O.17	Employ critical thinking skills (e.g., analyze, synthesize, and evaluate) independently and in teams to solve problems and make decisions.
9.4.12.O.68	Employ planning and time management skills and tools to enhance results and complete work tasks.
9.4.12.O.(1).11	Demonstrate understanding of processes and concepts that are key to understanding the design process.

Mathematics (Common Core)

Modeling with geometry.

G-MG.3. Apply geometric methods to solve design problems.

Geometric Measurement & Dimension

G-GMD.3. Use volume formulas for cylinders, pyramids, cones, and spheres to solve problems.

English Language Arts (Common Core)

Science and Technical > Key Ideas and Details

RST.9-10.3. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.

Industry Standards

NOCDI

- **Employability Skills – Workplace Readiness**
- **STEM – Pre-Engineering, Engineering Technology**

Unit Essential Questions	Unit Enduring Understandings
• What is technology? • How has technology shaped the world that we live in? • What is an efficient way to develop a viable solution to a problem? • What is the benefit of teamwork?	• Technology is how people modify the natural world to satisfy human needs and wants. • Technology effects both society and the environment and conversely, the environment and society impact technology. • The Engineering Design Process is an iterative process, and not always followed in a linear path.

	• Everyone has the ability to be creative and innovative. • There are multiple possible solutions to a problem that often have risks and require trade-offs.

Unit Learning Targets (ULT)

Throughout the unit, students will acquire an understanding of the steps of the Engineering Design process and be able to apply it in the design, creation, and evaluation of solutions to two given design briefs (project based learning experiences).

Students will...

1. Develop an understanding of technology, technology's impact on society, and the Engineering Design Process (8.2.12.B.3, 8.2.12.C.2)
2. Apply the Engineering Design Process by using it to create a solution to a proposed problem, and document the process (4.2.12.D.2, 8.2.12.F.1, 9.4.12.A.1, 9.4.12.O.(1).11)
3. Create a portfolio that documents the work completed throughout each step of the Engineering Design Process (RST.9-10.3)
4. Complete project based learning experiences within a given time period. (9.4.12.A.1, 9.4.12.O.68)
5. Demonstrate the ability to generate creative solutions to a given problem. (5.1.12.C.1, 9.1.12.A.1, 9.1.12.B.3)
6. Create morphological charts to aid in the brainstorming and solutions generation steps of the Engineering Design Process (9.4.12.A.1)
7. Create a final technical drawing based on the necessary principals, which include detailed sizes, locations, and key items of the design, which will aid in the building of the prototype (8.2.12.F.1, 9.4.12.A.1)
8. Safely and accurately use tools to process materials in generating a solution to a problem. (4.2.12.D.2, 8.2.12.F.1)
9. Design a product based on certain constraints, such as the material, supplies, and tools available to create it. (G-MG.3, G-GMD.3)
10. Effectively work as a member of a team to meet a common goal. (9.1.12.B.3, 9.4.12.O.17)
11. Evaluate the effectiveness of a solution to a problem through a testing process. (5.1.12.C.1)
12. Calculate volume and implement this knowledge into the creation of a successful solution (9.1.12.A.1).

Project-Based Learning Plan:
Engineering Design Process (Sequence and Assessments)

Teacher Instruction	Student Evaluation
Step One: Identify the Problem	
Lessons/Topics **Lesson 1:** Technology Kickoff 1. Class discussion regarding "What is Technology?" **Lesson 2:** Safety First 1. Demonstration and discussion on lab and tool safety.	**<u>Formative Assessments:</u>** ○ Students will list descriptions of what technology is as well as how technology impacts society on whiteboard or chart paper in groups followed by class discussion where teacher will provide oral feedback to all members of the class. (ULT# 1)

Lesson 3: Hung Up on Clothing Design Brief

1. One-day design challenge in which students design and create an innovative coat hanger. More details on the activity are in the design brief in the Notes Section below.

Lesson 4: Wow – We Did That?!

1. Review of the Design Challenge and Solutions
2. Introduction to the Engineering Design Process
3. Explanation of the Engineering Design Process Steps

- Teacher will assess knowledge and understanding on the importance of lab and tool safety throughout class discussion and demonstration on lab and tool safety (ULT# 8).

