



## Classroom Lesson Development

Title of Lesson **Physics, Design and Aesthetics**

RET Project Connection A study of the effects of crack (damage) patterns on the vibration and mechanical properties of components.  
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RET Teacher Santino Carnevale

School Brookline High School

Town/District Brookline

Subject(s) taught Physics

Subjects covered in lesson Newton's Law of Motion, Pressure, Free Body Diagrams

Grades appropriate 9

Lesson duration 4-5 Days

Goals/Objectives of lesson - To introduce students to an engineering project and the design process.  
- To have students independently form reasonable and logical criteria for assess the quality of their design.  
- For students to apply the concepts of physics, specifically Newton's Laws of Motion, to a practice situation.

Background information This lesson will be one part of four project based lessons I do in the upcoming year. While all four of these lessons will focus on design, I want this specific lesson to also deal with using computers to aid in modeling. This project will be the second of the four projects, so students will already have some experience with design. I hope that after their first experience students are able to recognize what a great advantage computer modelling is to the design process, in that you can try a multitude of ideas in a relatively short amount of time. I also hope that through all of these projects students will learn to set the criteria that a successful project must meet.

Essential questions -What concepts in physics must be used to assess the performance of your bridge?  
- What are the characteristics of a good design?

## Links to Frameworks and Standards

National Objects change their motion only when a net force is applied. Laws of motion are used to calculate precisely the effects of forces on the motion of objects. The Magnitude of the change in motion can be calculated using the relationship  $F=ma$ , which is independent of the nature of the force. Whenever one object exerts force on another, a force equal in magnitude and opposite in direction is exerted on the first object.

State I.1.4 Interpret and apply Newton's three laws of motion.

I.1.5 Use a free-body force diagram to show forces acting on a system consisting of a pair of interacting objects. For a diagram with only co-linear forces, determine the net force acting on a system and between the objects.

SIS1. Make observations, raise questions, and formulate hypotheses.

SIS2. Design and conduct scientific investigations.

SIS3. Analyze and interpret results of scientific investigations.

SIS4. Communicate and apply the results of scientific investigations.

Local 3.08 Construct a free body diagram  
3.09 Determine the net force on an object  
3.14 Distinguish between Force and Pressure  
4.03 Identify the reaction force given an action force

Materials required West Point Bridge Design Software, Microsoft Power Point

Lesson development This lesson is a bridge building competition. The basic assignment is to design a bridge that will hold a specific amount of load, and then present the bridge to the rest of the class. The presentation is meant to convince the audience that their bridge should be selected as the best among all the bridge models that have been constructed. Students will be given tasks to complete in three parts: initial planning, computer modelling, and presentation.

1. Initial Planning - It is in this step that students have to make the biggest decisions for their bridges, and use the most creativity. They will develop their own criteria to assess the quality of a bridge's design. They might take any factors into consideration, such as cost, aesthetic appeal, and the bridge's impact on the environment.

2. Computer modelling - Once students have developed their criteria for a good bridge, they need to start designing their bridge. Needless to say, they should use the criteria that they set forth in guiding their design decisions.

3. Presentation - Once all students have decided on a design, they must present their bridge. Students can use any method of presentation that they would like, but power point will be suggested. Each group's design should make explicit what criteria they found important for a successful bridge, the reasoning behind it, and how they addressed it in their design.

Grades will be based on how well they argued for their design. separate assignments will also be given that address what physics concepts come into play when designing a bridge.

References West Point Bridge Design Contest, <http://bridgecontest.usma.edu/>

