Gateway To Space

ASEN 1400

Class #3

Colorado Space Grant Consortium
Today:

- Announcements

- One Minute Report Questions

- Next Time

- BalloonSat Overview & RFPs
Day in Space:

THE MARTIAN
Day in Space:
Announcements:

- HW#1 DUE
- HW#3 Q?s 1 – 3 Assigned
- Pictures and 1st time?
Announcements:
- Spatial Visualization test due Wednesday at 9 AM
- 3 received 100%

PSVT PreTest Class Statistics

<table>
<thead>
<tr>
<th>Metric</th>
<th>Value</th>
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<tbody>
<tr>
<td>Number of submitted grades</td>
<td>41 / 599</td>
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<tr>
<td>Minimum</td>
<td>50 %</td>
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<tr>
<td>Maximum</td>
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<tr>
<td>Average</td>
<td>79.35 %</td>
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<tr>
<td>Mode</td>
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<tr>
<td>Median</td>
<td>80 %</td>
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<td>Standard Deviation</td>
<td>13.24 %</td>
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Grade Distribution

Grade Received (%)
Announcements:

- Workshops start next Tuesday and Thursday for those that did not pass

- Look for email from Jacob Segil

<table>
<thead>
<tr>
<th>Block A</th>
<th>Session A (Tuesdays, 5-7pm, ITLL 150)</th>
<th>Session B (Thursdays, 5-7pm, ITLL 150)</th>
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<tbody>
<tr>
<td>Week 1</td>
<td>9/6 &amp; 9/8</td>
<td>Isometric Drawing</td>
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<tr>
<td>Week 2</td>
<td>9/13 &amp; 9/15</td>
<td>Orthographic Views</td>
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<td>Week 3</td>
<td>9/20 &amp; 9/22</td>
<td>1D &amp; 2D Rotations</td>
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<td>Week 4</td>
<td>9/27 &amp; 9/29</td>
<td>Review + TEST</td>
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<td>Block B</td>
<td>Winter Break</td>
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<td>Week 5</td>
<td>10/4 &amp; 10/6</td>
<td>Individual Help</td>
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<td>Week 6</td>
<td>10/11 &amp; 10/13</td>
<td>Write a Rule</td>
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<td>Week 7</td>
<td>10/18 &amp; 10/20</td>
<td>Time Trials</td>
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<tr>
<td>Week 8</td>
<td>10/25 &amp; 10/27</td>
<td>Review + TEST</td>
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*makeup sessions on Sundays 4-6pm in ITLL 150*
Announcements:

- Class email list
- Check that email is on the list
- Make any corrections
- If email is missing, write it on the list

<table>
<thead>
<tr>
<th>Email address</th>
<th>Nickname</th>
</tr>
</thead>
<tbody>
<tr>
<td><a href="mailto:aab1141@colorado.edu">aab1141@colorado.edu</a></td>
<td>Aaron Aboaf</td>
</tr>
<tr>
<td><a href="mailto:abett4@gmail.com">abett4@gmail.com</a></td>
<td>Alan Tett</td>
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<tr>
<td><a href="mailto:alha0934@colorado.edu">alha0934@colorado.edu</a></td>
<td>Alan Blaisdel</td>
</tr>
<tr>
<td><a href="mailto:also3761@colorado.edu">also3761@colorado.edu</a></td>
<td>Anahid Blaisdel</td>
</tr>
<tr>
<td><a href="mailto:anbl2346@colorado.edu">anbl2346@colorado.edu</a></td>
<td>Ashley Montalvo</td>
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<td><a href="mailto:asmo4361@colorado.edu">asmo4361@colorado.edu</a></td>
<td>Audrey Vland</td>
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<td><a href="mailto:ewi3908@colorado.edu">ewi3908@colorado.edu</a></td>
<td>Blake Gambel</td>
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<td>Kassandra Gurule</td>
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<td>Keith Covington</td>
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<td>Lin Ye</td>
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<td>Michael Flores</td>
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<td><a href="mailto:neba8845@colorado.edu">neba8845@colorado.edu</a></td>
<td>Michael Flores</td>
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</tbody>
</table>
Announcements:

- Calculus

- High school vs. College

- A different animal in college

- Training for a race the day before…muscle building

- Take a minute to write…
One Minute Report Questions:

http://www.goatslive.com
Next Time...

