Designing a Strategy for the Design/Construction of a Water Rocket

Understand and Test the Simulator Do this step first to confirm that the simulator works on the computer.   It may take more than one session to resolve operating problems.

On Windows 07, the simulation works on both Chrome and Mozilla Firefox. You must however, click on the pop down window at the top of the browser, and allow Java to run (either this time, or every time).

On Mac OSX, the simulation works on both Chrome and Safari. Chrome works in the same way that it does on Windows 07, however, Safari will show a grey box with an "inactive plug in" statement in the middle of the box. Click on that and press enable for Java to run.

Bring up the NASA Simulator

>   Google: NASA water rocket simulator 2 or

>   Click on the top link to bring up the simulator
>   (It may take some time to appear in the window depending on your connection)

If the simulator does not run, address the issues with the computer
Typical Issues: Outdated version of Java
                    Security Settings

If you are unable to resolve the issues on your computer, identify a computer in the Computer Lab that has been demonstrated to run the simulator. (If you use the Lab, be sure to allow time to do the homework when the Lab is available.

Verify the Simulator Operation

>   Read the Operating Instructions:
>   **Set the simulator for Water Rockets.**
>   The rocket that appears has the dimensions of a 2 L soda bottle and are fixed.
>   A common error is to change the dimensions of the rocket body. The dimensions are a constant.

>   Note the input variables and their ranges: (nose, payload, fins, fairing, pressure, fuel, pad). Metric units should be used, but it is important that you have a physical feel for their significance.
>   (Pressure: 1 atm = 14.7 lb_f/in^2 (psi) = 101.3 kPa)

Test your computer with the simulator with these conditions:
        Use the following inputs: Water Rocket; P 423 kPa; Fuel 552 g. All other settings should be on default. The rocket should rise **30 m**. If it falls flat, there is a problem. Start by checking Java. Check with others in the class who have had success with the simulator.

RocketModeler II SIMULATOR
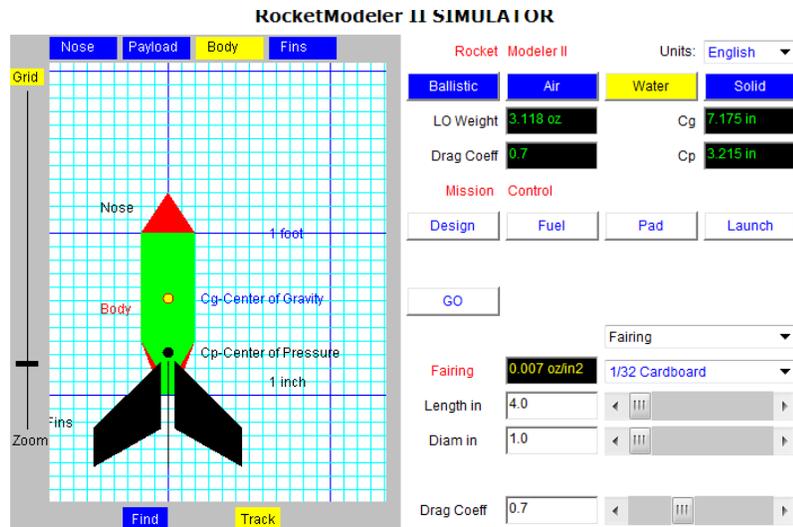
This is a copy of the **RocketModeler II** program. To test a Bottle Rocket, click on the blue button labeled "Water". You can change the design by clicking on the blue buttons above the graphic, then use the sliders or input boxes at the lower right. Click "Go" when you are finished, then click "Fuel". You can change the **pressure**

Design Spreadsheet

The spreadsheet must be constructed to capture all of the information (including units) for the inputs and outputs. It has to be laid thoughtfully with related variables together. Since there will not be the resources to test each variable independently, a clear data/results sheet is needed to guide the simulations.

Simulator Inputs/Outputs

Design
Body Length (fixed)
Body Width (fixed)

Nose Length (variable)
Nose Width (variable)

