



## **MAKER: Trash Sliders - Building Vehicles from Junk**

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## **Manufacturing Division MAKER Session: Trash Sliders - building vehicles from junk**



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### **Introduction**

*Trash Sliders* is the latest in a series of engineering design activities developed for middle and high school students by teams of mechanical engineering students and faculty at the University of Virginia. It introduces the problems of trash and waste, their environmental and social impacts, sustainability, the engineering design process, the basic physics of forces and motions, and the design of suspension systems. Over the years, we have developed several challenges involving vehicle design. This project has two unique features: the vehicle must be constructed entirely from trash, and it must involve a suspension system to protect a payload from spilling.

### **Implementation**

*Trash Sliders* has been used in two middle school science classes, in a teachers' workshop at ASEE 2015, and in BLAST - a summer program for high school students sponsored by the Virginia Space Grant Consortium. This paper emphasizes the Blast experience because it is similar to what might be done at a Maker Faire. In the summer of 2015, we hosted 160 8<sup>th</sup> and 9<sup>th</sup> grade students in two sessions of Blast. Eight separate 3-hour blocks were devoted to *Trash Sliders* in each session. Each block had 20 students arranged in 4 person groups.

After an initial ice-breaking activity designed to get the students working as teams, we discussed the problems of waste and trash, what happens to the things we discard; the ideas of recycling, reuse, and upcycling; and the function and design of suspension systems – how they work and why we need them.

In the design challenge, student teams had to design and build a vehicle capable of transporting liquid over rough terrain. We build a special ramp for testing the vehicles. Each vehicle must carry a 2L bottle with a rectangular opening cut in the top. The bottle is filled with 500mL of water. The goal is to complete the course with as little spillage as possible. All materials provided for construction of the vehicles are items normally considered trash, in order to emphasize the concept of reuse in promoting sustainability.

With the initial implementation of *Trash Sliders* with middle school science classes, we gave each team a box of trash so all teams started with the same materials. Figure 1 shows the kinds of materials they received. With our BLAST students (who were older and had limited time to complete the project), we arrayed a variety of types of trash at the front of the room. The teams were encouraged to examine these materials then meet in their teams to discuss design ideas and determine what materials they needed. We had a “work station” with a skilled craftsman to cut and shape the materials as directed by the teams. This avoided any safety problems associated with the use of knives, drills, saws, and Dremel tools in the hands of untrained students.



Figure 1: Assorted trash for making vehicles

The teams constructed, tested, and re-designed their vehicles in about 1.5 hours. Each was given the bottle they would use in the competition. For their initial tests, they used golf balls in the bottle, instead of water. In the final competition, each team had to propel their vehicle down the slide over several obstacles; then retrieve it and send it down the other side of the slide. We then measured the amount of water remaining after the two runs. Figure 2 shows the slide, the score sheet (500 is the maximum score), and one of the teams after a successful run.

Team	Volume left (ml)
Cyan	215
Lil' Einsteins	500
Fruitloops	$450 - 50 = 400$
The Kinetics	485
Clare	395
Annulists	$490 - 50 = 440$



Figure 2: Final competition and team scores



Figure 3: Some successful Trash Sliders

## Results

Most of the teams produced acceptable designs. A few managed several design iterations before the final competition. The Blast students were excited by this activity and rated it highly in their final survey. Although all teams achieved workable vehicles, they varied widely in terms of effectiveness and sophistication. The variation in designs was incredible; these students produced designs we never imagined. Their creativity and design/build skills amazed us. We intentionally did not show the students any examples of previous designs, so they were not limited by preconceived notions of what we expected them to produce.

The final half hour of each block was devoted to the final competition. Each team tested their vehicle with everyone watching. We carefully measured the amount of water remaining in the bottles, and posted the results on a blackboard (see Figure 2). After each competition, the entire group discussed the various designs and why some were more successful than others. We invited the students to consider how they might make an even better Trash Slider, and encourage them to *“try it at home!”*

## Afterthoughts

*Trash Sliders* is the latest in series of engineering design activities developed for pre-college engineering education outreach. We have over 60 such activities so far. Originally designed to introduce engineering in the context of science and math classes, these activities have been adapted to afterschool programs, campus visitations, STEM days at local schools, workshops for students and teachers, and summer programs, such as BLAST. In formal classes, these activities follow lessons on the science, math, and engineering content, fit into the existing curriculum, and meet relevant educational standards. In both formal and informal settings, the students must build and test a working artifact.

Our approach is distinctly low-tech; whenever possible, we use readily available materials and minimize the cost of parts and materials that must be purchased. The Maker Movement should not be limited to high tech approaches (3D printers, Arduinos, and computers), but can accommodate a much wider range of design/build/test/redesign activities. Any activity that requires students to use knowledge and skills from STEM fields to make machines, vehicles or

structures fits within the Maker Culture. Our approach challenges students from elementary school through college; and brings forth highly creative and innovative solutions.

### **Acknowledgements**

The first four authors of this paper are the mechanical engineering students who designed this activity, built the slide, and conducted the initial trials in a classroom. The initial classroom trials were conducted in two science classes taught by Ms. Deanine Lilley at Jack Jouett Middle School in Albemarle County, Virginia. Charlottesville artist Russell U. Richards managed the workstation and materials center for the BLAST program, and assisted the teams in creating parts for their designs.

Please visit our Facebook page (<https://www.facebook.com/theengineersway/>) or contact us at [lgr@virginia.edu](mailto:lgr@virginia.edu) to gain access to the complete lessons plans. A more complete article on Trash Sliders is being prepared for publication.