SOLVE REAL-WORLD PROBLEMS USING ENGINEERING DESIGN PROCESS

BY ELIZABETH FRILLES

What is Engineering and Engineering Design Process (EDP)?
What is the difference between Engineering Design Process (EDP) and the Scientific Method?
How do engineers or designers help solve real-world problems, overcome technological challenges, and improve products?
How can we use the Engineering Design Process to solve design challenges?
How can the Engineering Design Process help us to solve problems in our daily lives?

HIGH SCHOOL NINTH - TENTH GRADE

TIMEFRAME APPROXIMATELY ONE MONTH

STANDARD BENCHMARKS AND VALUES

Nā Hōpema A’o:
• Strengthened Sense of Hawai‘i
• Strengthened Sense of Belonging
• Strengthened Sense of Responsibility
• Strengthened Sense of Excellence

The Common Career Technical Core (CCTC): Career Ready Practices
1. Act as a responsible and contributing citizen and employee.
2. Apply appropriate academic and technical skills.
3. Attend to personal health and financial well-being.
4. Communicate clearly, effectively and with reason.
5. Consider the environmental, social and economic impacts of decisions.
6. Demonstrate creativity and innovation.
7. Employ valid and reliable research strategies.
8. Utilize critical thinking to make sense of problems and persevere in solving them.
9. Model integrity, ethical leadership and effective management.
10. Plan education and career path aligned to personal goals.
11. Use technology to enhance productivity.
12. Work productively in teams while using cultural/global competence.

Next Generation Science Standards (NGSS):
Science and Engineering Practices:
1. Asking questions (for science) and defining problems (for engineering).
2. Developing and using models.
3. Planning and carrying out investigations.
4. Analyzing and interpreting data.
5. Using mathematics and computational thinking.
6. Constructing explanations (for science) and designing solutions (for engineering).
7. Engaging in argument from evidence.
8. Obtaining, evaluating, and communicating information

Common Core State Standards (CCSS)
• RST.11-12.7, RST.11-12.8, RST.11-12.9;
• HS-ETS1-1, HS-ETS1-2, HS-ETS1-3, HS-ETS1-4;
• HS-LS2-1, HS-LS2-2, HS-LS2-6, HS-LS2-7, HS-LS2-8, HS-LS4-6;
• HSG.MG.A.1, HSG.MG.A.2, HSG.MG.A.3, HSS.ID.A.2;
• WHST.9-10.4, WHST.9-10.5, WHST.9-10.6, WHST.9-10.7, WHST.9-10.8, WHST.9-10.9
ENDURING UNDERSTANDING
Engineering Design Process is a method that is used to solve real-world issues, overcome technological challenges, and improve products for sustainability.

CRITICAL SKILLS AND CONCEPTS:
Student(s) will be able to
- list and explain the steps of the Engineering Design Process (EDP).
- explain the design involves a set of steps that can be performed in different sequences and repeated as needed.
- describe how engineers, scientists, and others who engage in design and technology use scientific knowledge to solve practical problems.

AUTHENTIC PERFORMANCE TASK:
A technical report or display board that will include applied mathematics, technical or scientific data, and a written summary of the design challenge for presentation and evaluation.

AUTHENTIC AUDIENCE(S):
Fellow students, other teachers, and science/engineering fair attendees.
LEARNING PLAN

TEACHER PREPARATION
- Create pre-test to hand out to students to assess prior knowledge.
- Search for and bookmark video clips about Engineering Design Process (EDP).
- Prepare a Powerpoint presentation that covers the essential questions and ask students open-ended questions to check for understanding.
- Research current issues in Hawai’i.
- Experiment with Tagxedo (www.tagxedo.com) in order to better instruct students.
- Provide copies of EDP graphic organizers and rubrics for each student.
- Prepare materials that inform students of safety protocols.
- Provide examples of how to write a technical report or create a display board that summarizes findings.

