

The Command Module

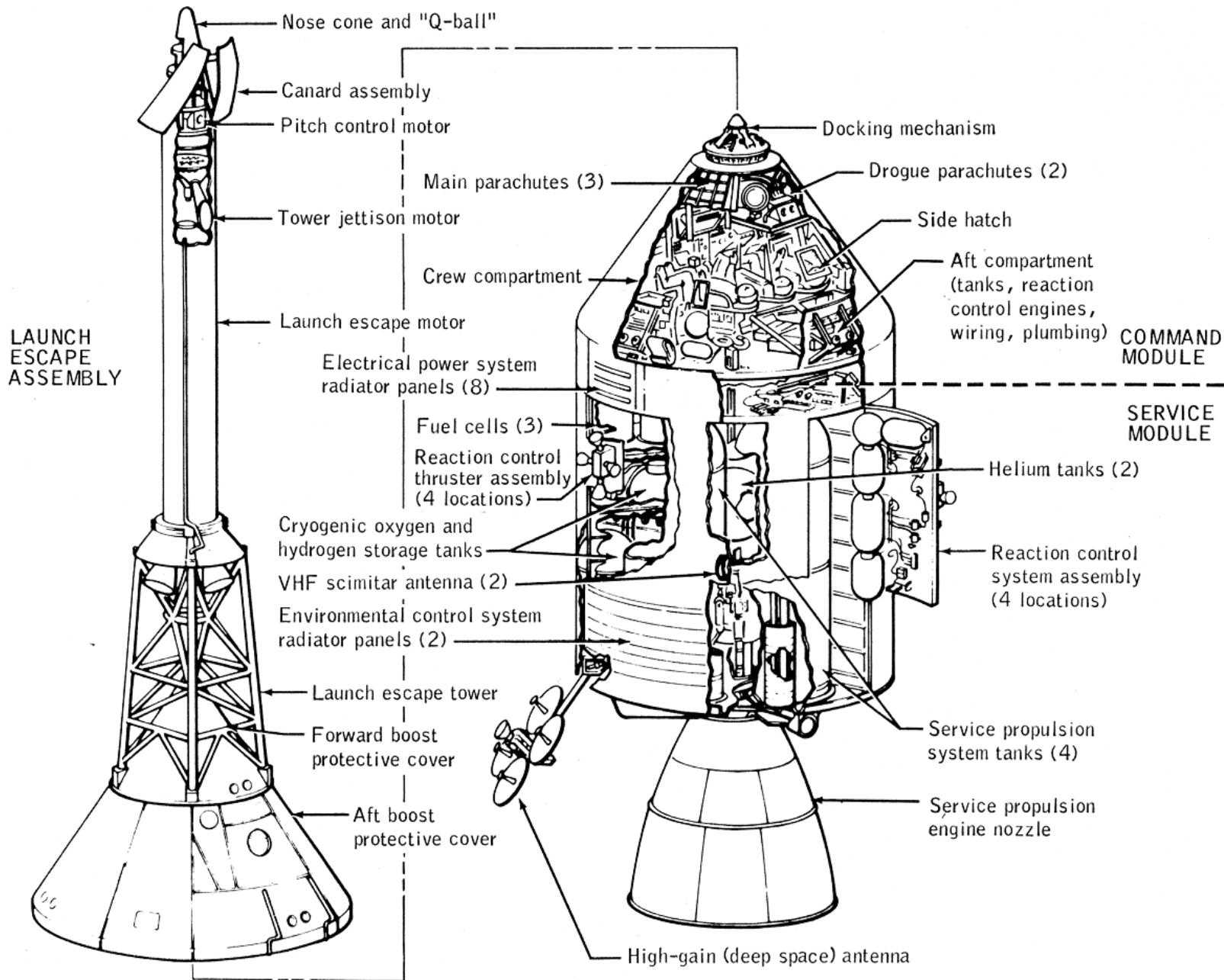
HONR 269i

To the Moon and Back: The Apollo Program