Team Forming and Team Activity

HW #2 DUE
HW #3 Questions 3 – 10 & Proposal Assigned
Other Questions?

Colorado Space Grant Consortium
Space Minor:

- Purpose is to illustrate that all undergraduates can be involved in the global space economy

- Open to any major from any college/school on Boulder campus

- 15 Credit hours (including required class)

- Press release today, event Thursday, bigger event in October

- Enrollment starts today
**Space Minor:**

**SPACE MINOR FOR ALL MAJORS**

Undergraduates from all disciplines can be part of the growing space economy worldwide.

**SET YOURSELF APART**

Enrich your major degree with the CU Space Minor. Gain a broad background in all aspects of space including, climate exploration, human spaceflight, arts, business, spacecraft systems, media, history, policy, and more...

[www.colorado.edu/spaceminor](http://www.colorado.edu/spaceminor)

**SEPTEMBER 1, 2016**

Enjoy a talk by Astronaut James Voss and the Planetarium Show *Bella Gaia*. Plus learn about CU Boulder's new Space Minor.

Fiske Planetarium
6:30 – 8:00 PM

Event for interested CU Boulder students only

Be a Space Buff.
Request For Proposals
What is an RFP?

- There is a lot of money out there
- There are a lot of ideas
- **Request For Proposal** bring them together
- Most satellites were at one time an RFP
- Most of you will write or help write a proposal in your job
- Now is your time to practice
BalloonSat Missions to the Edge of Space

Request For Proposal
#RFP 1400F16

Fall 2016 Announcement

Proposal Due No Later Than:
DATE: September 19, 2016
TIME: 8:00 AM
E. Proposal Instructions:

Proposals must be typed, **12 point**, Times font, 1 inch margins, page number and team name in footer, single spaced, and project name in header. Proposal must be **no less than 7 pages and not exceed 10 pages**, including cover sheet and budget. Proposal must include drawings of idea (include dimensions), organization chart with those responsible for each task, functional block diagram, schedule of design, build, and test dates, itemized budget with total, mission statement detailing what you expect to discover. Examples of these items are included in the back of this announcement.

Proposal must be written in Microsoft Word (.docx) and shall not exceed 25 MB. Please send proposal via email to your instructor by 8:00 AM on September 21, 2015. All pictures, budgets and schedules must be included in the single, electronic file. Proposals turned in after deadline will be penalized by 15% to 99% depending on the lateness. There shall be zero unknowns in your proposal (i.e. To Be Determined or Will Figure Out Later). This is not your final design and it can and will change but your mission, at its core, should not unless directed by the instructor. Your weight and cost estimates should be as detailed as possible. Cover the HOW and WHY of your mission in great detail. Most students lose all their points here. Avoid weasel words. **Do a VERY professional job on the formatting as well.** Proposals shall be written in the third person.
RFP Tells How to Write a Proposal

- RFP give you format for proposal

- Three sections

I. Overview and Mission Statement: (WHY and WHAT?)
- State your mission concept concisely (Mission Statement)
- Explain WHY you want to do what your team is proposing
- Propose WHAT you plan to discover
- This section shall be at least one page of your proposal
- The WHAT and/or WHY should be referenced with at least three sources (i.e. do research on the WHAT and WHY of your mission and cite those research references).
II. Technical Overview: (HOW?)

- Explain completely HOW you will achieve your WHAT and WHY above with proposed design (Small changes expected as your design becomes more refined)
- Illustrate your design (Drawings with dimensions with design components shall be labeled)
- Discuss the hardware you will need and where you plan to acquire it
- Discuss HOW your team will turn your design into an actual satellite ("we will order hardware XYZ and then test with hardware ABC and then we will integrate it into the structure and then we will test the XYZ and then we will use these results to make further changes.)
- Discuss HOW your team will test your design to ensure it meets all your science and mission objectives. This means have a detailed test plan.
- Discuss HOW you will keep people from getting hurt
- Include the special features of your design and HOW they will enhance and/or help you achieve your mission
- Include a preliminary summary of HOW you will do data retrieval during testing and after launch and recovery
- Include a Functional Block Diagram showing HOW all your systems of your design work together (HINT - Chris really likes these diagrams)
- Include a plan on HOW your team intends to track, meet, and verify all the requirements (coming up in Section G) of this RFP.
- All these requirements shall also be discussed in your proposal.
III. Management and Cost Overview: (WHO, WHEN, and COST)

