Objective

• As a team
Design & construct a lighter-than-air (LTA) vehicle that is
  • Stable
  • Controllable
  • Reliable
  • Able to carry a payload
  • Fast
  • Aesthetically pleasing and an elegant design
Race Course

Total race distance
87.8 m

28.7 m

start

finish

15.2 m
Judging Criteria

• Payload
  • Score = payload mass / time to complete race

• Reliability
  • Most successful course completions (trials + race day)

• Aesthetics
  • Most creative and elegant design
Constraints

• Maximum vehicle mass = 1.75 kg
  – includes structure + payload mass (not balloon mass)
  – vehicles will be weighed on trial day and race day
  – payload must be able to be detached from structure

• Maximum of 5 balloons

• Use supplied materials
  – exceptions via special request

• No one can touch blimp or apply force on safety string during official run
Standard Materials

• Balsa wood
• Large & Small motor sizes
• Propellers
• Radio control electronics
• Servos
• String
• Epoxy, glue, tape, other adhesives
• Weather balloons (1 m diameter)
• Helium gas

• Details in book and on CD-ROM, additional details available later
Spiral Design Process

Requirements:
- start
- brainstorming
- modifications

Design:
- final detailed design
- design selection
- PDR
- CDR

Test:
- trials
- race

Build:
- fixes
- final build
- prototypes
Initial Steps

• Get acquainted, set ground rules, meeting times, choose team name

• Identify the key design parameters
  – Balloon layout
  – Number of motors
  – etc.

• Brainstorm and sketch concepts
  – No filtering or critiquing of designs at this point!

• Identify strengths and weaknesses

• Downselect to several likely contenders

• Review +/−’s in more detail and formally select final design
## Product Design Matrix

<table>
<thead>
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<th>Requirement</th>
<th>Importance</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
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Key Dates

- February 27: Start
- March 20: Preliminary Design Review (PDR)
- April 24: Completed Design Review (CDR)
- April 29: Design Portfolios Due, 9:30am
- May 6: Trials in the gym
- May 8: Design Portfolios Due for Re-Grade, 9:30 am
- May 13: Race Day in the gym
- May 15: Mandatory class attendance, LTA Vehicle Awards
Objectives of the Preliminary Design Review

• Describe the design process to arrive at proposed vehicle layout

• Provide justification for the selected design

• Preliminary analysis of selected design’s performance

• Roadmap to arrive at finished product

• Bottom line: Convey technical ability and confidence that you will get the job done
  – e.g., to justify funding from a supporter
Preliminary Design Review Elements

• Introduction, Team name, Team members
• Discussion and analysis of proposed designs
• Selection of proposed design
• Schematic of selected design
  – approximate layout, balloons, propulsion, attitude control
• Analysis
  – He volume, mass estimates, drag & thrust estimates
  – Number and placement of motors & propellers
  – Number, size, and placement of batteries and electronics
  – Method of attitude control and maneuvering
  – Expected vehicle velocity and endurance
• Request and justification for additional materials (if necessary)
• Timeline for construction and testing
Example Gantt Chart
Presentation Logistics

• 10 teams, 80 minutes of class = 8 minutes / team
  – 5 minutes presentation, 2 minutes Q&A, 1 minute changeover

• Overhead transparency, Powerpoint, or Web-based
  – Powerpoint files must be emailed to Prof. Newman no later than 8:00am the day of the presentation, or brought to class on a CD-ROM
  – Web URLs must be finalized and sent to Prof. Newman no later than 8:00am the day of the presentation
  – See book and 16.00 web site schedule for links to html templates

• Each team member expected to participate in one presentation
  – PDR or CDR

• Staff will use standard scoring sheets, with comments
Personal Design Portfolios

• Compilation of all your personal effort/learning in the class throughout the semester
  – Briefly discuss, explain, and synthesize what you learned in lecture and Problem Sets (likes and dislikes are acceptable)
  – How does your synthesis above relate to your preparation for the LTA vehicle project?
  – Notes, team meeting minutes, ideas, observations (dated!)
  – Sketches, brainstorming concepts, schematics, drawings
  – Analyses (aerodynamics, structures, control,…)
  – Prototype elements and tests
  – Final engineering drawings to scale
  – Photos of prototypes and the finished vehicle
  – Discussion of the entire design process and race day results

• Portfolio must be in some form of notebook OR submitted electronically (provide Powerpoint presentation or URL)

• Start your portfolio immediately
Objectives of the Completed Design Review

• Describe the detailed design of the vehicle
  – Layout and analysis
  – Major modifications since PDR

• Present & discuss at least one built prototype component or subsystem

• Bottom line: Convey that you can overcome any issues that remain and will have a working vehicle on trial day
Completed Design Review Elements

• Introduction, team name, team members + roles in project

• Introduction of the final design

• Scale drawing of final design (at least a dimensioned 3-view)

• Control system details

• Aerodynamic analysis

• Other analysis (structural, construction, major concerns, etc.)

• Timeline for construction and test

• Conclusion
Teamwork Issues

• Effective teams do not just happen -- they take work

• Open lines of communication are critical

• Methods for arriving at decisions should be clear and acceptable
  – Strive for consensus

• Everyone should have clear responsibilities
  – and follow through on them

• Note your contributions in your Personal Design Portfolio
Self / Peer Reviews

• Prof. Newman will periodically hand out and collect self/peer review forms
  – Intellectual contribution (ideas, discussions, analyses)
  – Hands-on contribution (drawing, construction, testing)

• Opportunity for you to assess your own effort relative to your peers
  – Confidential
  – Note significant team problems
    • uneven participation
    • unproductive team meetings
    • team member personality issues
LTA Design Hints

1. It is easy to make a blimp that floats

2. It is not easy to make a blimp go where you want it to

Stability:
   Able to maintain altitude and attitude without control inputs

Controllability:
   Able to dictate direction of movement and rotation
X-29: Unstable but Controllable

(not something to emulate for LTA race)
Coefficient of Drag vs. Reynolds Number for a sphere

\[ \text{Re} = \frac{\rho \, v \, D}{\mu} \]
Team 7

Team 8

Team 9

Team 10