

The Command Module

INST 154

Apollo at 50

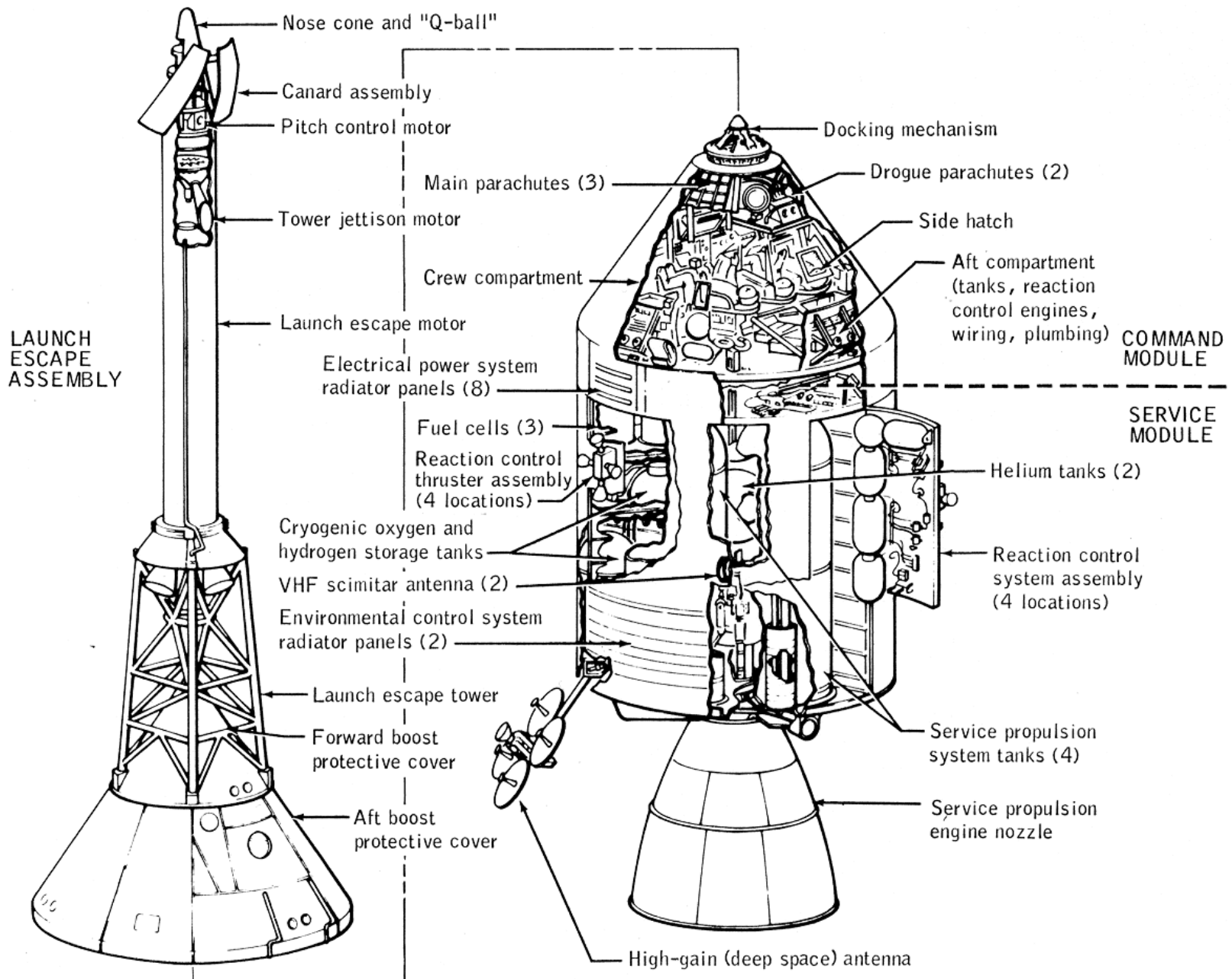
[The Apollo 11 Command Module](#)