- Create a detailed schedule of WHEN these events will occur. You may discover others to include while creating this schedule.
  (Design complete, acquire all hardware, prototyping design complete, testing final design complete, cold test complete, design reviews, other activities described on class syllabus (demos, mission sims, inspections, weigh-in), team meetings, etc)

- Include an organizational chart of WHO is on your team and their title

- Provide a plan of WHO is going to do what on the team with specific tasks listed (i.e. manage budget, software modification, camera programmer, etc.)

- You should include a brief description of WHO each team member.

- Document phone numbers, school, addresses, special skills, etc.

- Create a detailed and itemized budget for project COSTs with total including where hardware will be ordered.

- Include a plan on HOW your team will keep its budget & WHO will manage it.
To Recap RFP:

- Final weight shall not exceed 864 grams

- Shall image the Earth or the Balloon during flight, record internal and external temperature, humidity and pressure levels, and g forces in x, y, and z directions

- Must have one additional experiment and one additional sensor (minimum)

- Must follow all the guidelines while writing proposal

- Why and How – this is your plan and foundation for project

- Using screen shots…
So...

- Take the ideas you came up with individually during the HW#2

- Start with these in your team and expand them during HW #3

- But…Keep It Simple Stupid (KISS Principle)

- Start now!

- You are writing a proposal not a request for proposal

- Proposals Due September 19th (20 days)
- Launch is November 12th, (74 days)
Presentation:

Presentation Templates

- On Class Website

- Final presentation should cover same items in final report

- CoDRs are before Proposals (Elevator Pitch)

- Quick Look Presentation (Post Launch)

- Final Presentations before Final Report
Final Written Report:

Design Document Template

- You will write your team’s final report throughout the semester with our Design Document revisions

- 1st Draft of DD Rev D is due at Expo

- Final draft is due after final presentations to allow incorporation of action items from Expo, presentations
Team Video (Optional):

- Must be **3 minutes or less**

- Must be turned in at Expo

- Must be “**presentable**” to the public

- Extra, extra, extra credit if it goes viral (more than 100,000 hits)
Drawings:
Functional Block Diagrams
Concept of Operation Diagram

**Flight:**
- At take off, the accelerometer will detect ascent rates.
- As altitude increases, sensors will detect changes in temperature, pressure, and humidity.
- After burst, the accelerometer will detect the descent rates.
- As altitude decreases, sensors will keep detecting changes in pressure, humidity, and temperature.

**Post Flight:**
- At most extreme altitudes, the bacteria will be exposed to high level radiation, which the Geiger Counter will detect.
- Prepare Satellite for another launch and follow this procedure.

**Data and Analysis:**
- Bacteria will be taken to Mr. Kralji’s lab for incubation and analysis.
- After recovery, SD Cards and Arduinos will be connected to computers in order to transfer and collect the data from the flight.

**Pre-Launch:**
- 12 hours prior to launch, culture and sustain bacteria.
- Assembly of structure and subsystems.

**Launch:**
- Seal structure with glue and aluminum tape.
- All switches on.
- Camera turned on.

**Recovery:**

**Data and Analysis:**
**Concept of Operations**

**Flight**
- **Heater** turns on and begins to warm the interior
- **Arduino One** SD stores the collected data
- **Arduino Two** powers on and stores data for Magnetometer
- **Arduino Two** powers and measures radiation, heading, and external temp
- **Arduino Three** powers on and measures internal temp, pressure, humidity, and acceleration
- **After 500 photos** takes video until SD full
- **Camera** begins taking pictures every fifteen seconds

**Ground**
- **Heater light** turns on
- **Arduino One Two and three switch** light turns on
- **Flip Camera and Heater Switch to on**
- **Flip Arduino Uno switches to on**
- **Scan Structure with Aluminum Tape**

**Post Landing**
- **Track and retrieve via GPS**
- **Power off all switches**
- **Open data on laptops**
- **Analyze and draw conclusions**
- **Check functionality and ability to fly again**
**Concept of Operation**

**Mesosphere**
- Take pictures on specific intervals of time
- Collect data on altitude, beta, gamma, UV and IR radiation, temperature (internal/external), pressure, acceleration, and humidity
- Save data on a micro SD card
- Arrive at launch site
- Prepare balloon
- Turn on payload with switches
- LED’s indicate they are functioning
- Seal payload lid with aluminum tap
- Lift off!!

