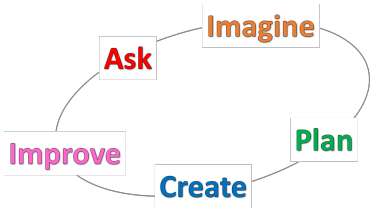


*Based off the Boston Museum Graphic

Composite Airplane Activity:

Good – Better – Best

Engineering Notebook

Teacher Edition

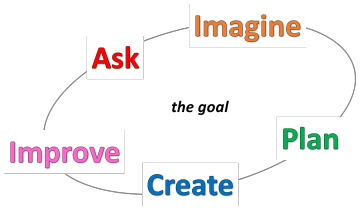
Please use Pen!

TEACHER NAME: _____

GRADE: _____ **SCHOOL NAME:** _____ **DATE:** _____

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. Use the checklist to monitor your EDP progress:



Self-Check	Peer Check	
		EXPLORE SCENARIO/PHENOMENON
		1. Document what you know about the phenomenon and what you wonder about.
		ASK STEP
		1. Define the *Problem Statement*. Who has the problem? What is the problem? Why is it important?
		2. Define the specifications to empathize and meet the customer's needs or design challenge parameters.
		3. Reflect on what you learned during this step and what you are still curious about.
		IMAGINE STEP
		1. Conduct background research.
		2. Brainstorm and sketch at least 2 designs and label. All ideas are welcome!
		3. Make a list of possible materials and quantity needed for each design.
		4. Reflect on what you learned during this step and what you are still curious about.
		PLAN STEP
		1. Create a **Gantt chart** to schedule the project timeline.
		2. Create a **Pugh chart** to **evaluate all designs** with the list of specifications. Evaluate all of the design's strengths and weaknesses. Evaluate if the design meets all the specifications?
		3. Choose the best design (based on Pugh Chart data).
		4. Write a justification for why you chose the selected design (based on Pugh Chart data).
		5. Draw a **detailed** sketch of your selected design and label the parts.
		6. Write out the steps for how to create and test the selected design.
		7. List the materials and quantities required to create and test your selected design.
		8. Reflect on what you learned during this step and what you are still curious about.
		CREATE STEP
		1. Follow your plan and create a prototype.
		2. Test the prototype and record the data.
		3. Evaluate the test results by comparing data with your specifications. What worked and what didn't work? What could work better? Why?
		4. Reflect on what you learned during this step and what you are still curious about.
		IMPROVE STEP
		1. Sketch and label an improved design based on previous test and evaluation.
		2. Write a description of the design change(s) and justification based on previous test and evaluation.
		3. Write out the steps for how to create and test the improved design.
		4. List the materials and quantities required to create and test your NEW design.
		5. Follow your plan and create an improved prototype.
		6. Test the prototype and record the data.
		7. Evaluate the test results by comparing data with your specifications.
		8. Reflect on what you learned during this step and what you are still curious about.

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 Engineering Design Process assignment*)

ASK

Ask

- Identify Need
- Define Problem
- Define Specification

Problem Statement

Composite materials combine two or more materials and can be specialized to meet unique specifications and constraints. The configurations of composite materials can result in desirable properties, present manufacturing challenges, such as orientation combinations, modeling, and reliability.

Your customer requests a composite airplane that can fly straight for at least 10 feet.

Specification Sheet:

1) Justification – *The reason why this is listed as a specification based on the engineering design challenge or the customer's needs.*
2) Weight – *Number of importance assigned to a specification (on a scale of 1 to 5, with 5 being the most important)*

#	Specifications	Weight	Justification (Why?)
1	The flight of the composite plane should fly straight within the 5 feet width.	3	
2	The average of the flight distance (5 trials) of the composite plane should travel at least 10 feet.	5	

Student Reflection (Teacher Reflection)

IMAGINE

Imagine

- Sketch Possible Solutions
- Background Research

Background research and science or technical concepts

- Summary of information from sources
- Bibliography

Pre- Session Assignment:

1. Define “composite” and be ready to discuss during the workshop.
2. Look for three (3) examples of interesting things made of composite materials and be ready to discuss during the workshop.

KEY SCIENCE CONCEPTS

Term	Definition
Composite	A composite material is a material made from two or more constituent materials with significantly different properties that, when combined, produce a material with characteristics different from the individual components.