Summative Assessments:

- General safety test to cover safe practices in the shop/lab. (ULT#8)
- Completed coat hanger and written description of the process used to design them, as assess by the rubric. (ULT# 2) (ULT# 4)

HUNG UP ON CLOTHING

Design Brief:

Design, model and test the next great coat hanger. Be sure that your design stays within the following criteria:

1. The coat hanger should not be a replica of one that currently exists.
2. You may only use materials provided.
3. The coat hanger must hold a t-shirt, it may also hold other clothing in addition to a t-shirt.
4. There must be minimal wrinkling in the process of holding clothes.

Suggested Materials:

- Plastic coated wire (or about 24” of 22 gauge wire)
- Wire cutters
- Pliers
- Wooden dowel – ¼”
- Hot glue gun
- Hot glue
- Wonder foam
- String or twine

It will be necessary to repeat information and terminology multiple times in order for students to begin comfortable with this new information.

These introductory activities are planned to:

1. Introduce students to the course, technological design, and the Engineering Design Process.
2. Provide a context and experiences for future discussions of the Engineering Design Process.
3. Allow students to experience “hands-on” modeling.

This step begins the students’ first application of the Engineering Design Process to a large project. They will apply it again a second time in this unit, and many more times during year one. Each time the students will be learning more about the use of tools and the applications of science, technology, engineering, and mathematics.

Notes: In the early stages of the design process all aspects are not graded. Formative assessment plays a more prominent role in these early stages. It would be most appropriate to grade the beginning stages/ focus on them. The assessments listed in each section are recommendations for possible ways to evaluate student learning, not all need to be used.

The teacher will review the steps of the engineering design process and reference the steps in the blank portfolio that students will complete during the course of the activity.	
Step Two: Frame the Design Brief	
Lesson 5: Framing the Design Brief 1. Requirements 2. Specifications 3. Constraints 4. Review the Engineering Design Process **Lesson 6:** Student Portfolios 1. Explain portfolios 2. Work on the first two steps of the Engineering Design Process in the portfolios.	**<u>Formative Assessments:</u>** ○ In groups, students will discuss the design brief and create a list of questions, which will be presented to the class for further discussion (ULT# 10). ○ Teacher feedback while circulating the room and discussing questions and progress with groups. **<u>Summative Assessments:</u>** ○ Student portfolios will be collected and graded based on this portion of work prior to moving on to step three by using a rubric. (ULT#3)
Notes: The students will be given blank portfolios, which they will fill out throughout each step of the Engineering Design Process. The portfolio will be explained, discussed, and begun in this lesson.	**Notes:**
Step Three: Research & Brainstorming	
Lesson 7: Structures & Shapes (Sample Note Taking Sheet & PowerPoint in Resources Section) 1. What is a Structure? 2. Strong Shapes 3. TSA Structural Engineering **Lesson 8:** Brainstorming Methods 1. What is Brainstorming? 2. Sketching Ideas **Lesson 9:** Introduction to Technical Drawing 1. Line Types 2. Types of Technical Drawings 3. 2D vs. 3D 4. Views	**<u>Formative Assessments:</u>** ○ Teacher feedback while circulating the room and discussing progress with each group during Strong Structure Activity. (ULT # 2 & 5) **<u>Summative Assessments:</u>** ○ Research and brainstorming will be documented in the portfolio and assessed, using the rubric (ULT# 3).
TSA Structural Engineering Design Project from the TSA Handbook	**Notes:**
Step Four: Generation Alternate Solutions	
Lesson 10: Morphological Charts 1. What is a Morphological Chart?	**<u>Formative Assessments:</u>** ○ Student created examples of Morphological Charts presented and

