

## ASTR 308 "Into the Final Frontier"

### Mercury and Gemini

#### 1. The Mode

(a) There were three “modes” being debated for how to get a manned rocket to the moon and back. State what each mode was.

1. Direct
2. Earth Orbit Rendezvous (EOR)
3. Lunar Orbit Rendezvous (LOR)

(b) Briefly describe each mode. Provide advantages (if any) and/or disadvantages (if any) associated with each mode.

**The Direct Mode** required a single gigantic rocket that carried all fuel and all equipment for landing on the moon and returning. The rocket being designed for this mode was called the NOVA. The disadvantages were (1) it required a gigantic rocket that would be a serious engineering challenge to design and build, (2) there were serious doubts that a rocket like this could land backwards on the moon and then take off again, given the large launch complex and millions of requirements and how many people are involved to launch a rocket from Earth. In the end, this mode had no real advantages over EOR or LOR except that orbital rendezvous had never been attempted while this mode was being decided upon, and orbital rendezvous, not being proven, was considered a fail-risk of the mode.

**Earth Orbit Rendezvous:** required two rockets. The first rocket carried the bulk of the fuel required to get the second rocket to the moon and back. The second rocket carried the astronauts and equipment for the moon landing. Advantages included (1) smaller rockets, and (2) orbital rendezvous in Earth orbit, where if something went wrong the astronauts could return safely to Earth. Disadvantages included (1) it still involved landing a largish rocket on the moon and that has the same problems as the Direct Mode, and (2) EOR, though unproven, was far less risky than LOR and this was a very strong point of argument, (3) two rockets were required and that means greater risk of failure.

**Lunar Orbit Rendezvous:** required a single multistage rocket and lunar landing vehicle (known as LEM, Lunar Excursion Vehicle). The large parts of the rocket carried only fuel to get the LEM, equipment, and astronauts to the moon in a small command module (CM) with an attached service module the (SM, together known as the CSM). At the moon, the docked CSM and LEM (the “stack” separated and the LEM lands on the moon. The tiny LEM then lifts off the moon

and rendezvous in lunar orbit with the CSM. The CSM returns to earth (though the SM is jettisoned first). Advantages include (1) a single rocket, and a rocket that is not as huge and dangerous as the NOVA, (2) less expensive because not so much fuel and rocket is required to be used and built, (3) landing and getting back off the moon is done with a small vehicle that can be managed by a small flight crew. Basically, there is only one disadvantage: orbital rendezvous at the moon was considered highly risky (recall orbital rendezvous was untried at the time of the planning)- if something went wrong, the astronauts would likely die.

- (c) Which mode finally was adopted? Provide a brief history on how this mode was at first least favored (by whom in general) and then because of whom and how it became the most favored mode. What was the main objection with this mode by those who at first did not favor it?

LOR was adopted. Von Braun favored and promoted EOR. Various engineers in the Space Task Group favored and promoted Direct. LOR was not really being considered in the debate, though the idea had been tossed around, but rejected outright because of the main objection that it was not originally calculated as being much more advantageous over EOR but was calculated as considerably much more riskier than EOR because if LOR went bad the astronauts were dead ducks. Enter Jon Houbolt. He tirelessly campaigned for LOR and battled it out with NASA and the other engineers and won his case. LOR was mega significantly more efficient and cost effective that the risk of LOR almost had to be accepted if a moon landing were to be feasible by the end of the decade.

## 2. Project Mercury

- (a) According to NASA, what were the three stated goals of Project Mercury? Were each of these goals successfully accomplished during Project Mercury?

From [http://www.nasa.gov/mission\\_pages/mercury/missions/goals.html](http://www.nasa.gov/mission_pages/mercury/missions/goals.html)

1. To orbit a manned spacecraft around the Earth
2. To investigate man's ability to function in space
3. To return both man and spacecraft safely

All goals were accomplished multiple times.

- (b) Provide a very brief synopsis of each of the Mercury flights, including who flew, the duration and orbits (if any), the rocket booster used, and the main accomplishments toward each of the Project Mercury goals.

