2004 Transportation Education Academy Activity:

The Need for Speed
Land Transportation

Educational Level: Middle School (8th Grade)/High School

Time to Complete: 5 – 10 hours (class periods)

Standards Being Met: During the completion of this activity, the student will meet the following Standards for Technological Literacy:

1. Number 8, The Attributes of Design.
2. Number 9, Engineering Design.
3. Number 10, The Role of Troubleshooting, Research and Development.
4. Number 11, Apply Design Processes.
5. Number 12, Use and Maintain Technological Products and Systems.
6. Number 13, Assess the Impact of Products and Systems.
7. Number 16, Energy and Power Technologies.
8. Number 18, Transportation Technologies.

Activity Description:

Students will design and build a CO2 dragster following specifications. Students will race the car on a track and determine the speed of the car by measuring time and distance traveled. Students will then determine several factors that influence the speed of the car and perform modifications to improve performance.

Objectives:

At the completion of this activity, students will be able to:

1. Read and follow directions.
2. Sketch design ideas.
3. Draw a design pattern for a CO2 car.
4. Build a CO2 car according to specifications.
5. Safely use hand tools and power tools to build a CO2 car.
6. Accurately use measuring tools to determine weight and distance.
7. Calculate the speed of a CO2 dragster.
8. Determine design factors that affect the speed of a CO2 car.
9. Use test results to modify CO2 dragster design for improvement of speed.
10. Identify control and guidance systems.
11. Describe the propulsion system of a dragster.
12. Using knowledge gained from this activity, identify how CO2 dragster test information can be applied to improve the speed and efficiency of automobiles and other land vehicles.

Group Size: This activity is best accomplished in groups of one to two students.

Background Information:

People and goods constantly need to be moved in our modern society. This is accomplished in many different ways. There is a need for speed in the movement of people and goods. It takes energy to accomplish this. There is a cost to this energy, so goods and people must be moved efficiently. Transportation vehicles must be carefully designed for smooth and efficient operation.

Drag racing has been a popular activity for auto enthusiasts for many years. People seem to have a constant need to see how fast they can travel in a vehicle. Many people look at drag racing as a waste of fuel and money. However, the technologies used in drag racing can help improve the speed and efficiency of vehicles used in land transportation.

CO2 dragsters are made of lightweight material usually balsawood or basswood. They are propelled down a track by compressed carbon dioxide gas. The CO2 cartridge is punctured so the compressed gas can rapidly leave the canister causing the dragster to move. The dragster is guided down the track by a fish line or wire. Track length is usually 50 to 75 feet. Many tracks have an electronic starting and timing system.

CO2 dragsters must be built to certain specifications to avoid interference with the propulsion system, wheel placement, launch system, guidance system as well as the prevention of failure or destruction during operation.

Several math skills will be used during this activity. They include measurement, multiplication, and division, use of formulas, graphing and estimation. This activity will provide students with an opportunity to apply the skills they learn in math to a “real world” situation.

Supplies, Tools, Materials Needed:

1. CO2 dragster kit (basswood blank, axles, wheels, washers, screw eyes, straws)
2. CO2 dragster directions
3. Graph Paper
4. CO2 racetrack (starting and timing system)
5. Calculator
6. Ruler & tape measure
7. Pencils
8. Scale
9. Spray paint
10. Sandpaper
11. Band saw
12. Files
13. Sanders (drum and belt)

14. Paper towels
15. Drill press
16. CO_2 cartridges
17. Wind tunnel

Safety Precautions:

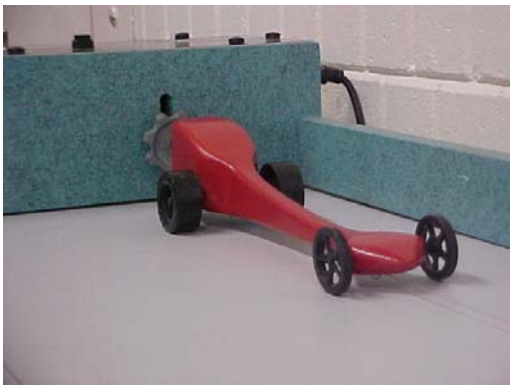
1. Wear safety glasses when using power or hand tools.
2. Wear safety glasses when sanding and spray painting.
3. Use spray paint only in paint booth with the exhaust fan running.
4. Wear safety glasses when operating starting system.
5. All spectators must stand two feet away from the track during races.
6. Practice appropriate safety procedures when using hand tools and power tools.
7. Get help from instructor when needed on power tools.
8. Keep hands and fingers two inches or more away from the cutting surface of power tools.
9. Properly dispose of all used CO_2 cartridges.
10. Properly secure CO_2 cartridge in dragster prior to racing.
11. Check the guiding mechanism (fish line) to make sure it is secure before launching dragster.
12. Make sure guiding mechanism (fish line) runs through both screw eyes on dragster and cannot slip.

