2016 Foldable Race Vehicle (FRV)

Background:

Concerns about the environment and rising costs of fossil fuels are driving automakers to design and build more aerodynamic, energy efficient vehicles. Everyone is trying to develop their own concept vehicle these days, and automakers are watching. Your new concept vehicle could be the next million dollar idea. Do you have what it takes to design and fabricated the next futuristic vehicle?

Design Challenge:

The student will design and fabricate a purposeful *Conceptually Foldable Race Vehicle that will be able to travel down an elevated ramp to achieve maximum distance, drag race for time and against other students and/or other specified events determined by the instructor. (*orthographically folding out)

Please <u>read all information</u> and instructions before beginning any activity or design process.

Objectives – Standards:

- Students design and conduct a scientific investigation.
- Students demonstrate applied physics principles of motion, vector geometry and friction.
- Students develop and evaluate inferences and predictions that are based on data.
- Work with tools to process materials and assemble a product.
- Demonstrate gluing techniques.
- Incorporate design and sketching techniques.
- Incorporate problem solving techniques.
- Students solve problems involving scale factors, using ratio and proportion.
- Better understand Newton's Law of Motion.
- Demonstrate skills in accommodating friction and alignment geometry.
- Demonstrate basic understanding of aerodynamics and the effects of rapid acceleration.
- Apply mathematical calculations and measurements and recognize and apply mathematics in contexts outside of mathematics.
- Students learn that modeling, testing, evaluating, and modifying are used to transform ideas into practical solutions.
- Students develop an understanding of the role of troubleshooting, research and development, invention and innovation and experimentation in problem solving.
- Students learn to test and evaluate the design in relation to pre-established requirements, such as criteria and constraints, and refine as needed.
- Students learn to make a product or system and document the solution.
- Work individually and cooperatively as well as competitively.

Constraints:

- The vehicle must have 4 wheels minimum that touch the ground all at the same time.
- Each student will be provided a 5" x 12" Chassis max (laser cut matte board).
- No two vehicles can be the same exact design.
- Vehicle chassis must be laser cut from matte board, with a body shell laser cut from matte board. Then the body finish will be printed on and cut from Card Stock supplied by the instructor.
- The maximum vehicle width requirement, including wheels, cannot exceed 5".
- The maximum vehicle length requirement, including wheels, cannot exceed 12".
- The maximum vehicle height requirement must be printable within the "B" size paper requirements. (per instructor demonstrations, and lecture – orthographic agreement between views)
- The final vehicle does not have weight limits although:

  You may NOT add Hot Glue or misc. items for weight.

Material:

- Students may use any materials in the fabrication for their FRV including the following:

• Matte Board	• Large Wheels	• Small Wheels
• Axle Rod	• Nylon Spacers	• Paper Card Stock
• Washers	• Straws	• Stick / Hot Glue

Safety First:

Be careful and avoid injury when working with all tools. Disclaimer: This product requires the use of tools that could be dangerous and might cause an injury if not handled with care. Follow all safety procedures and guidelines for each tool as provided for by the instructor and identified in the fabrication lab safety guidelines.

Procedure:

1. Brainstorm ideas for a fold-and-roll vehicle different from any of the pre-designed vehicles with which you have researched.
    - *Students may complete this part of the activity in groups, however each student will design and construct their own vehicle.*
2. Complete the demo vehicle fold out provided by the instructor
3. Select an idea for your Foldable Race Vehicle. On a piece of paper, create a sketch of the idea you select.
    - *The sketches do not need to be precise but should give a general impression of each idea. While the sketches do not need to be to scale, they should give a general idea of the size and shape of each proposed vehicle.*
4. Create an AutoCAD drawing of each of the six orthogonal drawing views of the vehicle: top view, bottom view, right view, left view, front view, and back view. Draw each view actual size. Add detail to make vehicle more realistic including colored hatch fill.
    - *Use the template provided by the instructor. Cut and paste your sample picture from your internet research into CAD to help for quicker designing. Remember only one printed "B" size paper can be used. All vehicle sizes must fit within the paper requirements and be at 1:1 scale (full).*
5. Using your drawings, determine the actual length of the edges of your vehicle. One of the views, if not more than one, will usually show the actual length of the edge. However, you must sometimes calculate the true length of an edge based upon the other lengths in your drawing. Measure the corresponding edges to verify that they are all the same length and will align properly when folded.
    - *Pay close attention to this demonstration during lecture to ensure a precise design.*
6. Add tabs to your pattern. The tabs should extend no more than 1/2 inch from an edge where two sides meet. Glue or tape will be placed on a tab to hold together the two sides it connects.
    - *If students choose to glue the vehicle, they may wish to also use tape to hold the vehicle together while the glue dries.*

7. On regular “B” size paper print (using CAD Lab A, B or C printers) a sample pattern of your vehicle and fold together making sure everything lines up for your final printing.

