Today:

- Announcements

- One Minute Report Questions

- Lecture on Rocket History (Best Lecture Ever)

- HW #7 Assigned
- DD Rev A/B DUE October 18th 7:00 AM
- pCDR Slides DUE October 18th 7:00 AM
Announcements:

- pCDR Template on website
- Design Document (eventually your final report) is on the website

- Hardware pick ups

- Passwords

- Review of Requirements
Announcements:

- Requirements are clear

1. NECESSARY
2. TRACEABLE
3. HAVE A METHOD OF VERIFICATION
4. ATTAINABLE
5. CLEAR

WARNING
NO LIFEGUARD ON DUTY
SWIM AT YOUR OWN RISK
SHALLOW WATER – NO DIVING, BACK DIVES OR BACK FLIPS

- Hours of pool operation are from 05:00 a.m. to 11:00 p.m.
- Pool depth is 3 ft. 6” at shallow end and 4 ft. 6” at deep end.
- An illustrated diagram of artificial respiration procedures and a telephone for an emergency is located near the Health Club water station.
- Pool is for exclusive use of hotel guests and their respective guests.
- No child under age 16 should use the pool unless accompanied by a parent or adult guardian.
- All bathers must shower prior to entering the pool.
- No glass bottles, jars, or other glass items allowed.
- No running, boisterous play, or excessive noise in pool.
- No diapers in pool.
- No person shall spit in, or in any other way contaminate the pool, its floors, or dressing rooms.

No person shall spit in, or in any other way contaminate the pool, its floors, or dressing rooms.
- Requirements flow from your mission statement and mission objectives
- Level 0 and Level 1
Anatomy of Requirements

**Mission Statement (aka Mission Goal)**
A very general description of the problem being addressed by the system.

**Mission Objectives**
3 to 5 general statements elaborating the Mission Statement.

**Objective Requirements**
Quantify each objective: when, what, where, for how long

**System Requirements**
The system as a whole must perform to this set of specifications in order to meet the objective requirements, mission objectives, and mission statements

**Subsystem Requirements**
Each subsystem must perform to these specifications in order to meet the criteria defined above. This part is done separately for each subsystem i.e. power, mechanical, computer, science, thermal.

---

**Step 1: General definition.**
Subjective description and a few numbers

**Step 2: Numbers and ranges.**
Focus in on defining the problem.

**Step 3: Subsystems.**
Repeat step 2 for every subsystem, tracing from system requirements.
Announcements:

- Good examples to look at from 2011
  - Team 05
  - Team 07

- Good examples to look at from 2010
  - Team 01
  - Team 02
  - Team 04
  - Team 05
  - Team 09
Announcements:

2.0 Requirements Flow-Down Chart

Mission Statement: Our BalloonSat *Aliquid In Spatio* will ascend to approximately 30 kilometers into the atmosphere to determine if bacterial microbes that inhabit the surface of the earth are able to withstand the harsh environment of near space, as well as to attempt to discover if there are bacterial microbes that inhabit the tropopause.

Objective 1 (Derives from Mission Statement): Our BalloonSat will measure the inside temperature, outside temperature, and humidity of the BalloonSat during the flight to assess the environment.

Objective 2 (Derives from Mission Statement): Our BalloonSat will also carry our bacterial samples into near space to test them if they can survive in that harsh environment.

Objective 3 (Derives from Mission Statement): Our BalloonSat will carry a sterile petri dish and expose it to the atmosphere at the altitude of the tropopause to see if any bacteria live in that environment.

Requirement 0.1 (Derives from O1) We will run the HOBO datalogger for the entirety of our flight to gather inside and outside temperature as well as humidity data from the start to finish of our flight.

