



### *Drexel-SDP GK-12 LESSON*

## **To Build or Destroy?**

<b>Subject Area(s)</b>	Science and Technology
<b>Lesson Title</b>	To Build or Destroy?
<b>Grade Level</b>	7 (6-12)
<b>Time Required</b>	50 mins

### **Summary**

While many engineers can point out features of hyped electronics that stem from engineering advances to provide a concept-to-application bridge, more persuasive examples are rooted in United States history. This lesson is based upon video clips that show how engineering – and the disastrous pitfalls that come with them – have shaped the Engineering profession and its contributions to United States’ military forces. Though intended as an introductory lesson to engage student, portions of this lesson may serve well as a lead-in for other lessons and activities.

### **Engineering Connection**

Most Research and Development (R&D) operations in the United States are funded by government projects, particularly those related to military-related tasks. American scientific and technological advances during decisive periods of war have shaped and propelled the United States to be the world power it is today. The “Engineering Disasters” clips used as supporting materials not only step through instances of engineering related to World War II and the Cold War, but also show the main difference between “Engineering” and “Science,” in that Engineering requires innovation based on observations to expand the current range of technology. By-products of innovation are not always positive, or expected, and technological progress during these periods are largely due to Engineers’ experimentation and persistence.

Among other things, students may thank military R&D for the role-player action video games currently produced for gaming consoles – ground forces used their precursors as warfare training exercises the way NASA and the Air Force use flight simulators. Thermal imaging is another technology initially reserved for military use, though by 1999-2000 Cadillac had plans to

use it as a night vision feature (which was later deemed as distracting) and its latest use has been identifying air leaks to determine where to lay (or spray) insulation for residential applications.

### **Keywords**

research and development, R&D, innovation, military, World War II, WWII, Cold War, NASA, space, rocket, Navy, submarine

### **Educational Standards**

- PA Science:
  - 3.1.7 – Unifying themes
  - 3.2.7.B – Apply process knowledge to make and interpret observations

### **Learning Objectives**

After this lesson, students should be able to:

- Identify ways that the United States used technology to their advantage
- Relate the role of engineering to technological developments and problems related to technical oversights or unexpected conditions
- Combine historical knowledge (particularly at the high-school level) with engineering perspective presented in the video clip
- Hypothesize possible outcomes for the situations presented if:
  - technology was not developed in support of military operations
  - the United States lacked an educated, technologically-literate group to work on developing applications of interest to national security

### **Introduction / Motivation**

*Start off with introducing yourself and your title. For the purpose of working within the GK-12 program, I find it important to state the reason why you're there – you're not a teacher, but the current "expert" in the K-12 classroom who is going to enhance the curriculum. Complete any surveys gauging impact or students' knowledge of engineering before the lesson. Many of you are probably unsure of what I mean when I talk about engineering (train conductors, auto mechanics, and the general politically-correct term for those involved in maintenance-related jobs are common misconceptions), but it's easier to show the impact of engineering than to explain what constitutes the engineering discipline.*

There are several shows that currently air on the Discovery and History channels, and perhaps you've flipped past them. One show, *Modern Marvels: Engineering Disasters*, sets a objective, respectful tone that shows how engineering advances involve more factors than a will to "build things." Engineering advances can improve our quality of life or technological abilities, but at the same time, they can magnify the destruction encountered during unexpected (or previously untested) situations. The following *Modern Marvels: Engineering Disasters* clip shows several clips, the first four of which cover historical instances of engineering in World War I (Chauchat), World War II (Liberty Ships), and the Cold War (Space Program, U.S.S. Tenosa).

## Lesson Background & Concepts for Teachers

There are particular points for certain clips.

1. **Space Program:** Rocket-building pioneers used quantities of highly explosive reactants (liquid oxygen, O<sub>2</sub>) which were not understood at the time (can relate to Chemical Engineering). As explained in the video, the alloys used to house the metal rockets sometimes melted under the intense heat due to the rocket's explosives. This relates to the **metallurgy** of the materials used, which affects decision-making for proper usage of engineering materials today.
2. **Chauchat:** One of the most striking things to be learned from the clip is the fact that military leaders may not be in control of all military decisions, just as scientists and engineers are not in control of governmental decisions regarding scientific and technological issues. However, engineers and scientists can play a role in shaping public and military **policy**. The way the Chauchat was made also contributed to its disastrous use - parts were not interchangeable, and the design was not durable. Many products are designed to be mass-produced with identical components, as prescribed by design and manufacturing engineers. This extends products' service life and limits replacement cost for items subject to wear-and-tear.
3. **U.S.S. Tenosa:** The story of the Tenosa is reminiscent of the plot in *The Hunt for Red October*, with attack submarines opposing others carrying long-range missiles. Nuclear submarines were an emerging technology used for our national defense. As explained in the clip, frozen-over debris screens on the air tanks prevented the submarine from "blowing." In addition to a possible discussion about pressure (in both air and water), the loss of the Tenosa demonstrates the importance of testing in environments similar to the operational environment.
4. **Liberty Ships:** The widespread use of a new technology, *welding*, came to play in the mass production of ships. Metallurgy again played a role in an engineering disaster, since the frigid waters of the Atlantic made the welded metal brittle. The change in the mechanical properties of the steel, induced by temperature, contributed to the overall catastrophic failure of the ships.

