SODA BOTTLE WATER ROCKETS

- a Fluid Mechanics project that students (seem to) like

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This poster explains the ins and outs of an undergraduate student project for a junior level Fluid Mechanics course. The goal was to let students participate in a hands-on project that would help them to develop and retain a better understanding for several fluid mechanics concepts, while simultaneously being challenged in an interesting and fun way.

GOAL

Find the balance between the amount of water on board and the pressure of the air in the propellant tank. The main constraint is that the maximum pressure in the bottle can only be a maximum of four atmospheres (gauge) to avoid structural damage.

Weekly milestones

1. Organize the team, hand in a list of team members. Each team had of 2-3 students.
2. Team organization, assigned tasks, definition of the problem, method of approach to the problem. Hand in progress report 1.
3. Control volume definition, equations of motion, method of solution, structural elements. Hand in progress report 2.
4. Preliminary results, problems with solution, methods for determining the optimum design, lists of graphs required. Hand in progress report 3.
5. Report outline with graphs. Hand in progress report 4.
6. Final results, rough draft of report with height vs time and velocity vs time estimates. Hand in preliminary report with everything except rocket launch data and final design of rocket.
7. 7:00 am rocket fly-off at the USC Baseball Field!
8. Final report due with comparison of actual flight data and numerical predictions. Why/why not do results match? Awards for highest launch and best design!

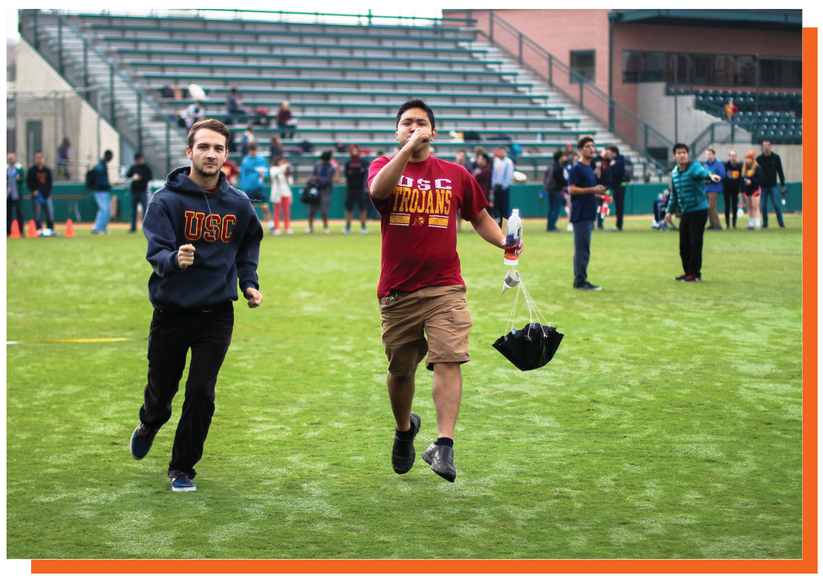
Challenges

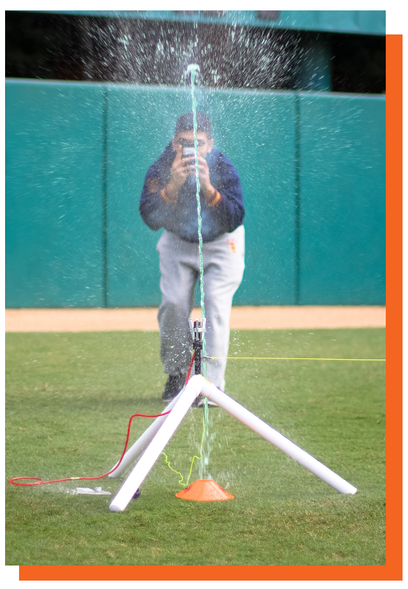
- What type of water bottle is best?
- Stability (center of gravity vs center of pressure) consderations.
- Numerical integration of control volume calculations
- Structural elements like nosecone, fins and parachute.
- Measure accurate height of rocket.

Materials & Support

Each week, the last lecture was cut short to provide students opportunity to sit down and work with their peers with instructors available to answer questions.

Various hand-outs* were provided to the students each week to build up the knowlege they needed to complete the next task.





Acknowledgments

All fantastic USC students, who volunteered their time to help with the rocket launch event. All staff and faculty who in various ways suported the event and kindly provided students (and sometimes visiting parents) with breakfast during the early morning launch. Thank you!

Student quotes

"I am the student who enjoyed the Fluid Dynamics class so much - and screamed out of fun during the water rocket project..."
"The assigned group project, which applies course content to a fun and exciting engineering problem, really highlights the significance of the study beyond the classroom."

*Examples of References: J. M. Prusa, "Hydrodynamics of a Water Rocket", SIAM REVIEW, 42(4), 719–726, (2000) give out together with an explanation of the details given in the paper. Description of numerical integration technique and MatLab examples for Predictor-Corrector method. Photos by V. Eliasson.