121st ASEE Annual Conference & Exposition
Indianapolis, IN
June 15-18, 2014
Paper ID #9807

Curriculum Exchange: Cantilever Bridging

Dr. Stephen J. Ressler, U.S. Military Academy

Stephen Ressler, P.E. Ph.D. is Professor Emeritus from the U.S. Military Academy (USMA) at West Point and currently serves as President of the Board of Directors for Engineering Encounters, a non-profit organization founded to promote K-12 engineering outreach. He earned a B.S. degree from USMA in 1979, a Master of Science in Civil Engineering from Lehigh University in 1989, and a Ph.D. from Lehigh in 1991. As an active duty Army officer, he served in a variety of military engineering assignments around the world. He served as a member of the USMA faculty for 21 years, including six years as Professor and Head of the Department of Civil and Mechanical Engineering. He retired as a Brigadier General in 2013. He is a registered Professional Engineer in Virginia and a Distinguished Member of ASCE.

Catherine Eve Bale, U.S. Military Academy

Catherine Bale is the Director of Outreach for the West Point Center for STEM Education. She holds a B.A. degree in Journalism from the University of Missouri and a M.S. degree in Education from Long Island University.

She has served as the coordinator of the West Point Bridge Design Contest for more than 10 years and spent the last year launching CSE. Additionally, she teaches childhood education classes at Mount Saint Mary College. Previous to her work as a teacher, in educational outreach and in higher education, Ms. Bale was a television news producer and a professional photographer.

As a certified New York State teacher, Ms. Bale's unique combination of classroom and mass media experience have provided her with a unique platform to organize and initiate quality STEM outreach programs. She has a passion for technology and is an advocate for finding creative ways to engage students and inspire them in the areas of science, technology, engineering and mathematics.

Curriculum Exchange: Cantilever Bridging

Target Grade Level: Grades 4-10

Contact Information:
Stephen Ressler, 2735 Briarwood Place, Bethlehem, PA18017 (sjressler@gmail.com)
Catherine Bale, Center for STEM Education, D/P&NE, West Point, NY 10996 (catherine.bale@usma.edu)

The purpose of the "Cantilever Bridging" activity is to provide an inductive, experiential introduction to the concept of ***static equilibrium*** and its application in structural engineering. From a broader perspective, this activity demonstrates the value of science as a tool in the engineering design process. The activity is best conducted outdoors or in a gymnasium; thus it can be used effectively to provide a change of pace from traditional indoor classroom activities.

The "Cantilever Bridging" activity proceeds as follows:

- Participants are organized into teams of 4 to 10 students each.
- The teams are oriented to the "construction site." (See Figure 1 on reverse side.) For each team, two bridge abutments (wooden boxes measuring 12" wide by 12" tall by 36" long) are placed 9 feet apart, on opposite sides of a simulated river. The simulated river is marked off with tape and is "off limits" to participants. On the near "shore" are two 8-foot-long wooden planks, as well as enough hard hats and work gloves for all team members.
- The teams are presented with the problem—to get *all members of the team* and *both planks* safely across the river in the shortest possible time.
- The teams are briefed on the rules of the game and then are given five minutes to organize themselves and plan their problem-solving strategies.
- Construction begins with "On your mark…get set…build!" The first team to cross all of its members and both planks without any person or plank touching the "river" is the winner.[*]
- The students are then led on a discussion of the activity and the underlying principles of engineering mechanics that served as the basis for their empirical solution to the bridging problem. The activity concludes with a demonstration of how the basic components used in the bridging activity can be used to model a real-world structure—the great Firth of Forth cantilever bridge in Scotland.
- Following this discussion, the teams are given the opportunity to repeat the exercise—and on this second iteration, the team with the greatest *improvement* in crossing time is declared the winner. Armed with knowledge of the underlying principles (and with the benefit of having already practiced the task once), the teams' performance on this second iteration invariably improves substantially. Teams that do badly on the first iteration often do particularly well on the second, because they have more room for improvement.

