Apr 28th, 8:00 AM

Panel Session IV - Creating a Tight Space Exploration Initiative

Robert Zubrin
President, The Mars Society

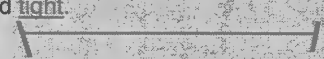
Creating a <u>Tight</u> Space Exploration Initiative

Dr. Robert Zubrin
President, Mars Society

Question: How much rope is needed to connect two posts separated by a distance of 10 meters?

In principle, it can take any amount:

But it can be done with about 10 meters, if the rope is pulled <u>tight</u>.

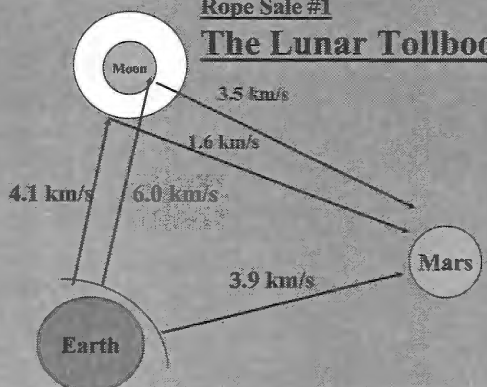


It is the same with the Space Exploration Initiative.

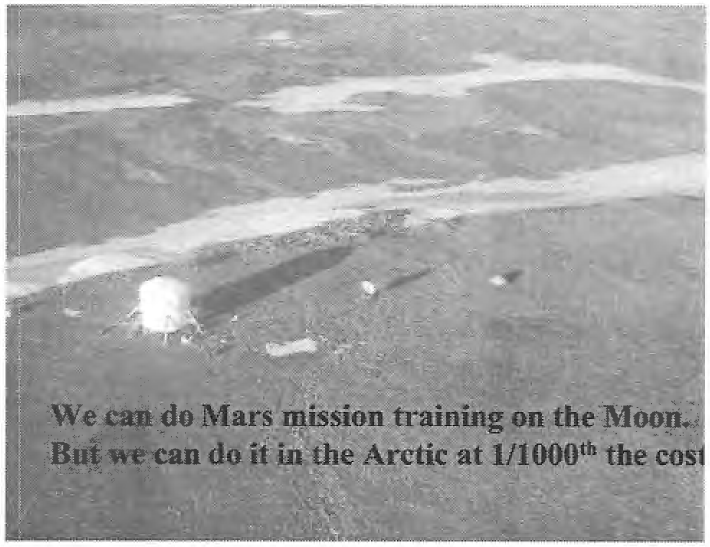
The issue is whether you want to connect the posts, or whether your goal is to sell rope.

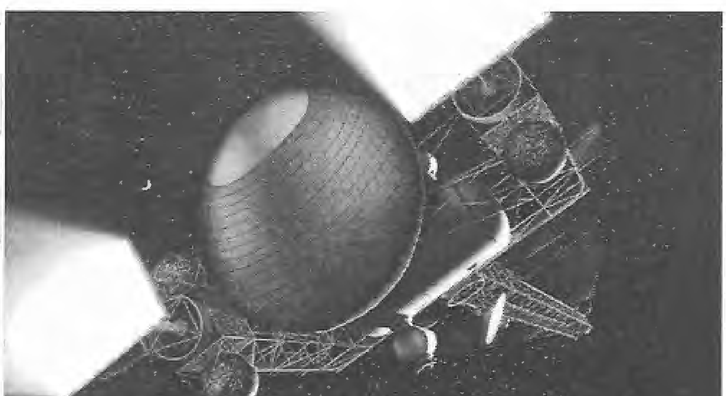
<u>Rope Sale #1</u>

<u>The Lunar Tollbooth</u>



Even if Lunar refueling were free, it's easier to go direct to Mars!

