2009 SECME Suvival Guide

This survival guide is to help you run a SECME team. It is not a replacement for the rules manual, but it will help you handle all the different design events.

“Rules to Watch” will cover rules that are important to your final score or are often misunderstood. “Tips” will give you some ideas that may or may not be helpful depending on the design that the students use. “Materials” will list the pieces that are commonly used for the projects. The list does not limit you in any way, but hopefully it will give you some ideas. “Activities and Concepts” may be useful to teachers who are looking for ideas for ways to present scientific ideas to their students.

Table of Contents

Mousetrap Cars

Elementary/Middle/High School

Description

Students design and build cars totally powered by a standard mousetrap. The objective is to build a small, light car that can go as far as possible. Along with the car itself, students make technical drawings of their design and complete a technical report. An interview held by UF SECME volunteers also contributes to the final score.

Rules to Watch

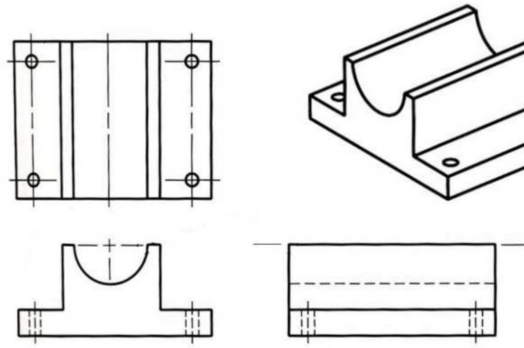
You don't need to worry about the "normalization" of scores - in the equations in your rules manual the normalized score is F. The only things in your control are weight of the car, dimension L, and distance traveled.

The weight restriction means you want to keep as much junk off your car as possible. So, if a piece of your car is not serving a purpose, you should probably get rid of it. Notice that the rules allow you to remove the locking lever and bait holder (you wouldn't want to use them to operate your car during the event anyway).

The dimension L is a little tricky. The judges will measure the length, width, and height of your car and the biggest number they get will be L. However, you should note that they will move the bail and they will be taking measurements to account for every position the bail can be in. That means that if having your bail straight up makes height your biggest dimension, then L is that height. Remember that a bigger L hurts your score because it is in the denominator, so try to pack things in to a small space if you can.

You are allowed to bend the bail into any shape you want. This will change the torque supplied to your wheels and possibly the L dimension.

Students often have problems following instructions with the technical drawings. The drawing must be on engineering paper as described in the rules. The drawings have to show 3 *different* views of the car: front, side, and top. If you show an "isometric" view of the object (from an angle), it would also improve your presentation. Here is an example of an object in isometric, front, side, and top views. Note that drawings for the competition have to be done by hand.



We ask that drawings be to scale and that somewhere on the drawing you say what the scale is. For example, if the car is 8 inches long and 6 inches high, and the drawing on the paper is 4 inches long, then the scale is 2:1. This also means that the drawing on the paper must be 3 inches high. The scale should be the same for each of the drawings. Try to make the drawing line up like the ones above do.

The technical report must include all of the parts listed in rules. The beginning must be an abstract (a general summary of the report) followed by a table of contents. Students must describe why their chose their design, how they put it together, and how it works. If the design, construction procedure, and operation sections show understanding and are detailed, the score will be much better. Discussion of any testing the students did would be especially useful.

Every student must be prepared for the interview. If it is obvious that one or two of the team members did not fully participate, scores will go down.

Tips

1. Keep your wheels straight and firmly attached to the axle. The axles have to be perfectly perpendicular to the direction the car is going or the car will turn.
2. Reduce the friction between the axle and the frame of the car as much as you can. Increase the friction between the wheels and the ground as much as possible.
3. Take your time when building the car. If the car breaks during the competition, there will not be much of a chance to fix it.
4. Test the cars and try multiple different setups.
5. If a car is turning to one side, a minor adjustment that makes it go straight can increase the score a lot.
6. If the wheels spin without pushing the car forward, you have few options. The first thing to do is make sure that there is that the wheels are gripping the ground well - balloons around the wheels usually work pretty well. You can also increase the weight on the wheels that do the pushing (but try not to increase the overall weight of the car). The last thing is to decrease the torque being applied to the wheels by the spring. This can be accomplished by manipulating the shape of the bail or the size of the axle itself.
7. Some cars stop or even go backwards when the spring has stopped moving. Change the way your axle or gears are connected to the spring so that the car can roll freely when the spring stops powering it.