SKETCH DESIGN A

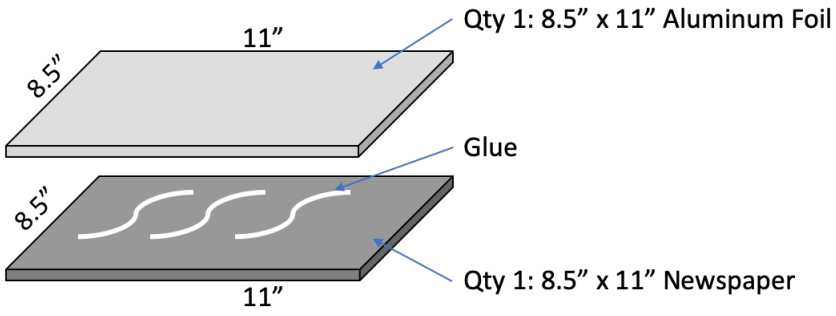
(NOT used for Today's Activity)

Instructions: Draw two sketches and include the following:

1) Label and include dimensions in your sketch. You can sketch multiple views or a single view.
2) Indicate all the materials and quantity in this design below

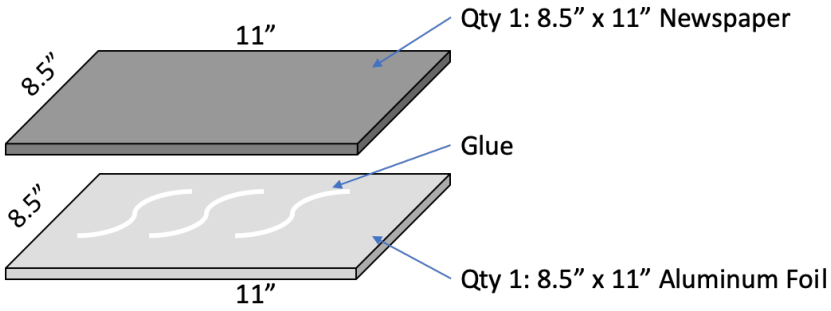
STEM TIP:
The purpose of an engineering sketch is to convey clear information using simple drawings and symbols.

EXAMPLE of Sketch:



SKETCH DESIGN B

EXAMPLE of Sketch:



Student Reflection (Teacher Reflection)

PLAN

Plan

- Evaluation Criteria
- Model
- Optimal Selection

Gantt Chart for Your Team *(sample)* **(NOT used for Today's Activity)**

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			Mo/day			
	Several designs created						
PLAN	Pugh chart completed				Mo/day		
	Gantt chart completed						
	Detailed diagram, material list complete						
CREATE	Assemble and Test					Mo/da	
	Evaluate results						
IMPROVE	Re-Design based on your results						
	Test and document your results						
	Share						

STEM TIP: Engineers are required to use Gantt Charts that represent a project schedule or timeline that shows a start and end date for each task, and often includes the person responsible for completing each task.

End Date: _____

PUGH CHART *(decision matrix)* **(NOT used for Today's Activity)**

Score is based on a scale of 1 to 5 with 5 being the design that best meets the specification.

Total = Weight x Score

Total Weighted Score = sum all of the numbers in the "Total" column. Do this separately for Design A and B

#	Criteria	Exceeds 5	Meets 3	Needs Improvement 1
1				
2				
3				

#	Specifications	Weight	Design A		Design B	
			Score	Total	Score	Total
1						
2						
3						
	Total Weighted Score					

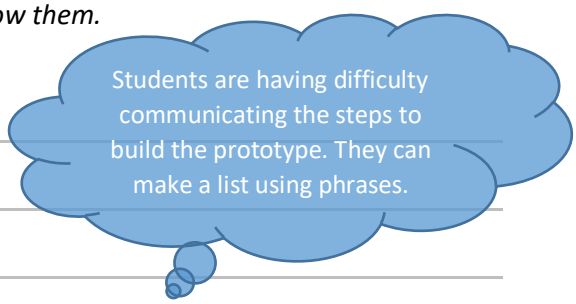
Which Plan Did You Choose? *Circle the Design which has the higher Total Weighted Score*

A *or* **B**

Justification:

Clearly Write Out the Steps for building your Design (NOT used for Today's Activity)

(These instructions should be clear enough to allow someone else to follow them. Use illustrations if necessary to make the instructions more clear.)



