



# PLANTING THE SEEDS OF TECHNOLOGICAL LITERACY

Teaching Technology,  
Engineering, Science & Mathematics by

## ***Dropping a Pumpkin!***

by Scott A. Warner, Ed.D.



An entry is loaded into the bucket. The target is visible on the ground directly in front of the truck.

**D**URING MY DOCTORAL STUDIES at West Virginia University (WVU) in Morgantown, West Virginia, I had the unique opportunity to work as a research assistant in the Engineering Research Center of the College of Engineering. This graduate position provided an opportunity to witness firsthand the early efforts of the WVU Pumpkin Drop. Every year around Halloween the student engineering organizations sponsor a technical challenge to design and build a device that protects a raw, unadulterated pumpkin from smashing after being dropped from the top of the main engineering building, which is eleven stories tall. Over the years the WVU Pumpkin Drop has grown and evolved into a major event that attracts students from across the entire campus and from public schools across West Virginia and Southwestern Pennsylvania.

Being an educator, I am always on the lookout for great ideas that can be used to improve the learning experience for students. The seeds of the [pumpkin drop] challenge were planted by my observations at West Virginia, and as I completed my studies and returned to the public schools, I took the idea of the Pumpkin Drop with me. The focus of this article will be an explanation, based on my experiences,

of what can be taught using a pumpkin drop activity and how such an event can be organized and run by a middle or high school program.

### **A SMASHING WAY TO ADVANCE TECHNOLOGICAL LITERACY**

After leaving WVU my next teaching experiences were at a high school in southeast Indiana. Not having access to an eleven-story building was simply a minor inconvenience. The top story window of the gymnasium or the use of a bucket truck from a local source such as a fire department were acceptable alternatives. With the basic idea in hand, the location identified, and an administration willing to try new ideas, my efforts to teach about technology, engineering, science, and mathematics using the pumpkin drop were off and running.

### **THE TECHNOLOGY, ENGINEERING, SCIENCE AND MATHEMATICS OF DROPPING A PUMPKIN**

Dropping a fragile thing from some height and trying to protect it from destruction is a common activity in many technology and science programs. The typical cargo is a raw



A typical entry in the 2002 Ball State University Pumpkin Drop sits at the judging area prior to being dropped.



egg, and the height of the drop is usually limited by the height of the tallest ladder available in the school. These efforts are a challenging and fun way of facilitating the learning process. However, dropping a much larger pumpkin from a more substantial height amplifies the technical challenges involved.

The use of a pumpkin drop activity can provide many opportunities to advance technological literacy by teaching a variety of concepts dealing with technical design and materials, mathematics, physics, and engineering. Examples of such concepts include:

- Calculating drop velocity
- Calculating appropriate canopy sizes for parachutes in relation to the weight of the pumpkin and its container
- Designing a container that will absorb or disperse impact forces
- Designing for the guidance and control of the pumpkin container as it drops
- Investigating the structural characteristics of a typical pumpkin
- Testing and evaluating the usability of various packing materials and structures for use in protecting the pumpkin from the impact of the drop

Many of these concepts can be investigated through traditional academic inquiry, such as performing calculations based on the principles of science. However, other concepts can only be

discovered through the personal research and experimentation of the students. For example, these experiments could include an investigation into the structural dynamics of pumpkins. Pumpkins, as a fragile cargo, provide a variety of challenges to the designer of the drop container. These challenges include the irregularity in the thickness of the flesh of the gourd, the freedom of movement of the seed mass in the center of the pumpkin, the undulations of the surface represented by the grooves of the various segments, and the inconsistencies of the structure of the gourd resulting from the stem and blossom areas at the top and bottom of the pumpkin. The unique characteristics of each pumpkin make it impossible to establish structural absolutes. However, students can do experiments, such as cutting open a number of pumpkins of the same size and shape to measure the thickness of the flesh at random locations or using a gauged press to apply pressure to a number of comparable pumpkins until they structurally fail. This collective data can provide statistical norms of the structural characteristics of other similar pumpkins.

