

MASSACHUSETTS INSTITUTE OF TECHNOLOGY  
Department of Aeronautics and Astronautics  
16.010 / 16.020 Unified Engineering

**Systems Problems #5**

Issued: October 8, 2003

Due: 5PM October 16, 2003

**CONCEPT DESIGN, CONCEPT SELECTION, DETAILED DESIGN**

**Objectives**

1. Develop design for functionality skills (Design for X).
2. Obtain basic experience using design selection matrix concepts.
3. Use unified engineering fundamentals to evaluate design concepts.
4. Develop and strengthen product documentation and communication skills.

**Mission Statement**

Your goal is to design a water rocket whose primary function is to achieve maximum altitude. However, your design must conform to the following *constraints*:

1. The water rocket must begin from rest at ground level.
2. You must utilize the given launching mechanism without modification or alteration.
3. The sole source of stored energy must be compressed air at a maximum of 60 psi gauge pressure.
4. You must launch your rocket three times in rapid succession (<5 minutes turn around time). The average altitude of the three launches is your performance rating.
5. You may use any components or materials you wish as long as your design is safe to operate.

**Particulars**

1. Certain materials will be freely available while in stock including balsa, clay, hot glue, and Household Goop™ adhesive.
2. Launching mechanisms and inclinometers for measuring altitude will be available for sign out during business hours. The maximum sign out period is two (2) hours except when sign out occurs after 4pm in which case return must occur at 9am the following business day.

3. Another person must be present during launch for safety and to help you launch or measure altitude. Expect more detailed launching instructions in a separate handout.

## Assignment

This is an individual assignment. You are required to hand-in your own solution and you will be assigned an individual grade for your efforts. However, students are encouraged to work and learn together. The collaboration policy in the Unified Engineering course syllabus applies.

1. Choose at least three (3) functional criteria for your water rocket system. One of the functional criteria must be flight altitude. Other functional criteria might be ease of manufacture, serviceability, reparability, total cost of manufacture, ease of launch, safety, and or durability.
2. Decide on a weighting scheme to indicate the importance of each of the functional criteria you have chosen. It is recommended that flight altitude have the highest weighting. Decide on an evaluation scale for the functional criteria. Develop a design selection matrix.
3. Develop at least three (3) different water rocket system concepts to achieve the functionality you have chosen. Make sketches of your concepts and explain their function.
4. Use engineering concepts (and your evaluation scale!) to evaluate your rocket system designs. Present a design selection matrix to document your selection process. Select a rocket design concept.
5. List at least three (3) design *parameters* you can control to improve your selected rocket's performance. Explain (text and graphics) how these parameters impact the performance of your design. Evaluate the importance of your selected design parameters.
6. Complete the detailed design of your selected rocket. Develop sketches, manufacturing instructions, operating procedures, and repair and service instructions. Also develop a short functional operation document. Your manufacturing documentation should be sufficient to allow another student to reproduce your rocket.

During the week following session SP6, you will build your design, launch it, measure the altitude it reaches, and write a report on the results. Detailed requirements for the report will be distributed at session SP6.