Requirement 0.2 (Derives from O2) We will carry three different sets of bacteria to test if they can survive. We will expose one set of bacteria to all of the effects of near space: low temperature, low pressure, and radiation. We will then expose one set of bacteria to just the radiation by sealing it so it retains pressure and by heating it so it does not go to low
<table>
<thead>
<tr>
<th>Requirement</th>
<th>Description</th>
<th>Parent Req.</th>
<th>Verification</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1</td>
<td>The radiation system shall measure UV radiation as altitude increases</td>
<td>Mission Statement</td>
<td>Verified through verification of requirements S1-S4</td>
</tr>
<tr>
<td>P2</td>
<td>The camera system shall record the flight from launch until landing through a series of pictures</td>
<td>Mission Statement</td>
<td>Verified through verification of requirements S5, S5.1</td>
</tr>
<tr>
<td>P3</td>
<td>The balloon sat shall follow the requirements presented in the balloon sat user guide</td>
<td>Mission Statement</td>
<td>Verified through verification of requirements S5, S6, S7, S8</td>
</tr>
<tr>
<td>P4</td>
<td>The HOBO system shall record internal and external temperature along with relative humidity</td>
<td>Mission Statement</td>
<td>Verified through verification of requirements S9</td>
</tr>
<tr>
<td>P5</td>
<td>The budget will be under $300 dollars.</td>
<td>Mission Statement</td>
<td>Budget</td>
</tr>
<tr>
<td>Level</td>
<td>Number</td>
<td>Derivation</td>
<td>Description</td>
</tr>
<tr>
<td>-------</td>
<td>--------</td>
<td>------------</td>
<td>------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>0</td>
<td>M.S.</td>
<td>1</td>
<td>Payload must ascend to an altitude of approximately 30.5 kilometers with a balloon provided by the Edge of Space Sciences</td>
</tr>
<tr>
<td>1</td>
<td>M.S.</td>
<td>2</td>
<td>Payload must collect and store science data related to the mission objective</td>
</tr>
<tr>
<td>2</td>
<td>M.S.</td>
<td>3</td>
<td>The payload must carry an active heater system, keeping the internal temperature of the payload above -10°C</td>
</tr>
<tr>
<td>3</td>
<td>M.S.</td>
<td>4</td>
<td>The payload must be constructed from foam core</td>
</tr>
<tr>
<td>4</td>
<td>M.S.</td>
<td>5</td>
<td>The total mass of the payload must not exceed 850 grams and the budget of the project must not exceed three-hundred dollars.</td>
</tr>
<tr>
<td>5</td>
<td>M.S.</td>
<td>6</td>
<td>The payload must allow for a HOBO H08-004-02 and the provided external temperature cable</td>
</tr>
<tr>
<td>6</td>
<td>M.S.</td>
<td>7</td>
<td>The payload must allow for a Canon A570IS Digital Camera with two AA lithium batteries</td>
</tr>
<tr>
<td>7</td>
<td>M.S.</td>
<td>8</td>
<td>The payload must have contact information written on the external of the payload, alongside an United States flag</td>
</tr>
<tr>
<td>8</td>
<td>M.S.</td>
<td>9</td>
<td>The team will be ready to launch on November 6, 2010, at Windsor, Colorado, at 6:50 AM.</td>
</tr>
<tr>
<td>9</td>
<td>M.S.</td>
<td>10</td>
<td>The team shall adhere to all safety procedures outlined in the proposal</td>
</tr>
</tbody>
</table>
2.0 Requirements Flow Down

The requirements flow down is designed to portray how the requirements relate to the objectives and the goal. The goal is derived from the mission statement. The level 0 requirements are the mission objectives. The mission objectives are derived exactly from the goal and mission requirements presented by Space Grant. Each objective has several requirements underneath it that explain how it will accomplish the objective. The requirements are considered level 1 requirements on the flow chart. In the chart, the name of the objective or requirement is in the left column, the middle column has the specific objective or requirement, and the far right column shows where that specific goal or requirement is referenced.

The goal of Team Lightning Rod was to send a balloon satellite equipped with two electromagnetic generators to an altitude of thirty kilometers to determine if the kinetic energy from vibrational and rotational motion can be harnessed as supplemental energy source for future spacecraft.