A Pumpkin Drop Calculator, which can aid teachers who want to explore many of the engineering calculations involved with this challenge, is available at the following URL – <http://www.bsu.edu/cast/itech/ties.htm>. A screen capture of a sample calculation is shown below in **Figure 1**. The calculator enables the user to change the properties of the pumpkin and the height and environmental conditions of the drop site. Changes in any of the input data will automatically result in the calculator adjusting the output data to reflect the effects

Pumpkin Drop Velocity-Time Analysis			
Developed by Wes Baldwin Department of Industry and Technology Ball State University - Muncie, IN			
Program Description			Time (sec)
Basic Instructions			Acceleration (ft/sec <sup>2</sup> )
Data Section			Velocity (ft/sec)
Pumpkin Properties (Assumes Sphere)			Height (ft)
Pumpkin Calculated Properties			
This program calculates the acceleration, velocity, and position of a pumpkin falling from a specified height above the ground as a function of time. The effect of the drag force of the air is included.			0.000
1. Enter pumpkin diameter in cell C30.			0.018
2. Enter pumpkin weight in cell C31.			0.180
3. Enter drop height of pumpkin in cell C32.			0.053
4. Select Goal Seek under Tools on the menu bar.			0.071
5. Enter \$B\$110 after "Set cell".			0.089
6. Enter 0.0 after "To value".			0.107
7. Enter \$C\$47 after "By changing cell", OK, OK.			0.124
8. Results on the Right in Vertical Format.			0.142
Measured Diameter (ft) = 1.50			0.160
Measured Weight (lbs) = 15.00			0.178
Pumpkin Drop Height (ft) = 50.00			0.196
Volume (ft <sup>3</sup> ) = 1.7671			0.213
Cross Section Area (ft <sup>2</sup> ) = 1.7671			0.231
Mass (slugs) = 0.4663			0.249
			0.267
			0.285
			0.302
			0.320
			0.338
			0.356
			0.373
			0.391
			0.409
			0.427
			0.445
			0.462
			0.480
			0.498
			0.516
			0.534
			0.552
			0.570
			0.588
			0.606
			0.624
			0.642
			0.660
			0.678
			0.696
			0.714
			0.732
			0.750
			0.768
			0.786
			0.804
			0.822
			0.840
			0.858
			0.876
			0.894
			0.912
			0.930
			0.948
			0.966
			0.984
			1.002
			1.020
			1.038
			1.056
			1.074
			1.092
			1.110
			1.128
			1.146
			1.164
			1.182
			1.200
			1.218
			1.236
			1.254
			1.272
			1.290
			1.308
			1.326
			1.344
			1.362
			1.380
			1.398
			1.416
			1.434
			1.452
			1.470
			1.488
			1.506
			1.524
			1.542
			1.560
			1.578
			1.596
			1.614
			1.632
			1.650
			1.668
			1.686
			1.704
			1.722
			1.740
			1.758
			1.776
			1.794
			1.812
			1.830
			1.848
			1.866
			1.884
			1.902
			1.920
			1.938
			1.956
			1.974
			1.992
			2.010
			2.028
			2.046
			2.064
			2.082
			2.100
			2.118
			2.136
			2.154
			2.172
			2.190
			2.208
			2.226
			2.244
			2.262
			2.280
			2.298
			2.316
			2.334
			2.352
			2.370
			2.388
			2.406
			2.424
			2.442
			2.460
			2.478
			2.496
			2.514
			2.532
			2.550
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			2.586
			2.604
			2.622
			2.640
			2.658
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			2.694
			2.712
			2.730
			2.748
			2.766
			2.784
			2.802
			2.820
			2.838
			2.856
			2.874
			2.892
			2.910
			2.928
			2.946
			2.964
			2.982
			3.000



on an idealized pumpkin. Of course, all of these calculations are based on an unprotected pumpkin. The technical challenge to the student designers is to interpret the output data and research means of protecting the pumpkin from the calculated impact forces. A more detailed description of each of the variables from the Pumpkin Drop Calculator can be found on the web site <http://www.bsu.edu/cast/itech/ties.htm> and is explained in the side bar to this article.

## ORGANIZING AND OPERATING A PUMPKIN DROP EVENT

As with any educational activity, it is necessary to lay a strong foundation of preparation and organization for the event to be successful. The novelty of a pumpkin drop activity not only encourages educational benefits to the students but also provides an opportunity for media coverage of both the event and the sponsoring program.

Another entry is loaded into the bucket. The rope across the center of the picture was used to measure the drop height consistently between entries.



In preparing for an event of this type the coordinating teacher should keep these dual benefits in mind. If run successfully, a pumpkin drop event can grow in size with each passing year and can serve as a spotlight activity for the school.

In an effort to make the technical challenge as broad as possible, I have scored entries based on three criteria. The criteria are: (1) Has the pumpkin survived the fall?; (2) How close did the design land to a bulls-eye target placed directly below the drop platform?; and (3) What was the quality of the engineering efforts of the design and its aesthetic characteristics?