Procedure:

1. Read all of the instructions for designing and building a CO_2 dragster.
2. Sketch ideas for dragster design.
3. Draw full size pattern for top and side profiles on graph paper.
4. Have your design approved by the instructor.
5. Cut patterns out of graph paper and trace on side and top of CO_2 dragster wood blank.
6. Measure and drill holes for axles.
7. Using a band saw, cut out the side profile.
8. Gather all waste pieces and tape them together in their original form. Use three strips of masking tape to completely wrap all pieces.
9. Cut out the top profile.
10. Carefully sand dragster body to desired shape. Use drum sander, belt sander, files and 60-grit sandpaper.
11. Weigh dragster body.
12. Have dragster shape approved by instructor.
13. Sand dragster body smooth with 150-grit and 220-grit sandpaper.
14. Wipe sanding dust off of dry dragster body . Use a dry paper towel.
15. Apply spray paint to dragster body. Apply four light coats. Allow paint to dry at least 15 minutes between coats. Be careful so paint doesn't form runs or drips.
16. Attach wheels and screw eyes after paint is completely dry (24 hours).
17. Ask the instructor for a CO_2 cartridge.
18. Place the CO_2 cartridge in the dragster and mount on the track.
19. Run CO_2 dragster on the track.
20. Record the time of the dragster.
21. Calculate the speed of the dragster.
22. Complete test worksheet.
23. Analyze test results.
24. Decide on what modifications will be done to make the dragster improve speed.
25. Modify CO_2 dragster.
26. Run the CO_2 dragster a second time on the track. Record time.
27. Complete the test worksheet for the second run. Compare results.
28. Complete CO_2 dragster activity quiz.
29. Clean work area and properly store tools and supplies.

Evaluation and Assessment:

See attached worksheet and quiz.



CO2 DRAGSTER WORKSHEET

CHECKOFFS: ____ design approval

____ dragster meets all specifications

____ dragster meets all specifications after modification

DATA: _____ dragster weight

_____ dragster weight after modification

_____ length of track

_____ time of first run

_____ speed of first run (miles per hour)

_____ time of second run

_____ speed of second run (miles per hour)

SPECIFICATIONS:

Body: Basswood

Length	12”
Width	½” minimum, 1/8” minimum material thickness around CO2 cartridge.
Height:	minimum height not less than 1/8” above CO2 cartridge hole.
Weight:	3 ounces minimum

Wheels: Standard Kit Wheels. 3/16” axle hole

Rear axle hole location: 3/8” up from bottom of basswood blank
2 ¾” in from the rear of basswood blank

Front axle hole location: 3/8” up from bottom of basswood blank
1 ¼” in from the front of basswood blank

Others: CO2 cartridge must be completely surrounded by material.
Screw eyes are located in the center of the bottom of the car ¼” in front of the wheel axles.

1 mile = 5280 feet.

THE NEED FOR SPEED

CO2 DRAGSTER ACTIVITY EVALUATION

Carefully read each question and choose the correct answer.