<table>
<thead>
<tr>
<th>Objective</th>
<th>Mission Objectives Level 0</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>O1</td>
<td>Fly a satellite to 30 km</td>
<td>Goal (G)</td>
</tr>
<tr>
<td>O2</td>
<td>Keep the internal temperature of the satellite above -10 degrees Celsius</td>
<td>Goal (G)</td>
</tr>
<tr>
<td>O3</td>
<td>Keep the overall weight of the satellite below 1200 g</td>
<td>Goal (G)</td>
</tr>
<tr>
<td>O4</td>
<td>Fly a Cannon Camera and the HOBO datalogger on the satellite</td>
<td>Goal (G)</td>
</tr>
<tr>
<td>O5</td>
<td>Capture and store vibrational energy using the vibrating electromagnetic generator</td>
<td>Goal (G)</td>
</tr>
<tr>
<td>O6</td>
<td>Capture and store rotational energy using the rotating electromagnetic generator</td>
<td>Goal (G)</td>
</tr>
<tr>
<td>O7</td>
<td>Compare the results of the rotational generator and the vibrational generator to see which one is most effective</td>
<td>Goal (G)</td>
</tr>
</tbody>
</table>
### Objective 1 Requirements Level 1

<table>
<thead>
<tr>
<th>Requirements</th>
<th>Objective 1 Requirements Level 1</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>O1.R1</td>
<td>Satellite <em>Zeus</em> shall be attached to a helium weather balloon that shall carry it up to 30 km.</td>
<td>O1</td>
</tr>
<tr>
<td>O1.R2</td>
<td>Satellite <em>Zeus</em> shall be attached to the balloon on a piece of rope that shall run directly through the center of the satellite.</td>
<td>O1</td>
</tr>
<tr>
<td>O1.R3</td>
<td>Satellite <em>Zeus</em> shall be kept stable on the rope by using washers and clips.</td>
<td>O1</td>
</tr>
</tbody>
</table>

### Objective 2 Requirements Level 1

<table>
<thead>
<tr>
<th>Requirements</th>
<th>Objective 2 Requirements Level 1</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>O2.R1</td>
<td>Satellite <em>Zeus</em> shall be kept above -10 degrees by using an electric heater that shall be created by Team Lightning Rod and shall be powered using 9V batteries.</td>
<td>O2</td>
</tr>
<tr>
<td>O2.R2</td>
<td>Satellite <em>Zeus</em> shall have ½ inch foam insulation to keep the Satellite above -10 degrees Celsius.</td>
<td>O2</td>
</tr>
<tr>
<td>O2.R3</td>
<td>Satellite <em>Zeus</em> shall also have no holes to contain the heat in the satellite.</td>
<td>O2</td>
</tr>
</tbody>
</table>

### Objective 3 Requirements Level 1

<table>
<thead>
<tr>
<th>Requirements</th>
<th>Objective 3 Requirements Level 1</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>O3.R1</td>
<td>Satellite <em>Zeus</em> shall be less than 1200 grams by keeping a very meticulous budget that keeps track of the weight of every piece of equipment that shall be on the satellite.</td>
<td>O3</td>
</tr>
</tbody>
</table>

### Objective 4 Requirements Level 1

<table>
<thead>
<tr>
<th>Requirements</th>
<th>Objective 4 Requirements Level 1</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>O4.R1</td>
<td>Satellite <em>Zeus</em> shall fly the Cannon camera to capture photos of near space.</td>
<td>O4</td>
</tr>
<tr>
<td>O4.R2</td>
<td>The camera on Satellite <em>Zeus</em> shall be programmed ahead of time so that it shall work independently of all other electronics during the flight.</td>
<td>O4</td>
</tr>
<tr>
<td>O4.R3</td>
<td>The HOBO datalogger shall be a standalone item in the satellite that shall record the internal temperature, external temperature, and relative pressure as measured by the sensors.</td>
<td>O4</td>
</tr>
<tr>
<td>O4.R4</td>
<td>The HOBO datalogger information shall then be used to determine the satellites position at certain times during the ascent and descent of the satellite.</td>
<td>O4</td>
</tr>
</tbody>
</table>

### Objective 5 Requirements Level 1

<table>
<thead>
<tr>
<th>Requirements</th>
<th>Objective 5 Requirements Level 1</th>
<th>Reference</th>
</tr>
</thead>
</table>
**OBJECTIVE**

The mission of Team Solkraft is to test the effectiveness of different types of solar panels (monocrystalline and polycrystalline) under conditions on the ground and up to near-space conditions of approximately 30 km.