Agenda

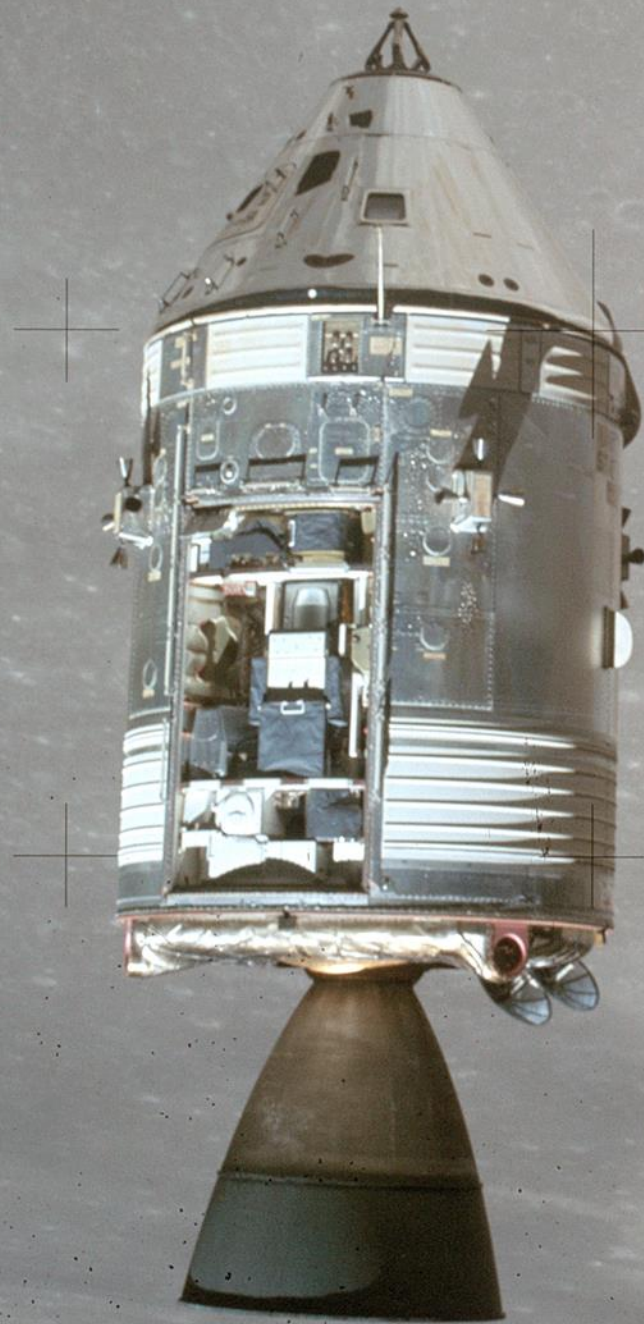
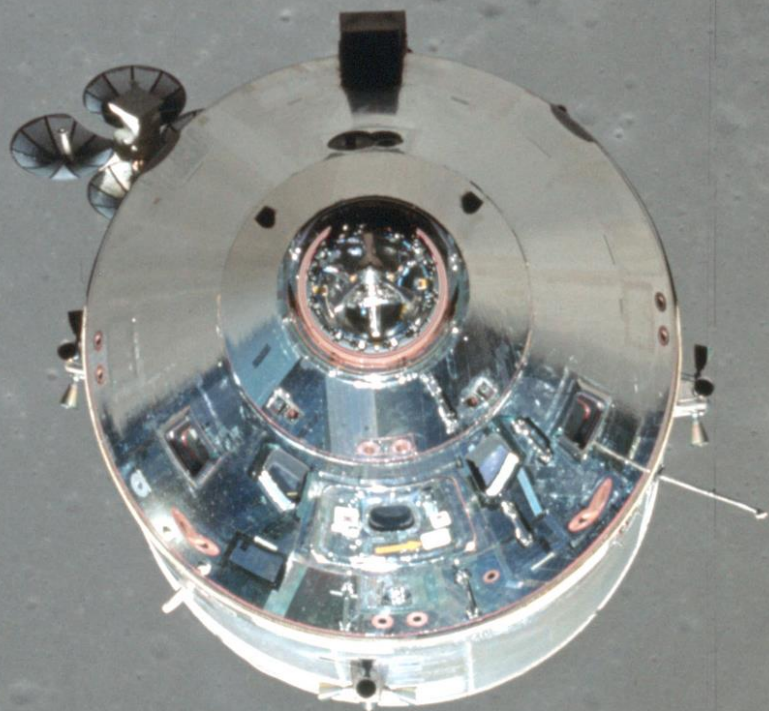
- Command and Service Modules
- Apollo Guidance Computer
- Contracting
- (Discussion Groups)
- Writing your case study