Because the river is 9 feet wide and each plank is only 8 feet long, the only feasible way to solve this problem is to build a cantilever bridge (see Figures 2 and 3 on the reverse side), with the anchor span extending only about half-way across the river and one or more students standing on its near end to provide a counterweight. Once all but the final team member have crossed, the cantilever configuration must be reversed in order to get the final student across the river and recover the planks. The student teams rarely recognize this potential solution in their planning, but invariably discover it through trial and error—and by observing the other competing teams. Their improved performance on the second iteration serves as the basis for a final discussion on the value of science as a tool in engineering design.

---

[*] If any student touches the river, then he or she must return to the "near shore" and start again. If a plank touches the river, then all students on the bridge at that moment must return to the "near shore" and start again.

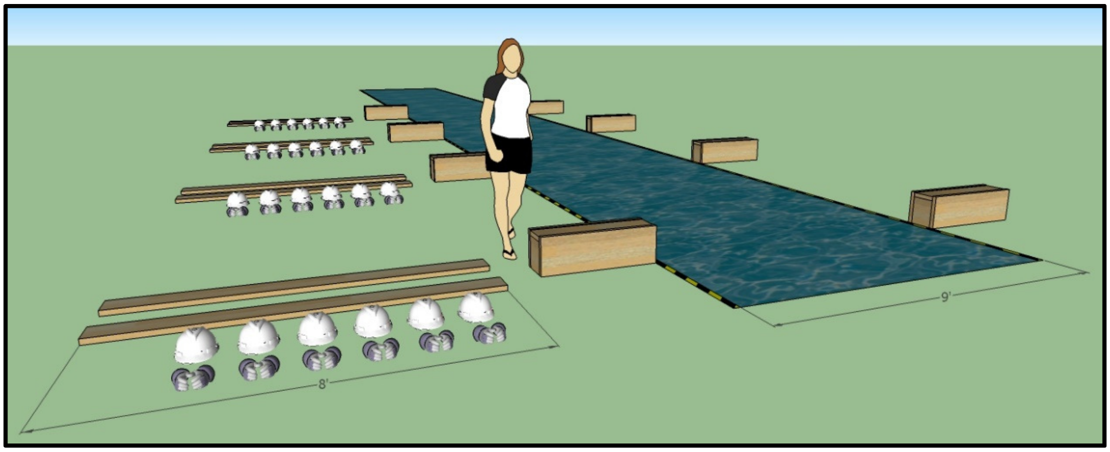

Figure 1. Site layout for the Cantilever Bridging Activity

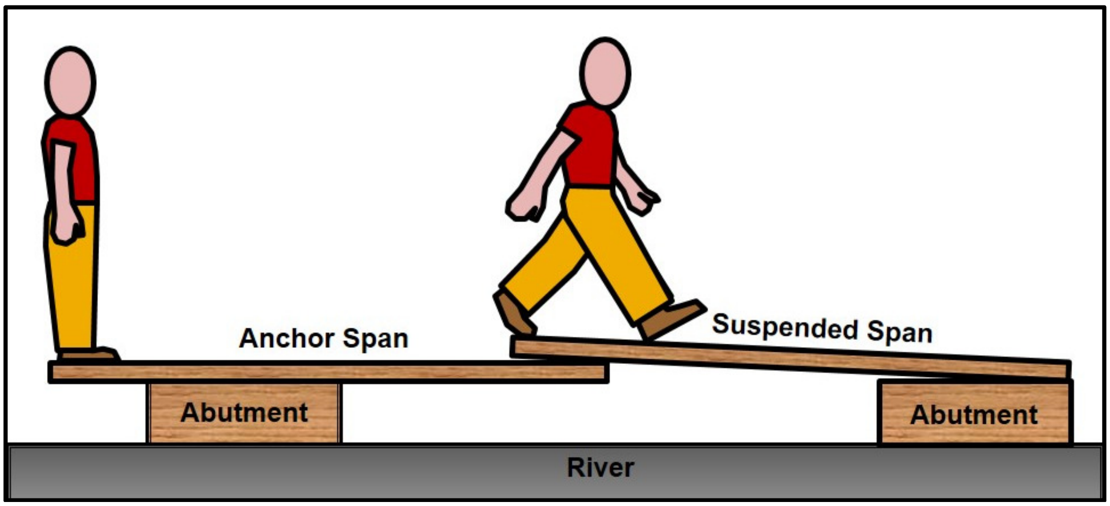

Figure 2. The Problem Solution


Figure 3. Students participating in the activity