Rules and guidelines keep the designs within a common specification framework, help to maintain the safety of the participants, and keep the cleanup after the event to a reasonable degree. Examples of rules that I have used which could be common to all pumpkin drops include:

1. The pumpkin must be at least a minimum size. I have used 10 inches in diameter as a standard. Ties in the scoring can be decided by the entry with the largest diameter.
2. The pumpkin and the protective structure combined may not weigh more than 60 pounds.
3. The pumpkin container can have dimensions no greater than 30 x 30 x 30 inches.
4. The pumpkin may not be altered in any way (*no freezing or adding chemicals*).
5. No packing peanuts or other small, non-biodegradable fillers are allowed.
6. The protective structure should be designed so that judges can open it and remove the pumpkin within 30 seconds.
7. The protective structure cannot hold or use any glass, ceramic, explosives, or other potentially dangerous substance.

Other rules and guidelines can be added that will help with the operation of the event, such as registration information and drop sequence. To help assure that the designs meet all of the rules and safety guidelines, the entries should be accepted for judging at least one day before the event. This also provides an opportunity for the event judges to carefully review and evaluate the engineering design and aesthetic quality of the entries prior to the actual drop.



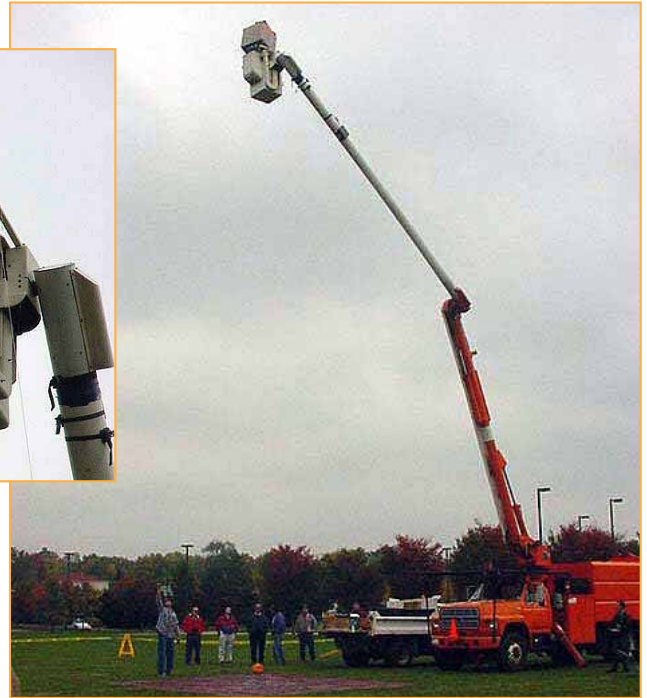
My personal experience at organizing and running pumpkin drops in both high school and university settings has enabled me to develop the following list of issues to consider:

- Always have the permission and support of administrative and supervisory groups. This involvement and support of the event should extend to both the administrators in a school organization and to local police and fire personnel.
- Find one or more community sponsors for the event. These community sponsors can provide prize money and other resources toward the operation and success

A bucket truck and a grounds crew provided the drop platform for the Ball State event.



An entry is ready to be dropped 50 feet from the bucket to the target on the ground below.



## THE PUMPKIN DROP CALCULATOR

By Wesley Baldwin

**I**N ITS SIMPLEST FORM, the Pumpkin Drop Calculator (PDC) determines the position, velocity, and acceleration of a falling pumpkin with respect to time. The PDC uses basic physics equations to calculate the motion parameters of the pumpkin during its fall. The PDC expands on the basic motion equations studied in elementary physics by including the drag forces, which occur due to its motion through the air. The PDC is a Microsoft EXCEL program and runs on both the PC and Mac computer. PDC is easy to use and the only user inputs required are the diameter and weight of the pumpkin and the height from which it is to be dropped.

More advanced users will find that the PDC is a general-purpose program for determining the motion parameters of an object falling in a fluid. The advanced users will be able to determine terminal velocity, study the effects of fluid temperature on an object's motion and predict the motion of a falling object on another planet.