INSTRUCTIONS
1. Have students discuss the essential questions in groups.
2. Show the students a video about EDP (https://www.youtube.com/watch?v=fxJWin195kU); next have each student write down their own definition of EDP and take turns sharing them as a class.
3. Students will brainstorm critical issues in Hawai’i that could be solved with technology and use Tagxedo (http://www.tagxedo.com/) to create a word cloud.
4. Group students into teams, and have each team select an issue to research and solve.
5. Students will be provided with an EDP graphic organizer and rubric. Give them time to read the materials and ask clarifying questions.
6. Students will use the EDP graphic organizer to help them design their solutions with reference to the rubric.
7. Give students time in class to prepare materials and create prototypes of products (always keeping safety in mind).
8. Once each group has a prototype, provide class time for students to compose their technical reports or create display boards that summarize their design solution.
9. Have student groups present their projects and evaluate each other using the rubrics provided earlier.
10. Finally, allow students to reflect on the process.
REFERENCES/RESOURCES:


Engineering Design Process
http://www.sciencebuddies.org/engineering-design-process/engineering-design-process-steps.shtml
https://www.teachengineering.org/k12engineering/designprocess

Engineering Design Process versus Scientific Method
http://www.sciencebuddies.org/engineering-design-process/engineering-design-compare-scientific-method.shtml

NASA Engineering Design Process
https://www.nasa.gov/audience/foreducators/best/edp.html

VIDEOS
What’s an Engineer? Crash Course Kids #12.1
https://www.youtube.com/watch?v=owHF9iLyxic

The Engineering Process: Crash Course Kids #12.2
https://www.youtube.com/watch?v=fxJWin195kU
## ENGINEERING DESIGN PROCESS (EDP)

<table>
<thead>
<tr>
<th>STEP</th>
<th>DESCRIPTION, EXPLANATION, DRAWING, ILLUSTRATION OR DIAGRAM</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. IDENTIFY THE PROBLEM</td>
<td>How can I design a _______ that will ________?</td>
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<tr>
<td>- Re-state the problem</td>
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<td>- Identify the criteria or constraints</td>
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<tr>
<td>2. RESEARCH THE PROBLEM</td>
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<tr>
<td>- Examine the current state of the issue and current solutions</td>
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<tr>
<td>- Explore the other options via internet, library, interviews, etcetera</td>
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<tr>
<td>3. BRAINSTORM SOLUTIONS</td>
<td></td>
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<tr>
<td>- Develop possible solutions</td>
<td></td>
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<td>- Draw on mathematics and science</td>
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<td>- Articulate possible solutions in two or three dimensions</td>
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<td>- Sketch ideas with Labels and arrows to identify parts and function</td>
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<td>5. CREATE &amp; DEVELOP A PROTOTYPE</td>
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<tr>
<td>- Model the selected solution(s) in two or three dimensions</td>
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<tr>
<td>- Construct a full-size or scale model based on their drawings</td>
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<tr>
<td>6. TEST AND EVALUATE THE PROTOTYPE</td>
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<tr>
<td>- Does it work?</td>
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<td>- Does it meet the original design criteria or constraints?</td>
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<tr>
<td>7. IMPROVE &amp; REDESIGN</td>
<td></td>
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<td>8. PRESENTATION</td>
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<tr>
<td>- Communicate the solution(s) by making an engineering presentation that includes a discussion of how the solution(s) best meet(s) the needs of initial problem, opportunity, or need</td>
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<td>- Discuss societal impact and tradeoffs of the solutions</td>
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<tr>
<td>STEP</td>
<td>WELL-BELOW (1-POINT)</td>
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<tr>
<td>1 - IDENTIFY THE PROBLEM</td>
<td>Student(s) cannot state the challenge problem in his/her own words.</td>
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<tr>
<td>2 - RESEARCH THE PROBLEM</td>
<td>Student(s) write a short 5-sentence summary of the research which includes 1 reliable source.</td>
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<tr>
<td>3 - BRAINSTORM SOLUTIONS</td>
<td>Student(s) cannot sketch or draw their ideas. No labels and arrows present on his/her notes. No student participation is observed.</td>
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<tr>
<td>4 - CHOOSE A SOLUTION</td>
<td>Student(s) did not attempt to specify design limitations and requirements. Measuring tools and units are not used appropriately. No safety measure is observed.</td>
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<tr>
<td>5 - CREATE &amp; DEVELOP A PROTOTYPE</td>
<td>Student(s) choose a design to solve the problem however lacking in reasons why it was chosen. Model or prototype is incomplete. Safety is not observed.</td>
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<tr>
<td>6 - TEST &amp; EVALUATE PROTOTYPE</td>
<td>Student(s) did try to examine and evaluate the model or prototype.</td>
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<td>7 - IMPROVE &amp; REDESIGN</td>
<td>The presentation is poor and the brainstorming with other teams lacks details. The problems are not identified and no clear proposal is created.</td>
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<tr>
<td>TIME MANAGEMENT</td>
<td>Student(s) did not use time well. Time was wasted during phase 2-5 of the EDP.</td>
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<td>TOTAL &amp; COMMENTS</td>
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