1. _____ is the propellant used for the dragster.

    a. H2O
    b. Gravity
    c. CO2
    d. Nitrous oxide
    e. Gasoline

2. The fish line is used as a _____ system for the dragsters.

    a. support
    b. guidance
    c. control
    d. structure
    e. propulsion

3. The dragsters use a _____ type of engine.

    a. reaction
    b. external combustion
    c. rocket
    d. internal combustion
    e. none of the above

4. Basswood is used as the _____ system for the dragsters.

    a. structure
    b. support
    c. control
    d. suspension
    e. guidance

5. _____ is a factor related to the speed of a vehicle.

    a. weight
    b. aerodynamics
    c. friction
    d. type of propulsion
    e. all of the above

6. Explain how weight affects the speed of a vehicle.

7. Describe the term aerodynamics and how it affects the speed of a vehicle.

8. Describe the modifications you made to your dragster to increase its speed.

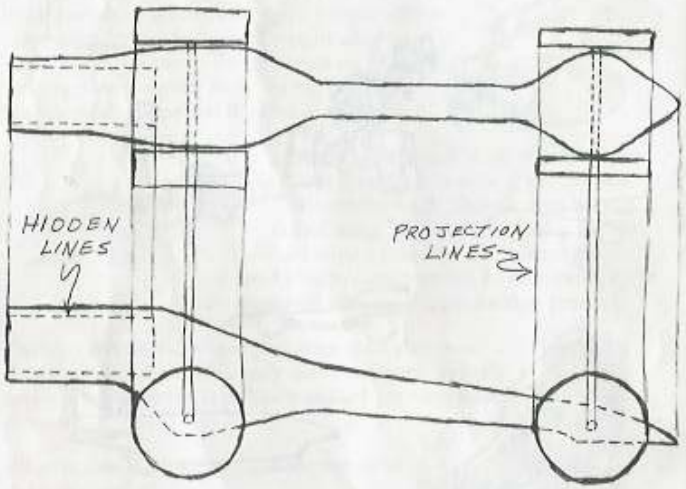
9. Describe three things you learned from this activity that could be applied to technologies for improving speed and efficiency of land transportation vehicles.

10. What were the two most important things you learned in this activity?

Design Sketch

On a clean sheet of paper, sketch your favorite idea from the concept sketches to a larger scale with more detail. Draw the top and side view.

Make light projection lines from one view to the other to help you locate axle holes and other features of your design. Show the location of hidden details (like the cartridge hole) by using hidden (dashed) lines.



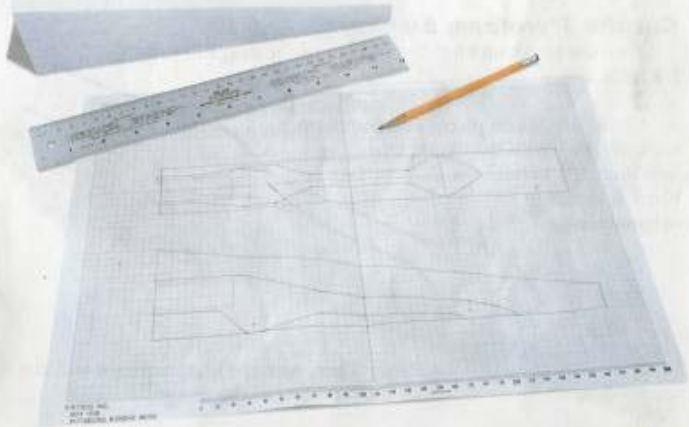
Working Drawing

Measure your dragster blank and draw (to full scale) its top and profile (side) outline on the grid paper. Then measure the depth and location of the power plant hole and draw its outline on both views. Next, draw the top and side view contours of your design within the outlines of the blank.

As you make your drawing, refer to the specifications sheet. You don't want your dragster to be longer or shorter than allowed. There are many other specs to follow as well, so you should check your design repeatedly against the spec sheet as you do your drawing. When you are sure your design is within specs, move on to the prototype process.

Make 2 or 3 copies of your drawing. This will allow you to make templates for your prototype, your production dragster and have an extra drawing to turn in to the teacher if necessary.

Hint: *If you decide to change your dragster design during prototyping, you'll need to repeat the working drawing.*



CO2 RACE CAR DIRECTIONS;
Pitsco Inc.

Production

The Right Tool

You'll need these tools to design and build your dragster:

- 18" – 24" length of ¾" dowel rod
- 3/16" drill bit
- Scale
- Sandpaper: coarse (80 grit), medium (120 grit), and fine (220 grit)
- Wood rasp
- Scratch awl
- Ruler
- Spray paint
- Hobby knife
- Drill
- Scissors
- Coping saw
- Half round wood file
- Pencil and ballpoint pen

Optional Tools

If you have access to them, these tools make the dragster building process easier and more precise.

