

Engineering Design



Background Information: Engineering is any engagement in a systematic practice of design to achieve solutions to particular human problems. (NRC 2012, p. 11-12) To solve engineering problems, engineers follow a series of steps often called the “**engineering design process**”

The design process may be described in many ways, but it generally looks like this -



Engineering is similar to science in many ways. Engineers and scientists:

- Ask questions (for science) and define problems (for engineering)
- develop and use models
- Plan and carry out investigations
- Analyze and interpret data
- Use mathematics and computational thinking
- Construct explanations (for science) and design solutions (for engineering)
- Engage in argument from evidence
- Obtain, evaluate, and communicate information

Engineering projects have **criteria** and **constraints**. Design criteria are requirements that will be used to make decisions about how to build the product. Criteria usually come from needs expressed by customers. Criteria define the product’s physical and functional characteristics. Some examples of criteria are shape, size, weight, speed, ruggedness, and ease of manufacture.

Constraints are factors that limit the engineer’s flexibility. Some typical constraints are cost, time, and knowledge; legal issues; natural factors such as topography, climate, raw materials; and where the product will be used.

Good designs will meet important design criteria within the limits fixed by the constraints. Good designs are also economical to make and use because cost is always a design constraint!

Purpose: to design and test a solution to an engineering design challenge

What to do:

- Work with a team of 3-4
- Select an engineering challenge (only one team per class on a problem)
- Using the engineering design model:
 - **Define** your problem.
 - What are you trying to do? – This has been given to you.
 - **Imagine** solutions to your problem.
 - Brainstorm with your team.
 - Research what has been done before.
 - Consider the criteria and constraints.
 - **Plan** and **Create** a solution.
 - Choose your best ideas.
 - Build a model or prototype.
 - Test your model or prototype.
 - **Improve** your solution.
 - After testing, what would make your solution better?
 - Re-design your model to be faster, slower, stronger, last longer, less material...
 - **Communicate** your results
 - In written and verbal form, describe what you did and your results
- Keep a daily journal of your work.
 - May be hand written on the journal provided or typed. The typed version must follow the same format as the provided journal.
 - These are individual journals, not team journals.
- Pay attention to the timeline!!! Don't get behind.

Engineering Challenges

Build a vehicle with an attached container that can carry a payload	
Criteria	Constraints
<ul style="list-style-type: none"> • Payload a minimum of 250g • Travels a minimum of 10m 	<ul style="list-style-type: none"> • Materials include a balloon & fishing line • Container must be attached to the balloon

Build a bridge	
Criteria	Constraints
<ul style="list-style-type: none"> • A span of at least 30cm • A height of at least 10cm at shortest point • Can support a minimum of 200g on top of the bridge 	<ul style="list-style-type: none"> • Materials are newspaper & 2m of masking tape

Build a domed structure	
Criteria	Constraints
<ul style="list-style-type: none"> • At least 15cm high • Can support a minimum of 1000g on top 	<ul style="list-style-type: none"> • Materials are gumdrops & toothpicks

Build a bridge	
Criteria	Constraints
<ul style="list-style-type: none"> • Span of at least 40cm • A height of at least 10cm at shortest point • Can support a minimum of 200g hanging from the bottom of the bridge 	<ul style="list-style-type: none"> • Materials are spaghetti & miniature marshmallows

Make something that flies	
Criteria	Constraints
<ul style="list-style-type: none"> Will fly a minimum of 10m 	<ul style="list-style-type: none"> Materials are 1 sheet of printer paper & 1 straw

Build a machine that will move a marble across the floor	
Criteria	Constraints
<ul style="list-style-type: none"> Exactly 5 meters 	<ul style="list-style-type: none"> Machine cannot touch the floor Machine cannot be thrown by a person

Build a car	
Criteria	Constraints
<ul style="list-style-type: none"> Can travel a minimum of 10m Propelled by a mousetrap 	<ul style="list-style-type: none">

Build a boat or raft	
Criteria	Constraints
<ul style="list-style-type: none"> Will float a minimum of 1 minute Can support a minimum of 500g in pennies 	<ul style="list-style-type: none"> Material is a 30cm x 30cm piece of aluminum foil

Build a catapult	
Criteria	Constraints
<ul style="list-style-type: none"> Will knock over a wall of 15 paper cups 	<ul style="list-style-type: none"> Material that is launched is a large marshmallow Wall of cups is 2m from catapult

