Gateway To Space

ASEN / ASTR 2500

Class # 02

Colorado Space Grant Consortium
1 Minute Reports:

- Is building and team stuff done during class? If so how much?
- Homework slides went by quickly
- More on the actual meat of the class
- Clarify how to write email so you get them
- What is Space Grant and how do I get involved?
- How do the resume?
- Go over website and homework at the beginning
- What exactly are we building in this class?
- Are we doing anything with UAV’s?
Spacecraft Systems Overview
Introduction:

- Say you wanted to put this into orbit…

- What are some of the questions you would need to answer?
**Answers:**

- The answers make up most spacecraft systems
- Today we’ll look at most of them
Questions:

- What would you have to worry about?

- What would you need?

- How much would it cost?

- How much would it weigh?

- How long would it work?

- What type of orbit would it need to be in?

- How long would it take to get it to orbit?

- How do you know it will work when it gets there?
What To Worry About?

- Radiation
- Temperature Extremes
- Vacuum of Space
- Atmospheric Drag
- Cleanliness
- Launch Loads
- Shock
- Power
- Mission Life
- Autonomy
- Cash
- Pointing
- Schedule
- Weight
### What Do You Need?

<table>
<thead>
<tr>
<th>System</th>
<th>What Do You Need?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Launch Vehicle</td>
<td>Schedule</td>
</tr>
<tr>
<td>Temperature Control System</td>
<td>Budget</td>
</tr>
<tr>
<td>Communication System</td>
<td>Plan</td>
</tr>
<tr>
<td>Command and Data System</td>
<td>Testing</td>
</tr>
<tr>
<td>Structure and Mechanisms</td>
<td>Reliability</td>
</tr>
<tr>
<td>Power System</td>
<td>Operators</td>
</tr>
<tr>
<td>Attitude System</td>
<td>People, People, People</td>
</tr>
<tr>
<td>Software</td>
<td>Organization</td>
</tr>
<tr>
<td>Propulsion System</td>
<td></td>
</tr>
<tr>
<td>Cash</td>
<td></td>
</tr>
</tbody>
</table>
What Do You Need?
Organization?

- Teamwork

- Project Management
  - Systems Engineering
    - Comm
    - Structures
    - Thermal
    - ADCS
    - C&DH
    - Power
      - Ground Ops
      - Education
      - Web
      - Science
      - Software
      - MOPS
Do you want to take picture of Boulder every day?
- At the same time?
- As many times as possible per day?

- Pick orbit right up front

**Different Types of Orbits**
- Polar Orbits
- LEO
- GEO
- Different altitudes and inclinations
- Sun Synchronous Orbits

- STK (Satellite Tool Kit)
Launch Vehicle:

- Then pick launch vehicle based on your orbit needs

- Weight needs

- Cost needs

- Certain launch vehicles can’t go to all orbits
Structure:

- Your launch vehicle helps direct your structure design

- Volume, CG, and weight constraints

- Launch loads and shock issues associated with LV

- Interface constraints

- Vibration constraints
Structure:
Structure:
Structure:
Structure:
The whole purpose of the structure is to support the payload.

Then the other systems:

- Composites
  - Honeycomb

- Aluminum
  - Plate
  - Isogrid

- Titanium

- Stainless Steel
Mechanisms:

- In addition to structure you have mechanisms
- People are afraid of mechanisms
- Two types, deployment and payload support
- They usually are single point failures
- Hard to test on ground as they are used in space
  - Mast example (Special Programs, Balloon)
  - KC-135 Boom Video
Boom:
Mechanisms:
Mechanisms:

- Deployment failures usually are mission ending
- Spacecraft design try to minimize mechanisms
- Deployment mechanisms are the biggest concern
- Pointing mechanisms are less of an issue
Mechanisms:
Communication:

- Think of it as an internet connection
- Data rates are similar
- Can only connect for 10 minutes (pass time)
  - This can vary based on orbit

- Transmitter (TX)
- Receiver (RX)
- Antennas (TX, RX, and Ground)
- Sometimes modems and TNC
- TX are big power hogs but usually not on all the time

- Cell phone technology
- IP technology
**ADCS:**

- Attitude Determination and Control System

- Driving a car on a mountain pass at night without headlights and no tires

- Some determination can be done on ground

- Determination System
  - Star Trackers, Magnetometer, Sun Sensors
  - Booms
ADCS:

- Controls Systems
  - Torque Rods, Momentum Wheel, Thrusters, gyros

- A lot of software and control laws
There is high likelihood of power being the reason a satellite fails.

- Miniature power plant

- Most spacecraft use less power than a 300 W light bulb

- Very complicated system

- Batteries
*Power:*

- Solar cells
- Charging circuits
- Distribution system
- Control system
- Conversion system
Propulsion:

- Is limiting factor on long missions
- Station keeping
- Attitude Control
- Delta V burns (orbit maneuvers)
- Atmospheric Drag

- Different types
  - Mono-propellant
  - Bi-propellant
  - Cold Gas
  - Ion
Propulsion:
Thermal:

- Can make or break a system literally

- Three types of thermal control: Active, Passive, Do Nothing

- Active
  - Heaters, heat pipes, thermostats, cryogenics

- Passive
  - Radiators, insulation, surface finishes, conductive materials

- Do Nothing

- Usually a combination of first two
Thermal:
Thermal:
- Command and Data Handling

- The brain of a satellite

- Is pretty dumb without software

- Basically a home computer but much smaller and less of a power hog

- Very difficult system, many unknowns and bugs
C&DH:

- Consists of:
  - Motherboard or CPU
  - Firmware
  - Storage device or medium
  - Sub-nets or sub processors
  - Many sensors
  - Many interface boards
Software:

- Programmers are worth weight in gold
- Days of Voyager spacecraft are over
- Today, satellites are very complex and so is the software
- Software is usually last thing done
- Last minute fixes are very dangerous
Mission Operations:

- “Houston, we have a problem”
- MOPS is the command center of the satellite
- All human interaction occurs through this team
- Much coordination is required to properly operate satellite
- Failure modes determined FMEA
- Data storage and analysis
- All communication is done through MOPS
- Usually staffed 24/7
Other:

- Management
- Systems Engineering
- Budgets
- Contracts
- Planners
- Manufacturers & Technicians
- Test Engineers
Anatomy of a Satellite:
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Closing Items:

- 1 Minute Report
- Attendance Sheet
- Next time BalloonSat Overview & HW 01
- Who is here for the first time?
- Pictures
- Space Grant Overview