Engineers and Move Makers: The Importance of Scaling
(Lesson)

Subject Area(s): Engineering, Probability and Statistics

Associated Unit: A Fraction of Engineering

Lesson Title: Engineers and Movie Makers: The Importance of Scaling

Header: Insert Image 1, centered

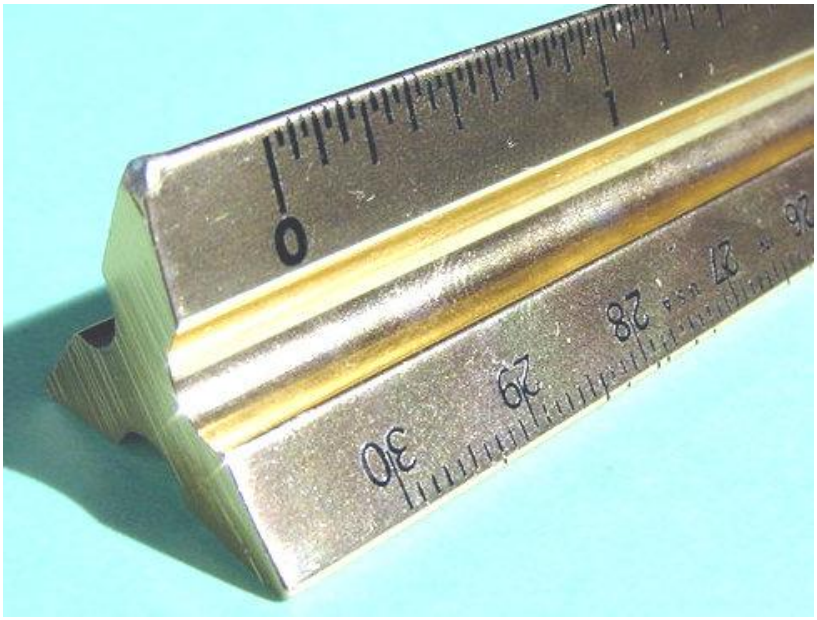

Image 1

ADA Description: This is a picture of an architecture scale also used by engineers and scientists

Caption: None

Image file: engine_ratio.jpg

Source/Rights: Copyright © 2006 by Catherine Munro on Wikimedia Commons

http://upload.wikimedia.org/wikipedia/commons/a/ae/Architects_scale.jpg

Grade Level 8 (6-8)

Lesson # 1of 3

Lesson Dependency None (leave blank)

Time Required 1 hour (lesson)
1 hour (worksheet – assessment)

Summary

The goal of this lesson is to review the concept of ratios (proportionality) with students while introducing them to different engineering applications where these principles are critical. During the introduction, students will review the concepts of ratios and percentages. As the lesson progresses, students will be exposed to then forced to apply this know to basic engineering concepts. The focus of this lesson is how ratios in the realm of scaling work through engineering and science. Movie miniatures are used as a stepping stone to discuss how engineers use scale models to present designs and understand the world around them.

Engineering Connection

Many times, students learn percentages and ratios as a means to an end of a homework assignment. However, these concepts are vital to engineers when designing and doing experiments. Using scaled down models, movies are able to have events happen without the destruction of millions of dollars of equipment. Similarly, engineers and scientists are able to learn about the reaction of a given set of conditions in a smaller contained area rather than a large area. Engineers used scaled models to present ideas and understand the interaction of things as simple static models of structures designs to as complicated as modeling the interaction of sand and water that creates alluvial fans.

Engineering Category = #1

1. Relating science and/or math concept(s) to engineering
2. Engineering analysis or partial design
3. Engineering design process

Keywords
miniatures, pyrotechnic, proportionality, ratio, scaling,

Educational Standards

International Technology and Engineering Educators Association (ITEEA) Standards

Standard 3, Grade Level 6-8, F. Knowledge gained from other fields of study has a direct effect on the development of technological products and systems.