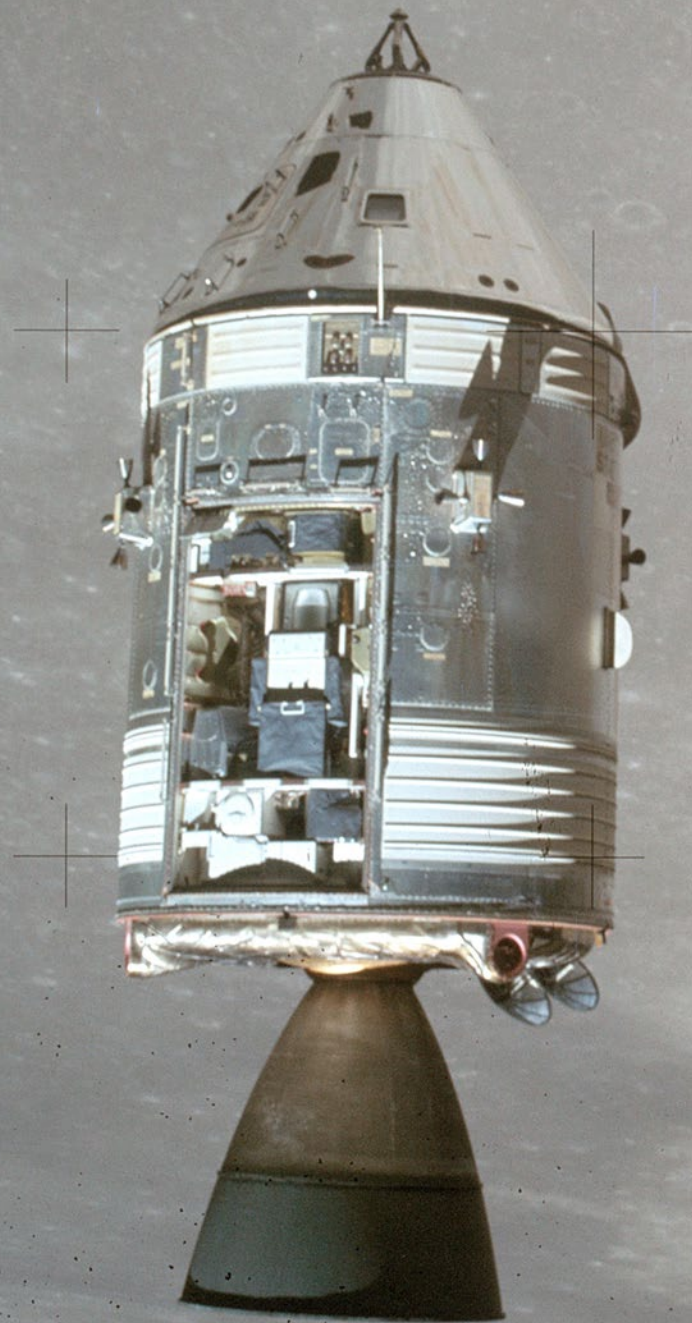
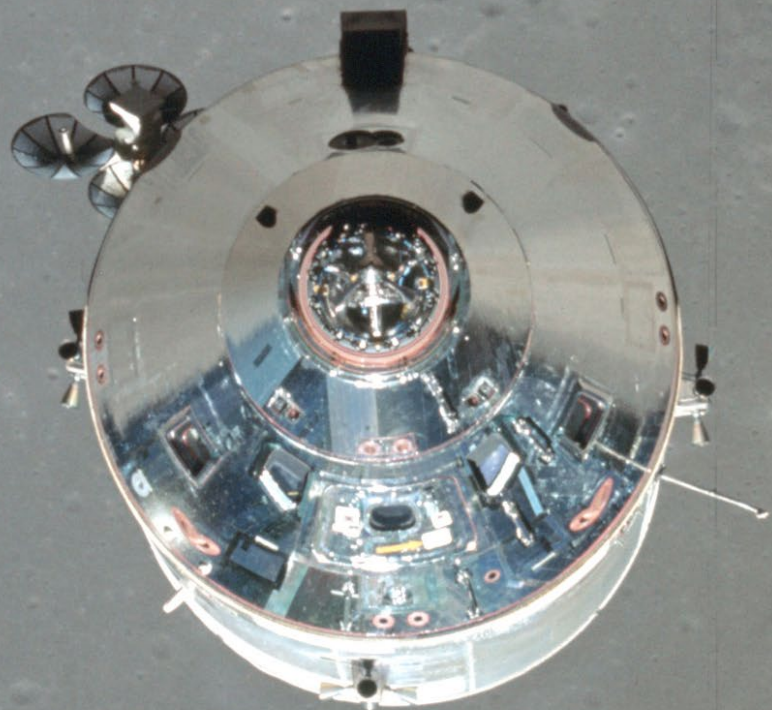
[The Apollo 11 Command Module](#)