From [http://www.nasa.gov/mission\\_pages/mercury/missions/manned\\_flights.html](http://www.nasa.gov/mission_pages/mercury/missions/manned_flights.html)

See next page... (I have also added which goals were accomplished)

### **Mercury-Redstone 3**

Astronaut: Alan B. Shepard, Jr. : Flight Summary: 15 minutes, 28 seconds -- Suborbital flight that successfully put the first American in space. **(Goals 2 and 3)**

### **Mercury-Redstone 4**

Astronaut: Virgil I. Grissom: Flight Summary: 15 minutes, 37 seconds -- Suborbital flight, successful flight but the spacecraft sank shortly after splashdown. **(Goals 2 and part of 3!)**

### **Mercury-Atlas 6**

Astronaut: John H. Glenn, Jr.: Flight Summary: 4 hours, 55 minutes, 23 seconds -- Three-orbit flight that placed the first American into orbit. **(Goals 1, 2, & 3)**

### **Mercury-Atlas 7**

Astronaut: Scott M. Carpenter: Flight Summary: 4 hours, 56 minutes, 5 seconds -- Confirmed the success of the Mercury-Atlas 6 by duplicating the flight. **(Goals 1, 2, & 3)**

### **Mercury-Atlas 8**

Astronaut: Walter M. Schirra: Flight Summary: 9 hours, 13 minutes, 11 seconds -- Six-orbit engineering test flight. **(Goals 1, 2, & 3)**

### **Mercury-Atlas 9**

Astronaut: L. Gordon Cooper, Jr.: Flight Summary: 34 hours, 19 minutes, 49 seconds -- The last Mercury mission; completed 22 orbits to evaluate effects of one day in space. **(Goals 1, 2, & 3)**

- (c) On which flight and for which astronaut did the Mercury capsule sink? On which flight and which astronaut almost got killed because he was more concerned with the feeling of being in space than in evaluating his spacecraft? For which flight and which astronaut was Alan Shepard almost replaced to be the pilot? Why?

Gus Grissom's flight ended with the capsule sinking on the ocean. Scott Carpenter was the astronaut who almost died because he was not focusing on his job while in orbit. Alan Shepard almost replaced Gordon (Gordo) Cooper because Gordo had barnstormed the NASA Administrative building in his jet with the afterburners on! The NASA "brass" wanted him pulled from the flight. Deke Slayton, the astronaut boss, kept Gordo on his flight to save his astronaut career.

### 3. Project Gemini

- (a) According to NASA, what were the three stated goals of Project Gemini? Were each of these goals successfully accomplished during Project Gemini? If not, which one was abandoned? What was the goal, not originally stated by NASA, that then became a goal of Project Gemini? Was this goal easily accomplished or was there difficulty?

From <http://www-pao.ksc.nasa.gov/kscpao/history/gemini/gemini-goals.htm>

- 1) To subject man and equipment to space flight up to two weeks in duration
- 2) To rendezvous and dock with orbiting vehicles and maneuver the docked combination by using the target vehicle's propulsion system
- 3) To perfect methods of entering the atmosphere and landing at a preselected point on land

Goal 3 was abandoned in 1964. A new goal (call it Goal 4) was introduced to have the astronaut leave the spacecraft while in orbit, perform useful tasks, and return him safely into the spacecraft. (This goal was never stated in exact words anywhere, though it was stated in the movie Moon Shot and in the movie To the Moon). This goal turned out to be very difficult at first.

- (b) Describe the “upgrades” made to the Gemini Spacecraft as compared to the Mercury Spacecraft. Given the goals of Project Gemini, identify which new capabilities made it possible to achieve which goals.

- 1) two manned vehicle (necessary for Goal 4)
- 2) opening/closing hatches and ability to repressurize while in space (Goal 4)
- 3) computers and thrusters allowing the spacecraft to change orbits (Goal 2)
- 4) Docking ring (Goal 2)
- 5) long duration power and consumables (Goal 1)

- (c) Provide a very brief synopsis of each of the Gemini flights, including who flew, the duration and orbits (if any), the rocket booster used, and the main accomplishments toward each of the Project Mercury goals (final version).

From <http://www-pao.ksc.nasa.gov/kscpao/history/gemini/flight-summary.htm>

See next page. I added the goals accomplished; all flights used the Titan II rocket.

**Gemini III**, Molly Brown March 23, 1965 Virgil I. Grissom, John W. Young 4 hours, 52 minutes 31 seconds First manned Gemini flight, three orbits. **(Goals: none- just a test)**

**Gemini IV** June 03-07, 1965 James A. McDivitt, Edward H. White II 4 days 1 hour 56 minutes 12 seconds Included first extravehicular activity (EVA) by an American; White's "space walk" was a 22 minute EVA exercise. **(Goals: parts of #1 and #4)**

**Gemini V** August 21-29, 1965 L. Gordon Cooper, Jr., Charles Conrad, Jr. 7 days 22 hours 55 minutes 14 seconds First use of fuel cells for electrical power; evaluated guidance and navigation system for future rendezvous missions. Completed 120 orbits. **(Goals: working toward #1)**

**Gemini VII** December 04-18, 1965 Frank Borman, James A. Lovell, Jr. 13 days, 18 hours, 35 minutes 1 seconds When the Gemini VI mission was scrubbed because its Agena target for rendezvous and docking failed, Gemini VII was used for the rendezvous instead. Primary objective was to determine whether humans could live in space for 14 days. **(Goals: #1)**