Texas Essential Knowledge and Skills (TEKS)

Technology Applications

126.12 (c) (7) (A) plan, create, and edit documents created with a word processor using readable fonts, alignment, page setup, tabs, and ruler settings;

Math

111.22. (b) (4) (A) use tables and symbols to represent and describe proportional and other relationships such as those involving conversions, arithmetic sequences (with a constant rate of change), perimeter and area; and

111.22. (b) (4) (B) use tables of data to generate formulas representing relationships involving perimeter, area, volume of a rectangular prism, etc.

111.22. (b) (8) (A) estimate measurements (including circumference) and evaluate reasonableness of results;
111.22. (b) (8) (B) select and use appropriate units, tools, or formulas to measure and to solve problems involving length (including perimeter), area, time, temperature, volume, and weight;

111.23. (b) (D) use division to find unit rates and ratios in proportional relationships such as speed, density, price, recipes, and student-teacher ratio;

Pre-Requisite Knowledge
None (leave blank)

Learning Objectives
After this lesson, students should be able to:

- Convert ratios to percentages and vice versa
- What does it mean when something is proportional
- Explain, in their own words, the meaning of a ratio and percentage.
- Explain, in their own words, how scaling is just like a ratio.
- Identify 2 engineering examples where ratios are used.
- Explain why engineers use scaling and models.

Introduction / Motivation

Are ratios or percentages important? (Call on a few students to give their opinion). The first thing in understanding their importance is to understand what they are. So what is a ratio? (Have a few of the answers write on the board to record the student's initial thoughts on the idea). Now, what is a percentage? (Again, have a few student answers put on the board) Are they different or the same thing? After having a student or two give their opinion, right a fraction up on the board and ask students what it means. The point of this is to show that ratios or percentages do not mean anything if you do not know anything about where the numbers come from. Without any meaning, it is just a fraction. A ratio/percentage means more.

Ratios exist everywhere around you. Either using previously collected data about the class or the students that are in the class currently, have the students quickly calculated the ratio of girls to boys then convert that to a ratio and percentage. But this is a very simple example and is not exciting. Now, show the students a clip of a movie that used scaling in order to create that scene. Would you believe me that ratios were vital part in creating this. This is a called a miniature effect and in this lesson we are going to learn how it is used and how engineers use this same principle every day.

(Discuss or present information in the Lesson Background & Concepts for Teacher section and perform assessment as described in the Assessment section.)

Lesson Background & Concepts for Teachers

This video 1 presents the concept of the miniature effect and how it is used in movies.
A miniature effect is a special effect used in movies that have been scaled down. Scaling is a way of making something smaller or bigger without change how all of the components work together. It is one method that engineers use to design. When engineers design buildings, bridges, and roadways, they are able to fit their design on small pieces of paper. This is one of the simplest way engineers use ratios every day. Draw a house on the board and ask the students what it is. Most will say it is a house so point out that I did not need to draw it the size for them to know what it is. Our brain is able to do this because the picture that was drawn is proportional. Proportional means that we used the same ratio on each element of the picture. This means the roof of the house is half the size of a real roof, the door should also be half the size of the real door. This is how movies are so effective when making something so small look so real. [2]

A different kind of miniature effect is called miniature pyrotechnics. This goes beyond just scaling physical objects down but involved explosions. Video 2 introduces the topic of miniature pyrotechnics. Miniature pyrotechnics are special effects using scale models. While static objects are easy to scale up or down, the reaction of these objects are much more complicated. Engineers have the same issues when dealing with reactions. [1]

Figure 1 shows the movement of sediment in the Grand Canyon. This is called an alluvial fan and engineers at the University of Houston are trying simulating this movement of this large phenomena (spanning out miles) on a much smaller scale. Video 3 (reference) shows the simulation. It occurs in a 10 x 10 box compared to the miles in which it occurs in nature.