**MISSION REQUIREMENTS LEVEL 0**

<table>
<thead>
<tr>
<th>Requirement Number</th>
<th>Requirement</th>
<th>Where it comes from</th>
</tr>
</thead>
<tbody>
<tr>
<td>M 0.1</td>
<td>The solar panels on the BalloonSat shall be exposed to near-space conditions</td>
<td>Mission Objective</td>
</tr>
<tr>
<td>M 0.2</td>
<td>Team Solkraft shall measure the internal and external temperature with varying altitude</td>
<td>Mission Objective</td>
</tr>
<tr>
<td>M 0.3</td>
<td>Team Solkraft shall measure the light intensity with varying altitude</td>
<td>Mission Objective</td>
</tr>
<tr>
<td>M 0.4</td>
<td>Team Solkraft shall test for variations in solar cell output under varying climate conditions</td>
<td>Mission Objective</td>
</tr>
<tr>
<td>M 0.5</td>
<td>Team Solkraft shall meet the requirements for the request for proposal</td>
<td></td>
</tr>
<tr>
<td>M 0.6</td>
<td>Team Solkraft shall make sure no one is hurt during construction and testing</td>
<td></td>
</tr>
</tbody>
</table>

**MISSION REQUIREMENTS LEVEL 1**

<table>
<thead>
<tr>
<th>Requirement Number</th>
<th>Requirement</th>
<th>Where it comes from</th>
</tr>
</thead>
<tbody>
<tr>
<td>M 1.1</td>
<td>The solar panels shall be attached to the angled sides of the BalloonSat</td>
<td>M 0.1 M 0.4</td>
</tr>
<tr>
<td>M 1.2</td>
<td>Team Solkraft shall be able to record the altitude of the BalloonSat using data from EOSS GPS</td>
<td>M 0.2, M 0.3</td>
</tr>
<tr>
<td>M 1.3</td>
<td>Team Solkraft shall be able to record and save data during the flight</td>
<td>M 0.2, M 0.3, M 0.4</td>
</tr>
<tr>
<td>M 1.4</td>
<td>Team Solkraft shall maintain a minimum internal temperature of</td>
<td>M 0.5</td>
</tr>
</tbody>
</table>
# Level 0 Requirements

<table>
<thead>
<tr>
<th>#</th>
<th>Requirement</th>
<th>Origin</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>Test energy generation capabilities of Earth's magnetic field</td>
<td>Mission Statement</td>
</tr>
<tr>
<td>0.1</td>
<td>Measure magnetic field as function of altitude</td>
<td>Mission Statement</td>
</tr>
<tr>
<td>0.2</td>
<td>Reach an altitude of 30km</td>
<td>Mission Statement</td>
</tr>
<tr>
<td>0.3</td>
<td>Keep internal temperature above -10°C</td>
<td>RFP</td>
</tr>
<tr>
<td>0.4</td>
<td>Keep total weight and money spent under 850g and $250 respectively</td>
<td>RFP</td>
</tr>
<tr>
<td>0.5</td>
<td>Take inflight pictures, correlate pictures to heading, and measure temperature (internal and external)</td>
<td>RFP</td>
</tr>
<tr>
<td>0.6</td>
<td>Safety &amp; Reliability</td>
<td>RFP</td>
</tr>
<tr>
<td>0.7</td>
<td>BalloonSat must be able to fly again</td>
<td>RFP</td>
</tr>
</tbody>
</table>