No. of Fins (variable)
Fin Length (variable)
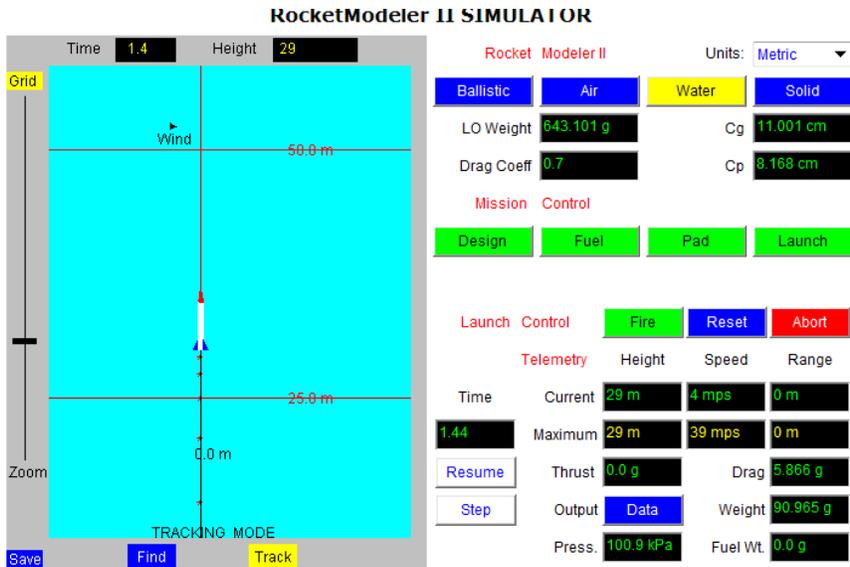Fin Width (variable)
Lift Off Weight (calculated)

Fuel
Vol. of Water (variable)
Pressure (variable) (maximum: 4.5 atm absolute = 3.5 atm gauge; 65 psia = 50 psig 2atm)
L. tube Width (fixed) (value = 10 cm/ 4 inches)
Center of Gravity (calculated)
Center of Pressure (calculated)

Launch
Max height (calculated)
Max speed (calculated)

Construct a Spreadsheet to record all of the input variables above and the output variables (use maximum height, and maximum speed). Lay out your spreadsheet using logical groupings of variables and show the units.

Flight Screen

RocketModeler II SIMULATOR

Flight Screen:First

| Time | 1.4 | Height | 29 |

Grid

Wind

50.0 m

25.0 m

0.0 m

Zoom

TRACKING MODE

Save | Find | Track

Rocket Modeler II   Units: Metric ▼

| Ballistic | Air | Water | Solid |

LO Weight 643.101 g   Cg 11.001 cm

Drag Coeff 0.7   Cp 8.168 cm

Mission Control

| Design | Fuel | Pad | Launch |

Launch Control   Fire | Reset | Abort

Telemetry	Height	Speed	Range
Time Current	29 m	4 mps	0 m
1.44 Maximum	29 m	39 mps	0 m
Resume Thrust	0.0 g	Drag	5.866 g
Step Output	Data	Weight	90.965 g
Press.	100.9 kPa	Fuel Wt.	0.0 g

Design Simulations: Individual Round

Each individual has a limited number (10) simulations in order to determine the best design and operating conditions of the rocket.

Read the Handout Introduction to Experimental Design: Fundamental Concepts
> Identify the three concepts (sections marked with *) that are the most useful to your thinking about experimental design.
> List each concept and add a few sentences of your own describing their significance.

Determine a strategy to best use the 10 trials to evaluate and determine the best design and operating conditions for the rocket. Document that strategy (including the conditions for the first several runs) before you do any simulations.

Do your 10 simulations. Put emphasis on the variables that you consider the most important.
Record the result. Do only 10!

This exercise is focused on understanding experimental strategy, not getting the final design.

Identify the best design of the water rocket and its operating conditions based on your 10 simulations. Mark the best selection on the spreadsheet.

Evaluate your experimental strategy based on the quality of the results. Identify the strengths of your approach as well as improvements in your strategy based on your observed results. The individual spreadsheet and narrative will be handed in.

Design Simulations: Final Group Round

The individual spreadsheets are compared and the project group can determine the optimal layout for a comprehensive spreadsheet.

Each individual should enter their result on the group spreadsheet.

As a group, determine a strategy for the final round of simulations.

Beginning with this starting point, additional simulations can be done to determine the final design of the rocket. (At this stage, it is important to consider materials of construction since the rocket will be built based on this design.) Record all simulations on the spread sheet.

As discussed in class, use effective graphical methods to reveal key relationships in the data.

This spreadsheet together with a narrative identifying the design process strategy and results and clearly indicating the final design specifications. Compare the final design to the first round recommendations.

Construction

Build your rocket as close to the design specifications as possible. Document construction techniques and compromises.

For the final report, there should be a table comparing the design specification (dimensions, material of construction, weight, Cp, Cg) with the as-built rocket.

Construction Tip from Previous Class:
        The attachment of the fins is important for both flight height and stability. Fins should by rigidly attached. If they are made of flexible material or can move on the body, they are ineffective in stabilizing the rocket and add to the drag.