LUNAR-MARS BASE ACTIVATION

NEEP 533 LECTURE 34
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NASA HST IMAGE
VARIOUS CLASS MISSIONS
(REVIEW AT YOUR LEISURE)

• SPLIT/SPRINT-OPPOSITION CLASS (1988 NASA OFFICE OF EXPLORATION)
  – ROBOTIC PRECURSORS
  – ONE CARGO VEHICLE/ONE CREW VEHICLE
  – 14 MONTHS
  – 30 DAYS IN ORBIT
  – 20 DAYS ON SURFACE
  – 4 CREW ON SURFACE / 4 IN ORBIT
  – 60 TOTAL HOURS OF EVAS BY 2 CREW MEMBERS
  – 3 MISSIONS

• SPLIT/SPRINT-OPPOSITION CLASS (1988 NASA JSC)
  – ROBOTIC PRECURSORS
  – ONE CARGO VEHICLE/ONE CREW VEHICLE
  – 14 MONTHS
  – 30 DAYS IN ORBIT
  – <20 DAYS ON SURFACE
  – 2 CREW ON SURFACE / 1 IN ORBIT
  – 60 TOTAL HOURS OF EVAS BY 2 CREW MEMBERS
  – 1 MISSION

• VENUS SWING-BY (COLLINS, 1988)
  – ROBOTIC PRECURSORS?
  – ONE VEHICLE
  – 22 MONTHS
  – 30 DAYS IN ORBIT?
  – 40 DAYS ON SURFACE
  – 4 CREW ON SURFACE / 4 IN ORBIT?
  – 120 TOTAL HOURS OF EVAS BY 2 CREW MEMBERS?
  – 3 MISSIONS?

• "MARS DIRECT" CONJUNCTION CLASS
  (ZUBRIN, 1996, NASA INTEREST, 1999)
  – ONE AUTOMATED CREW RETURN VEHICLE/ONE DELAYED CREW VEHICLE
  – 30 MONTHS
  – MANUFACTURE RETURN FUEL AND OXIDIZER PRIOR
  – TO CREW LAUNCH
  – 0 DAYS IN ORBIT
  – 18 MONTHS ON SURFACE
  – 4 CREW ON SURFACE / 0 IN ORBIT
  – REPEATED MISSIONS
MINIMUM ENERGY -1

- MINIMUM ENERGY-CONJUNCTION CLASS (Neal, et al., 1989)
  - FINAL RECONNAISSANCE FROM ORBIT / NO ROBOTIC PRECURSORS REQUIRED
  - ONE ORBITAL VEHICLE / TWO LANDERS
  - 32 MONTHS
  - 18 MONTHS IN ORBIT
  - 90 TOTAL DAYS ON SURFACE
  - 4 CREW ON SURFACE / 4 IN ORBIT ALTERNATING TO SURFACE
  - 1200 TOTAL HOURS EVAS BY 8 CREW MEMBERS AT TWO SITES
  - 4 MISSIONS / 8 SITES WITH FIFTH MISSION THE CREATION OF A PERMANENT MARS BASE WITH 8 INITIAL INHABITANTS
    - SYMMETRY WITH LUNAR ACTIVATION
MINIMUM ENERGY -2

- MAJOR POSSIBLE ENHANCEMENT OPTIONS
  - LAUNCH FROM THE MOON WITH LUNAR DERIVED CONSUMABLES (GREATER PAYLOAD) (SEE STANCATI, ET AL., 1991)
  - He-3 FUSION / NUCLEAR FISSION / SOLAR ELECTRIC PROPULSION (SHORTENED TRANSIT TIME)
  - TRAJECTORY SHAPING (FLEXIBLE STAY TIMES AT MARS)
  - AERO-BRAKING (MARS ORBIT INSERTION AND ON RETURN TO EARTH)
MINIMUM ENERGY -3
FLEXIBILITY IN TRANSIT AND ORBIT

• LANDING DELAY DUE TO EQUIPMENT OR WEATHER PROBLEMS
• SURFACE EXPLORATION DELAY DUE TO EQUIPMENT, WEATHER, ADAPTATION, OR BIOLOGICAL HAZARD PROBLEMS
• ASCENT DELAY DUE TO EQUIPMENT PROBLEMS
• EARLY ASCENT DUE TO DEGRADING SYSTEMS OR A CREW HEALTH PROBLEM
• DESIRE EXPLORE PHOBOS AND / OR DEIMOS(?)
• "MISSION CONTROL" AND COMMUNICATIONS RELAY IN MARS ORBIT
• LANDING SITE VERIFICATIONS FROM MARS ORBIT SENSORS AND ANALYSIS
MINIMUM ENERGY -4