**Gemini VI-A** December 15-16, 1965 Walter M. Schirra, Jr., Thomas P. Stafford 1 Day 1 hour 51 minutes 24 seconds First space rendezvous accomplished with Gemini VII, station-keeping for over five hours at distances from 0.3 to 90 m (1 to 295 ft). **(Goals: part of #2)**

**Gemini VIII** March 16, 1966 Neil A. Armstrong, David R. Scott 10 hours 41 minutes 26 seconds Accomplished first docking with another space vehicle, an unmanned Agena stage. A malfunction caused uncontrollable spinning of the craft; the crew undocked and effected the first emergency landing of a manned U.S. space mission. **(Goals: working toward #2, didn't complete due to abort)**

**Gemini IX-A** June 03-06, 1966 Thomas P. Stafford, Eugene A. Cernan 3 days 21 hours Rescheduled from May to rendezvous and dock with augmented target docking adapter (ATDA) after original Agena target vehicle failed to orbit. ATDA shroud did not completely separate, making docking impossible. Three different types of rendezvous, two hours of EVA, and 44 orbits were completed. **(Goals: part of #2, part of #4)**

**Gemini X** July 18-21, 1966 John W. Young, Michael Collins 2 days 22 hours 46 minutes 39 seconds First use of Agena target vehicle's propulsion systems. Spacecraft also rendezvoused with Gemini VIII target vehicle. Collins had 49 minutes of EVA standing in the hatch and 39 minutes of EVA to retrieve experiment from Agena stage. 43 orbits completed. **(Goals: #2 – finally!, working on #4)**

**Gemini XI** September 12-15, 1966 Charles Conrad, Jr., Richard F. Gordon, Jr. 2 days 23 hours 17 min 8 seconds Gemini record altitude, 1,189.3 km (739.2 mi) reached using Agena propulsion system after first orbit rendezvous and docking. Gordon made 33-minute EVA and two-hour standup EVA. 44 orbits. **(Goals: #2 working on #4)**

**Gemini XII** November 11-15, 1966 James A. Lovell, Jr., Edwin E. Aldrin, Jr. 3 days 22 hours 34 minutes 31 seconds Final Gemini flight. Rendezvoused and docked with its target Agena and kept station with it during EVA. Aldrin set an EVA record of 5 hours, 30 minutes for one space walk and two stand-up exercises. **(Goals: #2 and #4- finally!)**

- (d) What event happened in the launch of Gemini 6 that was a “heart stopper”?  
What event happened in Gemini 8 that was a “heart stopper”?

During the first launch of Gemini 6, a valve cover had not been removed from a part of the engine and the engine shut down during lift off (without the rocket leaving the pad). [Had the ejection seats been automatic, the astronauts would have been ejected and probably seriously injured). Worst case, the rocket could have exploded on the pad killing the astronauts. Just after the Gemini 8 docked with the Agena spacecraft, the docked combination began spinning out of control. They undocked and found that the Gemini spacecraft had a stuck thruster. The astronauts were tumbling at a rate of a few revolutions per second before they stabilized the spacecraft. The mission had to be aborted, so they didn't get to complete Goal #2 or attempt Goal #4.

- (e) Which law of physics was it that the astronauts seemed to not be able to incorporate when trying to work outside the vehicle (EVA)? Why did they have so much problem (describe the physics)? Which astronaut finally showed that once this law of physics is mastered that a working EVA was actually very doable?

The astronauts seemed to not understand Newton's 3<sup>rd</sup> Law of Motion, for every action there is an equal and opposite reaction. For example, when they would turn a valve or push on something, the spacecraft would push back on them and they would lose control of their bodies. Buzz Aldrin mastered this problem on Gemini 12 and proved that doing useful working outside the spacecraft was possible.

4. Tom Hanks wanted to make a documentary on the moon landings and the space program. He never did make a documentary, but he did produce an HBO mini series. What was the name of this series? What great literary work was this name taken from? What was it above all that Tom Hanks wanted to convey about the entire endeavor of going to the moon (he compares it to some other events in history)? [Have you watched the series????]

The HBO miniseries is “From the Earth to the Moon”, named after Jules Verne's book. Quoting Hanks from the Forward... “What I hoped to convey with *From the Earth to the Moon* is what Andy captured so well in this book- just how magnificent an undertaking Apollo really was. That going to the moon was not just a technological endeavor, but an artistic one, like Michelangelo's frescoes on the Sistine chapel ceiling. The same kind of imagination that allowed Michelangelo to produce the crowning achievement of his era helped NASA's engineers build their moon ships. Just as Michelangelo's faith in his own abilities sustained him... so faith was at the heart of what it took to put men... on the moon.”