The PDC could also be expanded to study two-dimensional motion through a fluid (the flight path of a bullet or submarine for example). The following fluid properties can be directly manipulated using the PDC:

1. Density
2. Dynamic Viscosity
3. Coefficient of Drag

The PDC is an example of applying mathematics and science to the study of technology

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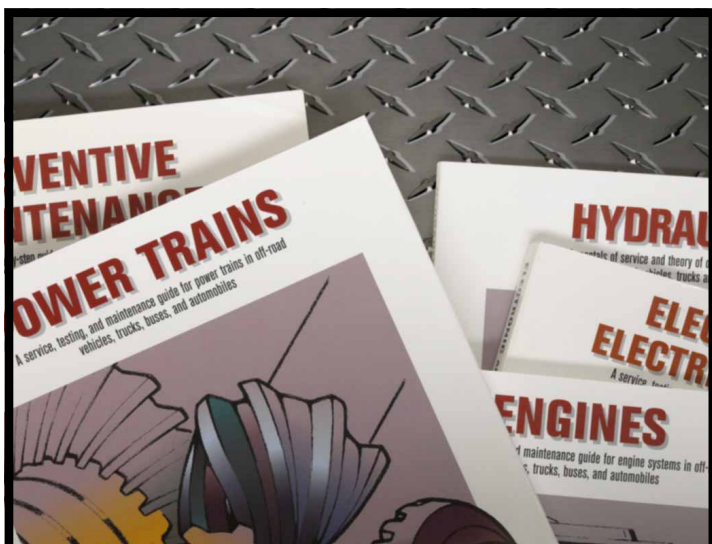
of the event. As an example, the local fire company may be willing to use their bucket truck to provide a platform from which the designs can be dropped onto a target. I have also called upon local farmers, who grow commercial pumpkins, for support of the event through prize money for contest winners. Toward the educational growth of participating students, I have also had local professional engineers visit the school and work with student design teams to explore their design options. This type of personal involvement with the education of students has immeasurable benefits for the students, the sponsoring program, and the relationship between the greater community and the school.

- **Open the event to the entire school.** A competition between the various classes, subject areas, and groups of people who teach, learn or work in the school can help to encourage the spirit of school community. One of the most enthusiastic groups to enter the last pumpkin drop I helped to coordinate came from the facilities and ground crew. A successful school-wide experience can only reflect positively on the sponsoring group or program.
- **Schedule the pumpkin drop close to Halloween.** The day naturally lends itself to using the pumpkin as the fragile cargo. Furthermore, the harvest season for the pumpkin typically occurs around this time of year, and thus they are more readily available.
- **Schedule the event well in advance.** Many schools schedule events, such as sports competitions, meetings, and other proceedings, months or even years in advance. The further ahead you can schedule the event, the more advance preparation design teams can make and the less stress the organizers will experience in preparing for the drop.
- **Do not try to invent the rules and guidelines from scratch.** Others have done similar events, and they have encountered issues that cannot be anticipated by those who are just starting out to organize a pumpkin drop. Many of these rules have been posted on the Internet or are available from event organizers if you contact them and ask for a copy. The event organizers at WVU have been very helpful to me over the years in sharing their evolving rules and guidelines.

- **Make certain that the rules are readily available to everyone.** From the first public posting of the event, the rules should be clearly stated and available to anyone. However, with any event that encourages creativity, there will be those who will stretch the limits of those rules and those who will take their designs in directions that were never anticipated. Above all keep the safety of everyone as the primary concern. If a design is judged to threaten the health and safety of anyone for any reason, do not allow the entry to be dropped. Use the experiences from each year to help modify the rules for the next pumpkin drop.
- **Have fun!** Encourage the energy for learning that a pumpkin drop will spark. I have learned that enthusiasm for learning about technology, engineering, science, and mathematics is initiated, embraced, and becomes contagious as a result of participation in a pumpkin drop. This applies to both design teams and observers, regardless of whether they are students, faculty, or staff. Observers frequently become participants the following year.

## SUMMARY

A pumpkin drop activity can offer a unique opportunity to teach concepts that contribute toward technological literacy. Students can learn to work cooperatively on design teams as they apply concepts of technology, engineering, science and mathematics to overcome the problem of maintaining the structural integrity of a pumpkin that is dropped from a substantial height. Placed in the context of a school-wide competition, a pumpkin drop can be a catalyst for the development and support of a sense of school community. A pumpkin drop can also serve as a means of creating links to the greater community through publicity in the local media, sponsorship of the competition, and mentoring of the engineering process by practicing professionals. Finally, a pumpkin drop provides an opportunity for students to learn complex concepts through an activity that is simply fun to do and one that participants will undoubtedly remember for the rest of their lives. What better way to plant the seeds of technological literacy while encouraging a lifetime of learning?



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## REFERENCE LIST

A search of the Internet reveals a large number of web pages that may be helpful in preparing for a pumpkin drop. A sampling of those sites include:

- ASME student section event is a big smash. (1998). Retrieved on October 1, 2002 from <http://www.asme.org/mechanicaladvantage/Spring98/pumpkin.htm>
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