2. Examples of Morphological Charts 3. Create a Morphological Chart 4. How to Generate Multiple Solutions	compared against rubric, if available (ULT# 6). **Summative Assessments:** ○ Completed Morphological Charts and generation of solution sketches/drawings will be graded per grading rubric and included in the portfolio prior to completing the next step of the design process. (ULT #2, 3, 5 &6)
Notes:	**Notes:**
Step Five: Chosen Solution with Rationale	
Lesson 11: Choosing and Supporting the Best Solution 1. What is a Constraints/Specification Matrix? 2. How to Create a Constraints/Specification Matrix 3. Explaining and Supporting Your Choice	**Formative Assessments:** ○ Teacher will critique sketches/drawings and charts in portfolios (ULT# 5). **Summative Assessments:** ○ Optimum solution portion of portfolio graded per rubric. (ULT#2,3,5 &6)
Notes:	**Notes:** Teacher will collect the portfolio with technical drawing and rationale to provide feedback.
Step Six: Developmental Work	
Lesson 12: Details, Details, Details 1. Review Technical Drawing 2. Creation of Final Technical Drawings ▪ Sizes, Locations, and Details Must Be Shown	**Formative Assessments:** ○ Teacher review and critique of student work. Students will progress with the design after given approval by teacher. **Summative Assessments:** ○ Final Technical Drawing will be assessed using the rubric. Must be approved prior to prototyping (ULT# 2, 3, & 7).
Notes: Teacher will ensure that students continue to plan viable solutions to the challenge, while emphasizing design and experimentation.	**Notes:**
Step Seven: Prototype	
Lesson 13: Modeling Techniques 1. Demonstration of tools and techniques for modeling. 2. Students will model their chosen design, as detailed in their portfolio.	**Formative Assessments:** ○ Students will meet and discuss with peers in order to review and critique the model. **Summative Assessments:** ○ Final Prototype will be assessed using the rubric. (ULT# 8, 9, & 10).
Notes:	**Notes:**

Teacher will ensure that all students complete tasks with an emphasis on safety, accuracy, and teamwork.	Completed model will be tested and evaluated in Step 8/Lesson 15.
Step Eight: Testing / Evaluation	
Lesson 14: Will It Hold? 1. Explain how to test and evaluate a design 2. Clarify expectations of how testing results should be documented.	**<u>Formative Assessments:</u>** ○ Teacher to conference with teams on an "as needed" basis to ensure proper testing procedure. (ULT# 11) **<u>Summative Assessments:</u>** *All to be included in the portfolio. To be assessed using the given rubric:* ○ Documentation of modeling process and any modifications made to the design during construction. (ULT# 2 & 3) ○ Written record of test results and efficiency calculations in portfolio. (ULT# 3, 11) ○ Written analysis of testing performance. (ULT#3, 11)
Notes: Teacher will organize the testing of each group's structure, after they weigh it. The results will be recorded. Forces acting on the structure should be pointed out during the testing process. Students will use the maximum weight held to calculate the efficiency of their truss.	**Notes:**
Step Nine: Redesign and Reflect	
Lesson 15: Same Problem, Different Solutions	**<u>Formative Assessments:</u>** ○ Teacher to conference with, or provide written feedback, to each team on the performance of their structure. ○ Class discussion on the number of possible solutions to a problem that can be developed when applying the engineering design process. **<u>Summative Assessments:</u>** ○ N/A
Notes:	**Notes:**
Step Ten: Communicate	
Lesson 16: Presentations	**<u>Formative Assessments:</u>** ○ Peer and/or teacher critique of practice presentation based on the rubric. **<u>Summative Assessments:</u>** ○ Assessment of presentation based on parameters in rubric. (ULT# 2 & 4)
Notes: Teacher will establish procedures and timeframe for student presentations to the class. Teacher will review the rubric and show	**Notes:**

past student videotaped presentations, if available. Students are expected to use technical terminology to demonstrate an understanding of concepts during their presentation. Classmates should be encouraged to provide constructive feedback based on the rubric.	

Sweet Project Design Challenge

Step One: Identify the Problem

Lesson 17: Introduction to Sweet Project 1. Explain/Review Problem Statement (See Notes Section Below) **Lesson 18:** Machine Tool Safety 1. See Notes Section Below	**Formative Assessments:** o Opportunity for class questions and discussion during safety lecture and demonstration. **Summative Assessments:** o Written Safety Tests on the drill press and scroll saw. (ULT#8)
Notes: This step begins the student's second application of the Engineering Design Process within this unit. The students will be working on creating a more complex solution to a different design challenge. They will be exposed to additional brainstorming techniques and the elements of design. Students will also be given the opportunity to us power tools to create the prototype for their solution to the design problem. The teacher will review the steps of the engineering design process and reference the steps in the blank portfolio that students will complete during the course of the activity. **--------** The safety lessons are in support of the design challenge and the timing of them is flexible, since the lessons just need to occur prior to the students using the tools. It may be most beneficial to introduce the tools to students one at a time when they are almost ready to use them.	**Notes:**