# Level 1 Requirements

## Requirement 0.0: Test energy generation capabilities of Earth's magnetic field

<table>
<thead>
<tr>
<th>#</th>
<th>Requirement</th>
<th>Origin</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0.0</td>
<td>Induce emf (electromotive force) in solenoid</td>
<td>0.0</td>
</tr>
<tr>
<td>0.0.1</td>
<td>Measure current with ACS712 Low Current Sensor Breakout</td>
<td>0.0</td>
</tr>
<tr>
<td>0.0.2</td>
<td>Record and timestamp current readings with Arduino Uno</td>
<td>0.0</td>
</tr>
<tr>
<td>0.0.3</td>
<td>Measure resistance of solenoid-current sensor-Arduino Uno circuit</td>
<td>0.0</td>
</tr>
<tr>
<td>0.0.4</td>
<td>Calculate power generated in circuit</td>
<td>0.0</td>
</tr>
<tr>
<td>0.0.5</td>
<td>Recover and analyze data and compare with altitude and field strength readings</td>
<td>0.0</td>
</tr>
</tbody>
</table>

## Requirement 0.1: Measure magnetic field as function of altitude

<table>
<thead>
<tr>
<th>#</th>
<th>Requirement</th>
<th>Origin</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.1.0</td>
<td>Measure magnetic field strength with MicroMag 3-Axis Magnetometer</td>
<td>0.1</td>
</tr>
<tr>
<td>0.1.1</td>
<td>Record and timestamp field strength readings with Arduino Uno</td>
<td>0.1</td>
</tr>
</tbody>
</table>
Announcements:

- Refer to previous class final reports
- Great examples of what I am looking for
- Look at graded versions too
- Copy or use format and style but don’t copy text or effort
- Questions on Requirements?
- Questions on Level 0 and Level 1?
Announcements:

- Arduino accelerometer testing...How did it go?
Announcements:

- Pressure Sensor is...
Announcements:

- Arduino Special Session…
- How many are interested in coming to this session?
- If it was during the day?
- If it was in the evening?
Announcements:

- Cameras next class but instructions on the website

- Class email list – Working?

- Who is doing the outreach in Longmont tonight?

- HASP 2013 Team and proposal

- Other teams 1 to 2 RocketSat projects

- Details coming during first week of November
Other thoughts:

- This is the point the class where I may begin frustrate more of you

- No spoon-feeding, you must think on your own

- Will help as long as it is scheduled and not at the last minute
This is the point the class where I will begin frustrate more of you. No spoon-feeding, you must think on your own. Will help as long as it is scheduled and not at the last minute.
Next Tuesday...

Launch Vehicles

Colorado Space Grant Consortium
Next Thursday...

pCDR

DD Rev A/B Due

Colorado Space Grant Consortium
This is the point the class where I will begin frustrate more of you. No spoon-feeding, you must think on your own. Will help as long as it is scheduled and not at the last minute.
Proposals:
Today:

Journey Through Rocket History
Introduction:

- Standing on the shoulders of giants

- In your careers, remember how you got there
What is a Rocket?

- A reaction engine

- Propellant in a chamber, accelerated to high speed and expelled at one end through a nozzle

- Newton’s 3rd Law
What is a Rocket?

- Is a jet engine a rocket?
What is a Rocket?

- Is a balloon a rocket?
What is a Rocket?
What is a Rocket?
Early History:

- **China, 1232**
  - Chinese history in the use of primitive rockets spans centuries
  - Armies fired flaming rockets at enemies
  - Battle of Kai-fung-fu, rockets launched could be heard for 15 miles when launched and upon impact devastated everything in all directions for 2,000 feet
  - Carried incendiary materials and iron shrapnel
Early History:

• **1665 A.D.**
  
  Isaac Newton
  
  - At 23, plague while at Cambridge
  - Went to be one with nature
  - He studied gravity
  - Discovered “Newton’s Laws of Motion”
    
    $F = ma$
  
  - 1666, he understood planetary motion
  - Did zip for 20 years until Edmund Halley
Early History:

• British, 1814
  - In 1799, the British attacked Tippoo Sultan’s Mogol forces in India
  - British forces were bombed by rockets 5,000 rocketeers
  - Losses were severe, but the British learned something
  - British developed a rocket program
  - Used this program on United States
  - Bombed Baltimore for 25 hours
  - Francis Scott Key wrote poem

  “...and the rockets red glare...gave proof through the night that our flag was still there...”
Early History:

- **Confederate States of America, 1864**
  - 12 foot long rocket
  - 10 pounds of gunpowder
  - Launched from Richmond, Virginia
  - Intended to be first ballistic missile
  - Target was Washington, D.C.
  - Brass case marked C.S.A.
  - Roar out of sight
  - Never found
Introduction:

- What’s the point?
- Rockets = weapons
- No real thought on how they worked or functioned
- No control, just light it and hope it doesn’t return
- Someone changed all that…
Verne:

- Jules Verne

- 1866, published, “From the Earth to the Moon”

- He changed the thinking of rockets

- He saw them as method of travel

- He presented the world with a glimpse of the future
Verne:
Verne:
Verne:

- Deeply affected the course of rockets
- Also published Time travel
- Makes you wonder
Tsiolkovsky:

- **Russia, 1883**
  - School Teacher, Konstantin Tsiolkovsky, published famous “Rocket Equation” in 1903
  - Considered mad at time now a monument stands in Moscow
  - Influenced by Verne
Tsiolkovsky:

- Was an amazing person
- Very poor and nearly deaf
- Was self educated
- He published over 500 papers
- Talked about multistage rockets, liquid rockets
The Rocket Equation:

\[ u = v \ln \left( \frac{M_0}{M} \right) + u_0, \]

where \( u \) is the final rocket velocity, \( v \) is the velocity of the exhaust gases, \( M_0 \) and \( M \) are the starting and ending masses of the rocket, and \( u_0 \) is the initial rocket velocity prior to the fuel burn. This equation was published by Tsiolkovsky in 1903.
Tsiolkovsky:

- Very depressed, until this guy paid him a visit

- Dimitri Mendeleyev

- Invented the Periodic Table

- He inspired Tsiolkovsky
Tsiolkovsky:

Tsiolkovsky Rocket Designs
Tsiolkovsky:
“Happiness is the absence of all kind of suffering in all the Universe, for all times, as well as the absence of all of the processes for destroying goodness.”

- To do this, one needs to understand the universe

- To do that, one needs to go to space and live

The Earth is the cradle of the mind, but we cannot live forever in a cradle
In 1926 Tsiolkovsky defined his "Plan of Space Exploration," consisting of sixteen steps for human expansion into space:

1) Creation of rocket airplanes with wings.
2) Progressively increasing the speed and altitude of these airplanes.
3) Production of real rockets-without wings.
4) Ability to land on the surface of the sea.
5) Reaching escape velocity (about 8 Km/second), and the first flight into Earth orbit.
6) Lengthening rocket flight times in space.
7) Experimental use of plants to make an artificial atmosphere in spaceships.
8) Using pressurized space suits for activity outside of spaceships.
9) Making orbiting greenhouses for plants.
10) Constructing large orbital habitats around the Earth.
11) Using solar radiation to grow food, to heat space quarters, and for transport throughout Solar System.
12) Colonization of the asteroid belt.
13) Colonization of the entire Solar System and beyond.
14) Achievement of individual and social perfection.
15) Overcrowding of the Solar System and the colonization of the Milky Way (the Galaxy).
16) The Sun begins to die and the people remaining in the Solar System's population go to other suns.
Other tidbits…

- As early as 1894, Tsiolkovsky designed a monoplane which flew in 1915.

- He built the first Russian wind tunnel in 1897.

- Tsiolkovsky was interested in the theories of space flight, but he never built a rocket or motor himself.

- In December, 1996, U.S. Astronaut John Blaha, aboard the Russian space station MIR, harvested the first wheat crop completely grown in space, thus fulfilling Step 9 of his 16 step plan for the first time.