8. The easiest thing to forget when you are designing your car is that all of the pieces have to fit together. Make sure your wheels are connected well to your axles and that your axles fit into the frame of your car when you are buying the components.

Materials

1. Mousetraps – Home Depot, Walmart
2. CDs for wheels – old ones from home, blank ones from Walmart, Circuit City, or Office Depot
3. Balloons to increase friction between ground and wheels – Walmart, party store
4. Straws to decrease friction between axle and frame – Publix, Walmart, free at any restaurant
5. String to connect mousetrap to axle - Walmart
6. Metal or wooden cylinders for axles – hobby shop, Michael's, Home Depot
7. Super glue (not Elmer's!) – Publix, Walmart
8. Pliers to bend the bail – toolbox at home, Home Depot, Walmart
9. Hack saw (but don't cut the wood base!) – toolbox at home, Home Depot
10. Wood for a "frame" - Home Depot, Michael's
11. Gears and ball bearings – you'll have to do internet research to find what you are looking for

Activities and Concepts

1. Have each student go up to a door. Where is it easier to push the door open: at the end close to the hinge or far from the edge? Hold a pencil in your hand. Where is it easier to make the pencil rotate: Close to your fingers or near the top? This is a great opportunity to explain torque. The bigger your wheels are, the more torque the ground will exert on them, so the weaker the car will be (but also the more spins of the wheels you will get). The longer you make your bail, the bigger the torque you exert on it with your finger with the same force, so the force supplied by the bail is smaller. Gear ratios are also applicable.
2. If you have a spring or a rubber band, have the kids pull on it. Is it easier to get it to move the first inch or the fifth inch? Make rubber band launchers (putting the rubber band on your left thumb and pulling back with your right index finger will do). Point the launcher straight up. How high does it go if you pull it back as far as you can? How high if you only pull half as far? Discuss kinetic and potential energy.
3. Have them drag their hands across a desk. Note how you have to push your hand along to get it to go. Now put a piece of paper down on the desk and have them try again. Why is it easier to move their hand now?
4. Finding the dimension L of the cars is a great opportunity to go over basic ideas about measurement. Have them take measurements in metric and English units and see if they can find the conversion factors. Show that on a straight line the distance from point A to point C is the same as the distance from A to B plus the distance from B to C. The distance from one corner of the mousetrap to the far

corner is the square root of the sum of the squares of the width and length of the mousetrap.

Water Bottle Rockets
Middle/High School

Description

Students build rockets out of 2-liter soda bottles. Pressurized air is used to launch them. Whichever team has the longest hang time wins.

Rules to Watch

The rules for this one are pretty straightforward. Don't exceed the limitations and get a big hang time! The diagrams below from Nationals show the limitations on the dimensions of the rocket.