Chronology

- MIT guidance computer contract award (August 1961)
- North American CSM contract award (November 1961)
- LOR mode decision (July 1962)
- First Block II CSM design (January 1964)
- First boilerplate launch (March 1964)
- First Block I launch (January 1966, Little Joe 2)
- Apollo 1 fire in a Block I CM (January 1967)
- First Block II launch (October 1968, Apollo 7)

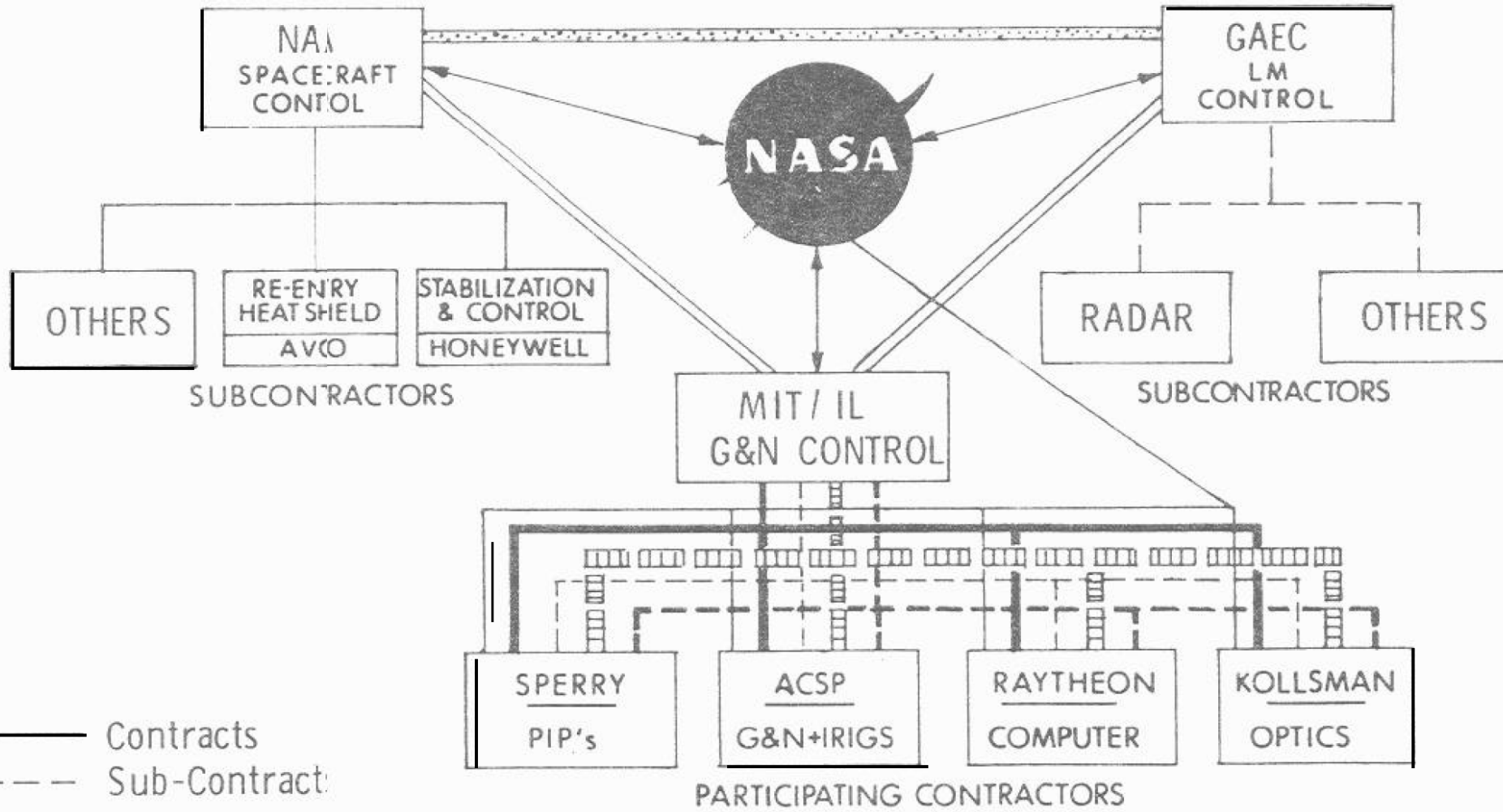


**APOLLO COMMAND AND SERVICE MODULES
AND LAUNCH ESCAPE SYSTEM**