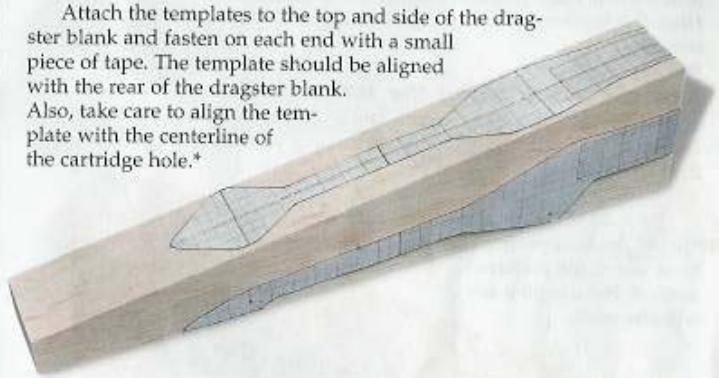
- Band saw
- Drill press– *great for drilling perfect axle holes*
- Belt/disc sander– *for rough shaping*
- Dremel® or other hobby tool with accessories– *for intricate shaping and polishing*
- Carving tool set

What's the ideal track length? 66 feet, which is 1/20 of a quarter mile.

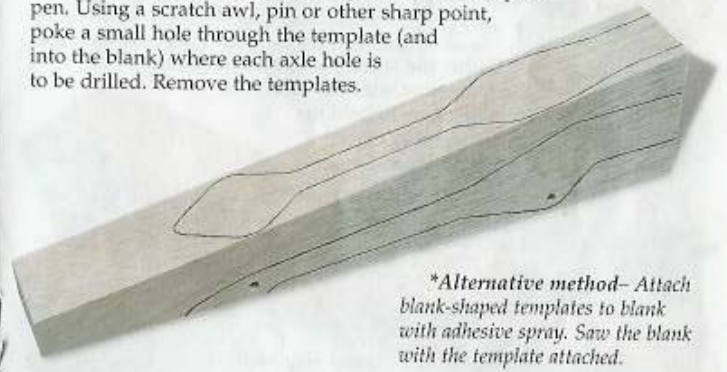
Make the design templates.

Use a pair of scissors to cut out the top view and side views of your design from a copy of the template drawing.

Attach the templates to the top and side of the dragster blank and fasten on each end with a small piece of tape. The template should be aligned with the rear of the dragster blank. Also, take care to align the template with the centerline of the cartridge hole.*



Carefully trace around the templates with a ballpoint pen. Using a scratch awl, pin or other sharp point, poke a small hole through the template (and into the blank) where each axle hole is to be drilled. Remove the templates.



**Alternative method– Attach blank-shaped templates to blank with adhesive spray. Saw the blank with the template attached.*

It's ideal because CO_2 dragsters are about 1/20 the length of real dragsters.

Drill the axle holes.

Place the blank on its side and drill the axle holes with a 3/16" drill bit. Using a drill press is the best way to do this because it makes it easy to drill the axle holes perpendicular to the car body.

Hint: *It is important to drill the axle holes before cutting the body of the dragster.*

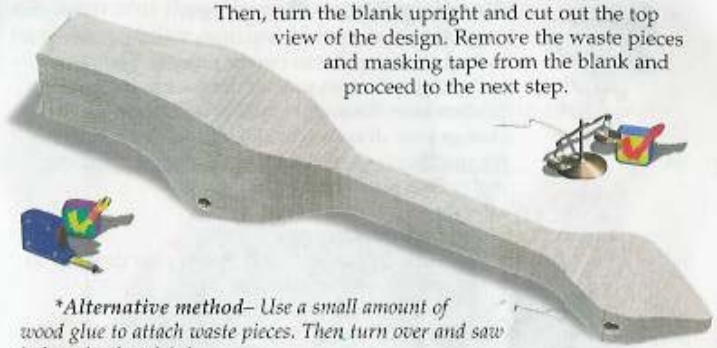
Saw the blank along the template lines.

Cut on the outside of the template lines. This will help you avoid cutting away too much material and causing your dragster to be disqualified.

Turn the blank on its side and cut out the dragster profile. Using a band saw is the preferred method, but a coping saw will also work.