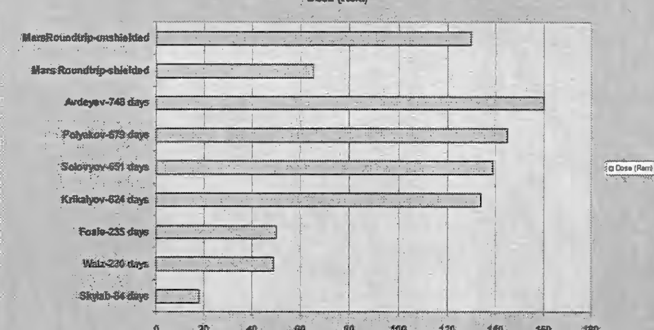




Rope Sale #2 — Nuclear Electric Propulsion

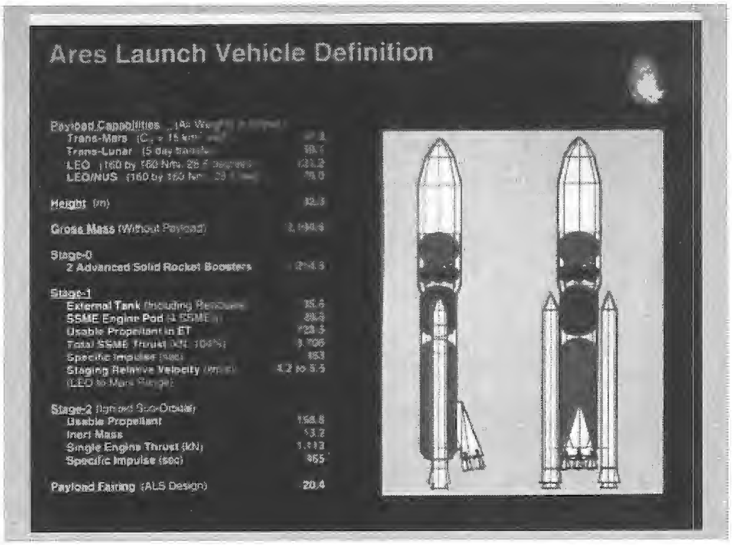
	Claim	vs.	Reality
One-way Transit Time	60 days		1460 days
Power Density	3000 W/kg		16 W/kg

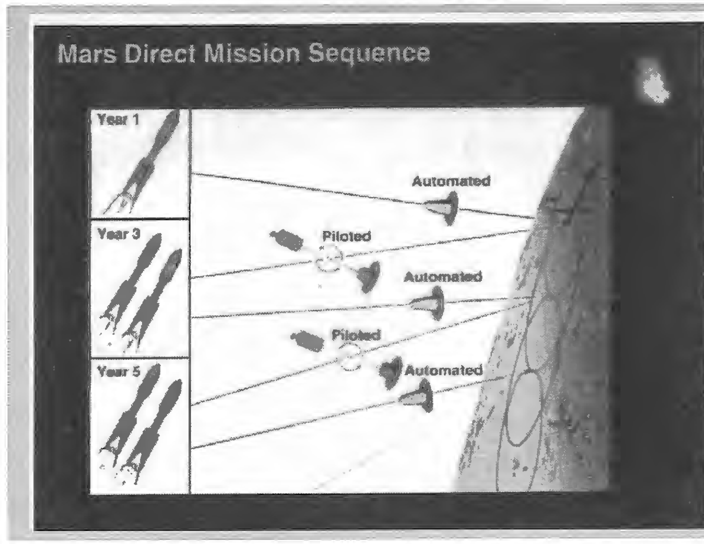
Cumulative Radiation Doses Received in Space

