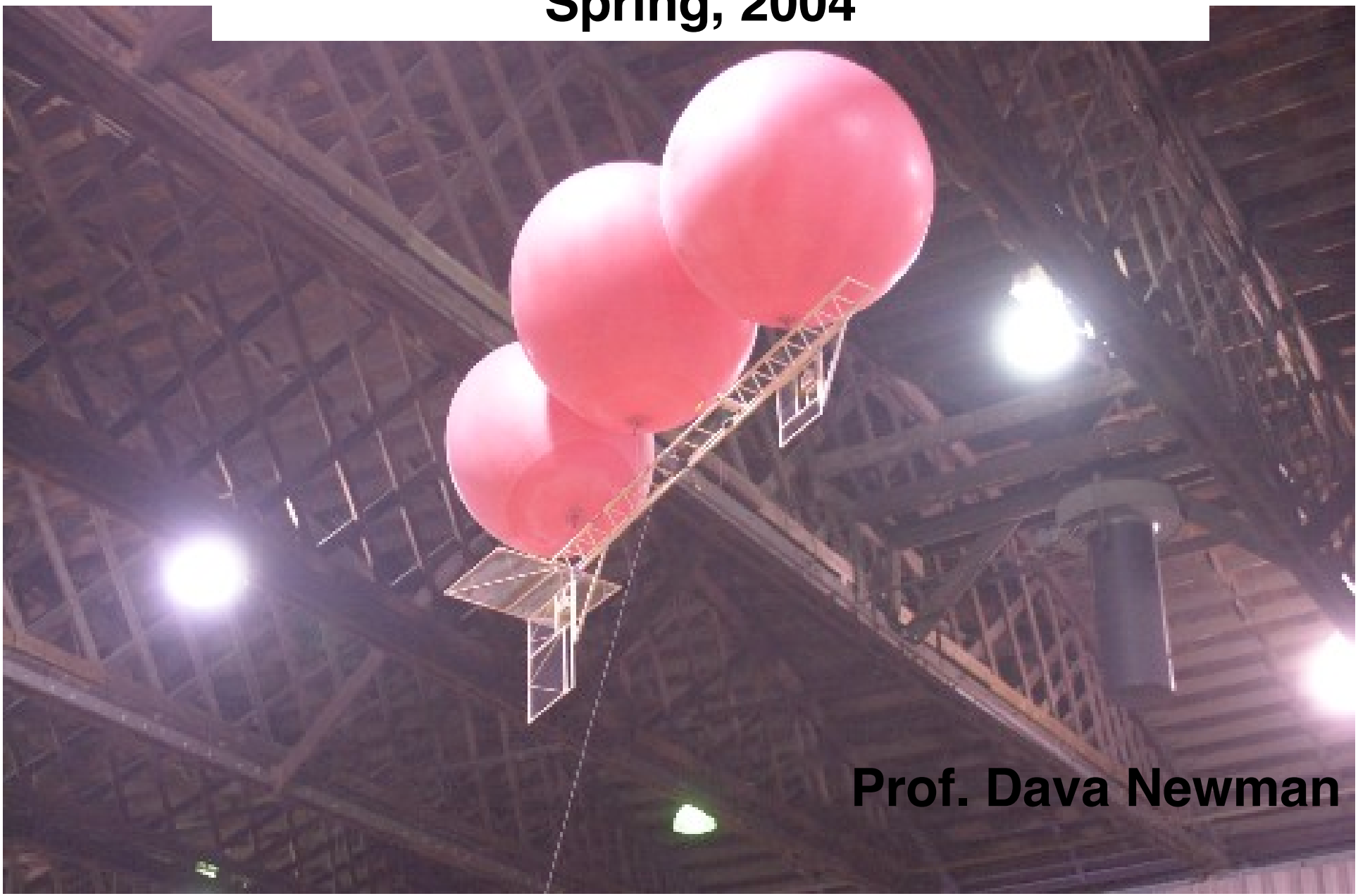
16.00 Lighter Than Air Design Competition
Spring, 2004