DIAGRAM 1 – Rocket Identification

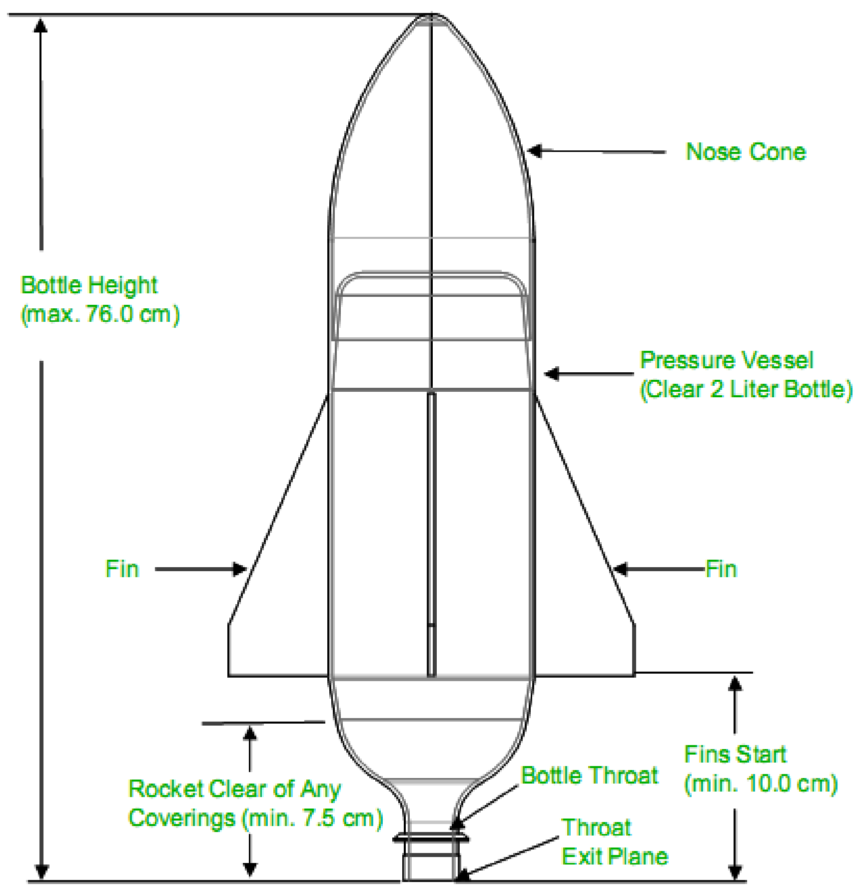


DIAGRAM 2 – Nose Cone Diagram

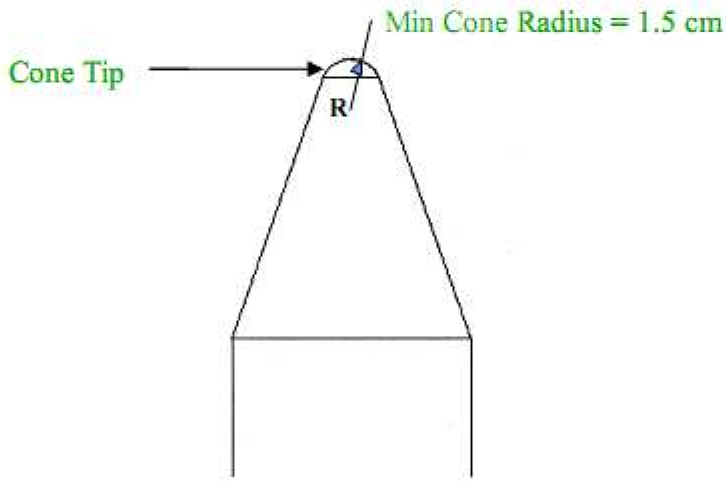
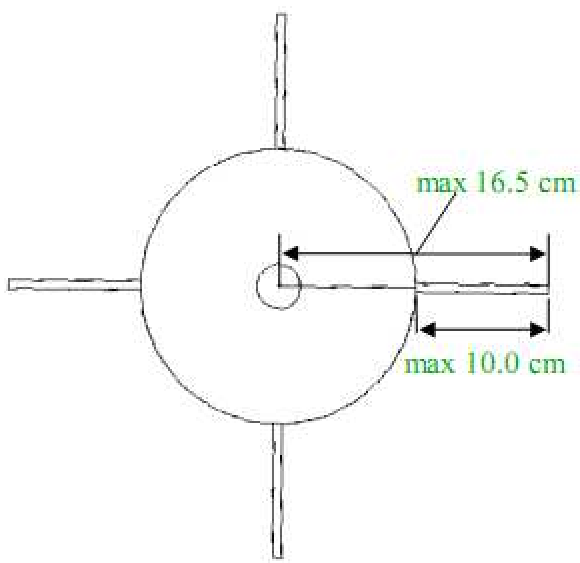


DIAGRAM 3 – Fin Diagram



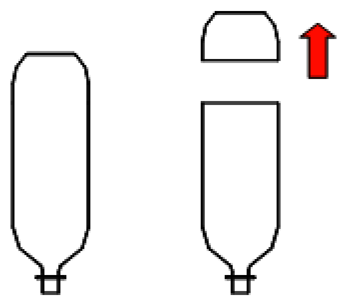
Materials

1. Pressure vessel (clear 2-liter bottle free of scratches, nicks, dents, and discoloration)
2. Adhesive. CAUTION: Hot glue guns weaken walls of the pressure vessel
3. Foam mounting tape (approximately 1/16 thick, 2-sided adhesive)