Step Two: Frame the Design Brief

Lesson 19: Review the Engineering Design Process 1. Design Process 2. Design Brief 3. Specifications 4. Constraints	**Formative Assessments:** o Teacher review and comments on completed specifications and constraints. **Summative Assessments:** o Student portfolios will be collected and graded based on this portion of work prior to moving on to step three by using a rubric (ULT# 3).
Notes:	**Notes:**

Step Three: Research & Brainstorming	
Lesson 20: Creative Spark 1. Show Examples of Existing Products 2. Calculating Volume/Size 3. Design Ideas	**Formative Assessments:** ○ Teacher will review and critique initial design ideas. ○ Ungraded practice quizzes on volume calculations – reviewed by teacher. **Summative Assessments:** ○ Volume calculation quiz (ULT#12).
Notes: These websites can help your students come up with candy bar ideas in the brainstorming step: http://www.customcandybar.com/Default.asp http://www.chocomize.com/	**Notes:**
Step Four: Generation Alternate Solutions	
Lesson 21: Technical Drawings – Part II 1. How to draw 2D & 3D Drawings 2. Isometric, Oblique & Multi-view	**Formative Assessments:** ○ Teacher and peer review of completed design sketches. ○ Review of items that will be assessed on quiz [multi-view drawings] (ULT# 7). **Summative Assessments:** ○ Multi-view sketch quiz (ULT# 7). ○ Completed Morphological Charts and generation of solution drawings will be graded per grading rubric and included in the portfolio prior to completing the next step of the design process. (ULT #2, 3, & 5)
Notes:	**Notes:**
Step Five: Chosen Solution with Rationale	
Lesson 22: Justifying the Final Solution 1. Create Constraints/Specification Matrix 2. Choose a solution	**Formative Assessments:** ○ Teacher will review the possible solutions and provide feedback. **Summative Assessments:** ○ Optimum solution portion of portfolio graded per rubric. (ULT#2,3,5 &6)
Notes:	**Notes:**

Step Six: Developmental Work	
Lesson 23: Documenting Development 1. Review Technical Drawings & Quiz 2. Creation of Final Technical Drawings ▪ Sizes, Locations, and Details Must Be Shown	**Formative Assessments:** ○ Peer and teacher review of documentation prior to submission. **Summative Assessments:** ○ Student portfolios will be collected to be graded on proper documentation of steps three, four, five and six of the design process using the given rubric. Final Technical Draw will be assessed using the rubric and must be approved prior to prototyping (ULT#1,2,3,4 & 7)
Notes:	**Notes:** It is important to stress to students to double check their volume calculations to avoid making mistakes in construction and wasting materials.
Step Seven: Prototype	
Lesson 24: Patterns and Molds 1. Review Volume & Calculations 2. What is a Pattern and Mold? 3. How to Create a Pattern & Mold?	**Formative Assessments:** ○ Teacher observation, questioning, and guidance during construction process. **Summative Assessments:** ○ Final prototype will be assessed using the rubric (ULT# 8, 9, & 10)
Notes: Teacher will ensure that all students complete tasks with an emphasis on safety, accuracy, and teamwork.	**Notes:**
Step Eight: Testing and Evaluation	
Lesson 25: Testing & Evaluation	**Formative Assessments:** ○ Check volumes of patterns and molds by measuring volume necessary to fill them. **Summative Assessments:** *The following will be assessed using a rubric:* ○ Documentation of modeling process and any modifications made to the design during construction (ULT# 2 &3) ○ Written analysis of how well the final product satisfies the specifications and constraints defined at the start of the project (ULT#3 & 11)
Notes:	**Notes:**

<table>
<tr><th colspan="2">Step Nine: Redesign and Reflect</th></tr>
<tr><td>Lesson 26: Redesign & Reflect</td><td><u>Formative Assessments:</u>
○ Teacher review of portfolio expectations.
○ Class discussion of overall outcomes of design challenge.

<u>Summative Assessments:</u>
○ Written reflection with technical terminology and ideas for improvement included in the portfolio as assessed by using the rubric. (ULT #2 & 11)</td></tr>
<tr><td>Notes:</td><td>Notes:</td></tr>
<tr><th colspan="2">Step Ten: Communicate</th></tr>
<tr><td>Lesson 27: Presentations</td><td><u>Formative Assessments:</u>
○ Practice presentations with peer feedback using rubric.