    - *If students discover that their vehicle patterns do not align properly, fold their vehicles anyway. You may choose to try and modify your design for a better fit but complete your original designs to discover all the flaws in their designs before redesigning.*

8. ***Final Printing:*** Once final drawing is approved use the card stock to print the pattern for the Foldable Race Vehicle using the color laser HP-M750. Be careful to determine where the sides need to connect for easy folding or accurate assembly.

9. Cut out and assemble your vehicle body. Layout and attach axles and wheels to your chassis. Use a scale, scribe and square to create lines on the chassis for layout purposes.

10. Fabricate or alter parts per your design requirements in the Fabrication Lab. (quality and precision of each part will ensure a smooth and functional assembly process)

11. Determine where components will be placed and use appropriate methods to attach axels, bearings and the body (fasteners or gluing).

12. Verify final assembly for quality, completeness and basic function.

13. Test your vehicle by rolling it down the ramp. Evaluate your vehicle’s trajectory or path and rolling performance. Modify if necessary and retest. Any flaws in your design and fabrication should be corrected to achieve maximum results and best scores.

Helpful Hints

- Keep in mind that **precision** fabrication will result in better performance during vehicle testing.
- Students should keep in mind the size and weight of their FRV. Most of the time longer is better. Shorter vehicles tend to veer or spin out easily.
- Identify each of the material components provided and possible purposes they will serve.
- Pre-test vehicle and make needed adjustments to the wheel alignment.
- Design and fabricate for speed. The most successful vehicles are usually those that are built with precision.
- Design and fabricate for durability. Accidents can damage a fragile design.
- Design and fabricate for easy repair. Keep it simple. Complex designs are more prone to breakdowns and are difficult to repair.
- Design and fabricate to race down and off the track. Low ground clearance vehicles will get stuck at the bottom of the track.
- Research - Foldable Paper Vehicles and Paper Toys
- Choose a vehicle that fits your personality and demonstrates your creativity.

Official Testing / Grading:

Testing:

- The vehicle may be unofficially tested as much as needed without penalty.
  - Upon deadline, vehicle **MUST** be tested.
- Instructor will pre-determine the ramp angle before each test.
- Student must state **"*official run*"** before a scored run. This must be witnessed by the instructor.
- Vehicle must complete the entire course for full points. The course may be tested on multiple surfaces thus the challenge will be variable and have a range of difficulty.

Distance:

- Students will test their FRV vehicle for maximum distance traveled. Farthest distance wins and all others will be graded on distance traveled relative to class leader.

Drag Race:

- Students will drag race for time and each other while using a common starting and ending point. Instructor will determine distance of race on testing day. Students with the fasted elapsed time or the most race wins will achieve the highest grade while all others will be graded based on finish time.

Open Testing

- Instructor will provide a testing scenario or gaming event depending on time left with project.
  - Testing may include: Bowling, Demolition Derby, Ramp Jumps, etc…..

Grading:

- Points will be earned and calculated by using the entire sketching, Precision CAD Design, fabrication and testing process.
  - Students must attempt / complete (3) three runs. An average of all three attempts will be used for grading. **50 points** maximum per event
  - The Precision CAD Drawings / Sketches: **50 points**
  - Vehicle Appearance: **50 points**
  - Build Quality / Craftsmanship: **100 points**
  - Participation: **75 points**
  - Extra Credit: up to **25 points** determined by the instructor

Time Line – *(may vary based on general school calendar and class pullouts etc..)*

Introduction / Research	Day 1
Sketches and CAD Drawing	Weeks 1 thru 3
Vehicle Construction	Weeks 4 thru 6
Vehicle Preliminary Testing	Weeks 7 thru 8
Foldable Race Vehicle Competition	Week 8
FRV Summary Report Due	Week 9

Final Summary Report

- Students will develop a ***Foldable Race Vehicle*** project summary and reflection paper.
  - Instructor will hand out requirements after the final testing has been completed.