Chronology

- MIT guidance computer contract award (August 1961)
- North American CSM contract award (November 1961)
- LOR mode decision (July 1962)
- Block II CSM design (January 1964)
- First boilerplate launch (March 1964: Saturn 1)
- 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**

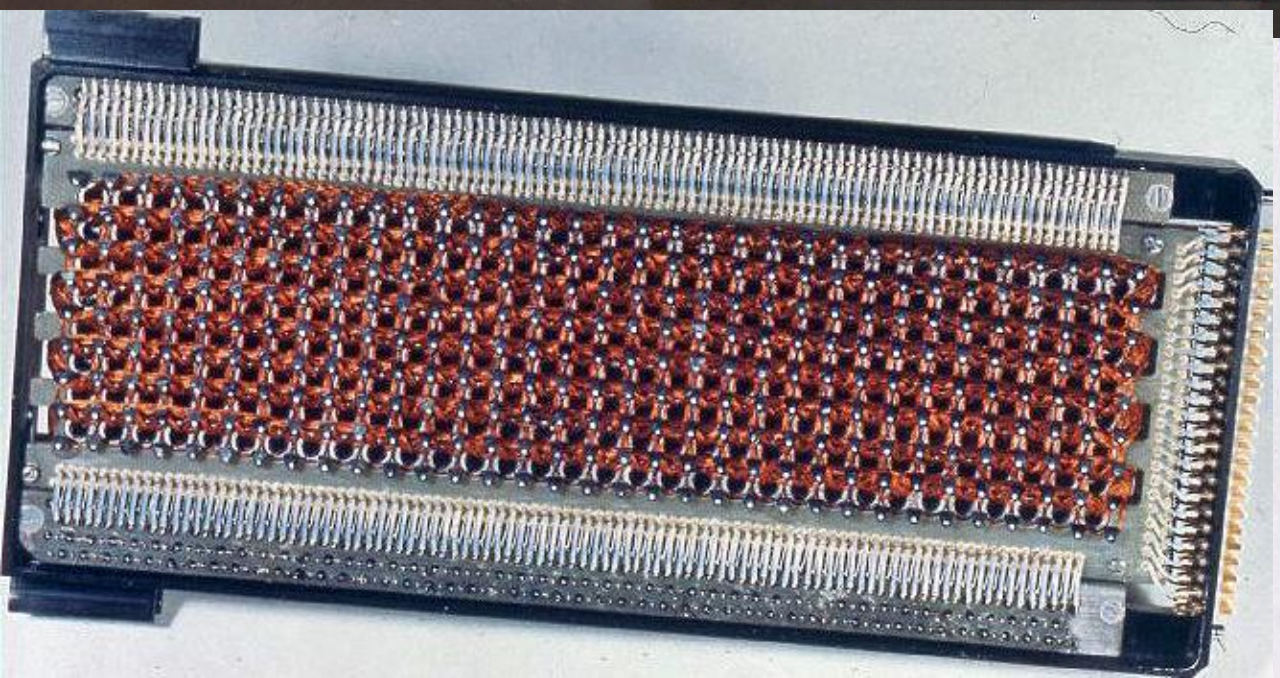


Some Design Questions