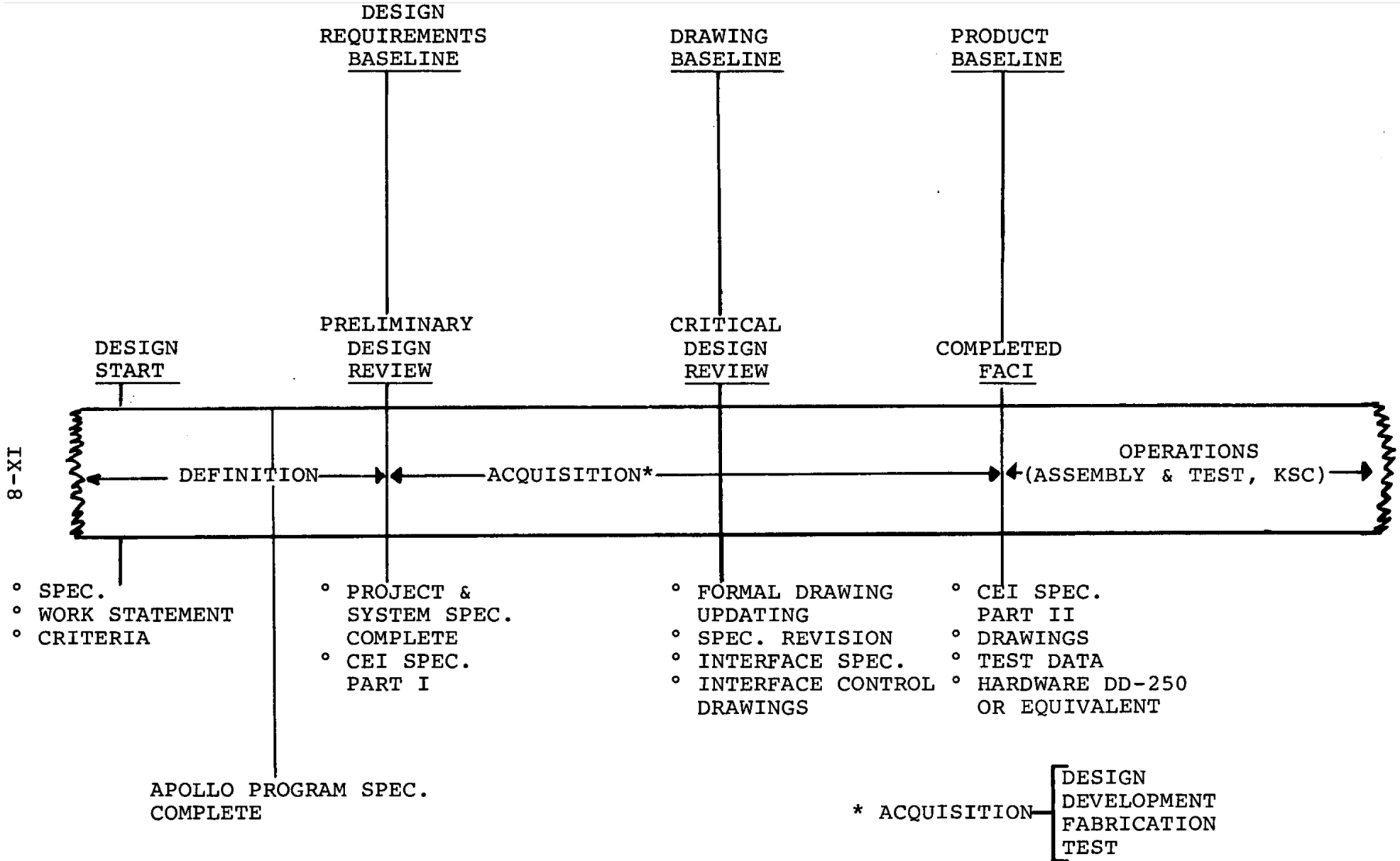
Some Design Questions

- How many stageable modules?
 - The Soviets had 3, we had 2. Why?
- How to transfer to the Lunar Module?
 - The Soviets used spacewalks, we used a tunnel. Why?
- Whether to land on land or in the water
 - We tried land; it was hard.
- How to navigate?
 - We spent \$100 million for onboard navigation, and then did it from Earth.
- When to wear spacesuits?
 - A bad decision on this killed three cosmonauts.