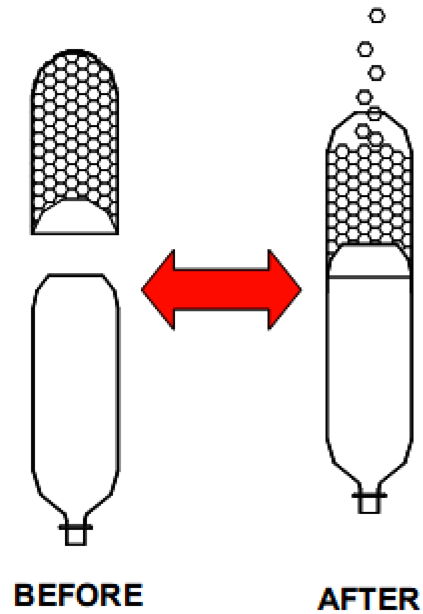
4. Carpet tape (thin 2-sided adhesive)
5. Clear packing tape is highly recommended
6. Cutting utensils (scissors, hacksaw blade, utility knife, etc.)
7. Markers, spray paint, stickers, etc for decoration of the rocket (No water color paint).
8. For fin construction: balsa and bass wood, plastic, foam board, 1/4" to 1/2" thick Styrofoam & Etha Foam, Plastic Plates, and/or PE (2L) Bottle Material

Tips

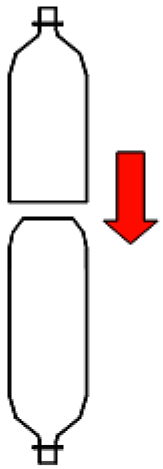
Below are the suggestions that Nationals has made for rocket construction:



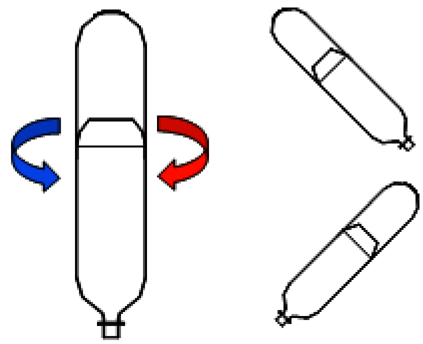
Step 1: Cut the bottom off of a 2L Bottle (discard bottom).



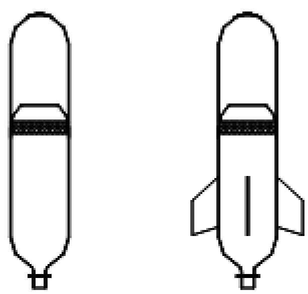
Step 2: Add ballast (weight) to shift your rocket's center of mass forward.



Step 3: Carefully align top portion of bottle on the 2L bottle to be used for the pressure vessel.

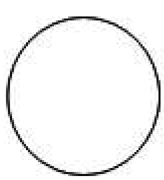


Step 4: Rotate and observe your water rocket from several angles to ensure good alignment.

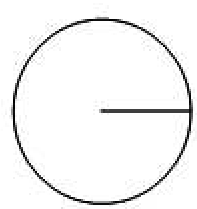


Step 5: Tape/secure the joint between the nose cone stage and the pressure vessel.

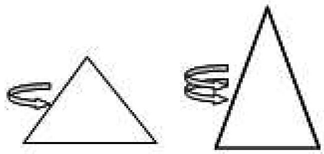
Nose cone construction:



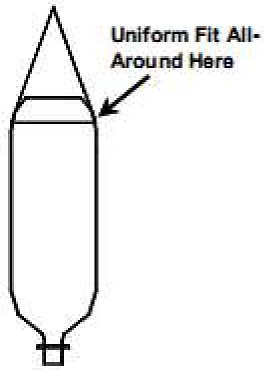
Step 1: Cut a Circle out of thick stock paper or thin poster material (Using 16" or larger diameter).



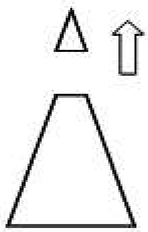
Step 2: Cut a line along the radius as shown.



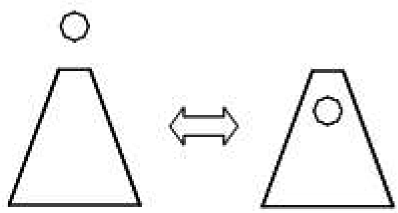
Step 3: Rotate the paper into a cone. Next Tape or Glue the seam to maintain the cone's shape. You can adjust the angle of the cone with more rotation.



