

# SOLVE REAL-WORLD PROBLEMS USING ENGINEERING DESIGN PROCESS

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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 HOPENA 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.
- connect the importance of the Science and Engineering Practices, Math Practices, and Career and Technical Education (CTE) Practices when solving design challenges in creating prototypes of the products.

### 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](http://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:**

- English Language Arts Standards » Science & Technical Subjects » Grade 9-10. (n.d.). Retrieved from <http://www.corestandards.org/ELA-Literacy/RST/9-10/>
- English Language Arts Standards » Writing » Grade 9-10. (n.d.). Retrieved from <http://www.corestandards.org/ELA-Literacy/WHST/9-10/>
- High School: Geometry » Modeling with Geometry. (n.d.). Retrieved from <http://www.corestandards.org/Math/Content/HSG/MG/>.
- High School: Modeling. (n.d.). Retrieved from <http://www.corestandards.org/Math/Content/HSM/>.
- High School: Statistics & Probability » Interpreting Categorical & Quantitative Data. (n.d.). Retrieved from <http://www.corestandards.org/Math/Content/HSS/ID/>.
- Nā Hopena A’o Learning Outcomes in Hawai’i | EPIC. (2015, September 24). Retrieved from <http://www.epiconline.org/na-hopena-ao-learning-outcomes/>
- Next Generation Science Standards. (n.d.). Retrieved from <http://www.nextgenscience.org/>
- Standards for Mathematical Practice. (n.d.). Retrieved from <http://www.corestandards.org/Math/Practice/>.
- The Career Ready Practices | Advance CTE. (n.d.). Retrieved from <http://www.careertech.org/career-ready-practices>
- 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>



NAME \_\_\_\_\_ SUBJECT \_\_\_\_\_ PERIOD \_\_\_\_\_ DATE \_\_\_\_\_

## ENGINEERING DESIGN PROCESS (EDP)

STEP	DESCRIPTION, EXPLANATION, DRAWING, ILLUSTRATION OR DIAGRAM
<b>1. IDENTIFY THE PROBLEM</b> <ul style="list-style-type: none"> <li>• Re-state the problem</li> <li>• Identify the criteria or constraints</li> </ul>	How can I design a _____ that will _____?
<b>2. RESEARCH THE PROBLEM</b> <ul style="list-style-type: none"> <li>• Examine the current state of the issue and current solutions</li> <li>• Explore the other options via internet, library, interviews, etcetera</li> </ul>	
<b>3. BRAINSTORM SOLUTIONS</b> <ul style="list-style-type: none"> <li>• Develop possible solutions</li> <li>• Draw on mathematics and science</li> <li>• Articulate possible solutions in two or three dimensions</li> <li>• Sketch ideas with Labels and arrows to identify parts and function</li> </ul>	
<b>4. CHOOSE A SOLUTION</b> <ul style="list-style-type: none"> <li>• Develop possible solutions</li> <li>• Draw on mathematics and science</li> <li>• Articulate possible solutions in two or three dimensions</li> <li>• Sketch ideas with Labels and arrows to identify parts and function</li> </ul>	
<b>5. CREATE &amp; DEVELOP A PROTOTYPE</b> <ul style="list-style-type: none"> <li>• Model the selected solution(s) in two or three dimensions</li> <li>• Construct a full-size or scale model based on their drawings</li> </ul>	
<b>6. TEST AND EVALUATE THE PROTOTYPE</b> <ul style="list-style-type: none"> <li>• Does it work?</li> <li>• Does it meet the original design criteria or constraints?</li> </ul>	
<b>7. IMPROVE &amp; REDESIGN</b> <ul style="list-style-type: none"> <li>• Does it work?</li> <li>• Does it meet the original design criteria or constraints?</li> </ul>	
<b>8. PRESENTATION</b> <ul style="list-style-type: none"> <li>• 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</li> <li>• Discuss societal impact and tradeoffs of the solutions</li> </ul>	