- Sputnik, the first artificial Earth satellite, was launched on October 4, 1957, just after the 100th anniversary of his birthday, in honor of Tsiolkovsky.

- The largest crater on the far side of the Moon is named after Tsiolkovsky.
Tsiolkovsky:

- Star Trek named a ship after him

- **USS Tsiolkovsky**, NCC-53911

- 2\textsuperscript{nd} Episode, season 1
  “The Naked Now”

- Oberth Class
EARTH

lemit of balloon, 20 miles

Moon

limit of atmosphere, 200 miles

200 miles

6 miles

Earth's orbit

Solis (M)
Goddard:

- Robert H. Goddard, 1882 to 1942
- Influenced by Verne
- 1912, he first explored mathematically the practicality of using rocket propulsion to reach high altitudes and even the moon
- Nearly died of TB in 1913
- First proved, by actual static test, that a rocket will work in a vacuum, that it needs no air to push against
- 1914 he received 1st U.S. patent in idea of multi-stage rocket
Goddard:

- He too, realized liquid fuels were better and more controlled
- He actually launched the first liquid rocket in 1926

2.5 sec flight, 41 ft high, 60 mph, and weighed 6 lbs
Goddard:

- He wrote a paper to the Smithsonian asking for $5,000
- To study the atmosphere higher than a balloon will go you must use rockets
- Then WWI, used money to develop bazooka
Goddard:

- Out of money and frustrated
- Then one fine day
- Charles Lindberg and Daniel Guggenheim showed up
- Gave him $50,000
- He moved to Roswell, New Mexico
- 1930, 11 ft, 35 lb, rocket 7,500 feet 560 mph

- He stated that rockets would be the way we would leave the Earth and even fly to the Moon and Mars

- New York Times ridiculed him in article, that he didn’t have the knowledge of a high school student

- This made a Goddard a hermit, and worked only with a small group of people
Goddard:

- 1937, 16 ft, 9,000 ft high

![Rocket Launch Image]

Goddard L-13
March 26, 1937
1/25 scale
Dimensions in inches
From Retro Rockets: Experimental Rockets 1906-1954
© 1996 Peter Alway

Sources:
Rocket Development: Liquid Fuel Rocket Research 1926-1941
Robert H. Goddard, ed. by Father Goddard and Edward Peniston, 1942, entry for November 20, 1911.
Rocket Experiments: Robert H. Goddard, typed transcripts of notes, Special Collections, Goddard Library, entries for L-10, L-11, L-12, L-13, and L-14.

Legend:
- Aluminum (Silver)
- Span aluminum (Light silver)
- Steel (Dark silver)
- Red

One quadrant painted red. One side of 2 lines painted red. Absence of paint on nose cone and oxygen tank is based on color description of the rocket L-14.

Note: Goddard reported an overall length of 197" for L-13, while his reported lengths of non-overlapping components and spaces add up to 200 5/8".

![Diagram of Rocket L-13]
Goddard:
Goddard:

1932, First used vanes in the rocket motor blast for guidance

1932, First developed gyro control apparatus for rocket flight

First developed pumps suitable for rocket fuels;

1937, First launched successfully a rocket with a motor pivoted on gimbals under the influence of a & gyro mechanism

NASA’s Goddard Space Flight Center

...The Times printed a retraction as Apollo 11 landed on the Moon.
Oberth:

- Herman Oberth, 1894-1989

- Inspired by Verne

- Mother gave him a copy when he was 11 and memorized it

- At 14, he had a design for a rocket in space

- His doctoral dissertation was rejected, said to be worthless
  “The Rocket in Planetary Space”
Oberth:

- His wife gave him money to publish it

- Was a commercial success

- Formed a rocket society or club and they believed they could build a rocket to go to the moon
Oberth:

