Engineering Design Process

Student Engineering Notebook

Project:

Whirligig Aerodynamic Activity

Museum of Science (Image creator). (2016). The engineering design process [Diagram]. Retrieved from http://www.eie.org/overview/engineering-design-process

STUDENT NAME: _____

TEACHER NAME: _____

GRADE: _____ **SCHOOL YEAR:** _____ **PERIOD:** _____

START DATE: _____ **END DATE:** _____

PEER REVIEWER NAME: _____

Engineering Notebook Instructions

Each step of the EDP will be documented to show important aspects including student reflections, data, illustrations, research, and instruments. A snapshot of each section maps the steps of the EDP.

Guidelines and *Guiding Questions* for your notebook:

1. **ASK**
    a. Define the *Problem Statement* – Who has the problem? What is the problem? Why is it important?
    b. Empathize – Identify the customer's needs.
    c. What are the constraints?
    d. Start background research.
    e. Define the requirements / specifications to meet the customer's needs or design challenge parameters.

2. **IMAGINE**
    a. Background research – What have others done?
    b. Brainstorm and sketch design ideas – All ideas are welcome!
    c. Develop multiple concepts before evaluating them.

3. **PLAN**
    a. Create a **Pugh chart** (a decision tool to **evaluate all design concepts** against your list of specifications / requirements) and choose the best idea or design.
        i. Evaluate all of the design's strengths and weaknesses.
        ii. Does the design meet all the specifications / requirements?
    b. Draw a detailed sketch and label the important elements of your selected design.
    c. Make a list of the materials required to build your selected design.
    d. Create a **Gantt chart** (a bar chart that represents **a project schedule**, showing a start and end date for each task and the person responsible for completing the task) for your project.

4. **CREATE**
    a. Follow your plan and create a prototype.
    b. Test the prototype against your specifications / requirements.
    c. Fully document and evaluate the test results.

5. **IMPROVE**
    a. What worked and what didn't work?
    b. What could work better?
    c. Improve your design based on your findings.
    d. Test your improved design against your specifications / requirements.
    e. Fully document and evaluate the test results.

6. **COMMUNICATE**
    a. Share your solution or design with your peers.
    b. Justify your design choices using the data you collected.
    c. Provide EDP documentation.

Adapted from:
King Intermediate, C. Chan, EDP Notebook
The Engineering Design Log: A Digital Design Journal Facilitating Learning and Assessment (RTP), ASEE Conference, New Orleans, LA, 2016), Center for Education Integrating Science, Mathematics, and Computing (CEISMC)
Georgia Institute of Technology

With input from:
University of Hawai'i at Mānoa, College of Engineering

Table of Contents *(to be completed at end of the EDP assignment*)

Description of the Engineering Design Challenge or Problem Statement *(insert)*

ASK

Suggested Guiding Questions (*teachers may select or write their own*):

1. What is the problem? *or* What are the customer's needs?
2. Who is the customer? *and* Why is the problem you are solving important?
3. What are the requirements / specifications for the solution to the problem?
4. Start background research.

Problem Statement *(Engineering Design Challenge)*

To design and create a device that will take the most time to fall by dropping the device from 7 feet.

Specification Sheet *(sample)*

Justification – *The reason why this is a requirement / specification based on the engineering design challenge or the customer's needs.*

Weight – *Number assigned to a requirement / specification based on its importance (on a scale of 1 to 5, with 5 being the most important)*

#	Requirements / Specifications	Weight	Justification (Why?)
1	Can only use materials provided in the parts list		
2	Design must incorporate aerodynamic concepts		
3	One part of the design must spin or whirl		
4	Design must include at least one paperclip		
5	Prototype will be dropped from 7 feet above the ground and must be in the air for at least 1.5 seconds. Time starts when the prototype is released and the time is stopped when the prototype touches the ground.		

Student Reflection

Background Research

- Bibliography
- Summary of information from sources

IMAGINE

Suggested Guiding Questions (*teachers may select or write their own*)

1. What appropriate sources were used for the background research?
2. How many sources are needed?
3. What was learned from each of the background research sources?
4. What are your ideas/sketches for solving the problem? (include multiple idea/sketch w/ labels.)
5. Consider how you would build and test each idea.
6. What materials do you need to test each of your ideas?

Problem Statement *(Engineering Design Challenge)*

To design and create a device that will take the most time to fall by dropping the device from 7 feet.