- Whether to use normal air or pure oxygen?
 - Oxygen is much lighter. It killed three astronauts.
- Whether to put a TV camera aboard
 - We had the technology to do this, but had chosen not to in Gemini.



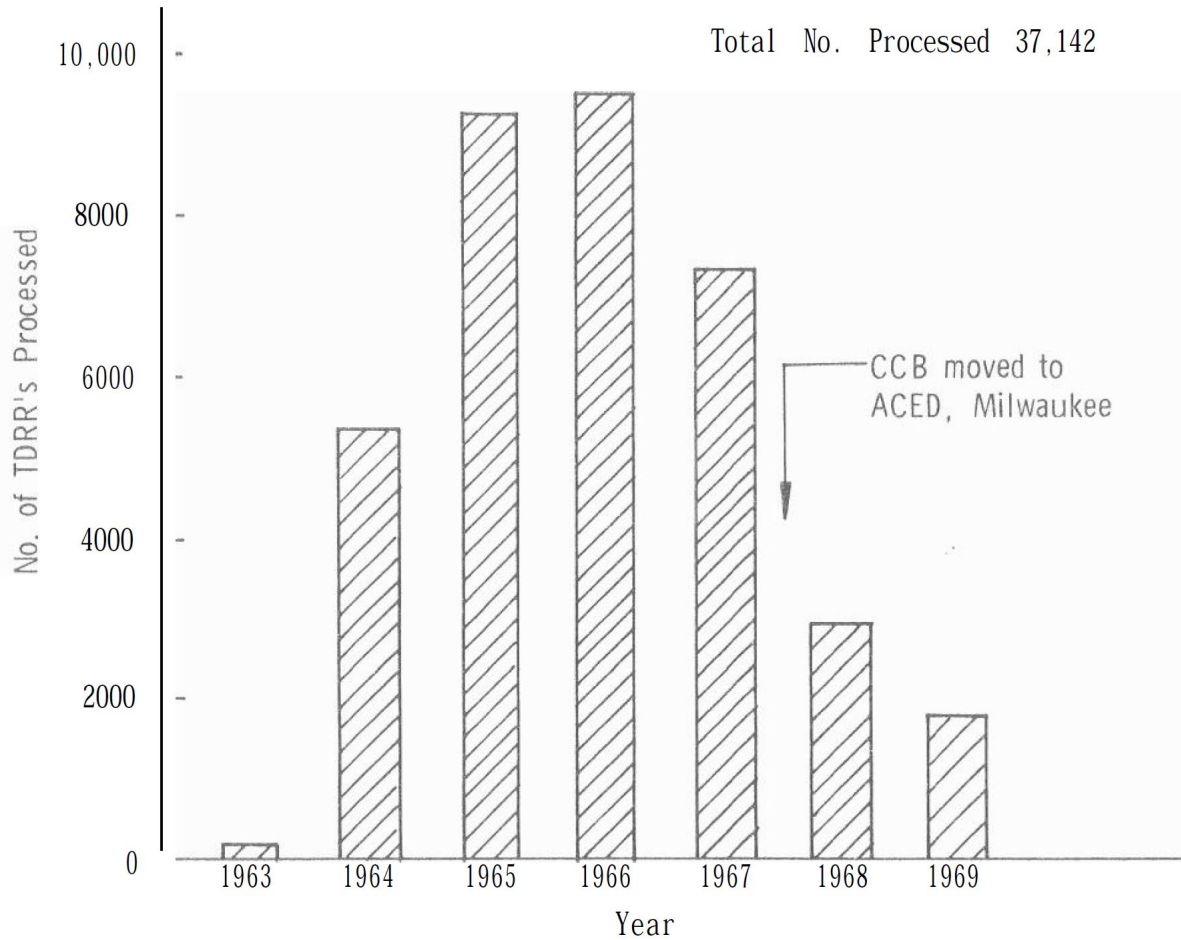
- Contracts
- - - - - Sub-Contract
- } Work Authorization Associated
- - - - - } with Design, Technical Control
 } and Resident Effort
- ▬▬▬▬▬▬▬▬▬▬ Informal Design Data Flow
- ▬▬▬▬▬▬▬▬▬▬ Design Approval & Controls
- ▬▬▬▬▬▬▬▬▬▬ Technical Coordination

