How Can We Get To The Moon?
Sourced from “selecting the Way To The Moon” by John Logsdon
and NASA SP-4009
https://www.hq.nasa.gov/office/pao/History/SP-4009/v1p2c.htm
Fleming Committee
2 May – 16 June
1961

• Tentative Plan (1st stage statistics, using F1 engine)
  – C1 (1.5M lbf F1) 1964, Earth orbit
  – C3 (2 x 1.5M lbf F1) 1965, Lunar Orbit
  – Nova (8 x 1.5M lbf F1; 160,000 lbs to lunar escape velocity) 1967, Lunar landing
Lundin Committee Instructions
25 May 1961

- All possible approaches for accomplishing the manned lunar landing mission in the 1967-1970 period should be considered.
- Primary emphasis should be placed on the launch vehicle portion of the system: vehicle size and type, the use of rendezvous, etc.
- Nuclear-powered launch vehicles should not be considered for use in the early manned lunar landing missions.
- Advantages, disadvantages, and problems associated with each technique should be indicated and, based on these, a relative rating of the various methods should be established.
- The time phasing and a rough order of magnitude cost should be indicated for each method considered.
- The study should be completed at about the same time as the one under way by the Ad Hoc Task Group on Manned Lunar Landing Study.
How can we get to the Moon?
Lundin Committee Finding

- Direct ascent
- **Earth orbital rendezvous (EOR)** *preferred*
- Lunar orbit rendezvous (LOR)
- Lunar surface rendezvous

*Two methods of landing techniques proposed for the direct ascent mose for the lunar landing mission*
Heaton Committee  
June 1961

- NASA HQ and NASA Centers – investigate EOR options

- “... that earth-orbital rendezvous offered the earliest possibility for a successful manned lunar landing.”
  - Worked with C3 rocket concept
  - And offered alternative 4 engine (C4) scenario, because C3 was immature and C4 provided more lift and thus more margin

- Rosen committee in Nov 1961: “space rendezvous presents the possibility of accomplishing the initial manned lunar landing mission earlier than by any other means ... " and that "the preferred rendezvous mode is the single rendezvous in earth orbit.” Added – the recommendation of 5 engine first stage rocket.
LOR Studies

• Idea goes back as far as 1916 and 1948
• Group at Langley Research Center tasked with fleshing out details of LOR early as 1959
• Vought astronautics was working in parallel on LOR scenarios, neither group knew about other effort
• John Houboldt was a tireless (fanatic?) advocate of LOR
Story continues...

- 28 November 1961 contract for Command and Service Modules awarded to North American Aviation
- 15-21 December 1961 Boeing given contract for first stage with 5 F1 engines (5x1.5M = 7.5M lbs thrust) – now called C5.
- What about upper stages?

    Still no decision on architecture!
LOR?

• March 1962 group formed at Marshall Space Flight Center study architectures:
  – Establish realistic schedules that would "second guess" failures but provide for exploitation of early success.
  – Schedule circumlunar, lunar orbit, and lunar landing missions at the earliest realistic dates.
  – Complete the flight development of spacecraft modules and operational techniques, using the Saturn C-1 and C-1B launch vehicles, prior to the time at which a "man-rated" C-5 launch vehicle would become available.
  – Develop the spacecraft operational techniques in "buildup" missions that would progress generally from the simple to the complex.
  – Use the spacecraft crew at the earliest time and to the maximum extent, commensurate with safety considerations, in the development of the spacecraft and its subsystems.

• 2-3 April 1962 – NASA HQ briefed on LOR and its benefits
• Marshall vs Langley! EOR vs LOR!
COMPARISON OF LANDER SIZES

DIRECT LANDING

APOLLO COMMAND MODULE
SERVICE MODULE

13.4’
65’
21.2’

LUNAR FERRY OF LUNAR RENDEZVOUS

LUNAR EXCURSION VEHICLE

John Houbolt, promoter, not inventor LRO
LOR It Is!

• 22 June 1962 Van Braun and Marshall reverse course and support LOR
• NASA tenatively accepted the decision, lots of push-back from within and outside of NASA
• Decision confirmed on 7 November 1962
• Grumman Aircraft Engineering selected to build lunar module

James Webb: “despite the very extensive study efforts, . . . we are dealing with a matter that cannot be conclusively proved before the fact, and in the final analysis the decision has been based upon the judgement of our most competent engineers and scientists who evaluated the studies and are experienced in this field."
Saturn 5 Fun Facts to Know and Tell

• 3 Stage Rocket
  – 1\textsuperscript{st} stage, 5 F-1 engines, 7.8M lbf (SI-C Boeing)
    • 2000 metric tons propellant (RP-1 and LOx)
  – 2\textsuperscript{nd} stage, 5 J-2 engines, 1.15M lbf (S-II North American)
    • 440 metric tons propellant (H, LOx)
  – 3\textsuperscript{rd} stage, 1 J-2 engine, 0.23M lbf (S-IVB Douglas)
    • 109 metric tons propellant (H, LOx)

• Payload to LEO (140 metric tons)

https://history.nasa.gov/SP-4029.pdf  Apollo by the Numbers, Orloff