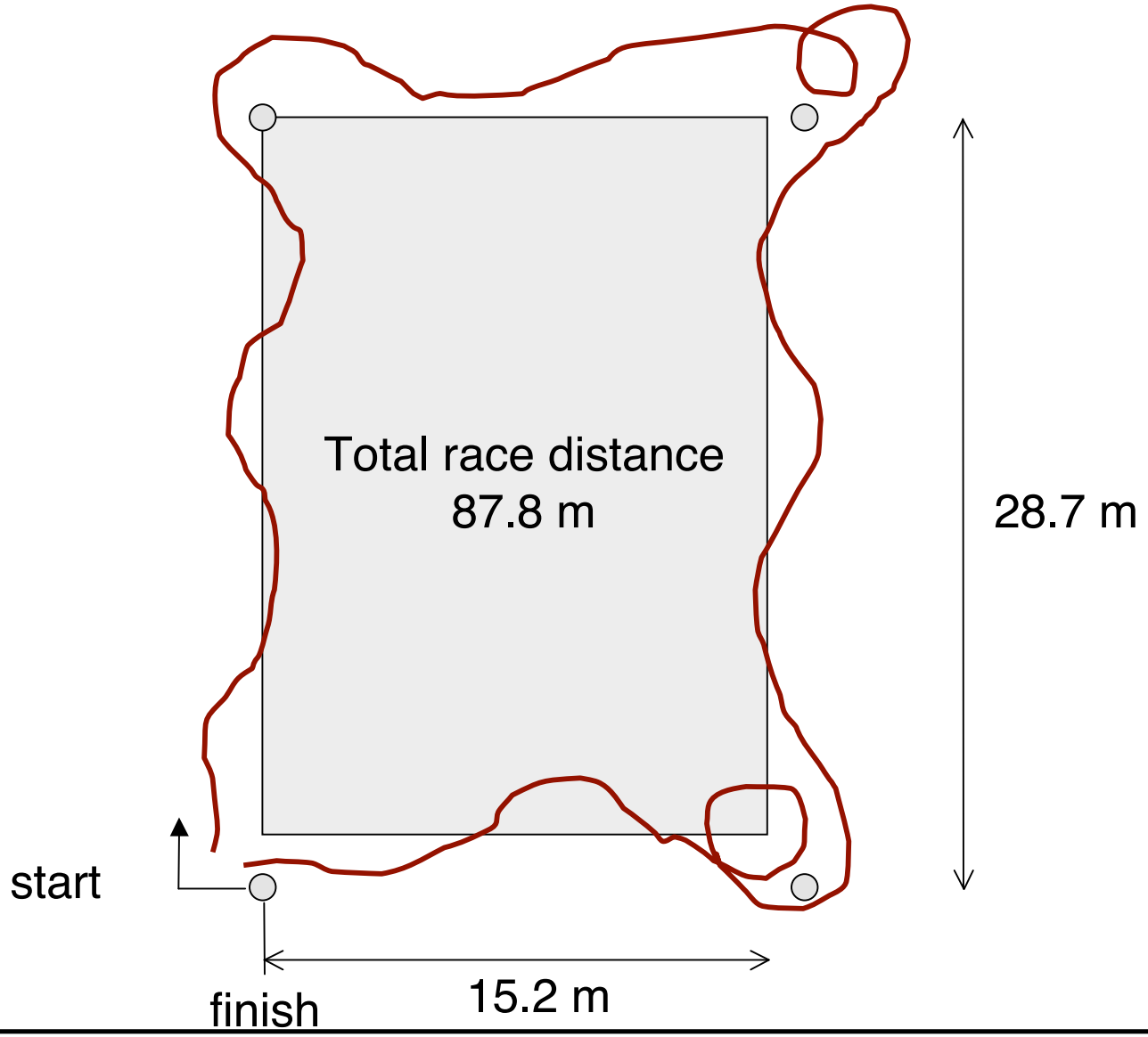


Prof. Dava Newman

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



Judging Criteria

- Payload
    - Score = payload mass / time to complete race
- Reliability
    - Most successful course completions (trials + race day)
- Aesthetics
    - Most creative and elegant design