Configuration Management



Configuration Control Board

HISTORY OF TDRR's (HARDWARE)
PROCESSED THROUGH APOLLO CCB

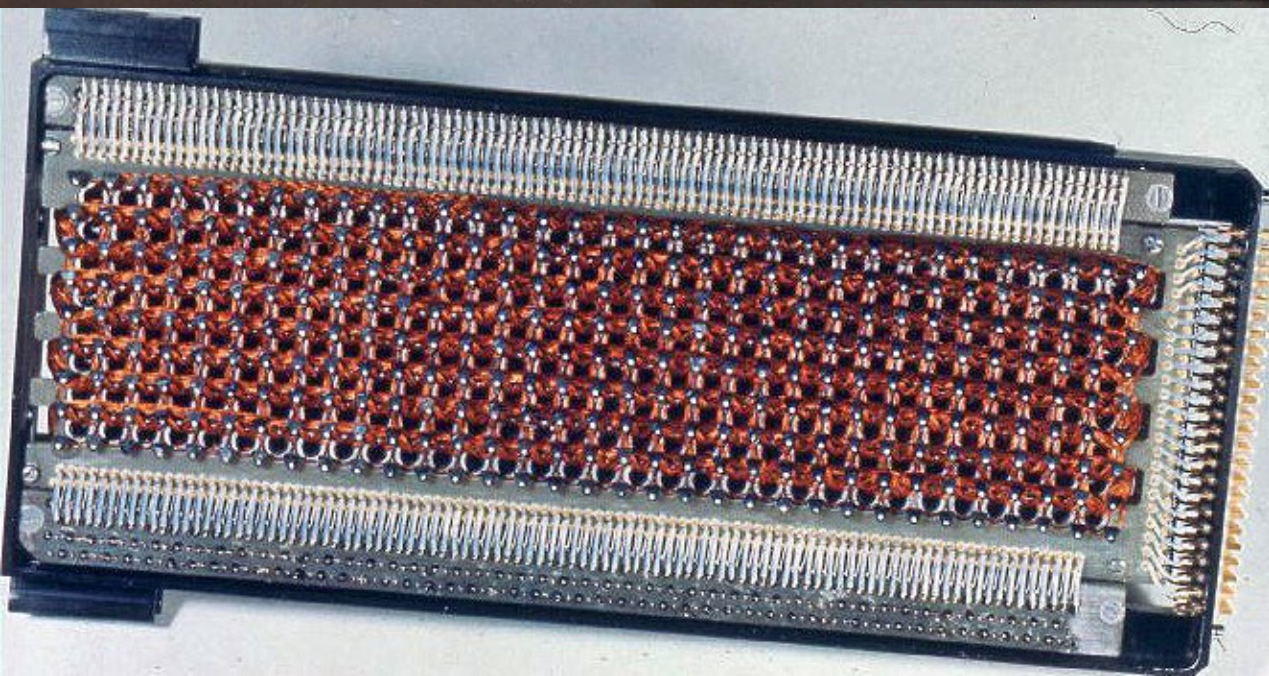


<input type="checkbox"/> SV <input type="checkbox"/> AGE <input type="checkbox"/> FAC <input type="checkbox"/> TRAINING <input type="checkbox"/> GIE <input type="checkbox"/> DS <input type="checkbox"/> RPIE		NASA ORG. _____		PAGE 1 OF _____			
(2) CCB NUMBER _____		CONFIGURATION CONTROL BOARD DIRECTIVE		DATE: DAY MO. YR.			
(3) CONTRACTOR: _____		(19) ECP TITLE _____		SUPERSEDES DAY MO. YR. ISSUE OF _____			
(4) ECP NO. _____		(4A) DATE: _____					
(5) SUPERSEDES ECP NO. _____		(5A) DATE: _____		(20) NOMENCLATURE, CONTRACT END ITEM _____			
(6) END ITEM NO. _____		(21) EFFECTIVITIES				(22) PROCUREMENT ACTION REQUIRED	
(7) END ITEM PART NO. _____		FIRST	LAST	TYPE	FIRST	LAST	TYPE
(8) TCTR NO. & TYPE _____							
PART NO CHANGE: <input type="checkbox"/> YES <input type="checkbox"/> NO							
(10) SPARES AFFECTED <input type="checkbox"/> YES <input type="checkbox"/> NO							