<u>Summative Assessments:</u>
○ Team presentation of portfolios (ULT# 3,4,9, &10)</td></tr>
<tr><td>Notes:
Teacher will establish procedures and timeframe for student presentations to the class. Teacher will review the rubric and show past student videotaped presentations, if available. Students are expected to use technical terminology to demonstrate an understanding of concepts during their presentation. Classmates should be encouraged to provide constructive feedback based on the rubric.</td><td>Notes:</td></tr>
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Corresponding Technology Student Association (TSA) Activities	
TSA Structural Engineering	
Lesson Plans	
Intro and Safety	
Lesson 1 Technology Kickoff	45 minutes /1 day Class discussion regarding "What Is Technology?"
Lesson 2 Safety First	45 minutes / 1 day Safety Demonstrations
Hung Up on Clothing Design Challenge	
Lesson 3 Hung Up on Clothing	45 minutes / 1 day 1 Day Design Challenge
Lesson 4 Wow – We Did That?!	45 minutes / 2 days 1 Day to Review/Introduce Engineering Design Process; 1 Day to Explain Steps
Lesson 5 Framing the Design Brief	25 minutes / ½ day ½ Day to Review Requirements, Specifications, Constraints, Engineering Design Process
Lesson 6 Student Portfolios	45 minutes / 1 day ½ Day to Introduce Portfolios; ½ Day for Students to Work on First Two Steps
Lesson 7 Structures & Shapes	45 minutes / 1 day ½ Day to Introduce Structures/Shapes; ½ Day for Design Activity
Lesson 8 Brainstorming Methods	45 minutes / 1 day Class Discussion/Demonstration on Sketching & Brainstorming
Lesson 9 Introduction to Technical Drawing	45 minutes / 2 days 1 Day to Introduce; 1 Day to Practice
Lesson 10 Morphological Charts	45 minutes / 3 days ½ to Introduce Morphological Charts; ½ Day to Create a Class Example; ½ Day to Create their Own; 2 ½ Days to Create Multiple Solutions Sketches
Lesson 11 Choosing and Supporting the Best Solution	45 minutes / 2 days ½ Day to Introduce Constraints/Specification Matrix, ½ Day to Create One; 1 Day to Choose Final Solution and Explain
Lesson 12 Details, Details, Details	45 minutes / 2 days ½ Day to Review Technical Drawings; 1 ½ Days to Create Technical Drawings of Final Solution
Lesson 13 Modeling Techniques	45 minutes / 2 days 1 Day to Demonstrate Tools and Modeling

	Techniques; 1 Day to Model
Lesson 14 Will It Hold?	45 minutes / 1 day ½ Day to Explain Testing and Evaluation; ½ Day to Test
Sweet Project Design Brief	
Lesson 15 Same Problem, Different Solutions	45 minutes / 1½ days ½ Day for Class Discussion on Possible Solutions; 1 Day to Finalize and Submit Portfolio
Lesson 16 Presentations	45 minutes / 1-2 days (depending on number of students) Presentations
Lesson 17 Introduction to Sweet Project!	45 minutes / ½ day ½ Day to Introduce Project and Problem Statement
Lesson 18 Machine Tool Safety	25 minutes / 2 days (depending in tools in lab) General Machine Tool Safety, Drill Press and Scroll Saw; Safety Tests
Lesson 19 Review the Engineering Design Process	45 minutes / 1 day 1 Day to Review Engineering Design Process; ½ Day to Introduce Design Challenge Design Brief
Lesson 20 Creative Spark	45 minutes / 2 days ½ Day to Explain Volume/Size; ½ Day to Show Examples and Come Up With Ideas; ½ Day for Volume Review; ½ Day for Volume Quiz
Lesson 21 Technical Drawings – Part II	45 minutes / 3 days 1 Day to Introduce Technical Drawing Types; 1 Day to Practice; 1 Day to Create Morphological Chart & Solution Sketches
Lesson 22 Justifying the Final Solution	45 minutes / 1 day 1 Day to Create Constraint/Specification Matrix and Choose a Solution
Lesson 23 Documenting Development	45 minutes / 2 days ½ Day to Review Technical Drawing Quiz; 1 ½ Days to Create Final Technical Drawings
Lesson 24 Patterns and Molds	45 minutes / 3 days 1 Day to Introduce Patterns & Molds; 2 Day to Plan and Model Molds
Lesson 25 Testing & Evaluation	45 minutes / 1 day ½ Day to Check Volumes; ½ Day to Test
Lesson 26 Redesign & Reflect	45 minutes / 1 day ½ Day for Class Discussion on Solutions; 1 Day to Finalize and Submit Portfolio
Lesson 27 Presentations	45 minutes / 1-2 days (depending on number of students) Presentations

Strong Structures Resources

Strong Structures Presentation & Note-Taking Sheet. Roselle Park High School – Danielle L. Romero. 2010.