**Stratosphere**
- Balloon burst at ~30 km
- Reach a possible acceleration of 10 G’s towards Earth
- Parachute deployment

**Troposphere**
- Payload recovery with GPS
- Expected LED’s off
- Expected batteries to be dead
- Data collection terminated

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**50 KM**

**10 KM**
**Concept of Operations Diagram**

- **Assemble of Structure and Subsystems**
  - Ensure structure is sealed
  - Turn switches on
  - Turn camera on

- **Measure Changes in Temperature, Pressure, and Humidity as Altitude Increases**

- **Solar Panel and Wind Turbine Collect Energy and Voltages for Each Will Be Logged**

- **Balloon Ruptures**
  - Accelerometer measures g-forces during burst

- **Measure Changes in Temperature, Pressure, and Humidity as Altitude Decreases**

- **Accelerometer Measures Descent Rate**

- **GPS Leads Gateway to Space Class to Recovery Site**
  - Turn switches off
  - Turn camera off

- **SD Shields and Arduinos Are Connected to Computers to Collect Data**

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**Timeline:**
- **PreLaunch**
- **Launch**
- **Ascent**
- **Burst**
- **Descent**
- **Recovery**
- **Data Analysis**
So…

- Get started now (Due in 20 days)

- Teams next class (Due in 18 days)

- Be opened minded about your team and how ideas fit into the team’s ideas
Questions?

Colorado Space Grant Consortium
BalloonSat Overview

Class #3

Colorado Space Grant Consortium
Origins:

- Started at Space Grant June 2000
- Was a student at Space Grant 1990-1995
- Programs had advanced
- Hard for freshman students to get plugged in
- Sink or Swim
Origins:

What if students could get close to space?

- Met Edge of Space Sciences (EOSS) in Fall 1996
Origins:

- Promise of recovery and 100,000 feet
- Price was right
- Many launches every year
- Some of the same engineering challenges
Origins:

With the combination of these items, BalloonSat was born
The StratoShuttle-1 student balloon, an educational project by the Quest for Stars group, captured NASA's shuttle Atlantis soaring into orbit as seen from 89,000 feet on July 8, 2011. Tweeted @questforstars: "Atlantis, GO at Throttle up!"
CREDIT: Quest for Stars
View full size image
**BalloonSat:**

- BalloonSat is an excellent, low cost platform for “Walk” level student missions to the Edge of Space.

- A BalloonSat weighing up to 9 kg can reach 30 km (100,000 feet).

- Students faced with many engineering challenges
  - Mach 1, -80 C, near vacuum, impact and burst

- No microgravity but BalloonSat can be recovered.
# Ballooning

## Some Visible Characteristics of Near Space

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<th>Altitude</th>
<th>Pressure</th>
<th>Horizon</th>
<th>Sky Color*</th>
<th>Cosmic Rays**</th>
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<tbody>
<tr>
<td>Ground</td>
<td>1013 millibars</td>
<td>3 miles</td>
<td>Blue</td>
<td>4 counts/min All secondaries</td>
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<tr>
<td>85,000 feet</td>
<td>20 millibars</td>
<td>350 miles</td>
<td>Black</td>
<td>700 counts/ Min Primaries and Secondaries</td>
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<tr>
<td>300 miles</td>
<td>0 millibars</td>
<td>1500 miles</td>
<td>Black</td>
<td>? All Primaries</td>
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</table>

* Chapter Fourteen discusses the topic of sky color  ** Chapter Eight discusses the topic of cosmic rays
Ballooning

- Ballooning is inexpensive
  - Helium (~$800) - Now Hydrogen (~$30)
  - Balloon (~$300)

- You mostly control launch
Ballooning

When your balloon and payload ascend into the sky...