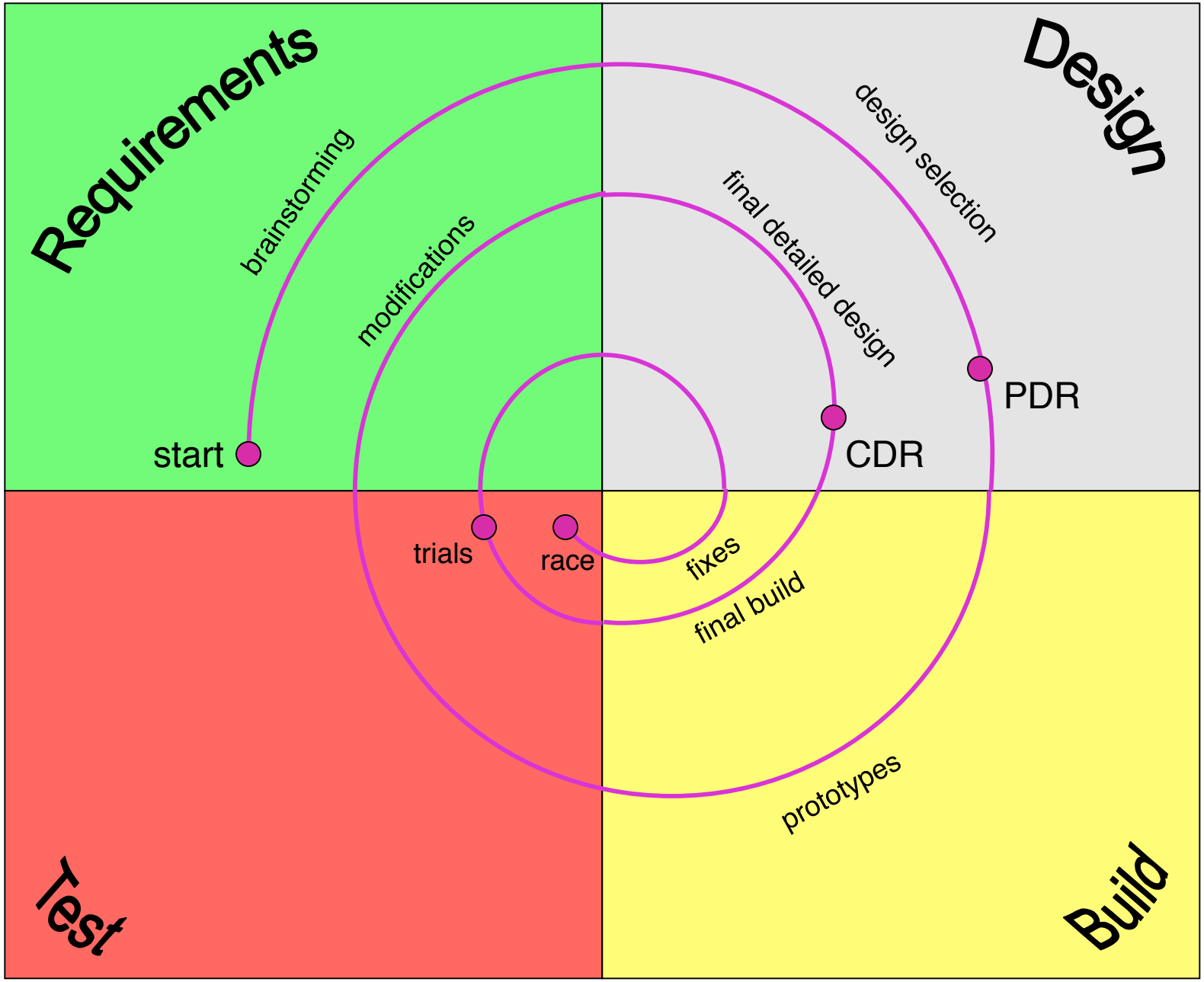
Constraints

- 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



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

		Design Solutions			
Requirement	Importance	**A**	**B**	**C**	**D**
speed	6	5			
weight	8	7			
noise level	4	2			
Totals		94			

Key Dates

- Feb 19, Mar 4: Start (In class Introduction, LTA vehicle teams)
- March 18: Preliminary Design Review (PDR)
- April 22: Completed Design Review (CDR)
- April 29: Design Portfolios Due, 9:30am
- May 4: Trials in the gym
- May 6: Design Portfolios Due for Re-Grade, 9:30 am
- May 11: Race Day in the gym
- May 13: Mandatory class attendance,
  - » LTA Vehicle Awards