NOTE-TAKING SHEET

Strong Structures

Introduction:

1. Engineers are constantly being challenged to solve the world's ____________________________.
   a. These problems initially seem _______________________.
2. In the 20th century, engineers developed previously unimaginable things:
   a. __________________________
   b. __________________________
   c. __________________________
   d. __________________________
3. Engineers often look back in ________________ to learn from past engineering _______________ and _________________.
   a. They improve on what ________________________.
   b. And develop ____________________________ that have never been created before.

Example of New Engineering Ideas:

4. Taipei 101
   a. Built in __________
   b. Was the _____________________________. It is now the ________________ (2010).
   c. Location: _____________
   d. Named for its _________________.
   e. Stands at _______________ feet tall (more than a ¼ mile!)

Taipei 101

Dubai Tower

What Makes Strong Buildings?

5. What makes a structure/building strong? ______________________

6. Pyramids (Egypt)
   a. They are very __________ (have lasted hundreds of years!)
   b. They have a very distinctive shape (_______________) that aids in their strength.

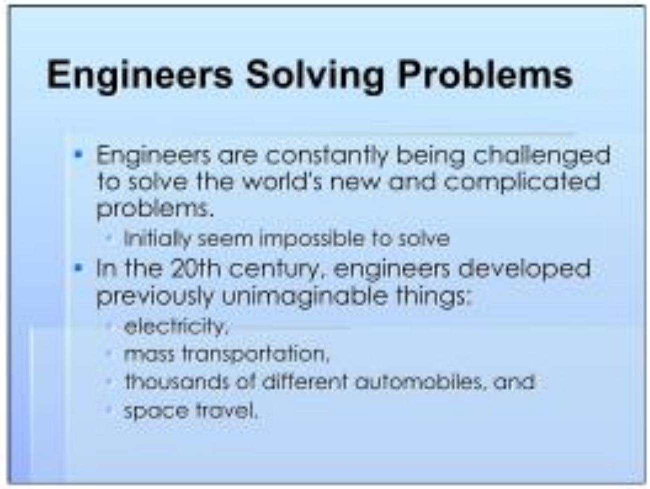
7. Structures need to be able to remain standing despite large amounts of force put on them by __________________ and other factors like __________________ and ____________.

Another Building Example:

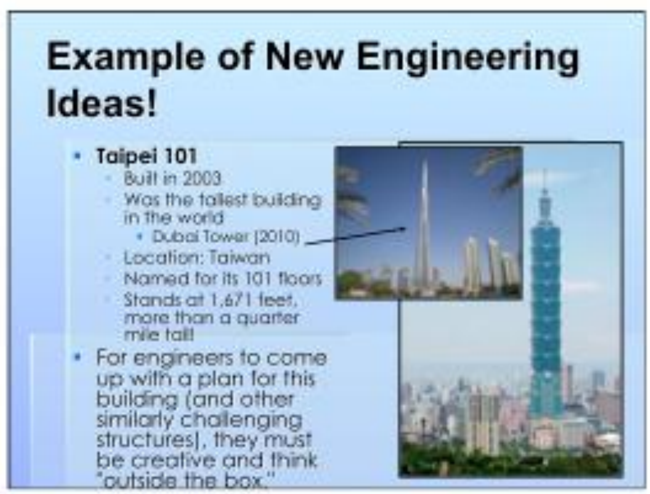
8. Parthenon
   a. Uses two different shapes (______________________ & ____________________)
   b. Began construction over ____________________ (______ BC).
      i. Height of the ___________ Empire.
      ii. Is still standing today.
   c. Temple was built to represent the _____________ and ____________ of the residents of Athens, Greece.

