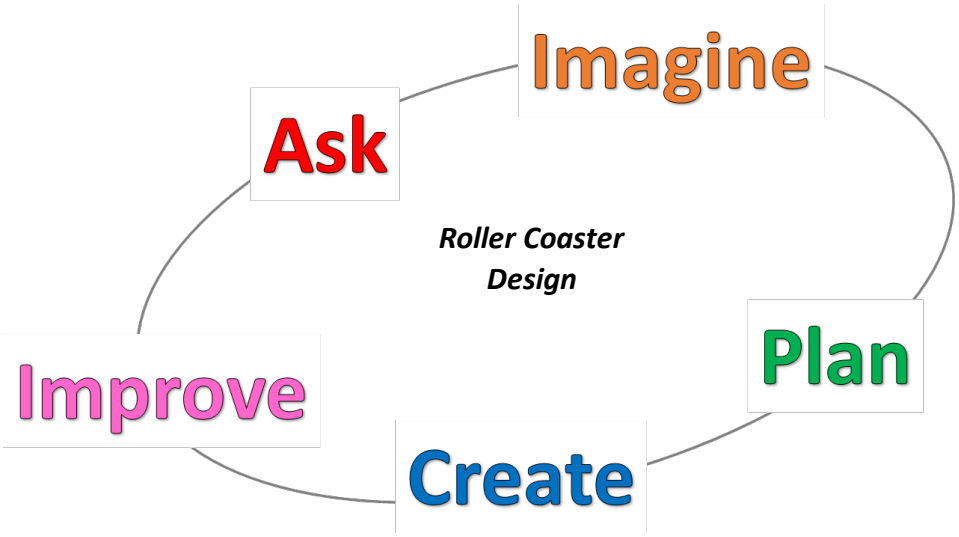
Engineering Design Process (EDP)

Engineering Notebook



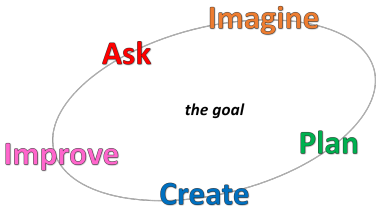
*Based off the Boston Museum Graphic

Roller Coster Design Challenge

STUDENT NAME: _____

PARTNER NAMES: _____

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 G*uiding 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 (PRESENT)**
    a. Share your solution or design with your peers.
    b. Justify your design choices using the data you collected.
    c. Provide EDP documentation.

Problem Statement:

Problem Statement: ***He'eia Elementary 6th Grade Engineer Teams need to design and build a durable free-standing roller coaster that includes at least two curves, loops, hills, and one additional ride element of your team's own design to allow a marble to successfully complete the track 3/3 times own its own from start to finish. The roller coaster should apply the following science concepts: distance, time, speed, velocity, acceleration, gravity, centripetal acceleration/force, and potential/kinetic energy.***

Specification Sheet:

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

#	Specifications/Requirements	Weight	Justification (Why?)
1	• Roller coaster should use the provided materials and apply the following science concepts: distance, time, speed, velocity, acceleration, gravity, centripetal acceleration/force, and potential/kinetic energy in the design.	5	
2	• Roller coaster includes at least two curves, loops, and hills (each element adds to the fun & excitement of the roller coaster).	5	
3	• Roller coasters include one ride element of your own design (each element adds to the fun & excitement of the roller coaster).	5	
4	• Design and build a durable free-standing roller coaster that can be used more than once.	4	
5	• Marble successfully completes the track 3/3 times. • Marble maintains contact with the track throughout each run.	3	
6	• Sign identifying the roller coaster is prominently displayed • Sign shows the name of the roller coaster, the names of the designers/builders, and their color group. • Sign is neat & attractive	2	

IMAGINE

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Background Research:

- Summary of information from sources
- Bibliography

Sketch or draw two Ideas (A & B) below. Please make sure to include labels in your design and indicate the science concepts where they apply. Also, please list all the materials including quantity used in your design.

A

Material	Quantity	Material	Quantity

B

Material	Quantity	Material	Quantity

Student Reflection:

PLAN

Plan

Evaluation Criteria
Model
Optimal Selection

Problem Statement:

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

End Date: _____

Pugh Chart *(decision matrix):*

Score: is on a scale of 1-5 with 5 being 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*

	Specifications/Requirements	**Weight**	**Design A**		**Design B**	
			Score	**Total**	**Score**	**Total**
1	• Roller coaster should use the provided materials and apply the following science concepts: distance, time, speed, velocity, acceleration, gravity, centripetal acceleration/force, and potential/kinetic energy in the design.	5				
2	• Roller coaster includes at least two curves, loops, and hills (each element adds to the fun & excitement of the roller coaster).	5				
3	• Roller coaster includes one ride element of your own design (each element adds to the fun & excitement of the roller coaster).	5				
4	• Design and build a durable free-standing roller coaster that can be used more than once.	4				
5	• Marble successfully completes the track 3/3 times. • Marble maintains contact with the track throughout each run.	3				
6	• Sign identifying the roller coaster is prominently displayed • Sign shows the name of the roller coaster, the names of the designers/builders, and their color group. • Sign is neat & attractive	2				
	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:

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

List the materials you will use to build your design:

Material	Quantity	Material	Quantity

Student Reflection:

CREATE

Problem Statement:

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

Criteria	Exceeds 5	Meets 3	Needs Improvement 1
1. Science concepts: distance, time, speed, velocity, acceleration, gravity, centripetal acceleration/force, and potential/kinetic energy	The design applies the science concepts and the engineering team can explain in great detail how the concepts apply to their roller coaster.	The design applies the science concepts and the engineering team can explain in detail how the concepts apply to their roller coaster.	The design did not apply the science concepts.
2. Durable and free-standing	The design is very durable and can stand on its own.	The design is durable and can stand on its own.	The design is not durable and cannot stand on its own.
3. At least two curves, loops, and hills	The design has more than two curves, loops, and hills.	The design has two curves, loops, and hills.	The design has one curve, loop, and hill.
4. One additional ride element of your team's own design	The design has more than one additional ride element of the team's own design.	The design has one additional ride element of the team's own design.	The design has no additional ride element of the team's own design.
4. Success	The marble is able to run the course of the roller coaster track from start to finish more than 3 times successfully.	The marble is able to run the course of the roller coaster track from start to finish a total of 3 times successfully.	The marble is not able to run the course of the roller coaster track from start to finish a total of 3 times successfully.

	Specifications/Requirements	**Weight**	**Score**	**Weighted Score = Weight x Score**
1	Roller coaster should use the provided materials and apply the following science concepts: distance, time, speed, velocity, acceleration, gravity, centripetal acceleration/force, and potential/kinetic energy in the design.	5		
2	Roller coaster includes at least two curves, loops, and hills (each element adds to the fun & excitement of the roller coaster).	5		
3	Roller coaster includes one ride element of your own design (each element adds to the fun & excitement of the roller coaster).	5		
4	Design and build a durable free-standing roller coaster that can be used more than once.	4		
5	● Marble successfully completes the track 3/3 times. ● Marble maintains contact with the track throughout each run.	3		
6	● Sign identifying the roller coaster is prominently displayed ● Sign shows the name of the roller coaster, the names of the designers/builders, and their color group. ● Sign is neat & attractive	2		
	Total Weighted Score			

Test Data:

Trials	**Did the roller coaster maintain its momentum from start to finish 3/3 times?**	**Did the roller coaster seem to fall apart at any point?**	**Did our own team's design hold up?**	**Are there any adjustments or changes that need to be made?**
Trial 1				
Trial 2				

Trial 3				
Extra Trials				

Observations:

Student Reflection:

IMPROVE

Improv

Re-Test
Evaluate
Communicate

Problem Statement:

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Student Reflection:

IMPROVE - PLAN

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Sketch your Improved Design: *(Include labels in your design and indicate the science concepts where they apply. Also, please list all the materials including quantity used in your design).*

Description of the Design Change and Justification:

Clearly Write Out the Steps for building your Design:

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

List the materials you will use to build your design:

Material	Quantity	Material	Quantity

Student Reflection:

CREATE

Problem Statement:

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Trial 1				
Trial 2				

Trial 3				
Extra Trials				

Observations:

Student Reflection:

Vocabulary Lists:

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.