Science and Innovation

A Boeing/Teaching Channel Partnership

DESIGN A QUIETER CABIN

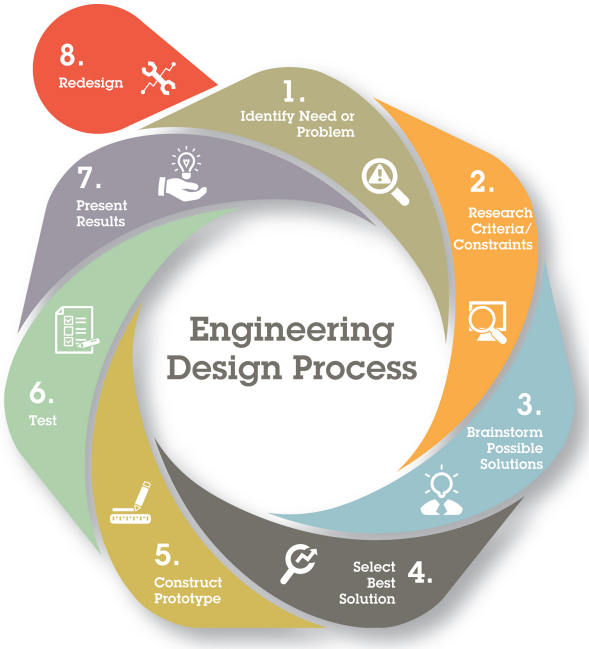
Student Handbook

Tch Teaching Channel

Engineering Design Process

Step 1 Identify the Need or Problem

Describe the engineering design challenge to be solved. Include the limits and constraints, customer description, and an explanation of why solving this challenge is important.



Step 2 Research Criteria and Constraints

Research how others have solved this or similar problems, and discover what materials have been used. Be sure to thoroughly research the limitations and design requirements for success.

Step 3 Brainstorm Possible Solutions

Use your knowledge and creativity to generate as many solutions as possible. During this brainstorming stage, do not reject any ideas.

Step 4 Select the Best Solution

Each team member presents their solution ideas to the team. Team members annotate how each solution does or does not meet each design requirement. The team then agrees on a solution, or combination of solutions, that best meets the design requirements.

Step 5 Construct a Prototype

Develop an operating version of the solution.

Step 6 Test

Test your solution. Annotate the results from each test to share with your team.

Step 7 Present Results

Present the results from each test to the team.

Step 8 Redesign

Determine a redesign to address failure points and/or design improvements. The design process involves multiple iterations and redesigns. Redesign is based on the data from your tests, your team discussions as to the next steps to improve the design, and the engineering design process Steps 1 through 7.

Once your team is confident of a prototype solution, you present the results to the client. The client may:

- Accept your solution as is, or
- Ask for additional constraints and criteria to be included in the solution. At this point, you and your team revisit the engineering design process and resume the iterative redesign cycle.

Introduction to the Engineering Design Problem

1. Once seated in an airplane, what are some of the sounds passengers might hear coming from outside of the aircraft?

2. Describe how you think airplane cabins are constructed to keep out as much sound as possible.

3. Describe how you think airplane cabins are constructed to keep out as much sound as possible. Shared team responses:

Engineering Design Problem

- You have a $10,000 budget to add materials to the interior of an airplane cabin to make it more resistant to sound.
- All materials must be fastened or laid inside the cabin so they are no more than 1.5 inches away from the container's walls.
- Materials can be placed on the cardboard lid, but the height of the lid should not exceed .5 inches.
- At no point should the material come in direct contact with the decibel meter.
- You must consider the properties, cost, and placement of each material.
- You must justify all design decisions using science ideas developed throughout the module.