In each of these examples, it's important to point out that problems were diagnosed from an original model (or re-tested on a duplicate model), leading to an explanation for the failure and/or eventual engineering success.

### Associated Activities

Jeff White *et al.* "Strawkets and Weight." Available <

[http://teachengineering.org/view\\_activity.php?url=http://www.teachengineering.org/collecton/cub/\\_activities/cub\\_rockets/cub\\_rockets\\_lesson03\\_activity2.xml&rights=true](http://teachengineering.org/view_activity.php?url=http://www.teachengineering.org/collecton/cub/_activities/cub_rockets/cub_rockets_lesson03_activity2.xml&rights=true)>.

This activity ties in well with the idea of a rocket as an "inverted pendulum." Students can change the weight distribution and balance the strawket to find the center of mass.

### Lesson Closure

Discuss results for "strawket" activity.

## **Additional Multimedia Support**

*Lesson\_ToBuildOrDestroy\_Media.zip* contains these files:

1of5 Modern Marvels Engineering Disasters 2.mp4, original video location

<http://www.youtube.com/watch?v=3AgYRb8x86s>

2of5 Modern Marvels Engineering Disasters 2.mp4, original video location

<http://www.youtube.com/watch?v=wqT5D-Kf88k>

3of5 Modern Marvels Engineering Disasters 2.mp4, original video location

[http://www.youtube.com/watch?v=1b\\_riIvu2hE](http://www.youtube.com/watch?v=1b_riIvu2hE)

4of5 Modern Marvels Engineering Disasters 2.mp4, original video location

<http://www.youtube.com/watch?v=P2BD1JdZXHg>

5of5 Modern Marvels Engineering Disasters 2.mp4, original video location

<http://www.youtube.com/watch?v=sW51b5HibVQ>

### **Owner**

Drexel University GK-12 Program

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Name: \_\_\_\_\_

### Space Program

1. Challenges of the space program included (check all that apply).
  - Knowledge of combustible materials used as fuels
  - Knowledge of metal alloys housing rockets
  - Lack of systems to guide and control rockets
  - Too many knowledgeable people participating in design and testing
  
2. von Braun moved from \_\_\_\_\_ to the United States to work with Robert Goddard on the space program. He could have worked with another participant in the Cold War, \_\_\_\_\_.
  
3. Over 3 \_\_\_\_\_ dollars were lost when the Titan rockets malfunctioned on 3 separate launch attempts.

### The Chauchat

4. Selection of the Chauchat as a weapon in WWI was done by \_\_\_\_\_ leaders.
  - a. Engineering
  - b. Military
  - c. Political
  - d. Entertainment
  
5. The U.S. military's problems included (check all that apply)
  - A cutout portion on the magazine that allowed dirt and water inside the weapon
  - Non-standardized manufacturing
  - Poor workmanship and material
  - Extreme kickback
  
6. The Browning automatic rifle was withheld from overseas war to keep it out of \_\_\_\_\_ hands.

### USS Thresher

7. The currency in submarine warfare is \_\_\_\_\_ .
  
8. The Thresher was a nuclear attack sub, designed to destroy "Boomers." The metal was \_\_\_\_\_ together.
  - a) Welded

- b) Riveted
- c) Glued

#### USS Thresher, continued

9. Though the quality of the welds was in question, the Navy tested a situation of blowing the compressed air tanks in the Tenosa and found that a screen \_\_\_\_\_, making it impossible for the sub to “blow.”

#### Liberty Ships

10. True or False: Liberty ships were America’s solution for fighting two wars across two oceans at the same time.
11. A Kaiser ship could be built in \_\_\_\_\_ days. They could be built so quickly because they were \_\_\_\_\_ together.
12. As a result of *metallurgy* tests, what was found to happen if the ships were in conditions similar to the frigid waters of the Arctic ocean?
- a) Welds lost their strength
  - b) The low grade steel became extremely brittle
  - c) The weakened steel intensified strain on the welds
  - d) All of the above
  - e) a and b
  - f) b and c

#### Andrea Doria

13. A \_\_\_\_\_ cent lightbulb illuminating the \_\_\_\_\_ setting of the radar screen could have made the crash between the Andrea Doria and the Stockholm avoidable.

#### Hartford Civic Center

14. The advanced space truss roof design was calculated using a \_\_\_\_\_.
15. True or False: The failure of the roof design was attributed to incorrect computer calculations.

#### St. Francis Dam

16. William Mulholland used a dam-and-reservoir system to transport water across California to Los Angeles. The dam gave way because the ground became \_\_\_\_\_ with water, causing a landslide that carried the dam with it.

#### Northeast Blackout

17. True or False: Engineering failures multiplied in the power grid only because a faulty relay switch had not been upgraded.