Every student knows, their experiment is going where no one - except astronauts - has ever gone before
BalloonSat Construction:

Aluminum Construction

Foam Core Construction
BalloonSat Construction:

- Velcro
- Silicon Adhesive and Hot Glue
- Aluminum Tape

- Insulation
- Venting
- Condensation
BalloonSats

- Easy to attach to balloon
- Easy to track and Recovery
- Fun for all
- You will build one this semester
What you will get:

- Batteries (some)
- Black Foam Insulation ¼ and ½ inch
- 3 half sheets
- Velcro & hot glue
- Aluminum tape
- Xacto knives
- Flight tube USA flag
- Coolers
- Multimeter & Wire
- Gateway Store
What you will get:
What you will get:

- Must fill out inventory sheet when you use the store
What you will get:
What your team supplies:

- Batteries (some)
- Dry Ice
- Mission
- Design
- Time & Effort - Build, Test, Document, Fly, Recovery, & Analyze
- Hardware order forms (HW #6)
Past Student Experiments:

- Atmospheric radiation levels
- Solar cell efficiency
- Atmospheric soundings
- Video imaging
- High altitude effects on roaches
- Digital sound recording of upper atmosphere
- Temperature studies

Use Past Team Reports
Launch:

- Sites typically in eastern Colorado
- Liftoff is 7:00 AM
- 90 minutes up, 45 minutes down
Launch: Supported by EOSS

- 3000 gram latex balloon
- Gaseous Hydrogen (~2 K bottles)
- Balloon filling system
- Flight string
- Radio Transceiver
- GPS
- Control Systems
- Parachute
- FAA notification
Introductions:
Introductions:
**Burst:**

- Altitude variable
- One of the most violent moments of the flight
- Mach I

Series of burst images
BalloonSats - Interesting burst
BalloonSats

- Interesting burst
Launch Review:
Recovery:

Thursday, November 4, 2004

What is it?

HAZELTON — Joe Nelson of Hazelton made an interesting discovery in one of his fields recently while he was harvesting.

A silver box approximately 5 1/2 inches square with wires and bolts sticking out of it was laying among the vines in the field. It was near dark and difficult to see any details.

“My first thought was that it was a bomb,” Nelson said.

The next morning after having a closer look, Nelson could see a hole cut in one side of the box with a camera in it. There also what appears to be an antenna on one side and a switch on another. A long bolt appears to be running through the contraption, sticking out 3 inches on each side.

The box looks to be made of foam board held together by foil and duct tape. Several stickers of badgers and American flags decorate the box.

In another nearby field, he found a similar contraption. This one was white with stickers saying USA1 and a second box was connected to it by a cable.

Nelson said that the boxes may have been part of a school science experiment and someone may want to retrieve the cameras from the boxes.

For more information, call Trena at 677-4042, extension 600.
Recovery:

- Begins after launch
- Can track real-time
- Recovery complete same day
BalloonSat Testing:

- Drop Test
- Cooler Test
- Subsystem Tests
- Functional Tests
- Mission Sim Tests
- Whip Test

DO NOT FOCUS ON STRUCTURAL TESTING ONLY
Quick Lesson on the Atmosphere
Environments at 30 km:

- How high do commercial jet fly? ~10 km
- How high is the ozone layer? ~20 to 50 km
- What are the layers of the atmosphere?
The 4 Layers of the Atmosphere:

- Troposphere
- Stratosphere
- Mesosphere
- Thermosphere
Environments at 30 km:

• Troposphere
• Stratosphere
• Mesosphere
• Thermosphere
Environments at 30 km:

Capt. Joe W. Kittinger jumps from a balloon at 102,800 feet

Forgot to mention, he exceeded the speed of sound with his body
Temperature varies in all directions as you climb through the different layers of the atmosphere.

Why?

Solar Radiation (UV, IR)
- Ozone Absorbs
- Surface Heats
- Convection
Environments at 30 km:

- Temperature can dip to -80°C
- Biggest killer of past missions
- Easy, repeatable science
Back to BalloonSats...
History and Results:
History and Results:

- Over 100 launches
- 18,550 students
- 98% recovery rate
- 90% recovered with some data
- 50% recovered with all expected data
- Papers have been written and presented
- More than 50% of students have continued with more research projects
History and Results:
History and Results:
Launch Review:
Introductions:
Introductions:
Introductions:
Introductions:
BalloonSats:

- BalloonSats are excellent way to do hands-on research
- Motivates you to go further
- See importance of your education
- Prepared to contribute to more complex projects
- Have the confidence to take the next step
Questions?