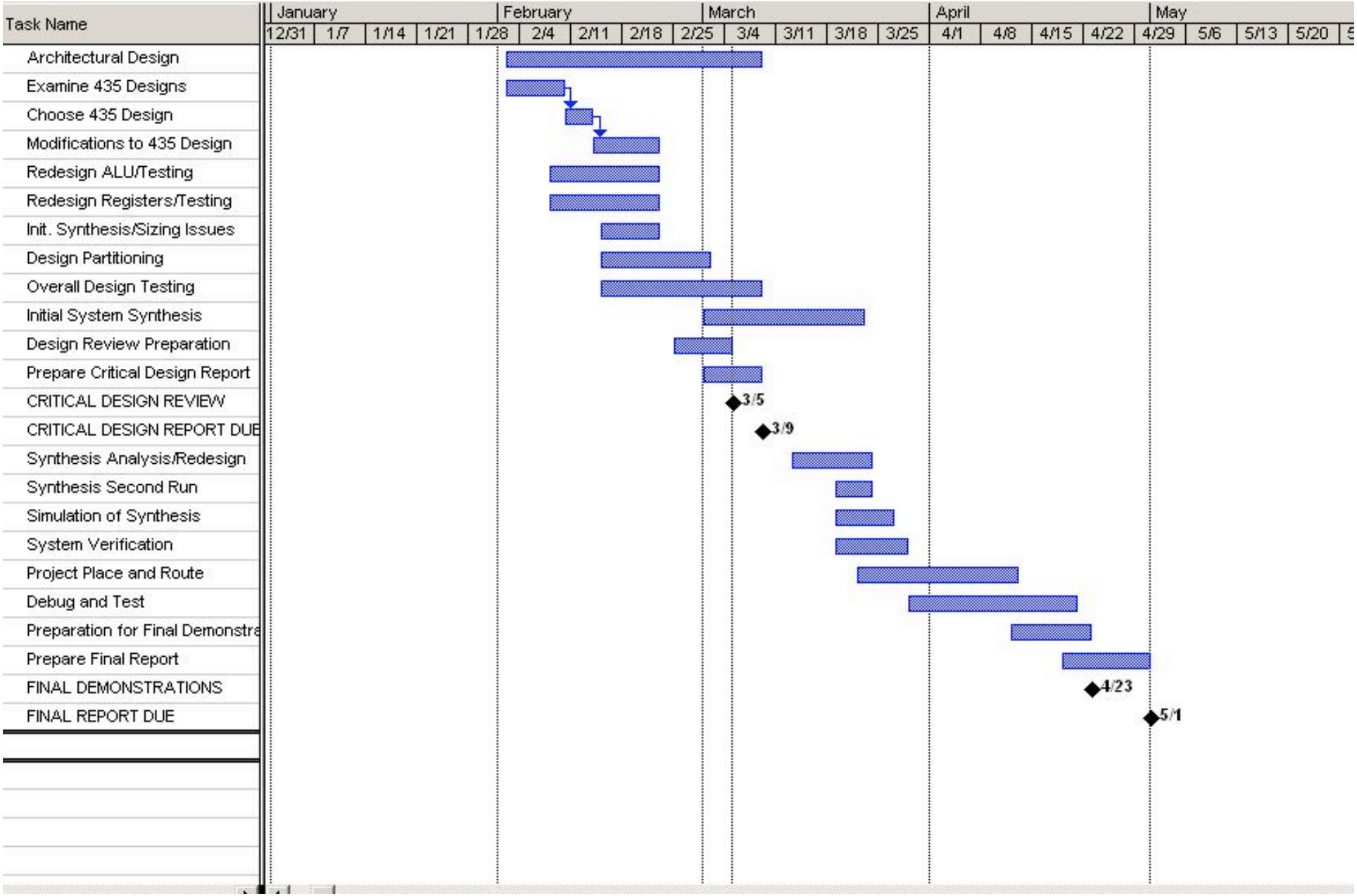
Objectives of the Preliminary Design Review

- 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, Slide, 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 8:00 am the day of the presentation
  - See book and CD-ROM for examples
  - File size limit: Any files e-mailed or on a CD-ROM MUST BE UNDER 10 Mbytes
- 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 Slide presentation or URL). File size limit: Electronic Portfolios MUST BE UNDER 10 Mbytes.
- 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
- File size limit: Any files e-mailed or on a CD-ROM MUST BE UNDER 10 Mbytes
- 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
- Individual's goals should be communicated
- Note your contributions in your Personal Design Portfolio