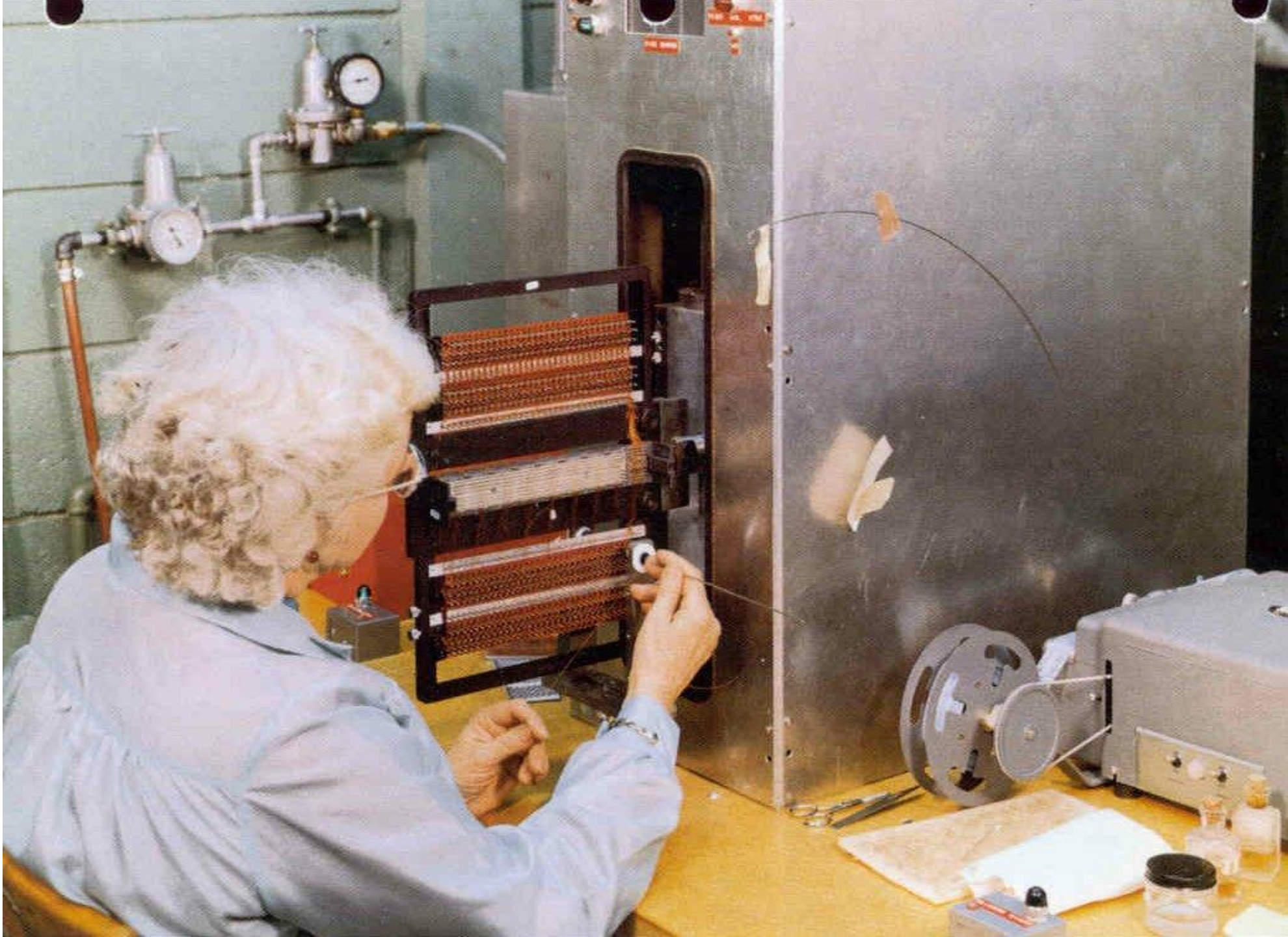
- How many stageable modules?
 - The Soviets had 3, we had 2. Why?
- How to transfer to the Lunar Module?
 - The Soviets used spacewalks, we used a tunnel. Why?
- Whether to land on land or in the water
 - We tried land; it was hard.
- How to navigate?
 - We spent \$100 million for onboard navigation, 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.

