Project Competition
"Hot Air Solar Balloon"

Prelude

The possibility of flight has always been fascinating and is of great practical importance. The creation of a flying device powered only by sunlight would be very useful but there must be little cloud cover and plenty of sunlight.

Balloons are amongst the very first flying devices invented (Montgolfiere) and very recently the first attempt to circumnavigate the globe using a balloon with someone inside was realized by Bertran Piccard of Switzerland and Brian Jones of Britain.

Balloons are not very effective flying devices but they are useful to lift a payload that requires little control/guidance high in the atmosphere (e.g. weather balloons). Such balloons often use an inert gas to become buoyant. Very recent successful flights have been made with solar montgolfiere balloons. Such balloons are for very high altitude (longest flight 69 days). They might be used on Mars by NASA.

The ME 412 design project will look at efficient ways of converting solar energy into heated air that will then provide buoyancy.

Project Statement

The project team is to design, analyze, build, and test a hot air balloon that will float with the assistance of sunlight only (or an equivalent source). The device will begin at room temperature and there are no restrictions on size. The objective will be to maximize the weight of a payload that can be lifted by the balloon, as well as to minimize the time to become airborne. A device must be manufactured by the project team. To test the device, four infrared lamps that provide approximately 300 W will be used.

Design Report

The design report shall consist of the following sections:

Abstract: The abstract is a very short summary of the project report. A brief paragraph should include a problem statement, the method of solution, and solution statement.

Background: In this section the heat transfer principles involved in the process should be defined. Appropriate equations modeling the physical
process should be provided. These equations should be solved to produce an analytical model for the process.

**Design Analysis:** Design alternatives should be presented and evaluated in this section. The criteria used in selecting the preferred design should be stated. The details of the fabrication of the device should also be included. This will include detailed drawings of the device, material specifications, and manufacturing processes. The material cost of the device must be provided in a documented fashion. That is, a receipt must be provided for each material component of the device. Only the cost of materials and not fabrication costs need to be provided, and only the material cost will be used in the evaluation of the device.

**Testing and Verification:** In this section the testing procedures and results will be presented. Several tests should be conducted with the device. The data collected should be compared to results generated from the analytical model and any difference between the two should be noted and explained. Presentation of the testing data should include an uncertainty analysis.

**Recommendations:** If you were to do this project again, what would you do differently? If you had another semester to work on the project, what additional things would you do?

**Project Competition**

On Monday, August 15, the competition for the project will be conducted. At 4:10 pm the device will be logged in. The payload mass will be measured, and the material cost recorded. Once all of the devices have gone through this procedure, its time to liftoff and maximum payload (if needed) will be determined. The design team will be allowed to prep their device. After liftoff, the payload must be added at some point.

Each team's device will be ranked from 1 to N (N being the number of teams) for each event (material cost, time for liftoff, and payload weight). For time for liftoff and device cost the ranking will be from low to high, while for the payload mass the ranking will be from high to low.

In each event the team ranked number one will receive N points, the team ranked second will receive N-1 points, and so on to the last place team which will receive one point. If a tie exists for a position, the two teams will equally share the sum of the points for that position and the next position. That is, if two teams tie for fourth in the cost event each team would receive one half the combined points for fourth and fifth place. The next ranked team would receive the points for sixth place. An overall champion will be determined by summing the time for liftoff
event points with the cost event points with two times the payload mass points. That is,

\[
\text{Total Pts} = \text{Cost Pts} + \text{Time for Liftoff Pts} + 2 \times (\text{Payload Mass Pts})
\]

**Grading**
The grade for the project will be based on the following weighting:

<table>
<thead>
<tr>
<th>Component</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Report</td>
<td>50%</td>
</tr>
<tr>
<td>Device</td>
<td>40%</td>
</tr>
<tr>
<td>Competition</td>
<td>10%</td>
</tr>
</tbody>
</table>

The project report will be graded out of 100 points (similar to the technical memos) with regards to the items requested in the above Project Report section and its quality. The device will be graded out of 100 points with 75 points awarded for a functional device. The remaining 25 points will be distributed on the basis of quality and creativity of the design. The project competition will be graded out of 100 points. The project team with the overall highest score will receive 100 points. The second place overall team will receive 95 points, and so forth through the final rankings at five point intervals.

**Cost Information**
To be consistent all design teams should use the following cost data.

copper $2.00/lbm
bronze or brass $1.75/lbm
aluminum $1.50/lbm
stainless steel $3.00/lbm
galvanized steel $0.75/lbm
steel $0.50/lbm
paper or cardboard $0.55/lbm
generic plastic $0.30/lbm
wood $0.25/lbm
Styrofoam $10/lbm
rubber $4.50/lbm
fiberglass $5.00/lbm
water: $ 0.13/kg