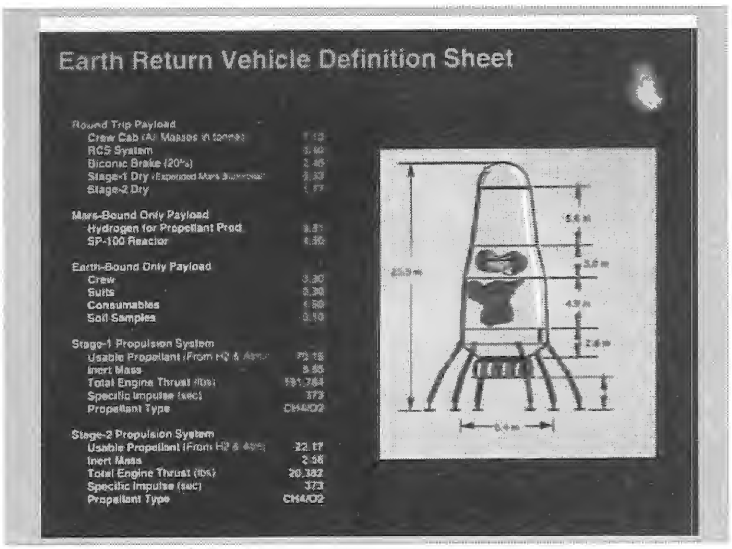


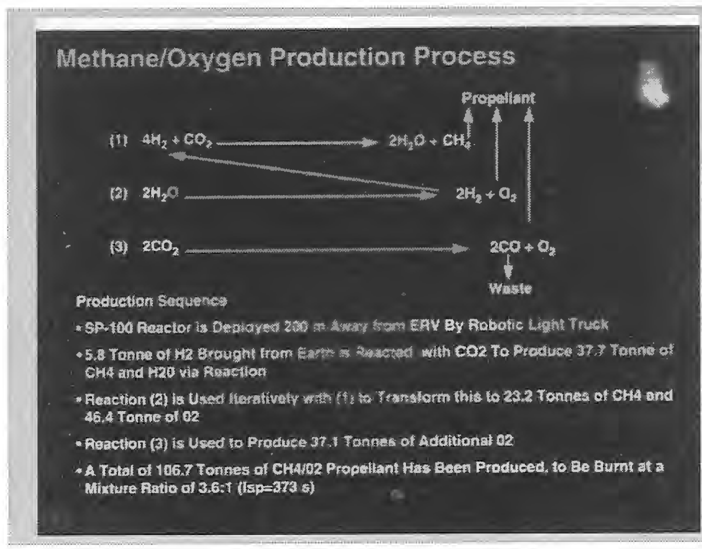
The cumulative radiation dose of a human roundtrip mission to Mars using current propulsion technology has already been experienced by numerous astronauts.

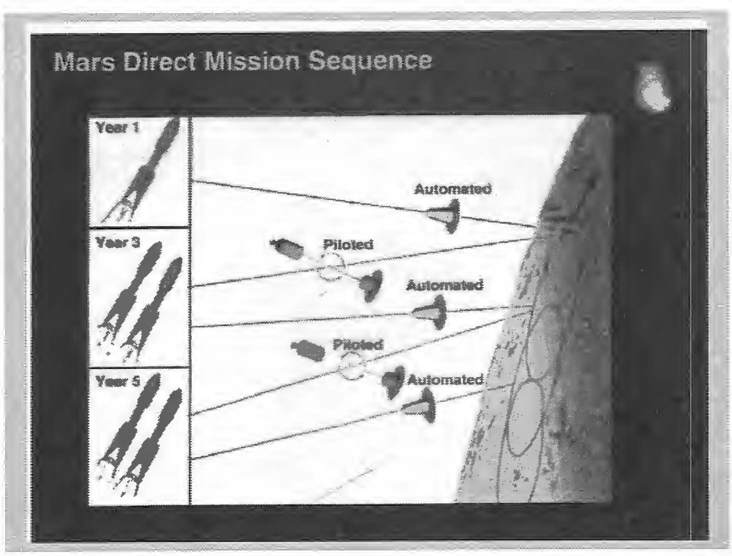
No radiation-induced health effects have been observed.


Ares Launch Vehicle Definition
Payload Capabilities
Trans-Mars
Trans-Lunar
LEO
LEO/NUS
Height (m)
Gross Mass (Without Payload)
Stage-0
2 Advanced Solid Rocket Boosters
Stage-1
External Tank
SSME Engine Pod
Usable Propellant in ET
Total SSME Thrust
Specific Impulse
Staging Relative Velocity
Stage-2
Usable Propellant
Inert Mass
Single Engine Thrust (kN)
Specific Impulse (sec)
Payload Fairing (ALS Design) 20.4


Mars Direct Mission Sequence
Year 1
Year 3
Year 5
Automated
Piloted
Automated
Piloted
Automated