(11) INTERFACE REQUIREMENTS _____							
(12) DESIGN DEFICIENCY <input type="checkbox"/> YES <input type="checkbox"/> NO							
(13) ECP NOTED IN BLOCK (4) IS <input type="checkbox"/> APPROVED AS WRITTEN <input type="checkbox"/> DISAPPROVED <input type="checkbox"/> APPROVED WITH CHANGES, AS NOTED BELOW							
(14) SPECIFICATION NO. _____		REMARKS:				(23)	
(15) SPECIFICATIONS AFFECTED: PROGRAM SPEC NO. <input type="checkbox"/> YES <input type="checkbox"/> NO						CONCUR	NON CONCUR
(16) PROJECT SPEC. NO. <input type="checkbox"/> YES <input type="checkbox"/> NO							
(17) SYSTEM SPEC. NO. <input type="checkbox"/> YES <input type="checkbox"/> NO							
(18) CEI SPEC. NO. <input type="checkbox"/> YES <input type="checkbox"/> NO							
PROGRAM MANAGER CCB-MSFC		CONCUR	NON CONCUR	PROGRAM MANAGER MSC-IMCC	CONCUR	NON CONCUR	CHAIRMAN PROGRAM MANAGER CCB CHAIRMAN APOLLO PROGRAM DIRECTOR CCB
PROGRAM MANAGER CCB-MSFC				OTHER			
PROGRAM MANAGER CCB-KSC				OTHER			