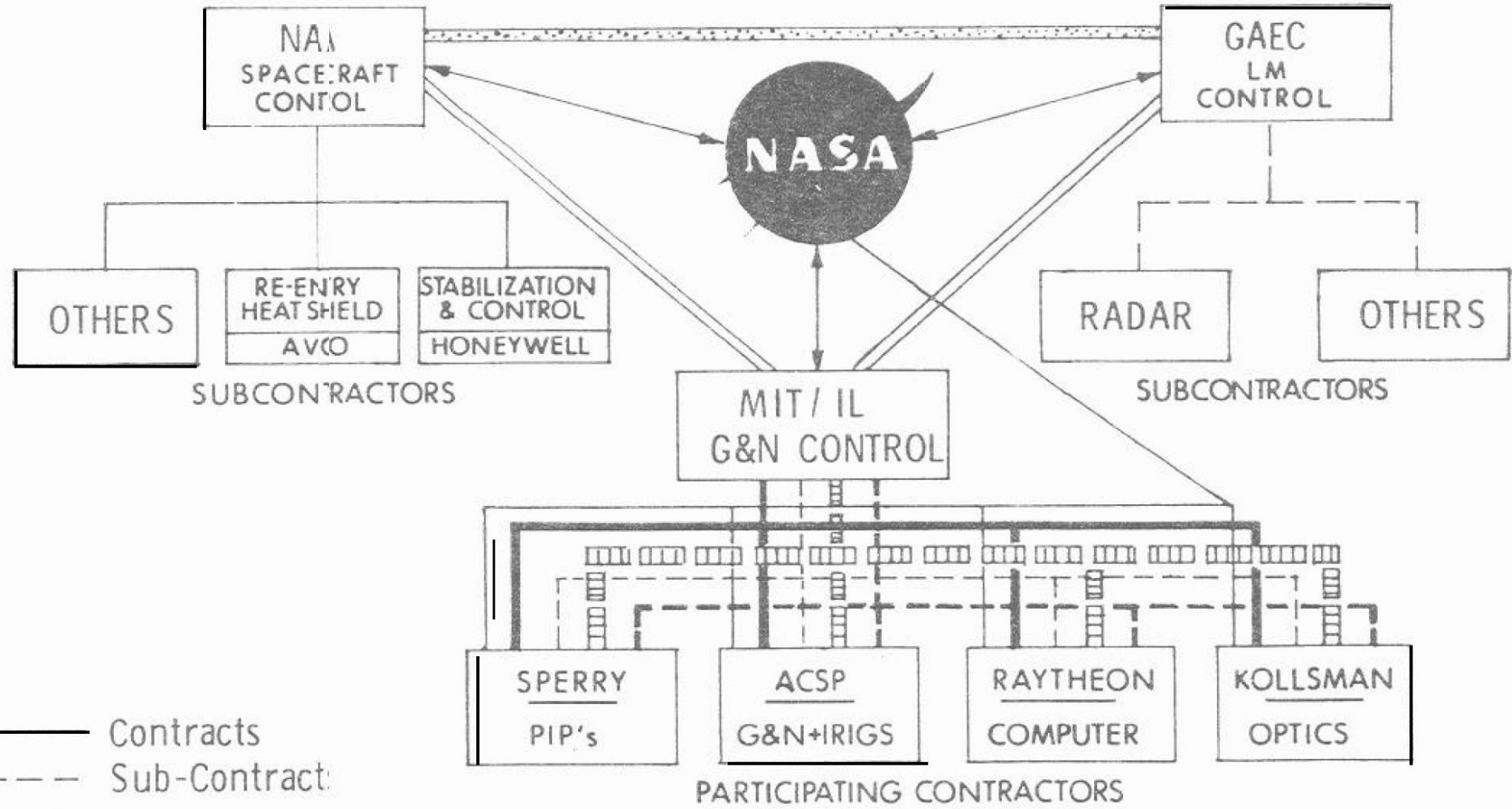
Apollo Guidance Computer

- 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, ...



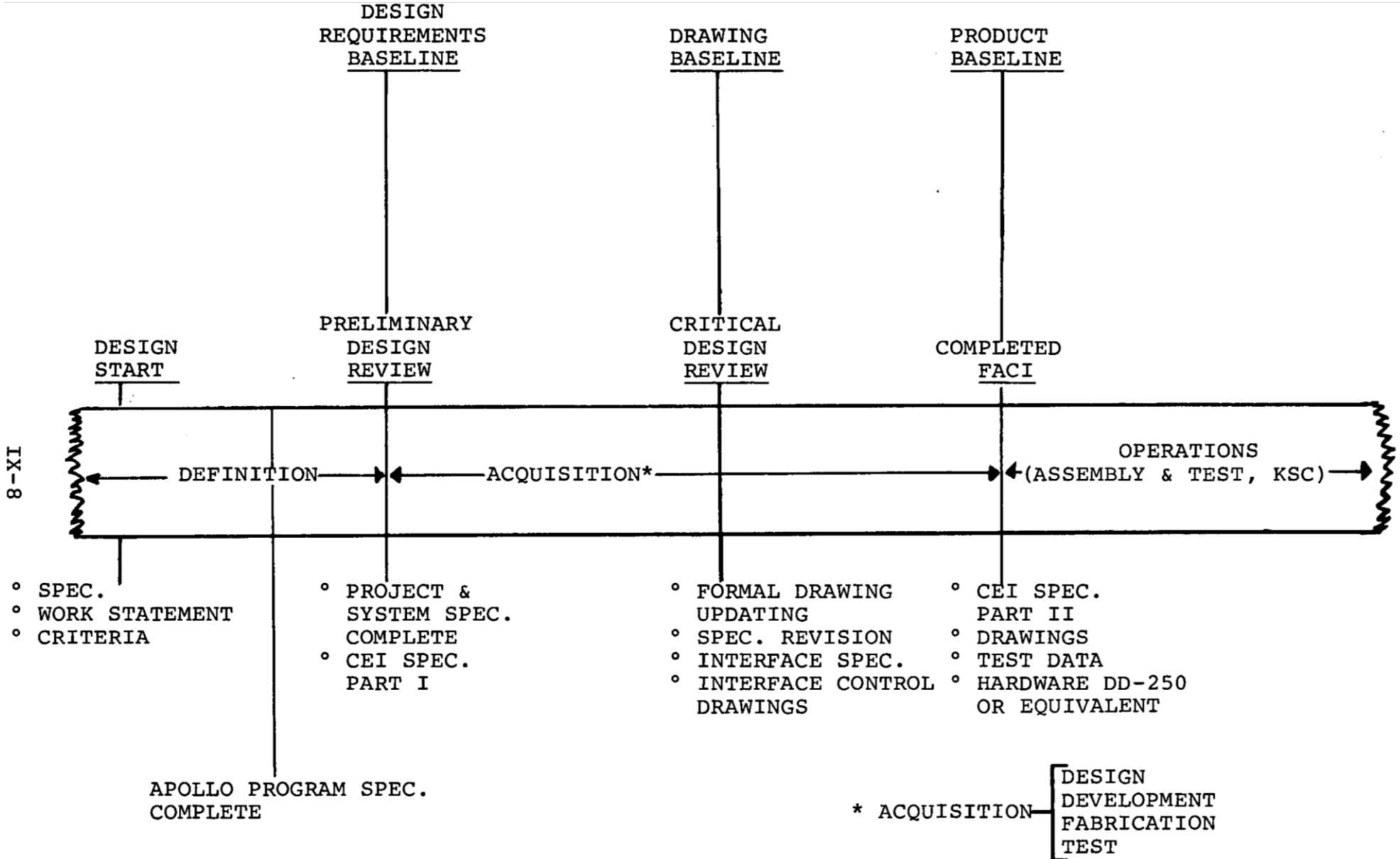
Programming
Core Rope
Memory





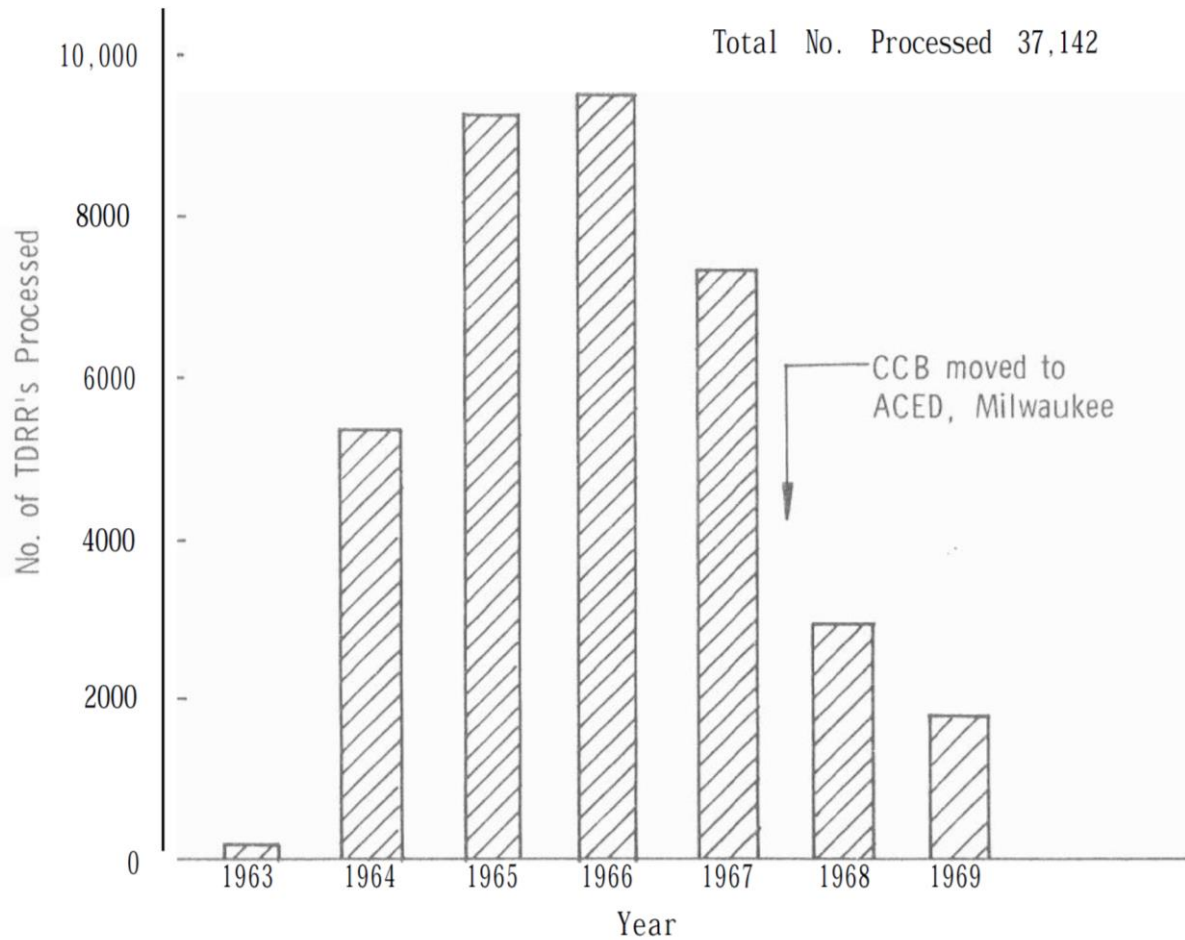
- Contracts
- - - - - Sub-Contract
- } Work Authorization Associated with Design, Technical Control and Resident Effort
- - - - - }
- ===== Informal Design Data Flow
- ===== Design Approval & Controls
- ===== Technical Coordination

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 <u>1</u> 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: _____	(20) NOMENCLATURE, CONTRACT END ITEM _____					
(5) SUPERSEDES ECP NO. _____	(5A) DATE: _____						
(6) END ITEM NO. _____	(21) EFFECTIVITIES		(22) PROCUREMENT ACTION REQUIRED				
(7) END ITEM PART NO. _____	FIRST	LAST	TYPE	FIRST	LAST	TYPE	A. END ITEM MOD. _____ B. SPARES MOD. _____ C. TECHNICAL DATA _____
(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							TYPE LEGEND P - PRODUCTION S - RETROFIT
(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)		CONCUR	NON CONCUR	TECHNICAL _____ RELIABILITY _____ TEST _____ MANUFACT. _____ QUAL. CONTROL _____ CONTRACTS _____ COSTS _____ SCHEDULE _____ OPERATIONS _____ LOGISTICS _____
(15) SPECIFICATIONS AFFECTED: PROGRAM SPEC NO. <input type="checkbox"/> YES <input type="checkbox"/> NO							
(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	
PROGRAM MANAGER CCB-MSFC			OTHER			CHAIRMAN APOLLO PROGRAM DIRECTOR CCB	
PROGRAM MANAGER CCB-KSC			OTHER				

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)

Case Study

- Read broadly about your assigned person
 - The one linked reading is just a starting point
 - Consult at least five sources
 - May take time to get some library materials!
- Organize your writing in four parts
 - Pre-Apollo career
 - Apollo career
 - Post-Apollo career
 - One vignette
- References
 - Any quoted content must be in quotes
 - Sources for all content that is not original must be cited