IMAGE Insert Figure 1 here, right justified

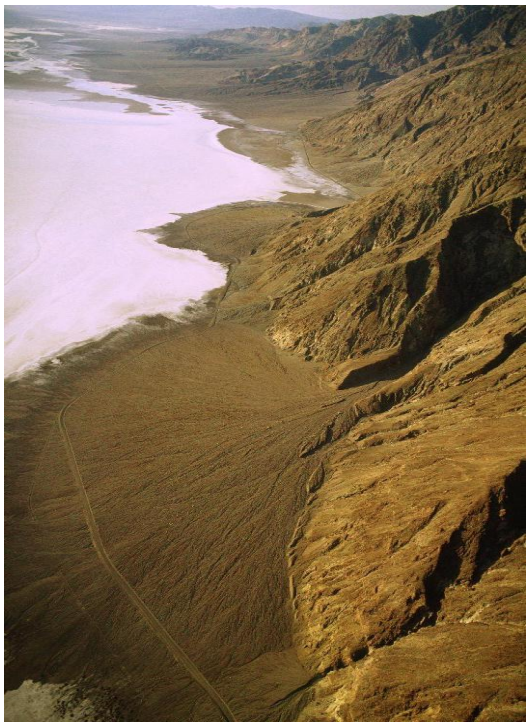

Figure #1

ADA Description: This is a picture of an alluvial fan in the Grand Canyon?

Caption: Figure 1: An alluvial fan in the Grand Canyon?

Image file: grand_canyon.jpg?

Vocabulary / Definitions

Word	Definition
Ratio	The relationship or comparison or two numbers
Percentage	Represents a part of another number. It is related to a ratio or fraction.
Proportional	The relationship between an object where the ratio is the same.
Scale Model	A replica or copy of an object. It can be larger or smaller. [3]
Miniature Effect	A special effect used in movies using scale models [2]
Miniature Pyrotechnics	The science of using material that when put together cause a reaction that can results in an explosion at small scale to imitate a reaction in real life scale. [1]

Associated Activities

None

Lesson Closure

Use the questions on the second page of the assessment as discussion questions to review the objectives stated at the beginning of the lesson. What are some different types of models that we did not talk about? If you were to create a model, what would you make and what do you think the ratio (scale) would be?

Take one student response and have a different students estimate the ratio with the input from his/her peers.

Assessment

Give the students the attached worksheet and have them work on and complete in class or at home. There are two version of the worksheet. The first worksheet was created for the intent of the students re-creating it in Microsoft Word and filling in the blanks throughout. Filling in the blanks is the assessment of the objectives stated in this lesson while the students also learn new features about Microsoft Word. The second version was created for the teacher to print out and students to fill in with pen or pencil.

Lesson Extension Activities

Have the students identify one movie where they think scaling occurs. Take a scene/image they like and have them create a model of it using the correct ratio throughout.

Additional Multimedia Support

1. Video 1: Miniature Effect (http://www.youtube.com/watch?v=7OqBi9AwPjo)
2. Video 2: Miniature Pyrotechnics (http://www.youtube.com/watch?v=dEmXA0Itv6A)
3. Video 3: Simulation of Alluvial Fan (2011, Paul Hamilton, University of Houston, Attachment)

References

[1] "Pyrotechnics" Accessed May 2, 2012. http://en.wikipedia.org/wiki/Pyrotechnics
[2] "Miniature Effect" Accessed May 2, 2012. http://en.wikipedia.org/wiki/Miniature_effect
[3] "Scale Model" Accessed May 2, 2012. http://en.wikipedia.org/wiki/Scale_model

Attachments

Worksheet:	Original_house.pdf
	Original_house.doc
	Scaling_for_Word.pdf
	Scaling_for_Word.doc
	Scaling_by_hand.pdf
	Scaling_by_hand.doc
Video:	simulation_alluvial_fan_hamilton.mp4

Other
None (leave blank)

Redirect URL
None (leave blank)

Contributors
Daniel W. Burleson, Andrey Koptelov

Copyright
None (leave blank)

Supporting Program
University of Houston, National Science Foundation GK-12 Grant No. 0840889 and Research Experience for Teachers (RET) Programs