

Lesson 3: Engineering Bridges for Our World

Lesson Snapshot

Overview, Grades 9-12

Big Idea: Structures are designed with a particular purpose, environment, life span, and culture in mind. Engineers must weigh these factors to produce optimal designs.

Teacher's Note: Big ideas should be made explicit to students by writing them on the board and/or reading them aloud.

Purpose of Lesson: To enable students to empathize with technologies and structures from different cultures.

Selected Learning Objectives: Students will learn to:

1. Recognize that engineering design is different based on context and culture.
2. Compare and contrast morale consideration in appropriate design.
3. Evaluate current construction methods used around the world.

Lesson Duration: Two to three hours.

Activity Highlights

Engagement: Students will view various long-lasting structures from history and aim to identify common characteristics.

Exploration: Students, working in pairs, will view historical Indiana bridges online. Student will compare and contrast characteristics from the long-lasting structures to the historical bridges.

Explanation: The students will read a case study on appropriate design.

Extension: Students will compare current bridge design in the United States with those in a developing country. Students will present on their findings.

Enrichment: Student will complete an Appropriate Engineering Design Challenge.

Lesson 2: 5-E Lesson Plan

Engagement

1. Students, working in pairs, will view famous bridges of world online at:
 - a. <http://www.famousbridge.com/>
2. Students will discuss:
 - a. What makes the bridges impressive?
 - b. What makes bridges last for a considerable amount of time?
 - c. What role does design, materials, the environment and politics play in the longevity of a bridge?
 - d. What make a “historical” bridge?

Exploration

3. Students, working in pairs, will view bridges of Indiana online at:
 - a. <http://earchives.lib.purdue.edu/cdm4/browse.php?CISOROOT=/inbridge>
4. Students will discuss similarities between historical bridges of Indiana and famous bridges of the world
 - a. What features are similar?
 - b. What features a significantly different?
5. Students will create a Venn diagram that explains what the bridges have in common and contrast.

Explanation

1. The students will complete the guided reading: Appropriate Design Case Study, Student Resource 1

Extension

1. Students, working in pairs, will search for examples of bridge designs from different parts of the world. The teacher may choose to assign particular locations, ie. Northern Africa, Southeast Asia, China.
2. Student will prepare a presentation explain the unique features of those bridges.
 - a. Google Earth can be utilized as a presentation tool to show location of discovered bridges.

Enrichment

1. Appropriate Technologies Design Challenge
 - a. Student Resource 2

Explanation: Appropriate Design Case Study

Reading and Discussion Question Guide

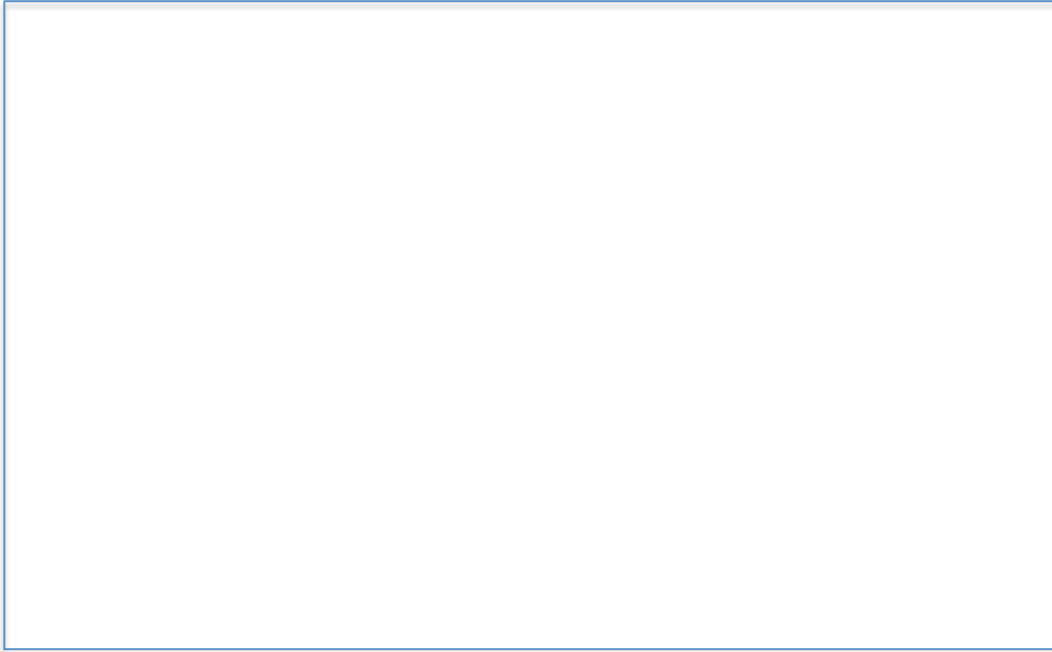
Open: MIT_Case_Study, <http://dspace.mit.edu/handle/1721.1/57549>

