Today:

- Announcements

- One Minute Report Questions

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- Rocket History (Best Lecture Ever)
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- Guest speaker talk on Systems Engineering is now October 16th
- Homework 8 is due then

- Questions about grades/passwords

- Attendance sheet last time – will use one minute reports

- Hardware orders Friday – Check email for delivery
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One Minute Report Questions:

- How do you know for sure when you have completed a requirement?
- For HELIOS, did you give them the students an RFP?
- How did HELIOS start?
- How can we get involved with stuff like HELIOS?
- Will we be doing a requirement homework?
- Are there dimensional limits on the size of the BalloonSat?
- How many team members should be working on the code?
One Minute Report Questions:

- Can we make a Death Star with our foam core?
One Minute Report Questions:

- How did the guest speakers get involved with HASP?
- What sensor should we use to measure ____ on our balloon flight?
- Is it possible to imitate the thermal vacuum testing here in Boulder?
- What should we do about non-responsive team members?
- What is the craziest thing I have done?
Next Tuesday...

Spacecraft Structures

Colorado Space Grant Consortium
Next Thursday...

Spacecraft Propulsion

Colorado Space Grant Consortium
- When I was in high school, I visited CU and saw these type of pictures in the lobby
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.
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 3\textsuperscript{rd} 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”
    \[ F = m a \]
  - 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:

- 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.
- Very depressed, until this guy paid him a visit

- Dimitri Mendeleyev

- Invented the Periodic Table

- He inspired Tsiolkovsky
Tsiolkovsky:

Tsiolkovsky Rocket Designs
Tsiolkovsky:
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*
Tsiolkovsky:

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
limit of balloon, 20 miles

limit of atmosphere: 200 miles

Earth

Moon

grav

5012 (Mr)
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
Out of money and frustrated

Then one fine day

Charles Lindbergh and Daniel Guggenheim showed up

Gave him $50,000

He moved to Roswell, New Mexico
Goddard:

- 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
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
Bras. 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: Ap, Af, S, De, Di, Do, 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:
von Braun:
You:

• **U.S.A., 2016**
  - 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 2030 after launching from I-25 and I-70 in your personal launch vehicle.
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.

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