• OTHER ISSUES
  – IN-ROUTE, IN-ORBIT, ON-SURFACE SIMULATION AND TRAINING REQUIRED
  – MISSION RELEVANT AND VALUABLE SCIENTIFIC ACTIVITIES IN-ROUTE
  – NON-TIME CRITICAL MISSION MONITORING AND DATA PROCESSING ON EARTH
  – NEED HIGH RATE DATA TRANSMISSION MARS-EARTH-MARS

• PROBLEMS
  – MASS COST TO SUPPORT CREW OF 8 (COULD REDUCE TO 4 AND ONE LANDING WITH INCREASE OVERALL RISK TO MISSION SUCCESS)
SPACE BIOMEDICAL ISSUES IN MICROGRAVITY

• MAJOR KNOWN PROBLEMS
  – MUSCLE ATROPHY
    • HEART
    • SUPPORT
  – BONE AND OTOLITH DE-MINERALIZATION
  – RATE OF RE-ADAPTATION TO GRAVITY ENVIRONMENT
  – IMMUNE SYSTEM COMPROMISE (?)
  – RADIATION PROTECTION

• COUNTER-MEASURE OPTIONS
  – HEAVY, ANAROBIC EXERCISE
  – CENTRIFUGAL FORCE
  – DRUG THERAPY
  – EXERCISE
  – CENTRIFUGAL FORCE
  – DRUG THERAPY
  – EXERCISE IN GRAVITY

ALL OF THE ABOVE

IN-TRANSIT AND IN ORBIT
“WATER” SURROUNDED STORM CELLAR
ON-SURFACE
“REGOLITH” COVER FOR ZENITH

NOTE: NO SCIENTIFICALLY CREDITABLE UNDERSTANDING OF THESE PROBLEMS AND OPTIONS HAS BEEN DEVELOPED TO DATE DUE TO THE LACK OF A SYSTEMATIC RESEARCH PROTOCOL AND USE OF INAPPROPRIATE TEST SUBJECTS.
ORBITAL “MISSION CONTROL” -1
(FIRST FEW MISSIONS)

• OVERALL SUCCESS NOT DEPENDENT ON SUCCESS OF PRECURSORS
• COMMUNICATIONS DELAY OF 8-40 MINUTES AND SUN PUTS EARTH “OUT OF THE LOOP”
• TAKE ADVANTAGE OF CONJUNCTION CLASS MARS-STAY REQUIREMENT
  – 16 MONTHS IN ORBIT
ORBITAL “MISSION CONTROL” -2
(FIRST FEW MISSIONS)

• PROVIDES CURRENT LANDING DATA AND HUMAN COGNITIVE ANALYSIS
  – LANDING SITE SELECTION AND VERIFICATION AND DETAILED SURFACE MISSION PLANNING
  – SPECTRAL DATA
  – RADAR DATA
  – SURFACE PROBES
  – LANDING BEACON DEPLOYMENT
  – LANDING TRAJECTORY PRECURSORS THROUGH ATMOSPHERE
  – DATA FUSION SOFTWARE
  – SAMPLE RETURN TO ORBIT VS. TESTS AFTER LANDING (?)
  – REFINE LANDER PAYLOAD
ORBITAL “MISSION CONTROL” -3
(FIRST FEW MISSIONS)

• BUILD ON EXISTING ROBOTIC DATA BASE
• USE EARTH DATA PROCESSING AND CONSULTATION
• MARS ENVIRONMENT AND SURFACE BETTER CHARACTERIZED THAN BEFORE APOLLO 11
  – EXCEPT FOR POTENTIAL PATHOGENS IN ISOLATED ECOSYSTEMS
• LANDING SYSTEMS MONITORING
• LANDER-EARTH DATA RELAY AS REQUIRED
• EVA PLANNING ASSISTANCE
• PHOBOS-DEIMOS EXPLORATION (SEE NEAL, ET AL, 1989)
IMAGINE, YOU ARRIVE IN MARS ORBIT AND THIS IS WHAT HAS HAPPENED SINCE LEAVING EARTH!
PICK YOUR LANDING REGION

OLYMPUS MONS ?

MERIDIANI

VALLES MARINERIS ?
VALLES MARINERIS AND OUTFLOW CHANNEL ELEVATIONS
NASA/MOLA

PICK YOUR LANDING AREA
...VALLES MARINERIS MAY PRESENT AN EXCITING APPROACH, LANDING, AND EXPLORATION TARGET!
WITH A LANDING AMONG THE LAYERS AND FOSSILS (?) OF CANDOR CHASMA

100 METERS OR A LITTLE LESS THAN A SATURN V OR A LITTLE MORE THAN A FOOTBALL FIELD

NASA/JPL/MALIN SPACE SCIENCE SYSTEMS
45 DAY HUMAN EXPLORATION FOR MARS BASE SITE EVALUATION

• WEEK ONE (DAYS 1-6)
  – READAPTATION
  – ENVIRONMENTAL TESTS
  – ACTIVATION OF EXTERIOR SENSORS
  – PHYSICAL MONITORING
  – PLANNING

• WEEK TWO (DAYS 8-13)
  – SHORT/SIMPLE PROXIMITY EVAS
  – DEPLOY COMM ANTENNA / SCIENCE STATION / AGRICULTURAL TEST STATION
  – START DEEP DRILL SYSTEM
  – SELECTED SAMPLE ANALYSIS
  – PHYSICAL MONITORING
  – PLANNING SESSIONS

• WEEK THREE (DAYS 15-20)
  – SECTOR 1 EXPLORATION
  – MID LENGTH EVAS USING ROVER
  – EXTENDED RANGE EVA WITH TWO ROVERS
  – SHALLOW DRILLING/DEPLOY GEO. NET
  – SELECTED SAMPLE ANALYSIS
  – PHYSICAL MONITORING
  – PLANNING SESSIONS

• WEEK FOUR (DAYS 22-27)
  – SECTOR 2 EXPLORATION
  – DITTO WEEK THREE

• WEEK FIVE (DAYS 29-34)
  – SECTOR 3 EXPLORATION
  – DITTO WEEK THREE

• WEEK SIX (DAYS 36-41)
  – SECTOR 4 EXPLORATION
  – ASCENT SIMULATIONS
  – DITTO WEEK THREE

• WEEK SEVEN (DAYS 43-45)
  – MOTHBALL FACILITY
  – PREPARE ROVER FOR REMOTE OPERATION
  – FINAL ASCENT SIMULATIONS
  – SAMPLE SELECTION AND STORAGE

• NOTE: ONE REST DAY PER WEEK
  – FOUR PERSON CREW
  – TWO PERSON EVAS, ALTERNATE BETWEEN PAIRS
EARLY LANDINGS STRATEGY

GOAL: PERMANENT BASE

• FIRST AND SECOND MISSIONS (POSSIBLE FOUR LANDINGS)
  – GENERAL EXPLORATION AND RECONNAISSANCE
    • AUTOMATED ROVER AFTER CREW DEPARTURE
  – DEVELOPMENT OF CRITERIA FOR BASE SELECTION
  – POTENTIAL TO ACCELERATE DECISION ON BASE SITE SELECTION
    • CORRELATION OF ORBITAL RECONNAISSANCE WITH DATA FROM SURFACE

• THIRD AND FOURTH MISSIONS (POSSIBLE FOUR LANDINGS)
  – EXAMINATION OF CANDIDATE BASE SITES
    • AUTOMATED ROVER AFTER CREW DEPARTURE
  – USE FOURTH LANDING TO SET UP CONSUMABLES PLANT AT SELECTED BASE SITE
  – GENERAL EXPLORATION AND RECONNAISSANCE
IF A LUNAR HELIUM-3 INITIATIVE BEGAN BY 2005 WITH ASSURED FUNDING, THE FIRST HUMAN MISSION TO MARS COULD BE LAUNCHED BY 2020, LARGELY USING TECHNOLOGY PAID FOR BY THE HELIUM-3 INITIATIVE.
ENJOY THE VIEW WHEN YOU GET THERE!!!!!!

“TRUE COLOR OF MARS”
PATHFINDER LANDER VIEW
NASA/JPL
A POSSIBLE REPRESENTATIVE VIEW FROM THE “MARTIAN MODULE” BEFORE THE FIRST EVA, HOWEVER.... VALLES MARINERIS WILL BE A TAD MORE SPECTACULAR