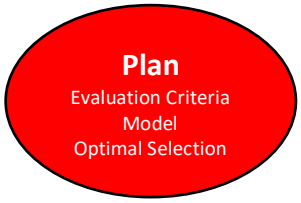
Sketch your Idea(s)

A

B

Student Reflection

PLAN



Suggested Guiding Questions (*teachers may select or write their own*)

1. What are the constants?
2. What are the dependent and independent variables?
3. Is there a justification for WHY one design chosen over the others?
4. Is there a list of materials that will be needed to solve the problem?
5. Are the procedures clear enough for someone else to follow?
6. How many tests / trials are needed? (Consider how many tests / trials are needed to verify your prototype is working.)
7. What data are you planning to collect? How and why?
8. What specifications / requirements were addressed in your design (from the Specifications / Requirements sheet)?
9. Do the specifications / requirements positively address your customer or client's needs (from the Pugh chart)?
10. How does your design demonstrate that the wants and needs of your customer or client are prioritized?

Problem Statement *(Engineering Design Challenge)*

To design and create a device that will take the most time to fall by dropping the device from 7 feet.

Pugh Chart *(decision matrix – sample)*

Total = Weight (points) x Score

	Requirements -> Specifications	Weight	Design A		Design B	
			Score	Total	Score	Total
1	Can only use materials provided in the parts list					
2	Design must incorporate aerodynamic concepts					
3	One part of the design must spin or whirl					
4	Design must include at least one paperclip					
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	Total					

Which Plan Did You Choose?

A *or* **B**

Justification

_____

_____

_____

_____

List Your Materials

Clearly Write Out the Steps for Executing the Design *(These instructions should be clear enough to allow someone else to follow them. Use illustrations if necessary to make the instructions clear. If more than one person has tasks to perform, indicate who is doing what and when.)*

Gantt Chart for Your Team *(sample)*

Start Date: _____

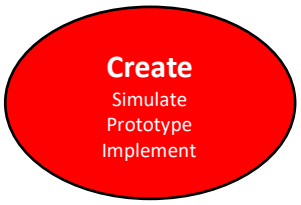
STEPS	Tasks	Responsible Person	Day or Week	Day or Week	Day or Week	Day or Week	Day or Week
ASK	Define Problem Statement		mo/day				
	Specification listed						
IMAGINE	Complete research						
	Several designs created						
PLAN	Pugh Chart completed				mo/day		
	Gantt Chart completed						
	Detailed digaram and material list completed						
CREATE	Assemble and Test your design					mo/day	
	Evaluate your results						
IMPROVE	Re-design based on your results						mo/day
	Test and document your results						
	Share your solution or design						

Not used for Today's Activity

End Date: _____

Student Reflection

CREATE



Suggested Guiding Questions (*teachers may select or write their own*)

1. Build the prototype being sure to follow the procedures / plan and justify any necessary changes.
2. What kind of data will be collected during testing of the prototype?
3. How will you record and display your data? Will you use tables / charts / illustrations?

Problem Statement *(Engineering Design Challenge)*

To design and create a device that will take the most time to fall by dropping the device from 7 feet.

Test Data

Trial	Drop Test (seconds)
1	
2	
3	
Slowest Time	

Requirements / Specifications	Pass (yes / no)
Can only use materials provided in the parts list	
Design must incorporate aerodynamic concepts	
One part of the design must spin or whirl	
Design must include at least one paperclip	
Prototype will be dropped from 7 feet above the ground and must be in the air for at least 1.5 seconds. Time starts when the prototype is released and the time is stopped when the prototype touches the ground.	

Student Reflection

IMPROVE

Suggested Guiding Questions *(teachers may select or write their own)*

1. Did the prototype successfully solve the problem? Why and / or why not?
2. Are there any possible errors in the data you collected?
3. How could the procedure / plan be improved to increase the accuracy of your collected data?
4. What can be done to improve the prototype and WHY?
5. What are the possible next iterations and WHY?

Problem Statement *(Engineering Design Challenge)*

To design and create a device that will take the most time to fall by dropping the device from 7 feet.

Note: You may request a new sheet of paper for the next iteration and add it to this Engineering Notebook. Then, go back to the appropriate EDP process to start your next iteration.

Group Information

	Name	School	Grade
1			
2			
3			
4			

Student Reflection

IMPROVE - IMAGINE

Problem Statement *(Engineering Design Challenge)*

To design and create a device that will take the most time to fall by dropping the device from 7 feet.