Student Reflection (Teacher Reflection)

CREATE

Create

- Build Prototype
- Test and Record Data

1) Please build two paper composite airplanes following the "Shape your Flight" instructions
2) Fill out the Data Collection Tables
3) Calculate averages for Straightness and Distance and use the Rubric Scoring table to enter your Rubric Score in the Specification table.

Composite Material Weight Table

(Weight includes bonding material)

Composite Combination	Weight
Copy Paper and Aluminum Foil	7.9g
Copy Paper and Newspaper	7.7g
Aluminum Foil and Newspaper	5.6g

Straightness Data Scoring Table

Width	Score for Straightness
Within 3ft	3
Between 3ft and 5ft	2
Greater than 5ft	1

Distance Data Scoring Table

Distance (ft)	Score for Distance
0 – 5 ft	5 ft
Between 5ft and 10ft	10 ft
Greater than 10ft	15ft

Individual Weight: Copy Paper 4.8g, Newspaper 2.5g, Aluminum Foil 2.6g

Use the Rubric scoring sheet below to determine which score to assign for each specification:

#	Criteria	Exceeds 3	Meets 2	Needs Improvement 1
1	The flight of the composite plane should fly straight within the 5 feet width.	Average score of straightness is between 2.6-3	Average score of straightness is between 2-2.5	Average score of straightness is less than 2
2	The average of the flight distance (5 trials) of the composite plane should travel at least 10 feet.	Average of 5 trials is greater than 15 feet	Average of 5 trials is between 10-15 feet	Average of 5 trials is less than 10 feet

Data Collection Table A

Weight of the Plane:_____

Composite Materials: Top Side: _____ Bottom Side: _____

Criteria	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Average	Observations
Straightness Data (Score)							
Distance Data (ft)							

Specification Table

#	Specifications	Weight	Design A		Why did it Succeed? Why did it Fail?	What can I improve on?
			Rubric Score	Total Rubric Score		
1	The flight of the composite plane should fly straight within the 5 feet width.	3				
2	The average of the flight distance (5 trials) of the composite plane should travel at least 10 feet.	5				
	Total Weighted Score					

Observations *(Example: Location of Flight Test and Weather Conditions if outside)*:

Data Collection Table B

Weight of the Plane:_____

Composite Materials: Top Side: _____ Bottom Side: _____

Criteria	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Average	Observations
Straightness Data (Score)							
Distance Data (ft)							

Specification Table

#	Specifications	Weight	Design B		Why did it Succeed? Why did it Fail?	What can I improve on?
			Rubric Score	Total Rubric Score		
1	The flight of the composite plane should fly straight within the 5 feet width.	3				
2	The average of the flight distance (5 trials) of the composite plane should travel at least 10 feet.	5				
	Total Weighted Score					

Observations *(Example: Location of Flight Test and Weather Conditions if outside)*:

Data Collection Table C

Weight of the Plane:_____

Composite Materials: Top Side: _____ Bottom Side: _____

Criteria	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Average	Observations
Straightness Data (Score)							
Distance Data (ft)							

Specification Table

#	Specifications	Weight	Design C		Why did it Succeed? Why did it Fail?	What can I improve on?
			Rubric Score	Total Rubric Score		
1	The flight of the composite plane should fly straight within the 5 feet width.	3				
2	The average of the flight distance (5 trials) of the composite plane should travel at least 10 feet.	5				
	Total Weighted Score					

Observations *(Example: Location of Flight Test and Weather Conditions if outside)*:

Student Reflection (Teacher Reflection)

IMPROVE

Improve

- Re-Design
- Re-Build and Test
- Evaluate

Design Review & Notes

- How did your airplane perform?
- What were the strengths and weaknesses of the design and the materials?
- What surprised you?
- What do you want to know?
- What can you learn about your design? What would you improve on your design? Why?
- Does it matter which composite component is on top versus the bottom?

Compare the Total Rubric scores for each of the designs and which design is best and why?

#	Specifications	Weight	Design A	Design B	Design C	Observations
			Total Rubric Score	Total Rubric Score	Total Rubric Score	
1	The flight of the composite plane should fly straight within the 5 feet width.	3				
2	The average of the flight distance (5 trials) of the composite plane should travel at least 10 feet.	5				
	Total Weighted Score					

Student Reflection (Teacher Reflection)

Engineering Design Process Vocabulary

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.

Independent Variable: a factor you changed in your trials, sometimes called the manipulated variable.

Iteration: going back to repeat a previous step at any time within the process in order to adjust or change your design.

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 system. 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.