- 1929 static firing of his first liquid-fueled rocket motor and took on assistant
Wernher von Braun, 1912 - 1977
- Age 13
- Strapped 6 skyrockets to a red wagon
- Launched the wagon five blocks
- Exploded in town
- Dad thought he was going to be a safecracker
- He came from a very upper class family
- His dad transferred him to a different school
- Oberth was teaching at the college the Von Braun was attending
- He received a BS in Aeronautical Engineering, PhD in Physics

- Age 24
- Director of Germany’s Military Rocket Program
von Braun:

- Von Braun’s passion in life was to go to other worlds

- He never thought the war would lead to killing people with rockets

- He was very depressed when it happened
von Braun:

- When the Nazis were about to lose the war, Hitler ordered von Braun and his entire team of 10,000 to be executed

- They decided to surrender to the US forces

- They traveled at night not to get bombed by US forces
von Braun:

- One night, von Braun’s vehicle rolled and he broke his arm

- Ran to the US forces with little white flags
von Braun: - Start of the Cold War

War Department
Bureau of Public Relations
Press Branch
Tel. RE 6500
Br. 3425 and 4860

October 1, 1945
IMMEDIATE
RELEASE

OUTSTANDING GERMAN SCIENTISTS
BEING BROUGHT TO U.S.

The Secretary of War has approved a project whereby certain understanding
German scientists and technicians are being brought to this country to ensure that
we take full advantage of those significant developments which are deemed
vital to our national security.

Interrogation and examination of documents, equipments and facilities in the
aggregate are but one means of exploiting German progress in science and
technology. In order that this country may benefit fully from this resource a number
of carefully selected scientists and technologists are being brought to the United
States on a voluntary basis. These individuals have been chosen from those fields
where German progress is of significant importance to us and in which these specialists
have played a dominant role.

Throughout their temporary stay in the United States these German scientists
and technical experts will be under the supervision of the War Department but will
be utilized for appropriate military projects of the Army and Navy.

END

DISTRIBUTION: A, A, B, E, D, D, D, S, N,
4:30 P.M.
von Braun:

- He helped the US launch its first satellite
- Also in this picture is William Pickering, and Mr. James Van Allen
1953
In the 1940's and 50's, these women were JPL's "computers", doing flight path calculations for rockets and compiling experimental data, as well as graphing performance data from JPL's wind tunnels.
von Braun:

- Work got slim for a while…
von Braun:

- Then the Russians launched the first man into space…
von Braun:
von Braun:
von Braun:
von Braun:

- He once said,

“that it is man’s nature to explore, to move on, and we when we stop doing that we are no longer human.”
von Braun:
von Braun:
You:

• **U.S.A., 2014**
  - You discover a new direction in rocketry
  - You propose a engine that weighs less than a car, can run on saltwater, and it can lift 10 Saturn V rocket payloads to Mars
  - The Denver Post reported that you were “you one Fruit Loop short of a full box.”
  - Aviation News followed with “your wheel is spinning but the hamsters not home.”
  - Time Magazine continued with, “Your antenna isn’t picking up all the channels”
  - All voted you person of the century when you land on Mars in 2025 after launching from I-25 and I-70 in your personal launch vehicle.
**Ansari X-PRIZE:**

- Created in May 1996 to jumpstart the space tourism industry
- 20+ teams from 7 countries have entered
- $10 million prize
- Terms:
  - Privately financed
  - Carries 3 people to 100km
  - Returns safely to Earth
  - Repeats the launch with the same ship in 2 weeks
**Ansari X-PRIZE:**

Future Applications:
- Space Tourism
- Low-cost satellite launching
- Same-day package delivery
- Rapid point-to-point passenger travel

Canadian Arrow

SpaceShipOne

Da Vinci Project
**SpaceShipOne:**

- First private, manned mission to space
- Launched June 21st, 2004
- Hoping to win X-Prize before the end of the summer
- Sparked other NASA/Congress prize campaigns
  - Soft lunar landing
  - Bring back piece of asteroid
  - First private, manned Earth orbit
Falcon 1 Flight 4 - Highlights

09/28/2008

A short compilation of highlights from flight 4. Stay tuned as more media will be added very soon.

Share this video: