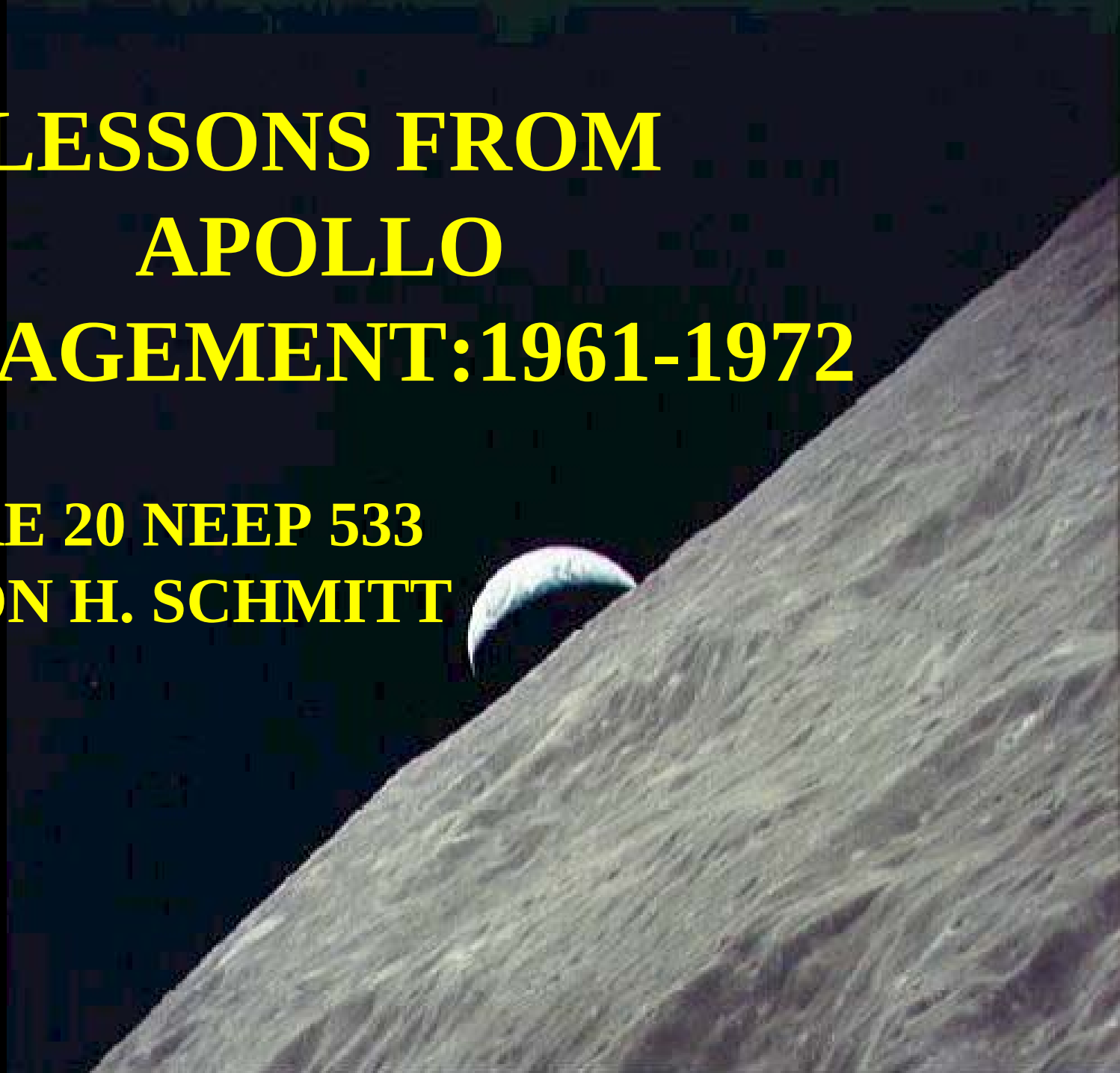
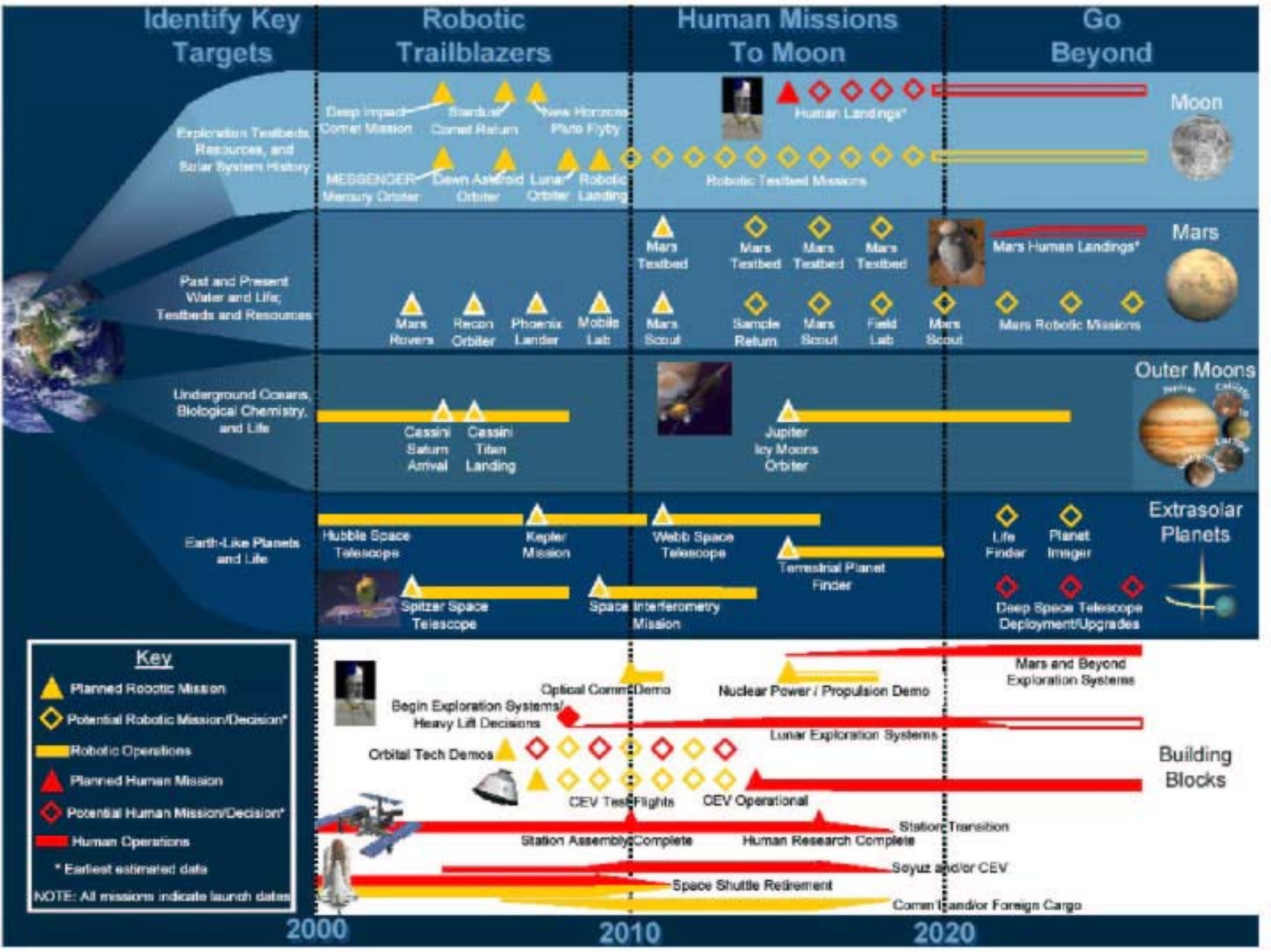
LESSONS FROM APOLLO MANAGEMENT:1961-1972



LECTURE 20 NEEP 533
HARRISON H. SCHMITT


Identify Key Targets
Robotic Trailblazers
Human Missions To Moon
Go Beyond
Exploration Testbeds, Resources, and Solar System History
Deep Impact Comet Mission
Stardust Comet Return
New Horizons Pluto Flyby
MESSENGER Mercury Orbiter
Dawn Asteroid Orbiter
Lunar Orbiter
Robotic Landing
Human Landings*
Robotic Testbed Missions
Moon
Past and Present Water and Life; Testbeds and Resources
Mars Rovers
Recon Orbiter
Phoenix Lander
Mobile Lab
Mars Testbed
Mars Scout
Sample Return
Mars Testbed
Mars Testbed
Mars Testbed
Mars Scout
Field Lab
Mars Scout
Mars Human Landings*
Mars Robotic Missions
Mars
Underground Oceans, Biological Chemistry, and Life
Cassini Saturn Arrival
Cassini Titan Landing
Jupiter Icy Moons Orbiter
Outer Moons
Earth-Like Planets and Life
Hubble Space Telescope
Kepler Mission
Webb Space Telescope
Terrestrial Planet Finder
Spitzer Space Telescope
Space Interferometry Mission
Life Finder
Planet Imager
Deep Space Telescope Deployment/Upgrades
Extrasolar Planets
Key
Planned Robotic Mission
Potential Robotic Mission/Decision*
Robotic Operations
Planned Human Mission
Potential Human Mission/Decision*
Human Operations
* Earliest estimated date
NOTE: All missions indicate launch dates
Optical Comm Demo
Begin Exploration Systems/ Heavy Lift Decisions
Orbital Tech Demos
CEV Test Flights
Nuclear Power / Propulsion Demo
Mars and Beyond Exploration Systems
Lunar Exploration Systems
CEV Operational
Station Assembly Complete
Station Transition
Human Research Complete
Soyuz and/or CEV
Space Shuttle Retirement
Comm and/or Foreign Cargo
Building Blocks
2000
2010
2020

Key Elements of the Nation's Vision

- **Objectives**
  - Implement a sustained and affordable human and robotic program
  - Extend human presence across the solar system and beyond
  - Develop supporting innovative technologies, knowledge, and infrastructures
  - Promote international and commercial participation in exploration

- **Major Milestones**
  - 2008: Initial flight test of CEV
  - 2008: Launch first lunar robotic orbiter
  - 2011 First Unmanned CEV flight
  - 2014: First crewed CEV flight
  - 2015: Jupiter Icy Moon Orbiter (JIMO)/Prometheus
  - 2015-2020: First human mission to the Moon

OR, THE PRIVATE SECTOR MIGHT DO SOMETHING A LITTLE MORE FOCUSED

EQUIPMENT AND PEOPLE

HELIUM-3 FUSION FUEL

SETTLERS

FUSION POWER TECHNOLOGY

OPERATIONS MANAGEMENT

INVESTORS

BUSINESS MANAGEMENT

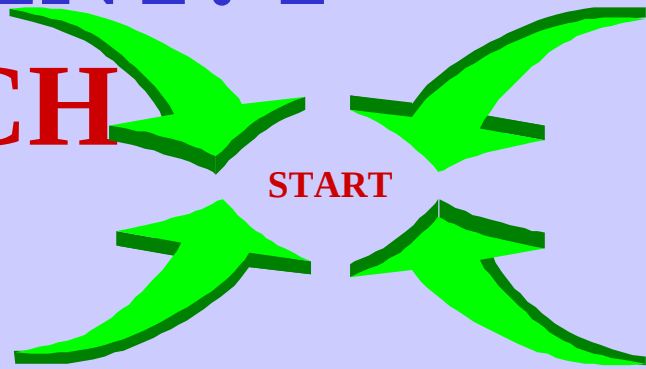
FIRST HUMAN MISSION TO THE MOON: 10-18 YEARS AFTER REACHING INITIAL INVESTMENT MILESTONE OF $15 M.

EQUIPMENT AND PEOPLE

HELIUM-3 FUSION FUEL

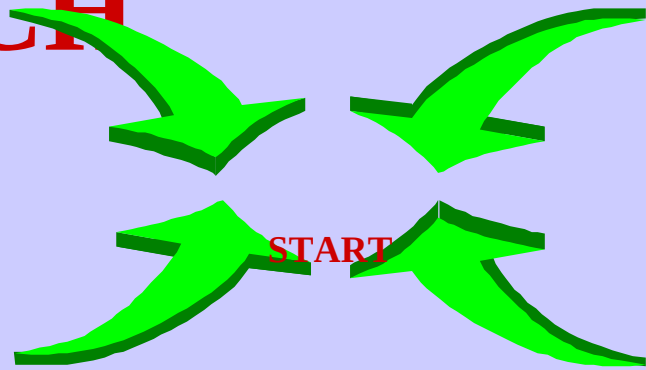
HOWEVER WE EVENTUALLY RETURN TO THE MOON, THE LESSONS OF APOLLO SHOULD BE REMEMBERED

APOLLO MANAGEMENT: 1
BROAD APPROACH



- **SET ATTAINABLE OBJECTIVE**
  - COMPONENTS OF SUCCESS OR FAILURE CLEAR
- **ESTABLISH ADMINISTRATIVE APPROACH**
  - COMBINE HARDWARE AND PROGRAMS
  - FLEXIBLE IMPLEMENTATION AT CENTERS
  - CENTERS REPORT TO PROGRAM OFFICES
  - SENIOR MANAGEMENT WORKS EXTERNAL ISSUES
    - PROVIDES TECHNICALLY COMPETENT OVERSIGHT
  - CONTRACT OUT MOST R&D
  - PARALLEL INTERNAL DESIGN / ENGINEERING
  - RIGOROUS COMPONENT TESTING / “ALL-UP” FLIGHT TESTING
  - SUFFICIENT MANAGEMENT RESERVE

APOLLO MANAGEMENT: 2
BROAD APPROACH



- **ITERATE DESIGN**
  - **CONFIGURATION CONTROL**
  - **COMPUTATIONAL MODELING**
  - **MANUFACTURING SYSTEM QUALITY**
  - **TEST AND EVALUATION**
- **IMPLEMENT AND ENHANCE**
  - **SINGLE DOCUMENT FOR PROJECT APPROVAL**
  - **“BETTER IS THE ENEMY OF GOOD”**
  - **LEARN FROM FAILURE**

SEE LECTURE 1

APOLLO MANAGEMENT:
SET ATTAINABLE OBJECTIVE

- **BASE OF TECHNOLOGY**
  - **AVIATION, ROCKETRY AND COMPUTATION**
- **PREPARATORY STUDIES**
  - **NACA, NASA, IKE'S SATURN DEVELOPMENT**
- **GENERAL COMPETITIVE UNEASE**
  - **COLD WAR ("MISSILE GAP" / NO VISIBLE END)**
- **CATALYTIC EVENT**
  - **GARGARIN FLIGHT**
- **TRUSTED AND ARTICULATE LEADER**
  - **JOHN F. KENNEDY (EISENHOWER ROLE)**
- **NECESSARY EMPLOYEE POOL**
  - **450,000 ENGINEERS, MOSTLY IN THEIR 20s AND 30s**

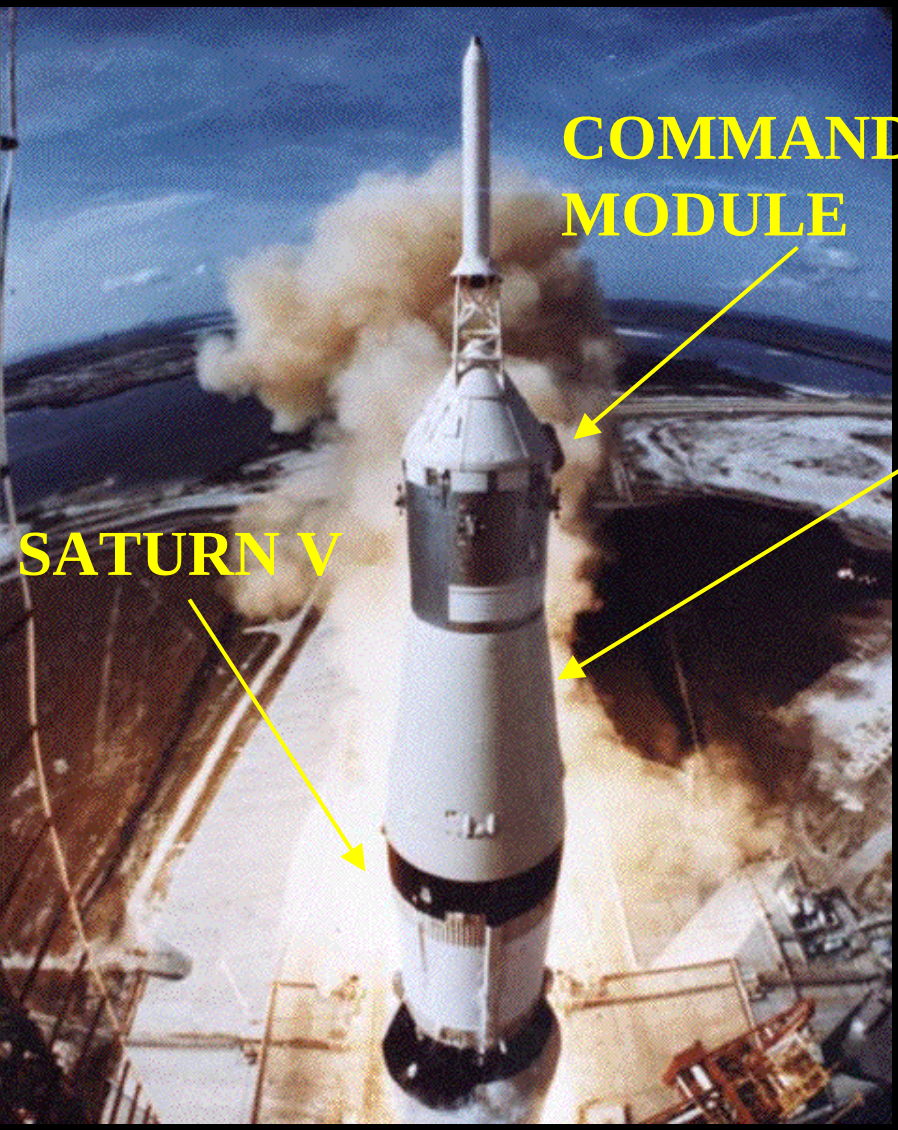
APOLLO MANAGEMENT
ESTABLISH GENERAL APPROACH

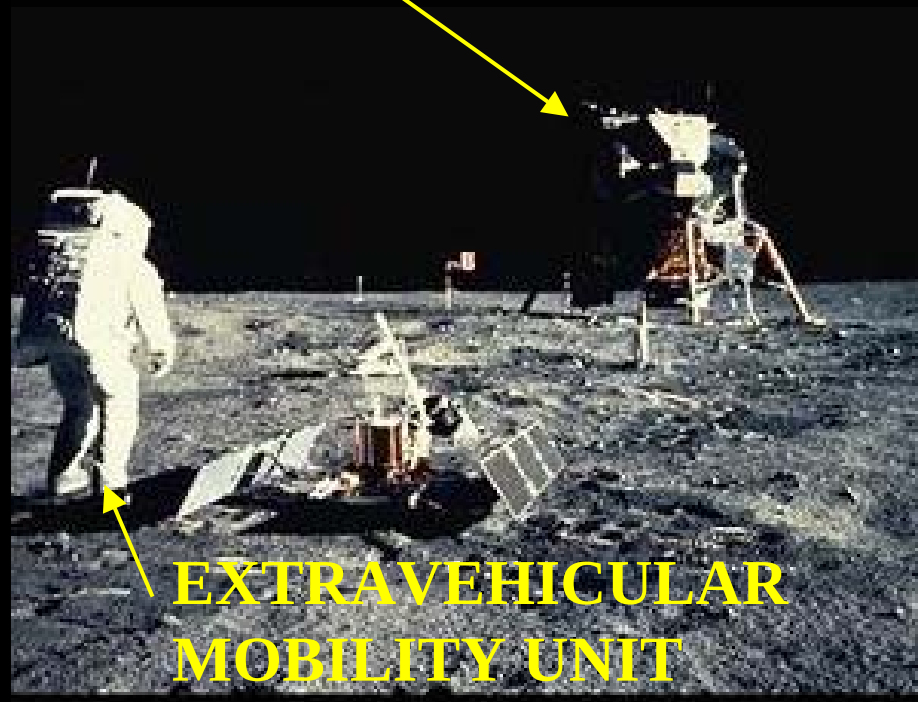
- **MISSION**
  - **MULTIPLE OPPORTUNITIES TO RE-EVALUATE**
    - **EARTH ORBIT TO LUNAR ORBIT TO LUNAR SURFACE TO LUNAR ORBIT TO LUNAR RENDEZVOUS TO EARTH DIRECT**
      - **NOT ORIGINAL CONCEPT: ONE ENGINEER, JOHN C. HOUBOLT, CHANGED IT**
- **DESIGN**
  - **NO SINGLE POINT FAILURES**
  - **PARALLEL DESIGN TEAMS**
  - **COMPETITIVE APPROACHES FOR CRITICAL SYSTEMS**
- **MANUFACTURING**
  - **COMPETITIVE BIDDING FOR MAJOR ITEMS**
  - **MAINTAIN CORE OF CAPABILITY IN NASA**

GENERAL APPROACH: DESIGN IMPLICATIONS

- **MAJOR DESIGN CHALLENGES**
  - **HEAVY LIFT LAUNCH VEHICLE (SATURN V)**
  - **PRIMARY SPACECRAFT (CSM)**
  - **LUNAR LANDING SPACECRAFT (LM)**
  - **LUNAR SURFACE ACTIVITY EQUIPMENT (EMU)**
- **MAJOR OPERATIONAL CHALLENGES**
  - **ORBITAL RENDEZVOUS (GEMINI AND APOLLO 9)**
  - **DEEP SPACE NAVIGATION (APOLLO 8 AND 10)**
  - **LUNAR LANDING NAVIGATION (INERTIAL GUIDANCE, LANDMARK TRACKING, LANDING RADAR, AND DOPPLER MEASUREMENT OF VELOCITY CHANGES)**

MAJOR ELEMENTS FOR APOLLO





APOLLO MANAGEMENT: SECOND CATALYTIC EVENT

- APOLLO 1 FIRE - JANUARY 1967
- DESIGN AND IMPLEMENTATION INADEQUATE
  - POTENTIAL IGNITION SOURCES
  - FLAMMABLE MATERIAL IN CABIN AND COOLANT LINES
  - HATCH COULD NOT BE OPENED QUICKLY
- QUALITY CONTROL INADEQUATE
  - ELECTRICAL SHORT PROBABLE IGNITION SOURCE
- NASA MANAGEMENT CONTROL INADEQUATE
  - RATE OF CHANGE ORDERS WAY AHEAD OF RATE OF CHANGES
- CONTACTOR MANAGEMENT CONTROL INADEQUATE
- TEST PROCEDURES HIGH RISK - PEOPLE MAKE DUMB JUDGMENTS
  - 16 PSI PURE OXYGEN IN CABIN

APOLLO MANAGEMENT: EFFECTS OF APOLLO 1 FIRE

- DESIGN
- QUALITY CONTROL
- MANAGEMENT
- TESTING / LAUNCH
- OVERALL

- "BLOCK II" DESIGN ADOPTED
  - APOLLO 7 THEN 8
- CONFIGURATION CONTROL REVISED
  - DISCIPLINE
- GEORGE LOW
  - ASPO DIRECTOR
- 60/40 NITROGEN/OXYGEN
  - BLEED TO 100% OXYGEN
- MET "END OF DECADE" CHALLENGE
  - FIRE MADE IT POSSIBLE

APOLLO MANAGEMENT:
FINAL DETAILED APPROACH -1

- **DESIGN**
  - **NO SINGLE POINT FAILURES**
  - **PARALLEL ENGINEERING TEAMS FOR PRIMARY DESIGNS**
  - **COMPETITIVE DESIGN APPROACHES IN CRITICAL AREAS**
- **MANUFATURING**
  - **COMPETITIVE BIDDING FOR MAJOR ITEMS**
  - **CLEAN ROOM TECHNOLOGY AND PROCEDURES**
- **WEEKLY CONFIURATION CONTROL REVIEW**
  - **GEORGE LOW IMPOSED DISCIPLINE ON THIS PROCESS**
  - **CHANGES EVALUATED INDEPENDENTLY BY CONTRACTOR AND NASA ENGINEERS**

APOLLO MANAGEMENT:
FINAL DETAILED APPROACH -2

- **QUALITY CONTROL**
  - **INHERENT MOTIVATION OF WORKERS**
    - **"SNOOPY" RECOGNITION AND AWARD PROGRAM**
  - **TWO-TIERED QC + SIGN-OFF ON INSTALLATION (CONTRACTOR(S) / GOVERNMENT)**
  - **ASTRONAUT VISIBILITY**
- **TESTING**
  - **COMPONENT TO SUBSYSTEM TO SYSTEM TO FULL-UP**
  - **"HIGH REL" PART SELECTION**
  - **ASTRONAUT PARTICIPATION IN FULL-UP TESTING OF MAJOR ELEMENTS**
    - **KEPT EVERYONE FOCUSED ON MINIMUM RISK**

APOLLO MANAGEMENT:

FINAL DETAILED APPROACH -3

- **OPERATIONS AND TRAINING**
  - SPACECRAFT SIMULATOR DEVELOPMENT
  - MALFUNCTION PROCEDURES DEVELOPMENT
  - MISSION RULES DEVELOPMENT AND DISCIPLINE
  - MISSION PLANNING AND ANALYSIS PROCESS
  - SIMULATIONS
    - FLIGHT CONTROLLERS ALONE
    - CREW PLUS ALL SUPPORT PERSONNEL (MISSION SIMS)
  - EARTH ORBIT HARDWARE AND RENDEZVOUS EXPERIENCE
    - GEMINI PROGRAM
    - APOLLO 7 AND 9
  - TRANS-EARTH AND LUNAR ORBIT EXPERIENCE
    - APOLLO 8 AND 10

APOLLO MANAGEMENT:

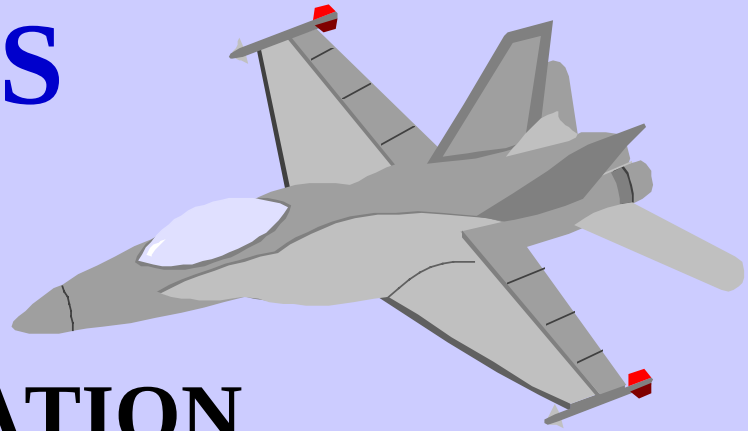
FINAL DETAILED APPROACH -4

- **REAL-TIME OPERATIONS**
  - **PROBLEM SOLVING (E.G., APOLLO 13)**
    - **BUILD ON SIMULATION EXPERIENCE**
    - **SPONTANEOUS TEAMS APPROPRIATE TO PROBLEM**
    - **RESULTS MORE IMPORTANT THAN CREDIT**
    - **TEST MULTIPLE SOLUTIONS / ANALYZE TRADE-OFFS**
    - **CHOOSE ANSWER AND FALL-BACK RESPONSES**
  - **DISCIPLINE**
    - **TRAINING**
    - **FINAL AUTHORITY RESTED IN LAUNCH AND FLIGHT DIRECTORS - ONLY COULD BE FIRED AFTER THE FACT**
  - **REAL-TIME "ON-LINE" SUPPORT**
    - **BACK ROOMS**
    - **MANUFACTURER SUPPORT (LOCAL AND PLANT)**

APOLLO MANAGEMENT:
ASTRONAUTS A SPECIAL FACTOR

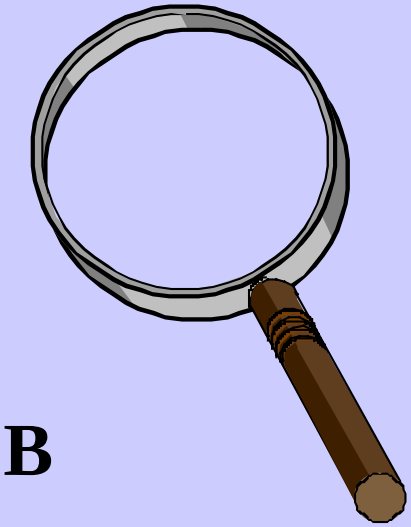
- ASTRONAUT TECHNICAL ASSIGNMENTS
  - TRAINING FOR ASTRONAUTS
  - OPERATIONAL DESIGN INPUTS
- NETWORK OF INTERNAL INTELLIGENCE
  - DESIGN ACTIVITIES, MISSION PLANNING, DESIGN REVIEWS, READINESS REVIEWS, ONE-ON-ONE CONTACT WITH ENGINEERS
  - MAJOR ISSUES FED BACK TO OTHERS ONCE A WEEK
    - PILOT MEETINGS
  - COULD BE TAKEN HIGHER IF NEEDED
    - THROUGH SHEPARD AND SLAYTON OR THROUGH MORE INFORMAL CONTACTS
  - SUPPLY OF TIGER TEAM LEADERS (BORMAN / DUKE)

APOLLO VALUES



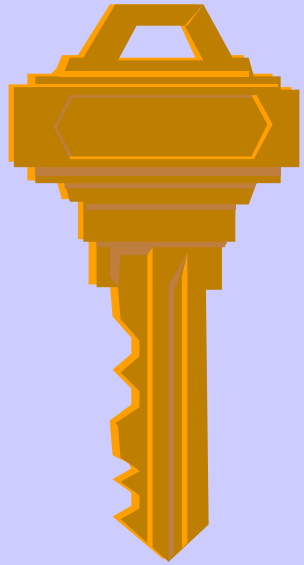
- **CUSTOMER ORIENTATION**
  - **– UNITED STATES OF AMERICA**
  - **– ASTRONAUTS**
    - **CLOSE CONTACT WITH TECHNICIANS AND ENGINEERS LOWERED RISK**
    - **MOST WERE VERY PROFESSIONAL IN THEIR APPROACH TO MISSIONS**

APOLLO VALUES



- **QUALITY**
  - **TREATED AS EVERYONE'S JOB**
    - **NO " QUALITY CZAR"**
  - **CONTRACTOR-NASA-CREW REVIEWS**
  - **CONFIGURATION CONTROL**

APOLLO VALUES



- GREAT PLACE TO WORK
  - PERSONAL MOTIVATION
- RESULTS ORIENTATION
  - YOUNG “VOLUNTEERS”
    - “FAILURE NOT AN OPTION”
  - ENGINEERING BACKGROUNDS
  - PROFESSIONAL VALUES
  - LEADERSHIP STYLE
    - INITIATIVE ENCOURAGED
    - GOOD IDEA COULD BE HEARD UP THE CHAIN OF MANAGEMENT

WHAT HAPPENED TO NASA AFTER APOLLO?

- **NASA DECISION TO DISCARD APOLLO CAPABILITY**
  - **NOT OVERRULED BY PRESIDENT OR CONGRESS**
- **OMB / CONGRESSIONAL BUDGET CUTS**
  - **NASA'S ACCEPTANCE OF UNDER-FUNDING FOR TOUGH PROJECTS - ETHICAL ISSUE?**
    - **LOSS OF MANAGEMENT RESERVE**
    - **ELIMINATION OF INTERNAL DESIGN TEAMS**
    - **DEPENDENCE ON CONTRACTORS**
    - **AVERAGE AGE INCREASE**
    - **RIFS DAMAGED SKILL MIXES / DEPENDENCE ON SUPPORT CONTRACTS**
    - **SCHEDULES STRETCH-OUT**

BUDGET CUTS AND OVER-RUNS

- LOSS OF STRONG POLITICAL SUPPORT AFTER 1970
  - LOSS OF MEDIA INTEREST IN SUCCESS
  - VIETNAM / COLD WAR
  - ENTITLEMENTS
  - WATERGATE
- NO INFRASTRUCTURE DOWNSIZING
  - 1/3 APOLLO BUDGET WITH MOST OF APOLLO INFRASTRUCTURE
- LOSS OF PROGRAM MANAGEMENT DISCIPLINE
  - CONTRACTS WITHOUT PROGRAM MANAGEMENT PLAN
- LOSS OF RISK MANAGEMENT DISCIPLINE
  - CONTRACTS WITHOUT RISK MANAGEMENT PLAN
- LOSS OF FINANCIAL MANAGEMENT DISCIPLINE
  - CONTRACTS WITHOUT FINANCIAL MANAGEMENT PLAN
- OVERALL MORALE DETERIORATION
- RESPONSE TO SHUTTLE ACCIDENTS INDECISIVE

SCHEDULES STRETCH-OUT

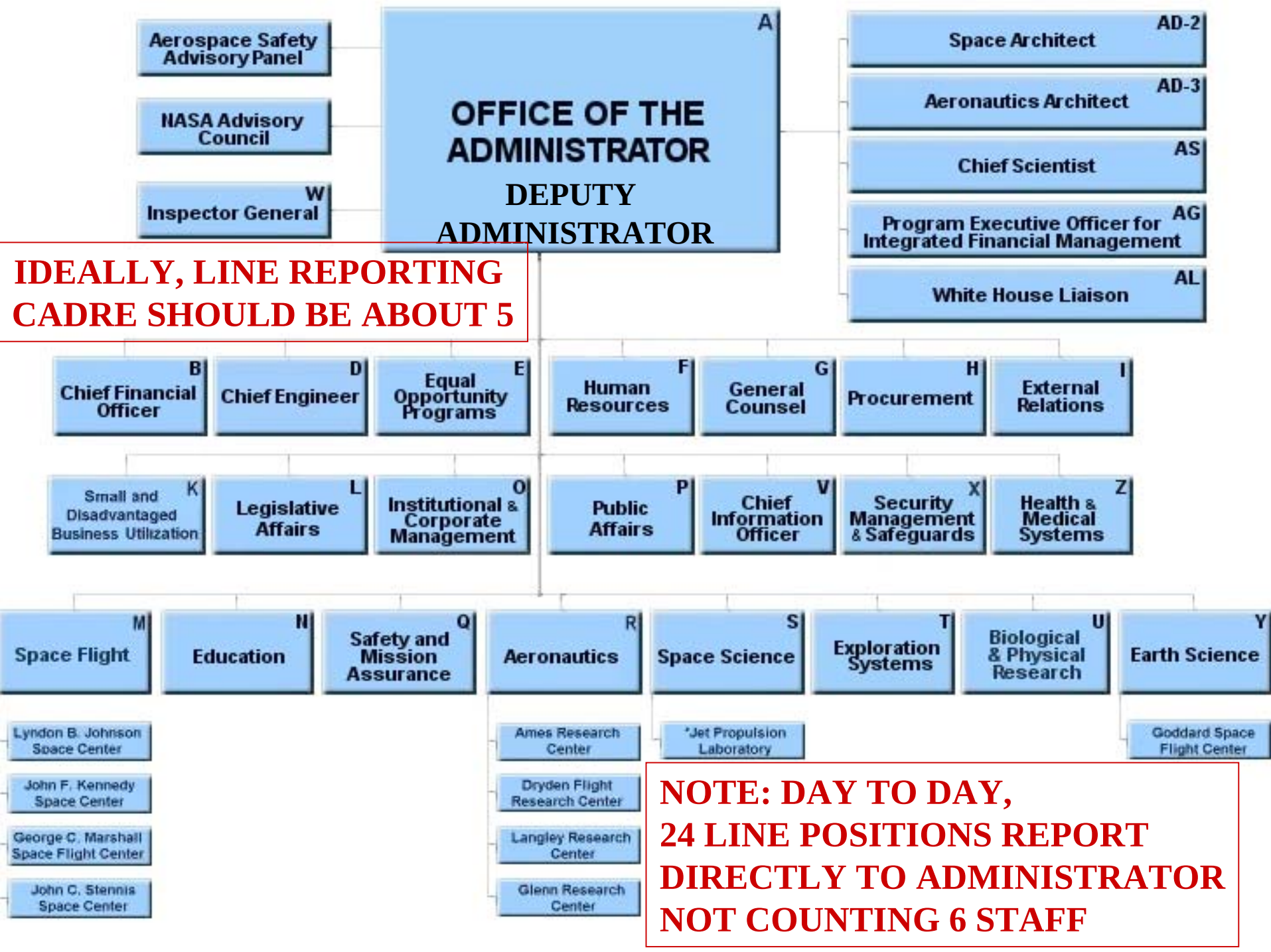
- COMMITED TO SHUTTLE / STATION WITH INSUFFICIENT MANAGEMENT RESERVES
  - MILESTONE FENCES NEED MONEY TO ELIMINATE
- LOSS OF PARALLEL ENGINEERING CAPABILITY
  - DEPENDENCE ON CONTRACTOR DECISIONS
- LOSS OF MANAGEMENT CONTROL OF STATION
  - NOT IN CONTROL OF PATH TO COMPLETION
- LOSS OF PROGRAM MANAGEMENT DISCIPLINE
  - PROGRAMS, FINANCIALS, AND RISKS

MORALE DETERIORATION

- LACK OF SENSE OF MISSION
- CENTRALIZED CONTROL IMPOSED
  - INCREASED BUREAUCRACY
  - DECISION MIGRATION UPWARDS
  - PERCEPTION OF VINDICTIVE MANAGEMENT
- LOSS OF PARALLEL ENGINEERING CAPABILITY
  - INCREASED DEPENDENCE ON CONTRACTORS
- INCONSISTENT MANAGEMENT OF SKILL MIX
  - INDISCRIMINATE PERSONNEL CUTS
- AVERAGE AGE INCREASE
- THIS MAY HAVE CHANGED IN JANUARY 2004

NASA'S CURRENT ORGANIZATIONAL ISSUES

- ORGANIZATIONAL INEFFICIENCY
  - MUCH WORSE THAN APOLLO
  - EVEN WORSE THAN GOLDIN ERA
- DECISION CREEP
  - MUST BE AGGRESSIVELY RESISTED

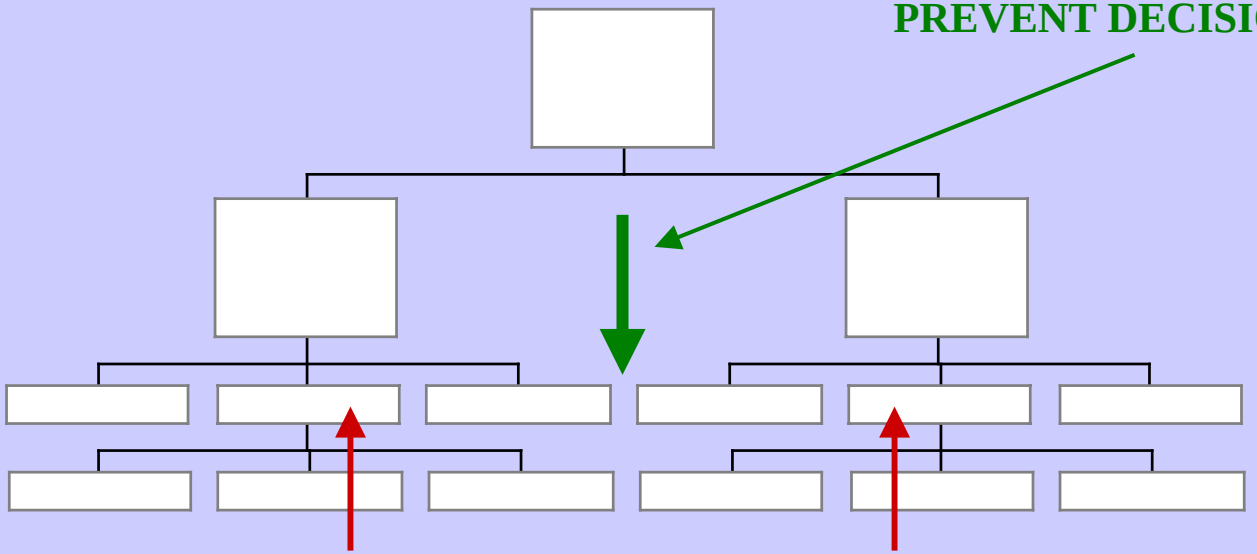

Aerospace Safety Advisory Panel
NASA Advisory Council
W Inspector General
A
OFFICE OF THE ADMINISTRATOR
DEPUTY ADMINISTRATOR
AD-2 Space Architect
AD-3 Aeronautics Architect
AS Chief Scientist
AG Program Executive Officer for Integrated Financial Management
AL White House Liaison
IDEALLY, LINE REPORTING CADRE SHOULD BE ABOUT 5
B Chief Financial Officer
D Chief Engineer
E Equal Opportunity Programs
F Human Resources
G General Counsel
H Procurement
I External Relations
K Small and Disadvantaged Business Utilization
L Legislative Affairs
O Institutional & Corporate Management
P Public Affairs
V Chief Information Officer
X Security Management & Safeguards
Z Health & Medical Systems
M Space Flight
N Education
Q Safety and Mission Assurance
R Aeronautics
S Space Science
T Exploration Systems
U Biological & Physical Research
Y Earth Science
Lyndon B. Johnson Space Center
John F. Kennedy Space Center
George C. Marshall Space Flight Center
John C. Stennis Space Center
Ames Research Center
Dryden Flight Research Center
Langley Research Center
Glenn Research Center
*Jet Propulsion Laboratory
Goddard Space Flight Center
NOTE: DAY TO DAY,
24 LINE POSITIONS REPORT DIRECTLY TO ADMINISTRATOR
NOT COUNTING 6 STAFF

HOW NEW AGENCIES CHANGE TO OLD AGENCIES

DECISION CREEP

MANAGEMENT OF DECISION CREEP

BUILT-IN REVIEW OF CHANGES IN RESPONSIBILITIES TO PREVENT DECISION CREEP



UNCONTROLLED DECISION FLOW WITH PROMOTION FOR GOOD PERFORMANCE

UNCONTROLLED DECISION FLOW WITH CORRECTION OF BAD DECISION

WHAT HAPPENED TO NASA AFTER APOLLO?

- **UNSUPPORTIVE POLITICAL STRATEGIES BY SEVERAL ADMINISTRATIONS**
  - **JOHNSON - VIETNAM OVERSHADOWED**
  - **NIXON/FORD - WATERGATE / "NIH" OVERSHADOWED**
  - **CARTER - NEGLECT / LACK OF INTEGRATION SKILLS**
  - **REAGAN - COLD WAR / SDI OVERSHADOWED**
  - **BUSH I - POOR SELLING STRATEGY FOR SEI / POOR MANAGEMENT**
  - **CLINTON - NEGLECT / POOR MANAGEMENT / INTERNATIONAL MANAGEMENT**
  - **BUSH II - HAS SHOWN INITIATIVE / WILL HE KEEP AS PRIORITY**
  - **BUSH II ALTERNATIVE - SUPPORTS HUMANS TO MARS BUT QUESTIONS COST**
- **UNTIL BUSH II, NONE SHOWED, CONSISTENT LONG-TERM VISION OF THE FUTURE OF HUMANKIND IN THE CONTEXT OF THE PRESENT**
  - **NO GUARANTEE THAT THIS VISION WILL BE SUSTAINED**

SHUTTLE ACCIDENTS

- **ALL OF THE ABOVE**
- **ROLE OF ASTRONAUTS CHANGED**
  - **NEW ASTRONAUTS NOT GIVEN TECHNICAL ASSIGNMENTS BEFORE *CHALLENGER* ACCIDENT**
    - **CHIEF OF ASTRONAUT OFFICE SAID THAT THE OFFICE DID NOT KNOW OF EARLIER SOLID ROCKET SEAL BURN-THROUGHS**
      - **MAY HAVE BEEN ONE EXCEPTION THAT DID NOT SPEAK UP**
    - **ABNORMAL BECAME NORMAL WITHOUT THEIR KNOWLEDGE AND/OR ACTION**
- **"FAILURE NOT AN OPTION" OPERATIONAL ATTITUDE LOST**
  - **ALL POSSIBLE PROBLEMS / SOLUTIONS NOT FULLY EXPLORED FOR *COLUMBIA* BEFORE RE-ENTRY**
    - **SATELLITE PHOTOS MIGHT HAVE SHOWN EXTENT OF DAMAGE**
    - **NEXT SHUTTLE MIGHT HAVE BEEN LAUNCHED IN 7-10 DAYS**
    - **APOLLO TEAM WOULD HAVE FULLY EXPLORED DEFINABLE OPTIONS**

TERM PAPER TOPICS

- **ETHICS OF ACCEPTING INSUFFICIENT MANAGEMENT RESERVE**
- **HOW COULD THE APOLLO SYSTEMS HAVE BEEN USED AFTER APOLLO?**
- **FIRST LEVEL DESIGN COMPARISON OF BUSH INITIATIVE WITH APOLLO**
- **COMPARISON OF APOLLO MANAGEMENT WITH ONE OR MORE OF THE FOLLOWING: PANAMA CANAL, TRANSCONTINENTAL RAILROAD, INTERNATIONAL SPACE STATION, INTERSTATE HIGHWAY SYSTEM, SPACE SHUTTLE, TRANS-ALASKA PIPELINE**

APOLLO'S CULTURAL LEGACY

- **NEW EVOLUTIONARY STATUS**
  - **HUMAN SPECIES CAN LIVE ON MOON AND MARS**
- **RAPID IMPROVEMENT IN HUMAN CONDITION ON EARTH**
  - **ACCELERATION OF TECHNOLOGICAL EXPANSION**
- **FUTURE TERRESTRIAL ENERGY AND ENVIORNMENTAL IMPROVEMENT**
  - **CONVERSION EFFICENCIES ENHANCED**
  - **LUNAR HELIUM-3 FUSION MADE FEASIBLE**
- **SPACE SETTLEMENT RESOURCES IDENTIFIED**
  - **HYDROGEN, OXYGEN, WATER, AND FOOD**

APOLLO'S COLD WAR LEGACY

- COLD WAR POLITICAL GOALS OF EISENHOWER AND KENNEDY MET
- SOVIET UNION LEADERSHIP INTIMIDATED
  - REAGAN'S STRATEGIC DEFENSE LATER BECAME CREDITABLE
    - AMERICA COULD SUCCEED - SOVIETS COULD NOT
- U.S. PRIDE AND CONFIDENCE ENHANCED
- OTHER PEOPLES ENCOURAGED ABOUT THEIR FUTURE

APOLLO'S KEYS TO SUCCESS

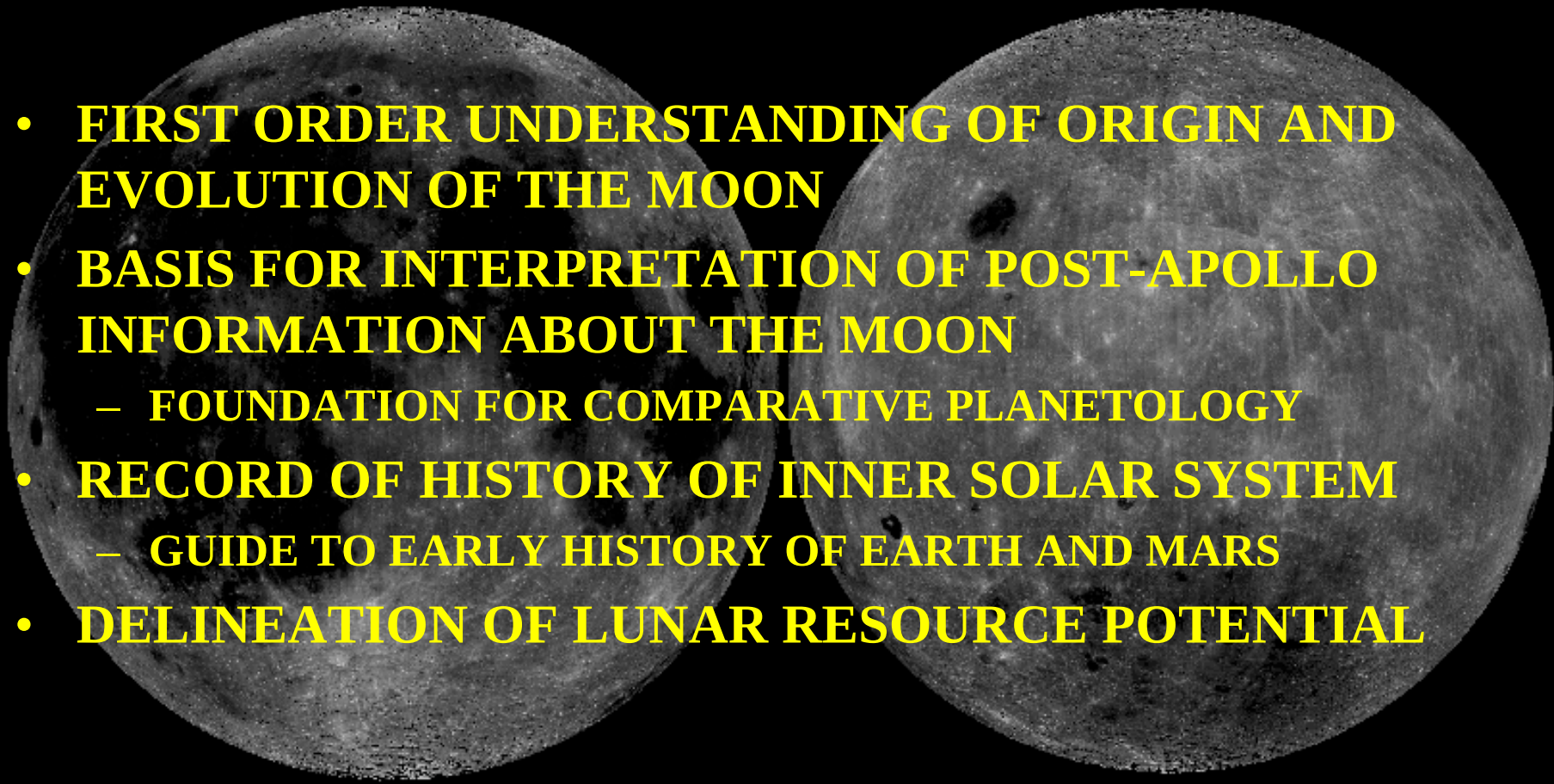
- SUFFICIENT BASE OF TECHNOLOGY
  - WWII / COLD WAR / EISENHOWER DECISIONS
- RESERVOIR OF YOUNG ENGINEERS AND SKILLED WORKERS
  - 1957 "SPUTNIK" GENERATION
- PERVASIVE ENVIRONMENT OF NATIONAL UNEASE
  - CAMPAIGN OF 1960
- CATALYTIC EVENT THAT BRINGS FOCUS TO EFFORT
  - GARGARIN'S FLIGHT
- ARTICULATE, TRUSTED AND PERSUASIVE PRESIDENT
  - JOHN F. KENNEDY
- SUSTAINED COMMITMENT
  - CONGRESS
- COMPETENT AND DISCIPLINED MANAGEMENT
  - POST-APOLLO 204 FIRE

DEEP SPACE OPERATIONS STILL REQUIRE THESE KEYS!

NASA'S WORST ACCCIDENTS: COMMON THREADS

- **APOLLO 204/CHALLENGER/COLUMBIA**
  - **ACCEPTANCE OF ABNORMAL AS NORMAL**
  - **LACK OF TECHNICALLY EXPERIENCED ADMINISTRATOR**
  - **LACK OF TOP LEVEL MANAGERIAL AND OPERATIONAL OVERSIGHT**
  - **LACK OF A MECHANISM FOR APPEAL IN THE CHAIN OF MANAGEMENT**
- **ONLY WITH APOLLO 13 CAN A "PURE" SET OF ACCIDENTS AND DESIGN FLAWS BE BLAMED**

APOLLO'S SCIENTIFIC LECACY



- FIRST ORDER UNDERSTANDING OF ORIGIN AND EVOLUTION OF THE MOON
- BASIS FOR INTERPRETATION OF POST-APOLLO INFORMATION ABOUT THE MOON
  - FOUNDATION FOR COMPARATIVE PLANETOLOGY
- RECORD OF HISTORY OF INNER SOLAR SYSTEM
  - GUIDE TO EARLY HISTORY OF EARTH AND MARS
- DELINEATION OF LUNAR RESOURCE POTENTIAL

NOT TOO SHABBY!