Create a paper airplane launcher	
Criteria	Constraints
<ul style="list-style-type: none"> Will send the paper airplane a minimum Of 20m 	<ul style="list-style-type: none">

Make a table	
Criteria	Constraints
<ul style="list-style-type: none"> Strong enough to hold a science book At least 20cm tall 	<ul style="list-style-type: none"> Materials are 10 sheets of newspaper & 1m of masking tape

Build a hovercraft	
Criteria	Constraints
<ul style="list-style-type: none"> Will hover at least 10 seconds 	<ul style="list-style-type: none"> Materials may not include battery or electric-powered devices

Build a catapult	
Criteria	Constraints
<ul style="list-style-type: none"> Will launch an object through a hole in a target 	<ul style="list-style-type: none"> Material that is launched is a large marshmallow Hole is 20cm x20cm Target is 1.5m from catapult

Do you have another idea???? Check with the teacher first.

Suggested Timeline		
	What to do	In your journal
Day 1 <i>Homework</i>	<ul style="list-style-type: none"> • Read the provided information • Think about who you want on a team • Think about possible design challenges 	N/A
Day 2 <i>In class</i>	<ul style="list-style-type: none"> • Select your team • Select design challenge • Begin assigning tasks • Begin brainstorming ideas • Write in journal 	<ul style="list-style-type: none"> • Record the date • Record the name(s) of your teammates • Record your design challenge • Record your brainstorming notes
Day 3 <i>In class</i>	<ul style="list-style-type: none"> • Continue brainstorm ideas • Choose solution • Sketch solution in journal • Label diagram • Write in journal 	<ul style="list-style-type: none"> • Record the date • Record your brainstorming ideas • Record chosen solution • Explain the reason for choosing the particular solution • Include at least two sentences describing how the team works together. Include your role as a team member.
Day 4 <i>In class</i>	<ul style="list-style-type: none"> • Build first model • Test first model • Write in journal 	<ul style="list-style-type: none"> • Record the date • Include a labeled sketch or photo of your model • Describe difficulties with your model and how you overcame them • Include at least two sentences describing how the team works together. Include your role as a team member.
Day 5 <i>In class</i>	<ul style="list-style-type: none"> • Test first model • Collect data • Improve your solution – re-design your model to work better, go faster, slower, hold more mass... • Write in journal 	<ul style="list-style-type: none"> • Record the date • Record your data (describe what happened when you tested your model) • Describe how and why you will improve your model • Include a labeled sketch or photo of the improved model • Include at least two sentences describing how the team works together. Include your role as a team member.
Day 6 <i>In class</i>	<ul style="list-style-type: none"> • Build an improved model • Test your improved model • Collect data • Write in journal 	<ul style="list-style-type: none"> • Record the date • Test the improved model • Record data (describe what happened when you tested your model) • Include at least two sentences describing how the team works together. Include your role as a team member.
Day 7 <i>In class</i>	<ul style="list-style-type: none"> • Communicate results • Share with class • <i>Completed journal due at the beginning of class</i> 	N/A

Engineering Design Journal



<i>Date</i>	<i>Journal Entry</i>	<i>Teacher Check</i>
	Engineering Design Challenge	
	Team Members	
	<p style="text-align: center;">Team Brainstorming & Discussion Notes <i>Ideas for solving the problem</i></p> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/>	

<i>Date</i>	<i>Journal Entry</i>	<i>Teacher Check</i>
	<p style="text-align: center;">The Solution The Team Chose <i>How we are going to solve the problem</i></p> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/>	
	<p style="text-align: center;">Rationale For the Solution <i>Why we chose this design</i></p> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/>	
	<p style="text-align: center;">Sketch of First Model <i>Draw & label your model</i></p>	

Date	Journal Entry	Teacher Check
	<p style="text-align: center;">Issues & Difficulties Building the Model <i>What happened & how you overcame obstacles</i></p> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/>	
	<p style="text-align: center;">Model Test Data <i>What happened when you tested your model?</i></p> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/>	

<i>Date</i>	<i>Journal Entry</i>	<i>Teacher Check</i>
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Improved Model Test Data
What happened when you tested your improved model?

Conclusions
What worked well, what didn't and why

Teamwork Reflections

*How did you work as a team?
 What worked well? What didn't?
 What did your team do to work through problems?
 How did you contribute in a positive way to your team?*