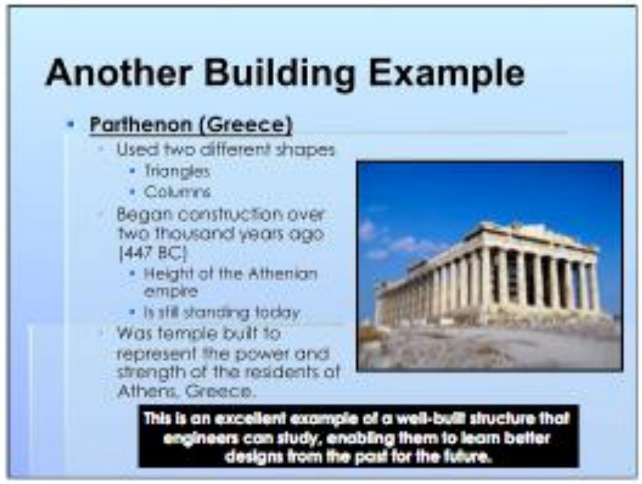
POWERPOINT

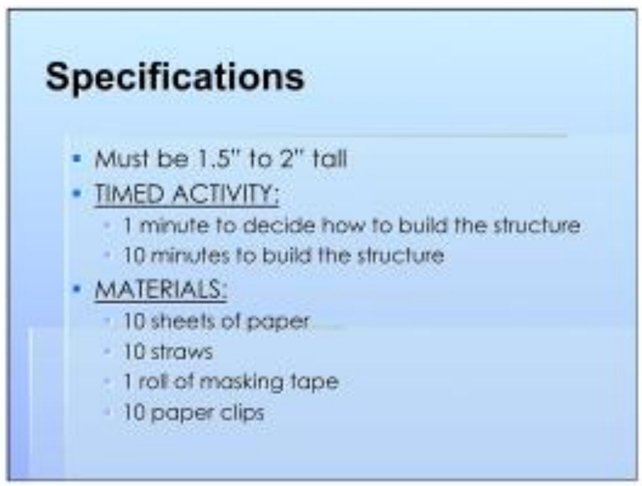

Strong Structures
Tech Drawing


Engineers Solving Problems
Engineers are constantly being challenged to solve the world's new and complicated problems.
Initially seem impossible to solve
In the 20th century, engineers developed previously unimaginable things:
electricity,
mass transportation,
thousands of different automobiles, and
space travel.


Looking Back at History
Engineers often:
Look back in history to learn from past engineering successes and failures
Improve on what already exists
Develop brand new ideas that have never been created before


Example of New Engineering Ideas!
Taipei 101
Built in 2003
Was the tallest building in the world
Dubai Tower (2010)
Location: Taiwan
Named for its 101 floors
Stands at 1,671 feet, more than a quarter mile tall!
For engineers to come up with a plan for this building (and other similarly challenging structures), they must be creative and think "outside the box."





Sweet Project Design Brief

Background/Scenario:

Your design firm has been hired to create a prototype candy bar for a large chocolate company.

Problem/Opportunity Statement:

Your team of 2-3 students will design, name and create a prototype candy bar. A theme will be developed to market a candy bar that will relate to the shape and texture of the bar as well as the packaging.

Specifications:

- Evaluation of the final solution will be based on its creativity and quality of construction.
- Only teacher provided tools and materials can be used.
- The size of the candy bar will be determined by its volume.

Constraints:
Time**:** 12-15 days

Space:
- The volume of the candy bar should be 180ml, which equal to roughly 100g of chocolate.

Energy:
- n/a

Money:
- n/a

Tools/Machines:
- Hand tools.
- Sandpaper.
- Hot glue guns.
- Scroll saw.
- Drill.
- Rotary tool (such as a Dremel).

Materials:
- Rigid foam.
- White glue.
- Paper.
- Sandpaper
  (Optional: If the teacher has the supplies and facilities, it is recommended that they have their students create molds and melt chocolate using thermoforming.)

Knowledge:
- From this unit and prior experiences.

People:
- Two students per group.

Stakeholders:
Candy manufacturer.
Retailers.
Consumers.

Suggested Materials:
Rigid foam is the most desirable material to use. However, it may be substituted with another material if the students are still provided with the same power tool experiences.

Suggested Tools/Machines:
Scroll Saw
Bandsaw
Sander(s)
Hot Wire Cutter
Vacuum Former

Suggested Student Grouping:
Two students per group. If there is an odd number of student's in the class it is possible for there to be either a group of three or a student that independently.

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