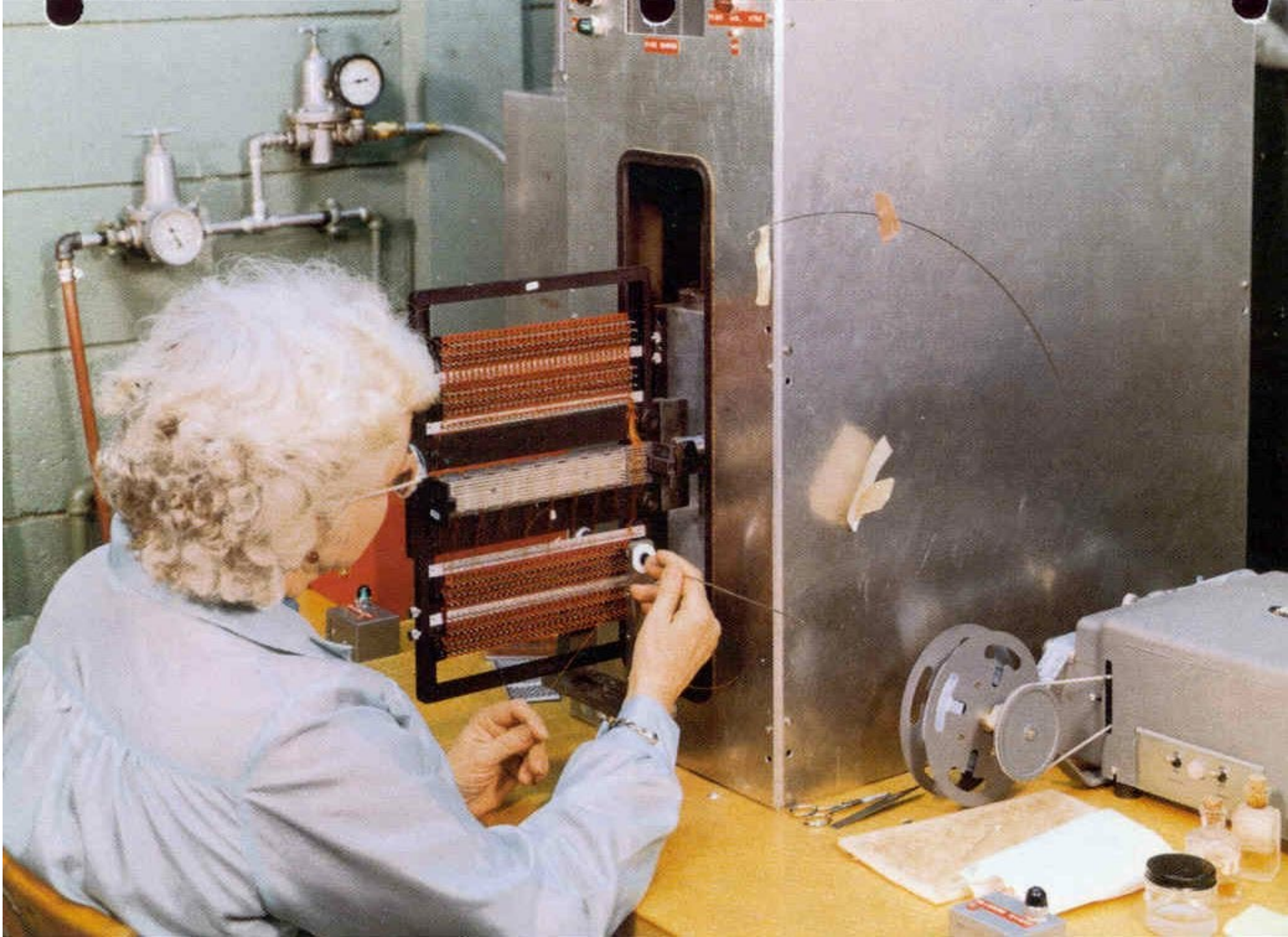
Figure 1

Apollo Guidance Computer

- Clock speed: ~500 μ sec
- ROM: ~70kB
- RAM: ~4kB
- Word length: 16 bits (15+parity)
- Weight: 70 lbs.
- Power: 55 watts
- Language: Assembler
- Peripherals: DSKY, IMU, landing radar, engine, ...



Programming
Core Rope
Memory



Discussion Groups

- Moon Machines Video (“Command Module”)
 - An overview, including interviews with some of its builders
- Brooks Chapter 5 (“Command Module and Program Changes”)
 - The view from NASA
- Gray Chapter 12
 - The view from the North American (the CSM prime contractor)
- Mindell Chapter 5 (“Braincase on the Tip of a Firecracker: Apollo Guidance”)
 - The view from MIT (the Guidance and Navigation prime contractor)

Activity: Case Studies

- James Webb
- Werner Von Braun
- Boris Chertok
- Max Faget
- Margaret Hamilton
- Katherine Johnson
- Gene Kranz
- Gunter Wendt
- Valentina Tereshkova
- Alan Sheppard
- Jim Lovell