1. Read: 1.2 Overview, Pages 12-13
 - a. Identifying the Challenge, What is the problem the engineers are attempting to solve?

2. Read: 2.1.5 Special role of Bridges, Page 24
 - a. What role do bridges play in the bigger picture of the transportation system?

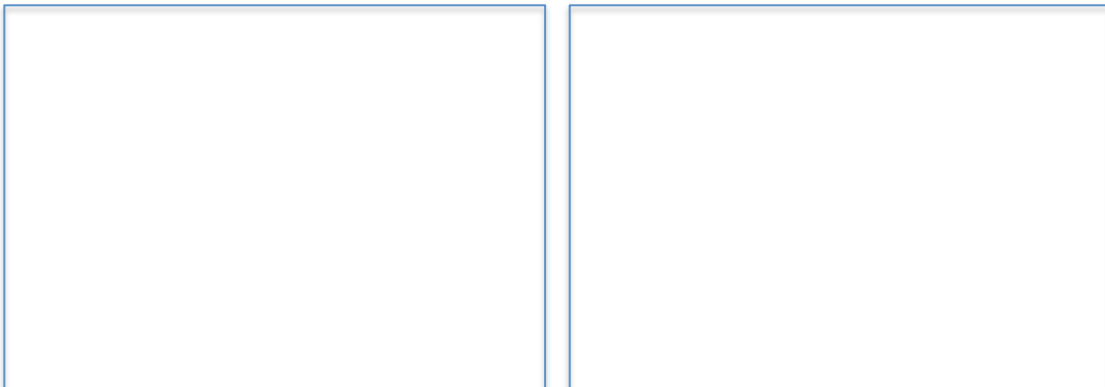
3. Read: 2.2.2 Defining Appropriate Technology, Pages 30-31
 - a. Summarize the three definitions the author provides of appropriate technologies. What are some common factors?

4. Read: 2.2.3 Appropriate Technology Framework, Pages 36-37
 - a. Sketch the graphic the authors provide on page 37.



5. Read: 2.4 Appropriate Bridge Technology, Pages 49-56
 - a. What bridge design did the authors select as the best? Why?

 - b. Provide a sketch of each design.



Enrichment: Appropriate Technology Design Challenge

Overview:

Recently the US military has increased involvement in the Far East as an attempt to eradicate terrorist activities. Many countries in the Far East share a distinct feature in terrain type, thick rain forest jungles.

The jungles in the Far East have become a difficult obstacle for the US military ground forces, due to the thick vegetation and numerous rivers and streams. It has become nearly impossible for the troops to carry movable bridge structures through the vegetation to where they are needed at the river shores. The moveable bridges currently in use are not appropriate for troops to carry through the thick jungles as they are both heavy and awkward.

Objectives:

Students will be able to:

1. Explain how an engineering design process can be used to solve design challenges.
2. Describe the importance of understanding many different aspects of a given design challenge prior to selecting a final design.
3. Work cooperatively to discuss, compare, and compromise on potential design ideas.
4. Recognize the importance of planning carefully when designing solutions.

Challenge:

Your challenge is to design, build, and test a working emergency bridge prototype. The additional criteria that you must follow include:

Bridge must:

1. Provide the basic necessity of a walkway for several military troops.
2. Be able to span at least a 10' wide river.
3. Be able to latch to one another to create a longer bridge if needed.
4. Be collapsible.
5. Be reusable.
6. Come in a container (collapsible form) able to be transported in a regular military issued back pack. 2'x3'x2'
7. Be able to be set up in less than 5 minutes.