Material	Size/Quantity	Cost
Copy Paper	each 8.5" x 11" sheet	$200.00
Aluminum Foil	each 4" x 6" sheet	$200.00
Plastic Wrap	each 4" x 6" sheet	$200.00
Wax Paper	each 4" x 6" sheet	$200.00
Rubber Liner	each 4" x 6" sheet	$300.00
Heavy Duty Trash Bag	each 4" x 6" sheet	$300.00
Cotton Cloth or T-shirt Fabric	each 4" x 6" sheet	$300.00
Corkboard	each 4" x 6" tile	$600.00
Cotton Balls	each	$20.00
Duct Tape	per linear foot	$1,000.00
Masking Tape	per linear foot	$700.00
Glue	unlimited	$500.00
Paper Clips	each	$50.00
Pipe Cleaners	each	$200.00
Clay	1 ounce	$200.00

How Airplane Engines Make Sound

How do you think an airplane engine makes sound? Create a model using words, pictures, or diagrams to explain how an airplane engine makes sound and how that sound travels.

How Sound Travels through Materials

Test how sound travels through different materials available to you in your design challenge. You can manipulate the materials as you see fit. Record your notes from testing in the space below.

How Sound Travels from an Airplane Engine to *Inside* the Cabin

Create a model using words, pictures, or diagrams to explain how sound travels from an airplane engine to *inside* the airplane cabin. Build on the model you developed on page 4.

Design Challenge: Can You Hear Me Now?

Individual Design

Drawing with Labels and Measurements	Justifications and Science Ideas

Team Design

Drawing with Labels and Measurements	Justifications and Science Ideas

Initial "Telephone Solution" Observations

Team Redesign "Telephone Solution"

Drawing with Labels and Measurements	Justifications and Science Ideas

Redesign "Telephone Solution" Observations

Include how your redesign (materials choices and modifications) impacted the effectiveness of your design.

Do We Hear All Pitches at the Same Volume?

Design an investigation to test the question, *Do we hear all pitches at the same volume?* Use the Online Tone Generator (onlinetonegenerator.com).

Describe your investigation below, and record your results.

Design a Quieter Cabin

Individual Design

Sketch your individual design for the noise-resistant cabin in the space below. Label the materials and use a ruler to calculate rough measurements. Use the table to calculate costs. Include science ideas to justify your design decisions.

Material	Cost Per Piece	Total
		Grand Total:

Team Design

Sketch your agreed upon team design for the noise-resistant cabin in the space below. Label the materials and use a ruler to calculate rough measurements. Use the table to calculate costs. Include science ideas to justify your design decisions.

Material	Cost Per Piece	Total
		Grand Total:

Modification after Private Test

Sketch your modified team design for the noise-resistant cabin in the space below. Label the materials and use a ruler to calculate rough measurements. Use the table to calculate costs. Include science ideas to justify your design decisions.

Material	Cost Per Piece	Total
		Grand Total:

First Class Trial

Control Reading _____ db

5:05	5:15	5:30	5:45	6:00	6:15	6:30	6:45	7:00	Average db

Modification after First Class Trial

After your first class, re-sketch your modified team design for the noise-resistant cabin in the space below. Label the materials and use a ruler to calculate rough measurements. Use the table to calculate costs. If your team is satisfied with your results, work to create a design that maintains your results while reducing cost.

Material	Cost Per Piece	Total
		Grand Total:

Modification Trial

Control Reading _____ db

5:05	5:15	5:30	5:45	6:00	6:15	6:30	6:45	7:00	Average db

Third and Final Iteration

Re-sketch your modified team design for the noise-resistant cabin in the space below. Label the materials and use a ruler to calculate rough measurements. Use the table to calculate costs. If your team is satisfied with your results, work to create a design that maintains your results while reducing cost.

Material	Cost Per Piece	Total
		Grand Total:

Final Class Trial

Control Reading _____ db

5:05	5:15	5:30	5:45	6:00	6:15	6:30	6:45	7:00	Average db

Reflect on your overall design process. What worked? What didn't work? Why? Ground your response in science ideas developed throughout the module.