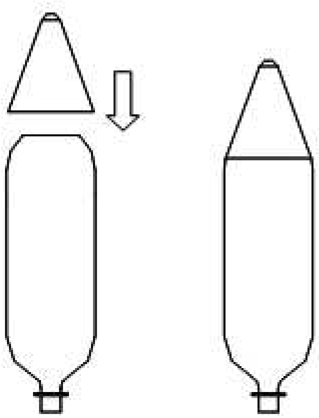
Step 4: If needed trim the base of cone as required so that it has a uniform fit with the diameter of a 2L bottle.



Step 5: Uniformly trim top of paper nose cone to accept a craft foam or Styrofoam ball or cone.



Step 6: Add the foam ball or cone to create a 0.5" or larger nose cone radius.

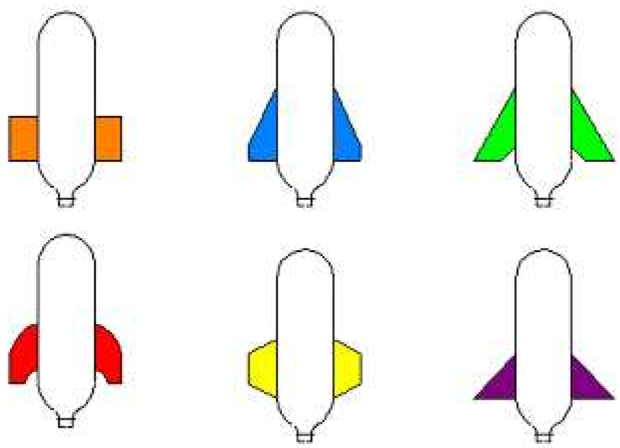


Step 7: Secure the resulting nose cone to the pressure vessel using an adhesive like tape, glue, velcro etc...

Fin construction:

1. Determine a fin pattern from your analytic design or trial and error.

2. Use the recommended materials, however we encourage you to be creative. Keep in mind not to use the off-limit materials.
3. Cut fins out of the material you choose.
4. You can use as many fins as you feel are needed.
5. Attach the fins to the lower section of the rocket using glue, Velcro, tape, or other adhesives.
6. Tip: It is easier to attach fins to a bottle that is slightly pressurized. You can pressurize the bottle by placing the bottle with its top off in a freezer for 2-3 hours. Next, take it out of the freezer and put the top on very tight, eventually, the air inside warms and the bottle will become slightly pressurized.
7. Tip: Using a low melt glue gun is an excellent way to quickly bond fins. First clearly mark desired locations on the bottle prior to bonding. Try applying glue to a fin; then apply the fin to one of the marked locations on your bottle. This technique will aid in preventing your pressure vessel (ie. bottle) from deforming due to the initially very warm temperature of the glue.
8. Fin design examples:



Activities and Concepts

1. Bring a few cups, some soda, and a bunch of straws to the session. Make a chain of a bunch of straws so that you have one long tube. You can do this by pinching the end of one straw while you shove it into other straw. Then tape the connections so that you don't get any leaks. Have the kids sip on a normal single straw, then have them try to sip through the extra-long straws. Is there any difference in how hard they have to suck to get the soda up the straw? What pushes the soda up the straw anyway? This is a good opportunity to talk about what pressure is.

2. Show a video like “conceptual physics Bed of Nails demo” at http://www.youtube.com/watch?v=hG7lGZqWFpM. Why does it hurt more to step on one nail than it does to step on a bunch of nails? Why does increasing the surface area decrease how much it hurts?
3. Why does the rocket have to shoot the air out to move forward? How does a rocket work in space (after all, there is nothing to push off of)? Discuss the conservation of momentum.
4. Take a glass of water that is 90% full and put something rigid and light that can cover the mouth of the glass on top of the cup (like a playing card). Flip the cup and let go of the card. Why doesn’t the card fall down?

Egg Drop

Elementary School

Description

Students design a container that can protect an egg from a drop off of the UF football stadium.

Rules to Watch

This event requires you to be extremely careful about rules! The maximum dimension is going to be strictly enforced. If your team does not satisfy the requirements, they will not receive an award, even if their team is the only one with an egg that survived.

That maximum weight is with the egg inside! If you bring a container that is 490g, you will definitely be disqualified, because your weight with the egg will be more than 500g. When you are putting your container together, weigh it with an egg inside.

A a bigger weight and a bigger maximum dimension decrease the score you receive. That means that you should take your containers *as small as possible* while still protecting the egg. If multiple eggs survive, the winning team will be the one that met the requirements and was the lightest and smallest.