A design journal will be collected that validates that you have followed an engineering design process. Special consideration will be given to designs that incorporate innovative building designs such as inflatable structures.

Materials:

- | | |
|--------------------------|------------------------------|
| 1. One roll of duct tape | 5. Medium Density Foam Board |
| 2. Plastic Drop Cloth | 6. Colored Markers |
| 3. Cloth Crop Cloth | 7. Graph paper (2 sheets) |
| 4. Box Fan | 8. Lined paper (2 sheets) |

Discussion Questions:

1. What was the reasoning behind your design?
2. How close did the initial designs resemble your final product?
3. What problems did you encounter?
4. How would you tackle this design problem differently?
5. Did your results cause you to think of some questions to explore?
6. How did your team resolve conflicts?

Major Concepts:

In the world in which we live, individuals are faced with technological challenges that were perhaps never anticipated nor envisioned. Forty years ago no one could have anticipated the challenges and opportunities that cell phones bring, let alone the concept of text messaging. At times we are faced with design challenges that require us to think “outside the box” and use some creative design processes rather than relying on just one possible solution.

Engineering and designers regularly keep a design journal. Documenting your design thinking strategies, through sketches, notes, and diagrams, is an important aspect of the creation of an engineering design journal.

Standards Alignment:

The primary focus of this design challenge activity is to assess student understanding of Standard 9. "Students will develop an understanding of engineering design" (*STL/ITEA 2007*) and the related benchmarks:

- F. Design involves a set of steps, which can be performed in different sequences and repeated as needed.
- G. Brainstorming is a group problem-solving design process in which each person in the group presents his or her ideas in an open forum.
- H. Modeling, testing, evaluating, and modifying are used to transform ideas into practical solutions."

Evaluation:

Assessment Instrument–Design Activity Rubric

	<i>Above Target (8-10 Points)</i>	<i>At Target (5-7 Points)</i>	<i>Below Target (0-4 Points)</i>	<i>Score (0-10 Points)</i>
Defining the Problem	Rephrases the problem clearly and precisely	Rephrases the problem clearly	Rephrases the problem with limited clarity	
Generating Ideas	Contributes multiple plausible ideas Produces accurate pictorial and orthographic sketches of design concepts	Contributes one plausible idea Produces marginally accurate pictorial and orthographic sketches of design concepts	Contributes few ideas Produces incomplete sketches Does not present a concept	
Identifying Criteria	Restates the criteria clearly and precisely and identifies many constraints	Restates the criteria clearly and identifies several constraints	Does not restate the criteria clearly and fails to identify constraints	
Exploring Possibilities	Thoroughly analyzes the pluses and minuses of a variety of possible solutions	Satisfactorily analyzes the pluses and minuses of a variety of possible solutions	Inadequately analyzes the pluses and minuses of a variety of possible solutions	
Making a Model or Prototype	Prototype meets the task criteria in insightful ways	Prototype meets the task criteria	Prototype meets the task criteria to a limited extent	
Testing and Evaluating the Design	Testing processes are innovative	Testing and evaluation processes are adequate for refining the problem solution	Testing and evaluation processes are inadequate	
Refining the Design	Significant improvement in the design is made based on prototype testing and evaluation	Refinements made based on testing and evaluation results	Refinement based on testing and evaluation is not evident	

Assessment Instrument – Engineering Design Journal Rubric

	<i>Above Target (8-10 Points)</i>	<i>At Target (5-7 Points)</i>	<i>Below Target (0-4 Points)</i>	<i>Score (0-10 Points)</i>
Organization	Journal contains a chronological section as well as sections for sketches, and reference sources.	Parts of the journal show organization, however some parts could be enhanced.	Journal is sloppy and/or haphazardly organized.	
Content	Journal entries are sufficiently descriptive to completely recreate the daily accomplishments.	Most information is detailed, however a few details may be missing.	Journal entries are insufficiently descriptive to completely recreate the daily accomplishments.	
Drawings and Sketches	Journal contains sketches and drawings that are related to the topic and express what will be created.	Sketches are drawn explaining the topic adequately.	Quantity of sketches and drawings are insufficient to explain the topic.	