TWO PATHS TO THE MOON

NEEP 533 LECTURE 39
Harrison H. Schmitt

SPACE POLICY 2004
PRESIDENT GEORGE W. BUSH
HUMAN EXPLORATION INITIATIVE
JANUARY 14, 2004
“RENEWED SPIRIT OF DISCOVERY”

• NASA COMMITTED TO LONG TERM HUMAN AND ROBOTIC SPACE EXPLORATION
  – ENABLE EXPLORATION OF MARS AND OTHER DESTINATIONS
    • RETURN TO THE MOON TO FACILITATE THIS
  – NEW FOCUS FOR NASA
  – AFFORDABLE, SUSTAINABLE, HIGH LEVELS OF SAFETY
  – TECHNOLOGICAL BENEFITS ON EARTH
NASA’S NEW AGENDA - 1

• COMPLETE ISS BY 2010
  – RETURN SPACE SHUTTLE TO FLIGHT 2005
  – RETIRE SPACE SHUTTLE BY 2010
  – FOCUS ISS RESEARCH ON BIOMEDICINE

• DEVELOP CEV BY 2014
  – FERRY TO ISS
  – MISSIONS BEYOND EARTH ORBIT
  – OTHER?
NASA’S NEW AGENDA - 2

• RETURN TO MOON BY 2015-2020
  – INCREASINGLY LONG STAY-TIMES
  – DEVELOP NEW EXPLORATION TECHNOLOGIES
  – HARNESS LUNAR RESOURCES
    • MISSIONS TO MARS AND BEYOND
  – ROBOTIC LUNAR MISSIONS BY 2008
  – INCREASED ROBOTIC EXPLORATION OF SOLAR SYSTEM
FY 2005-2010 NASA BUDGETS (REQUESTED)

- CURRENT FY 2004 BUDGET = $15.4 B
- FY 2005: ADD $800 M
- FY 2006-2010: ADD $200 M PER YEAR
  - RE-ALLOCATE $11 B FROM WITHIN 5 YEAR BASE
    PLAN OF $86 B
    - NASA ADMINISTRATOR WILL REVIEW ALL CURRENT
      PROGRAMS
      - REDIRECT TOWARD PRESIDENT’S NEW GOALS
- CONGRESSIONAL RELUCTANCE
PRESIDENTIAL COMMISSION ON IMPLEMENTATION OF US SPACE EXPLORATION POLICY

• PETE ALDRICH - CHAIRMAN
• REPORT IN FOUR MONTHS
• INDEFINITE LIFE?
ARE THERE TWO PATHS TO THE MOON?

NASA’S NEW VISION AND A PRIVATE ENTREPRENEURIAL INITIATIVE
WHY TWO PATHS FOR PRIVATE AND GOVERNMENT SECTORS?

• PROGRESS SOMETIMES REQUIRES A CATALYST
  – THRESHOLD FOR PRIVATE INVESTMENT MAY BE TOO HIGH
  – STILL NEEDED ADVANCEMENT FOR PUBLIC GOOD
  – MUST AVOID GOVERNMENT’S MISDIRECTION OF TECHNOLOGY
    • SPACE SHUTTLE DEVELOPMENT IN 1970s
      – SATURN SYSTEM ALTERNATIVE
    • SOLAR ENERGY EMPHASIS IN 1970s
      – TECHNOLOGY NOT READY
      – NET COSTS NOT COMPETITIVE
    • SYNFUELS / OIL SHALE EMPHASIS IN 1980s
      – WASTE DISPOSAL INTRACTABLE
      – NON-COMPETITIVE COSTS
    • ELECTRIC AUTOMOBILES IN THE 1990s
      – ENERGY STORAGE TECHNOLOGY NOT READY
      – INCREASED USE OF FOSSIL FUELS ABSENT COMMITMENT TO FISSION
    • D/T MAGNETIC FUSION IN THE 2000s
      – INHERENTLY NON-COMMERCIAL
WHY TWO PATHS FOR PRIVATE AND GOVERNMENT SECTORS?

- DUAL ROLES TRADITIONAL IN U.S. HISTORY
  - TRANSPORTATION: ARMY AND NACA
    - TURNPIKES, CANALS, RAILROADS, LOCKS AND DAMS, AERONAUTICS
  - AGRICULTURE: LAND GRANT COLLEGES
    - RESEARCH AND DEVELOPMENT OF CROPS AND TECHNOLOGY
  - COMMUNICATIONS: REGULATORY AGENCIES, NIST, AND NASA
    - STANDARDS AND SATELLITES
  - MEDICINE: NATIONAL INSTITUTES OF HEALTH AND ARMY
    - BASIC MEDICAL RESEARCH AND LARGE SCALE TRIALS
## COMPARISON OF TWO PATHS - 1

### GOVERNMENT
- HUMAN TENDED BASE
- POLICY DRIVEN IMPLEMENTATION
- OVERSIGHT BY PRESIDENTIAL COMMISSION?
- HEADQUARTERS PROGRAM & PROJECT MANAGEMENT
- HIGH OVERHEAD, DIVERSE FUNCTION POLITICAL “CENTERS”
- MID-CAREER TO RETIREMENT WORKFORCE
- CURRENT STABLE OF ELVs
  - 25-30 TONNES TO LEO
  - 5-6 TONNES TO MOON

### PRIVATE
- PERMANENT SETTLEMENT
- RETURN ON INVESTMENT DRIVEN IMPLEMENTATION
- OVERSIGHT BY INDEPENDENT BOARD OF DIRECTORS
- CENTRALIZED PROGRAM / DELEGATED PROJECT MGT.
- FOCUSED CENTERS OF EXCELLENCE
- YOUNG WORKFORCE / MID-CAREER MANAGERS
- NEW HEAVY LIFT ROCKET
  - 250-500 TONNES TO LEO
  - 50-100 TONNES TO MOON
## COMPARISON OF TWO PATHS - 2

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MUTUAL BENEFIT FROM TWO PATHS -1

• MAJOR PUBLIC BENEFITS FROM PRIVATE INITIATIVE
  – LOW COST, LARGE ROCKETS
    • PLANETARY EXPLORATION
    • NATIONAL DEFENSE
    • ASTEROID IMPACT PROTECTION
    • LUNAR TOURISM
  – ACCESS TO LUNAR RESOURCES
    • PLANETARY EXPLORATION CONSUMABLES
    • EARTH ORBIT CONSUMABLES
  – DEVELOPMENT OF COMMERCIAL HELIUM-3 FUSION POWER
    • CONTINUED ECONOMIC GROWTH AND COMPETITIVENESS
    • CLEAN ENERGY FOR TERRESTRIAL DEVELOPMENT
    • MEDICAL APPLICATIONS OF FUSION TECHNOLOGY
    • EXPLOSIVES DETECTION, INCLUDING LAND MINES
    • CLEAN-UP OF FISSION RADIOACTIVE WASTE
    • PLANETARY EXPLORATION PROPULSION
MUTUAL BENEFIT FROM TWO PATHS -2

• MAJOR PRIVATE INITIATIVE BENEFITS FROM GOVERNMENT EFFORT
  – CREDIBILITY WITH INVESTORS: “MOON IS IN PLAY”
  – DICHOTOMY OF APPROACHES TO RETURN TO THE MOON
    • MORE CONCEPTUAL APPROACHES CONSIDERED
    • ENGINEERING AT COMPONENT, SUBSYSTEM AND SYSTEMS LEVEL
      – MORE OPTIONS FOR BENEFICIAL OUTCOMES
  – COLLECTION OF LUNAR DATA SETS RELATED TO RESOURCES
    • 2008 LUNAR ORBITER
  – POSSIBLE LUNAR NAVIGATION SYSTEM
  – SPACE BIOMEDICAL RESEARCH AT ISS ?
  – CHAMPION IN INTERNATIONAL FORUMS
UNIQUE REQUIREMENTS: GOVERNMENT

- USE EXISTING LAUNCH VEHICLES
- MULTI-PURPOSE SPACECRAFT - ISS AND MOON AND ?
- EARTH ORBIT RENDEZVOUS IMPLEMENTATION MODE
- MULTI-PURPOSE LUNAR VEHICLES AND FACILITIES
- MULTI-PURPOSE ROBOTIC LUNAR MISSIONS
UNIQUE REQUIREMENTS:
PRIVATE LUNAR INITIATIVE

- HEAVY LIFT, LOW COST LAUNCH VEHICLE
- LOWEST COST, GREATEST PAYLOAD LANDING MODULE
- LUNAR ORBIT RENDEZVOUS IMPLEMENTATION MODE?
- LUNAR VEHICLES / FACILITIES FOCUSED ON RESOURCE RECOVERY
- HIGHLY MOBILE / LOW MAINTENANCE SPACE SUITS
- GLOVE DEXTERITY OF THE HUMAN HAND
- DESIGN FOR INDEFINITE OPERATIONAL LIFE
  - IMBEDDED DIAGNOSTICS
  - ANTICIPATORY MAINTENANCE BASED ON LIFE CYCLE TESTING
  - MODULAR REPLACEMENT AND REPAIR
- REQUIRED PRECURSOR ROBOTIC MISSIONS WILL BE LOW COST AND DATA SPECIFIC

ALL CAN BE BENEFICIAL TO NASA
POTENTIAL SYNERGISM BETWEEN NASA AND PRIVATE PATH

• ROBOTIC EXPLORATION
• SPACECRAFT SUB-SYSTEMS
• HABITATS
• ROVER SUB-SYSTEMS
• SPACE SUIT SUB-SYSTEMS
• LUNAR NAVIGATION SYSTEM
• MEDICAL RESEARCH
GOVERNMENT: MANAGEMENT SYSTEM

- SENIOR MANAGEMENT RESPONSIVE TO POLITICAL INTERESTS
  - DECISION MAKING TOP DOWN
  - INEFFICIENT REPORTING STRUCTURE THE NORM
- SUSTAINABILITY OF FUNDING UNCERTAIN YEAR TO YEAR
  - WHITE HOUSE SUPPORT
  - OMB SUPPORT
  - CONGRESSIONAL SUPPORT
  - MEDIA SUPPORT
  - PUBLIC SUPPORT
- HIRING / FIRING BASED ON CIVIL SERVICE CONSTRAINTS
  - DIFFICULT TO KEEP AGENCY “YOUNG”
- INFRASTRUCTURE INHERITED AND POLITICALLY FIXED
  - RESEARCH AND OPERATIONAL CENTERS FIXED
  - LAUNCH LOCATION FIXED
  - CONTRACTOR BASE LIMITED TO THREE MAJORS
- COORDINATION WITH DOD AND REGULATORY AGENCIES
PRIVATE INITIATIVE: MANAGEMENT SYSTEM

- SENIOR MANAGEMENT RESPONSIVE TO SHAREHOLDER INTERESTS
  - DECISION MAKING DELEGATED
  - EFFICIENT REPORTING STRUCTURE THE NORM
- SUSTAINABILITY OF FUNDING BASED ON PERFORMANCE
  - BOARD OF DIRECTORS SUPPORT
  - SHAREHOLDER SUPPORT
- HIRING / FIRING BASED ON OPERATIONAL REQUIREMENTS
  - COMPANY CAN STAY “YOUNG”
- INFRASTRUCTURE NEW AND CAN CHANGE
  - LOCATION OF RESEARCH AND OPERATIONAL CENTERS OPTIMIZED
  - LAUNCH LOCATION OPTIMIZED
  - CONTRACTOR BASE CAN BE BROAD AND RECREATED
- COORDINATION WITH REGULATORY AGENCIES
PRIVATE INITIATIVE: BOARD OF DIRECTORS

- LEGAL RESPONSIBILITY TO REPRESENT SHAREHOLDERS
- HIRE AND FIRE CHIEF EXECUTIVE OFFICER
- OVERSEE INDEPENDENT FINANCIAL AUDIT PROCESS
- OVERSEE COMPENSATION PLANS
- PLAN MANAGEMENT SUCCESSION
- CREATE AND REVISE STRATEGIC / CONCEPTUAL PLAN
- ASSIST IN GOVERNMENTAL AND CONTRACTOR INTERFACES
- APPROVE ACQUISITIONS AND SPIN-OFFS OF SUPPORT FUNCTIONS OR ANCILLARY BUSINESSES

NOTE: NO COMPARABLE FOCUS OF RESPONSIBILITY FOR A GOVERNMENT AGENCY
PRIVATE INITIATIVE: CORPORATE HEADQUARTERS

- CENTER DIRECTOR SELECTION
- PROGRAM AND OVERALL RISK MANAGEMENT
  - LEVEL ONE SCHEDULES INTEGRATION AND OVERSIGHT
- FINANCIAL PLANNING, MANAGEMENT, AND REPORTING
  - LEVEL ONE INTEGRATION AND OVERSIGHT
- INTEGRATED INFORMATION PROCESSING SYSTEM
- DEFINITION AND OVERSIGHT OF CENTER INTERFACES
- PERSONNEL AND BULK PURCHASING SYSTEMS
- PREVENTION OF DECISION CREEP
- REGULATORY INTERFACES AND GOVERNMENT RELATIONS
- INTELLECTUAL PROPERTY CONTROL
- GENERAL COUNSEL
  - LAWS AND TREATIES
- CENTER ADMINISTRATIVE SUPPORT AS REQUIRED
- FUSION POWER AND ENVIRONMENT FOUNDATION

NOTE: THESE ARE ALL FUNCTIONS REQUIRED OF NASA HEADQUARTERS IN A VERY MUCH MORE COMPLEX ADMINISTRATIVE ENVIRONMENT.
PRIVATE INITIATIVE: OPERATIONAL CENTERS

• EISENHOWER (?) LAUNCH CENTER (VLC)
  – LAUNCH SYSTEMS DEVELOPMENT AND OPERATIONS
  – LAUNCH SYSTEMS MARKETING, SALES AND SUPPORT
• LOW (?) SPACECRAFT AND FLIGHT CENTER (LSC)
  – SPACECRAFT DEVELOPMENT AND FLIGHT OPERATIONS
  – SPACECRAFT SYSTEMS MARKETING, SALES AND SUPPORT
• SANTARIUS (?) LUNAR RESOURCE CENTER (SLC)
  – RESOURCE EXTRACTION AND REFINING DEVELOPMENT AND SETTLEMENT SUPPORT
  – LUNAR RESOURCES MARKETING, SALES AND SUPPORT
  – LUNAR ANCILLARY BUSINESS MARKETING, SALES AND SUPPORT
• KULCINSKI (?) FUSION CENTER (KFC)
  – FUSION TECHNOLOGY DEVELOPMENT AND BRIDGING BUSINESS INCUBATION
  – POWER PLANT MARKETING, SALES AND SUPPORT
PRIVATE INITIATIVE: LUNAR SETTLEMENT ROLES

- SETTLEMENT HAS SAME STATUS AS A “CENTER”
- RESOURCE PRODUCTION MANAGEMENT
- RESOURCE DISTRIBUTION IMPLEMENTATION
- MINE PLANNING
- RESOURCE EXPLORATION
- SETTLEMENT MANAGEMENT
  - PERSONNEL ASSIGNMENTS AND SCHEDULES
  - AGRICULTURAL PRODUCTION
  - FACILITY AND EQUIPMENT MAINTENANCE
  - OCCUPATIONAL AND PREVENTIVE MEDICINE
  - INVENTORY MANAGEMENT
  - COORDINATION WITH LUNAR RESOURCE CENTER
PRIVATE INITIATIVE
SOME DESIGN PRINCIPLES

• FAIL TO OPERATE, FAIL TO MANUAL, FAIL TO SAFE
• INDEFINITE LIFE TO ALL MAJOR HARDWARE
  – MAINTENANCE DESIGN
  – IMBEDDED DIAGNOSTICS / TROUBLE-SHOOTING
  – LIFE TESTING AND PREDICTION
• PARALLEL DESIGNS FOR SYSTEMS CRITICAL TO SAFETY OR BUSINESS SUCCESS
• DESIGN FOR PERIODIC UPGRADES
  – HARDWARE
  – SOFTWARE
• DESIGN FOR MINIMUM DIRECT MONITORING
  – YELLOW-LINE ALARMS
  – SELF-DIAGNOSIS AND REPAIR (?)
• APOLLO CONFIGURATION CONTROL SYSTEM
  – ACTIVIVATE AT SYSTEM LEVEL PDR
PRIVATE INITIATIVE:
OPERATIONAL PRINCIPLES -1

• NO LAUNCH STAND-DOWN LONGER THAN TWO SCHEDULED LAUNCHES

• QUALITY CONTROL IS A HIGH PRIORITY, DISPERSED RESPONSIBILITY OF ALL PERSONNEL

• LUNAR WORK CYCLE (FIRST FEW YEARS):
  – 12 HOUR SHIFTS, TWO HOUR OVERLAP OF SHIFTS
    • TWO MINER-PROCESSOR MAINTENANCE HOURS PER 24 HOUR DAY
  – 6 DAY WORK WEEKS, 24 WORK DAYS PER LUNAR MONTH
    • ~4 MINER-PROCESSOR MAINTENANCE DAYS PER LUNAR MONTH
  – 12 WORK MONTHS OUT OF ~13 LUNAR MONTHS PER YEAR
    • ONE MINER-PROCESSOR MAINTENANCE MONTH PER LUNAR YEAR
PRIVATE INITIATIVE: OPERATIONAL PRINCIPLES -2
THE 204/CHALLENGER/COLUMBIA PROCESS

• EACH CENTER WILL HAVE A SPECIFIC PROCESS FOR IDENTIFYING AND WORKING TEST AND OPERATIONAL ANOMALIES
  – NO ANOMALY WILL BE CLEARED BY A CENTER EXCEPT AFTER REVIEW BY AT LEAST TWO LEVELS OF APPROPRIATE MANAGERIAL OVERSIGHT
  – CLEARANCE OF ANOMALIES RELATED TO PERSONNEL OR PUBLIC SAFETY ALSO REQUIRE REVIEW BY FLIGHT CREW COMMANDER, SENIOR TEST DIRECTOR, POWER PLANT MANAGER, AND/OR LUNAR SETTLEMENT MANAGER AS APPROPRIATE

• A SENIOR CORPORATE MANAGER AND THE CHAIRMAN OF THE RELEVANT BOARD OF DIRECTORS COMMITTEE WILL BE PROMPTLY NOTIFIED OF THE ANOMALY AND OF SUBSEQUENT CLEARANCE DECISION
IMPLICATIONS

- RETURNING TO THE MOON TO STAY
  - COMPARABLE TO THE FIRST MOVEMENT OF HUMANS OUT OF AFRICA ~150,000 YEARS AGO
  - OR TO THE FIRST MIGRATION OF HUMANS TO NORTH AMERICA IN SEARCH OF FREEDOM ~400 YEARS AGO