Self / Peer Reviews

- At the end of the term you are all required to fill in self/peer evaluations
  - 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:

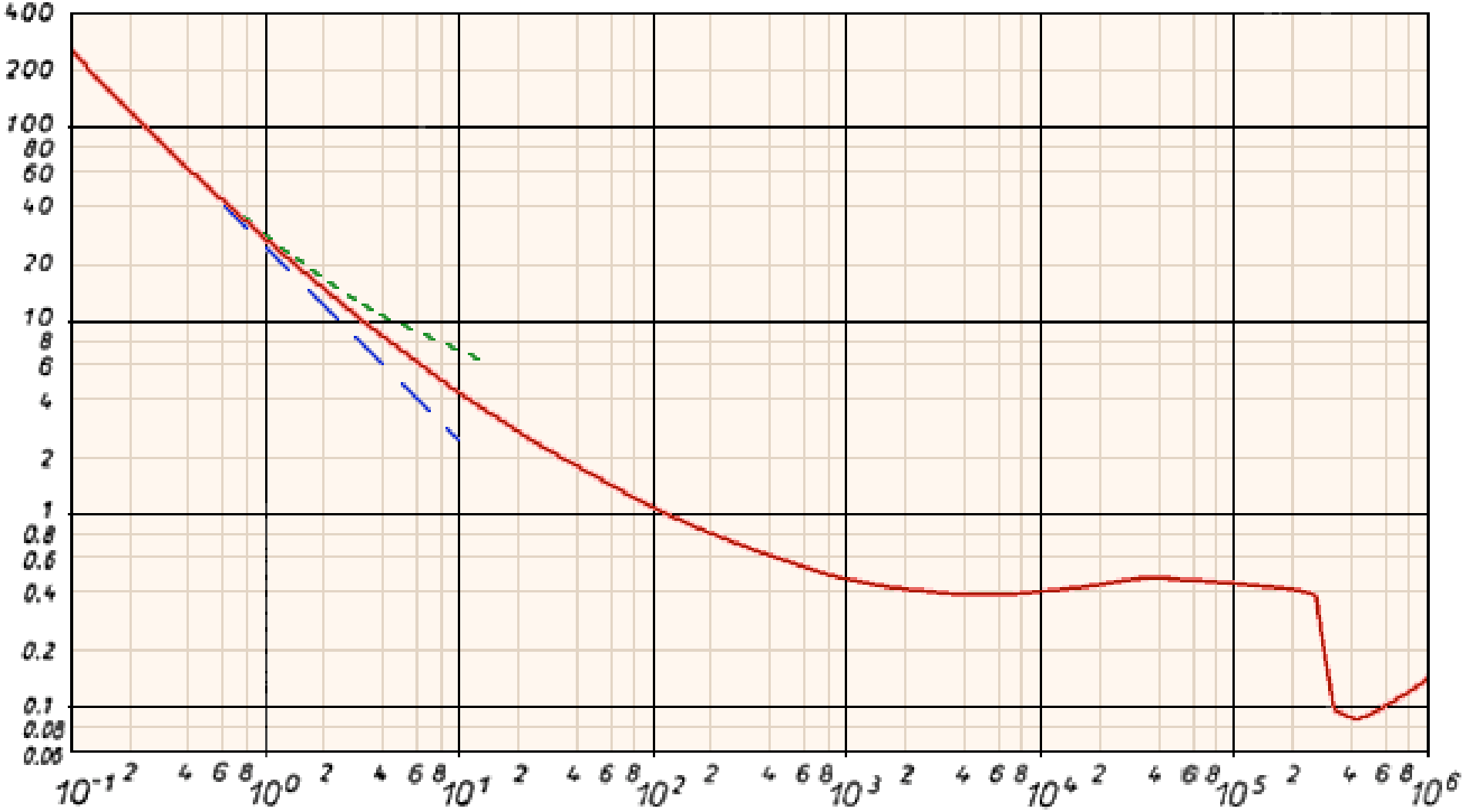
Able to maintain altitude and attitude without control inputs

Controllability:

Able to dictate direction of movement and rotation

X-29: Unstable but Controllable

Coefficient of Drag vs. Reynolds Number for a sphere



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