A

B

C

Student Reflection

IMPROVE - PLAN

Problem Statement *(Engineering Design Challenge)*

To design and create a device that will take the most time to fall by dropping the device from 7 feet.

Pugh Chart *(decision matrix – sample)*

Total = Weight (points) x Score

	Requirements -> Specifications	Weight	Design A		Design B		Design C	
			Score	Total	Score	Total	Score	Total
1	Can only use materials provided in the parts list							
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	Total							

Which Plan Did You Choose?

A *or* **B** *or* **C**

Justification

Procedure

List Your Materials

Student Reflection

IMPROVE - CREATE

Problem Statement *(Engineering Design Challenge)*

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Slowest Time	

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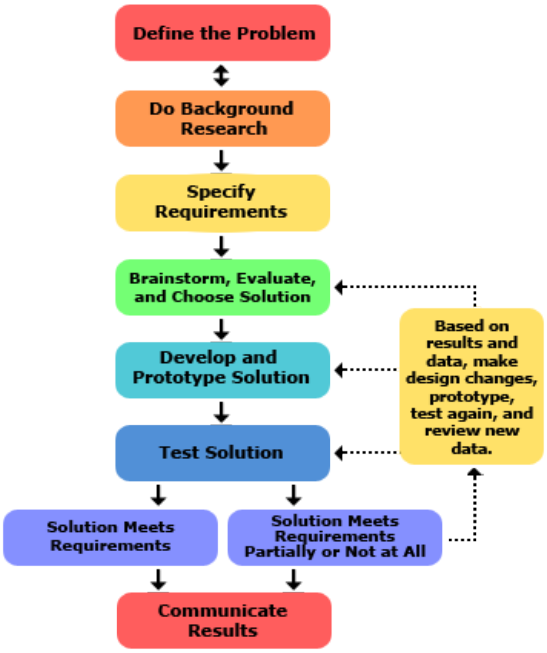
Student Reflection

VOCABULARY LIST

Dependent Variable	Something you measured that changed because you manipulated the independent variable.
Gantt Chart	A graphic that represents a project schedule showing a start and end date for each task, and often includes the person responsible for completing that task.
Iteration	Going back to repeat a previous step at any time within the process in order to adjust or change your design.
Independent Variable	A factor you changed in your trials, sometimes called the manipulated variable.
Prototype	Build an actual product by following a procedure / plan based on a design solution.
Pugh Chart	Also known as a decision matrix – it is a tool to help make decisions between multiple designs based on a specific set of criteria.
Reflection	Your thoughts based on the results of the current stem. At any time, it is okay to go to previous steps and change or add reflections, but be sure to document the reflection and explain why. Example: You're in the Plan step and discover you need to do more background research. Write it in the reflection with a clear explanation of why.

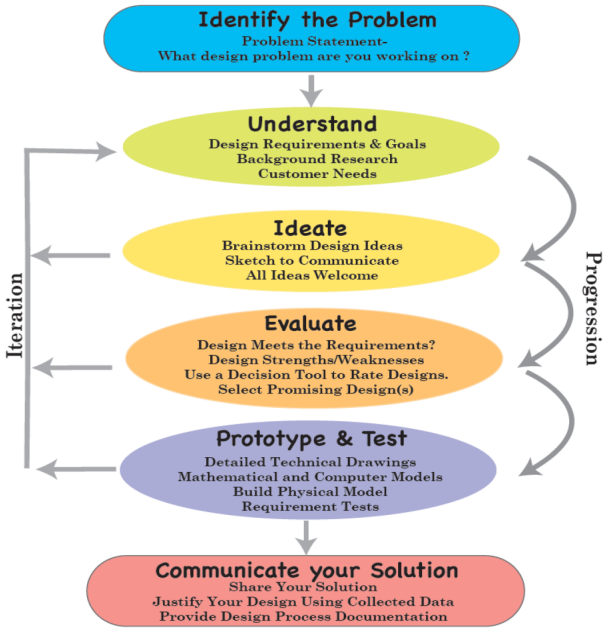
The Engineering Design Process (Teacher Reference):

Science Buddies



www.sciencebuddies.org

Georgia Institute of Technology*



https://www.asee.org/public/conferences/64/papers/14726/download

**GIT Rubric and NGSS available as separate attachment*