## ENGINEERING DESIGN PROCESS (EDP) 4-POINT RUBRIC

STEP	WELL-BELOW (1-POINT)	APPROACHING (2-POINT)	MEETS (3-POINT)	EXCEEDS (4-POINT)	STUDENT SELF-ASSESSMENT	TEACHER ASSESSMENT
<b>1 - IDENTIFY THE PROBLEM</b>	Student(s) cannot state the challenge problem in his/her own words.	Student(s) seek help from their PBL Facilitator to state the challenge problem in his/her own words.	Student(s) can state the challenge problem in his/her own words without any help from PBL Facilitator.	Student(s) can independently state the problem in his/her words precisely and explicitly using higher level of vocabulary.		
<b>2 - RESEARCH THE PROBLEM</b>	Student(s) write a short 5-sentence summary of the research which includes 1 reliable source.	Student(s) write a short 10-sentence summary of the research which includes 2 reliable sources.	Student(s) write a brief 15-sentence summary of the research which includes 3 major references or reliable sources.	Student(s) write a clear and concise 20-sentence summary of the research which includes 4 or more reliable sources.		
<b>3 - BRAINSTORM SOLUTIONS</b>	Student(s) cannot sketch or draw their ideas. No labels and arrows present on his/her notes. No student participation is observed.	Student(s) seek help from PBL facilitators how to sketch or draw his/her ideas. Some labels and arrows are missing. Student(s) rarely participate in the discussion.	Each student in the group can sketch his/her own ideas as the group discusses ways to solve the problem. Labels and arrows should be included to identify parts and how they might move. The student(s) actively participated in the discussion guided by the PBL facilitator.	Student(s) can independently brainstorm the design's specifications, limits and requirements precisely and explicitly as a group. Student(s) can independently record pros and cons of each design idea directly on the paper next to the drawings.		
<b>4 - CHOOSE A SOLUTION</b>	Student(s) did not attempt to specify design limitations and requirements. Measuring tools and units are not used appropriately. No safety measure is observed.	Student(s) has limited knowledge on the specifications and constraints of the designs. Measurements are not precise. Tools are used inappropriately. Safety is violated by one or two students in the group.	Student(s) can specify the design requirements (criteria). Student(s) can list the limits on the design due to available resources and the environment (constraints). Drawings are neat, using rulers to draw straight lines, and to make parts proportional. Parts and measurements should be labeled clearly and precisely. Safety is practiced by the entire group.	Student(s) develop two or more ideas thoroughly and can create new drawings that are orthographic projections (multiple views showing the top, front and one side) and isometric drawings (three-dimensional depiction). Safety is strictly observed.		
<b>5 - CREATE &amp; DEVELOP A PROTOTYPE</b>	Student(s) choose a design to solve the problem however lacking in reasons to why it was chosen. Model or prototype is incomplete. Safety is not observed.	Student(s) somewhat identify the best design to solve the challenge problem. Student(s) write the reason why he/she chose the solution but lacking in details. Model or prototype is constructed poorly showing incorrect measurements. Safety is loosely observed during the construction process.	Student(s) can identify the design that appears to solve the problem the best. Student(s) can write a statement that describes why he/she chose the solution which includes some reference to the criteria and constraints. Student(s) can construct a full-size or scale model based on their drawings. The PBL Facilitator will help identify and acquire appropriate modeling materials and tools. Safety is observed during the construction process.	Student(s) can independently identify the best design to solve the problem and write the rationale of the solution in a 5-paragraph essay. Student(s) can independently identify the appropriate tools and materials needed to construct the model or prototype. Precise measurements and safety are adhered throughout the construction process.		
<b>6 - TEST &amp; EVALUATE PROTOTYPE</b>	Student(s) did try to examine and evaluate the model or prototype.	Student(s) somewhat examine and evaluate the model or prototype with a lot of help from the PBL facilitator.	Student(s) can examine and evaluate his/her prototype or design based on the criteria and constraints with some help from their PBL facilitator.	Student(s) can independently examine and evaluate working model or prototype and present it thoroughly to other teams.		
<b>7 - IMPROVE &amp; REDESIGN</b>	The presentation is poor and the brainstorming with other teams lack details. The problems are not identified and no clear proposal is created.	Student(s) present the findings to other teams but not thorough. Brainstorming is poorly conducted due to lack of details, the problem is not clearly identified and the proposal to the solution is weak.	Student(s) will present their working model or prototype to other teams. Student(s) will enlist other students to review the solution and help identify changes that need to be made. The team must identify any problems and proposed solutions.	Student(s) can brainstorm using high level critical thinking questions with other teams. Student(s) or team(s) can identify the main problems and propose solutions strongly in details.		
<b>TIME MANAGEMENT</b>	Student(s) did not use time well. Time was wasted during phase 2-5 of the EDP.	Student(s) sometimes used time well. There were times when the group got off task during phase 2-5 of the EDP.	Student(s) used time appropriately, a few times the group got off task, but for the majority of the task time was well spent during the EDP.	Student(s) used time wisely. The group stayed on task during each phase of the EDP.		
<b>TOTAL &amp; COMMENTS</b>						