Materials

There is a lot of creativity in this event, so there can't be a general set of instructions to making the device. You not only have to come up with where to put everything – half of the challenge is figuring out which materials are the best. These are just ideas to start the brainstorming process.

1. Tape (just one or two pieces at the place where the egg is inserted)
2. Squishy material: "memory foam" in some beds, marshmallows, tissues, crumpled paper
3. A container: a Pringles container, a paper cup, the cardboard in a paper towel roll
4. Springs, rubber bands

Tips

1. Do not overuse tape! Teams that rely on a lot of tape are not able to get their egg inside the container within the 30 second time limit. We will not provide tape on the day of the event – whatever tape you use must already be on the container when you submit it to us.
2. Keep your device from flipping over during the fall if that would make your egg fall out. Make sure that the device is bottom-heavy.

3. It is not just the amount of squishy stuff you use that matters, it is how you use it! For example, only the material under the egg at impact prevents the egg from breaking.
4. You want to use materials that will “squish” a lot, which is not necessarily the same kind of material you would use to protect a package for shipping. Bubble wrap is stiff until it pops, so the forces on the egg are not decreased much.
5. You should test the devices before you come to the Olympiad. If you have access to a 2^{nd} story window or higher that you know no one will walk under, that will be great to approximate the first drop at the stadium.

Activities and Concepts

1. Prep the area to get messy. Put a bottle cap down with the open part facing up. Put an egg down on it and stand the egg up. Put a second bottle cap on top of the egg with the open part facing down. Do this with one more egg (three more if you want to get fancy). Now put down a brick or a book or some other heavy object on the eggs. You should be able to support quite an impressive weight. (We highly recommend the Bill Nye the Science Guy episode on pressure if you want to teach the kids about pressure. It can be found by searching for “Bill Nye the Science Guy - 42 - Pressure 1/3” at **www.youtube.com**.)
2. Modern cars are designed with “crumple zones.” Why do the engineers *purposely* make the cars crumple during a big crash? Why is it better to have the forces applied over a big time instead of a small time? To find a crumple zone video to show the class, search for “Crash Test of 2003- 2007 Mercedes E-Class E 500 IIHS” at www.youtube.com.

ISTF

Middle/High School

Description

The first step in the process is for the team to choose a "National Critical Technology" from the list provided by ISTF and then decide on an application of that technology that will solve a large-scale problem the world is facing. The students will research their issue and technology and make a presentation about their findings. ISTF recommends that the students seek out a mentor knowledgable about their technology during the research process The presentation will be in the form of a website.

The ISTF website at istf.ucf.edu will be your primary source of information in terms of dates, requirements, and how-to's. Any technical questions should be directed to director@istf.ucf.edu. This is a new event for everyone, so please start early so that problems can be tackled well in advance of deadlines. If you have any concerns, contact ufsecme@gmail.com.

Rules to Watch

You should set up an account with ISTF at http://istf.ucf.edu/EnrollAdmin/. You will find a teacher training guide and introductory material at the links at the bottom of the page.

A team progress report will be due on January 16, 2009. Students will log in to the ISTF website themselves to do this. The final project should be submitted by February 27, 2009 (not on the day of the Olympiad!). Final projects are websites hosted by the team's school – the submission is the address of the web page. Both are submitted to ISTF's "My ISTF" at http://istf.ucf.edu/EnrollAdmin/ and UF SECME.

The National Critical Technology must be chosen from the list provided at istf.ucf.edu/Tools/NCTs/.

The content and presentation guidelines can be found at istf.ucf.edu/Tools/Guidelines/ (click on the grade level in the upper right hand corner). They are very rigid about the way the website is set up, so make sure that you pay attention to the formating that they require.

Tips

1. To see previous winners visit istf.ucf.edu/Winners/Hall_of_Fame/. They will be a good formatting template and they will also show the level of research and the quality of presentation necessary to be competitive.
2. There are certain to be technical issues with making the websites, so be sure to get an early start so that your questions can be answered with time to make the necessary adjustments.

Activities

1. Have the students go to the science section of a major newspaper. What are the big issues that scientists and engineers are trying to confront? What technologies are being used to solve the problems? What are the major drawbacks of the technologies, or what are the alternatives?
2. Have them analyze a previous ISTF winner. How many different kinds of sources did the winners use (encyclopedias, websites, newspapers, professional organizations)? How did they increase the effectiveness of their proposal with the presentation of the website? How did they demonstrate both an understanding of the problem and of the technology?