Gather the waste pieces and put them back together with the blank. Use masking tape to hold the blank together in its original shape.*

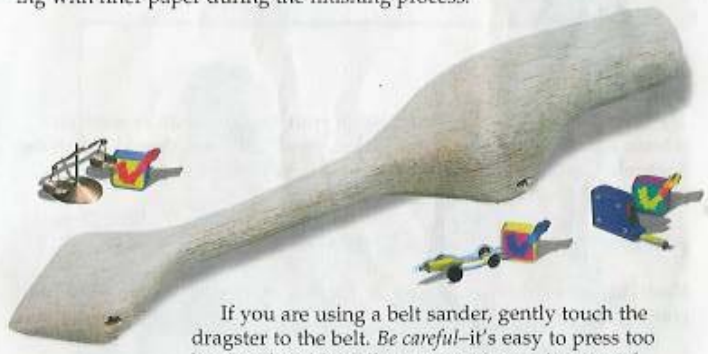
Then, turn the blank upright and cut out the top view of the design. Remove the waste pieces and masking tape from the blank and proceed to the next step.



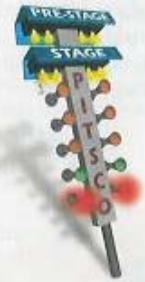
**Alternative method– Use a small amount of wood glue to attach waste pieces. Then turn over and saw before glue has dried.*

Shaping

Files, wood rasps, sandpaper, hobby knives, and belt sanders can be used to knock off the corners and smooth the dragster body to its basic shape. Use coarse (80 grit) sandpaper for shaping; you'll do more sanding with finer paper during the finishing process.



If you are using a belt sander, gently touch the dragster to the belt. *Be careful*–it's easy to press too hard and accidentally remove too much material.



Testing Your Dragster

This is an important step that should not be overlooked. At this point in the the process, you can make slight changes to your dragster to improve its performance. Testing will tell you just how to change your dragster. You should test your dragster for specifications, weight, aerodynamic efficiency, and rolling resistance.

Remember the specs!

Periodically measure and weigh your dragster to make sure it's within specifications!

Before testing the dragster, you may want to install the wheels and axles. Do not install the straw bearings at this time.

By the "weigh". . . You can weigh your dragster with or without wheels installed. If you weigh without the wheels, you should weigh the 4 wheels, 2 axles, 2 screweyes, and 4 washers separately and add their weight to the weight of the dragster body.

Check the spec sheet for the minimum weight specification. Does your dragster meet the weight requirement?

Hint: *Adding several coats of paint during the finishing process can add a few grams of weight.*

If your dragster weighs much more than the minimum specification, try carving or shaping the dragster body to make it lighter.

Go with the flow. . .airflow, that is. . . At various stages of the production process, you can test the aerodynamic properties of your evolving dragster.

The Pitsco AirTech 40di will measure the frontal drag and lift on the dragster body.

The FLO wind tunnel from Pitsco uses a fog vapor that passes over the dragster body so you can actually visualize the airflow over your race car.

Finishing the Dragster

Take your time during the finishing process. Not only will this make your dragster more attractive, it can make it go faster. A smoothly finished surface is more aerodynamically efficient than a rough one. If you installed wheels and axles for testing, remove them now.

Sand, sand, sand. . . Before painting your dragster, sand it first with medium grit sandpaper to smooth rough surfaces. Then sand with fine grit sandpaper to remove small scratches and marks.

Often, the amount of time spent sanding will determine the quality of the paint job. So take your time and try to remove all imperfections. For an ultra smooth surface, apply a coat of sanding sealer before sanding.

Painting. . . Insert a 18" - 24" length of ¾" dowel rod into the cartridge hole of the dragster body. You can either hold the end of the dowel or clamp it in a vise while spray painting the car body.

Hint: *A dragster painting stand is available from Pitsco for this purpose.*

Spray light coats and wait a few minutes between coats to let the paint dry. If desired, you can lightly sand between coats with fine sandpaper.

After the final coat of paint has dried, you can brush on fine detail work like pinstripes or add decals for a realistic race car appearance.

Finishing Ideas

Chrome wheels available from Pitsco will give your dragster a custom look.

Adding a final layer of clear coat or lacquer over the paint can provide a nice, glossy finish as well as protection for decals and detail work.

CAUTION: Clear coat is not compatible with some types of paint. Carefully read the label before using.