Earth Return Vehicle Definition Sheet
Round Trip Payload
Crew Cab
RCS System
Biconic Brake (20%)
Stage-1 Dry
Stage-2 Dry
Mars-Bound Only Payload
Hydrogen for Propellant Prod
SP-100 Reactor
Earth-Bound Only Payload
Crew
Suits
Consumables
Soil Samples
Stage-1 Propulsion System
Usable Propellant
Inert Mass
Total Engine Thrust (lbs)
Specific Impulse (sec) 373
Propellant Type CH4/O2
Stage-2 Propulsion System
Usable Propellant 22.17
Inert Mass 2.56
Total Engine Thrust (lbs) 20,382
Specific Impulse (sec) 373
Propellant Type CH4/O2


Methane/Oxygen Production Process
Propellant
(1) $4H_2 + CO_2$ → $2H_2O + CH_4$
(2) $2H_2O$ → $2H_2 + O_2$
(3) $2CO_2$ → $2CO + O_2$
Waste
Production Sequence
• SP-100 Reactor is Deployed 200 m Away from ERV By Robotic Light Truck
• 5.8 Tonne of H2 Brought from Earth is Reacted with CO2 To Produce 37.7 Tonne of CH4 and H20 via Reaction
• Reaction (2) is Used Iteratively with (1) to Transform this to 23.2 Tonnes of CH4 and 46.4 Tonne of 02
• Reaction (3) is Used to Produce 37.1 Tonnes of Additional 02
• A Total of 106.7 Tonnes of CH4/02 Propellant Has Been Produced, to Be Burnt at a Mixture Ratio of 3.6:1 (Isp=373 s)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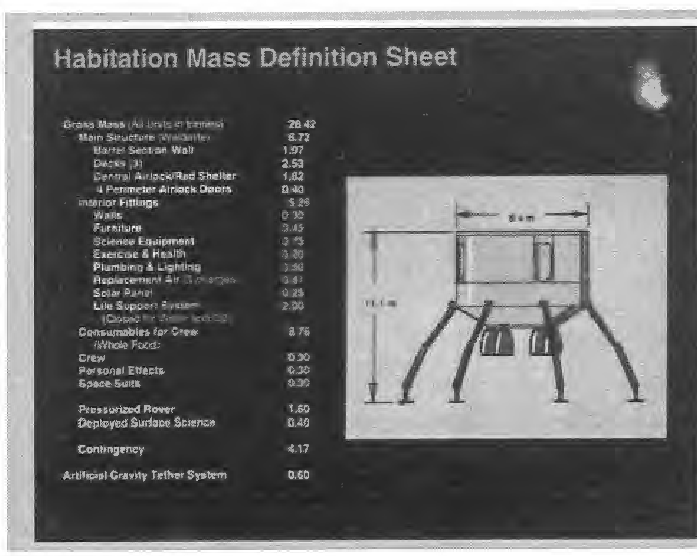
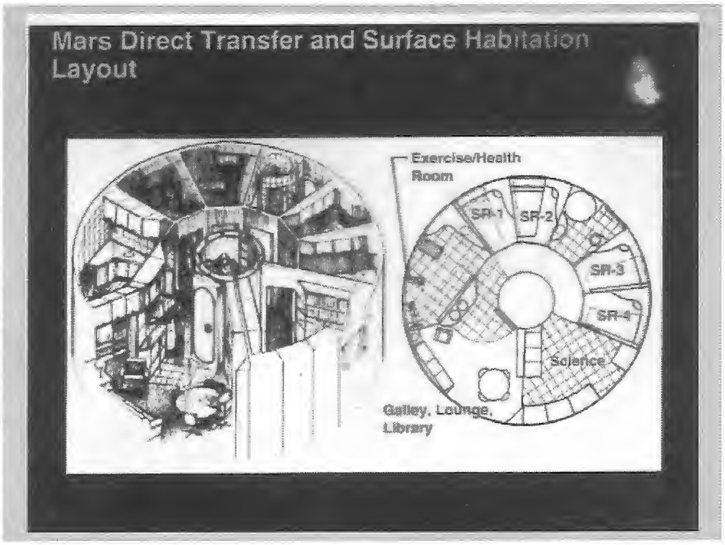
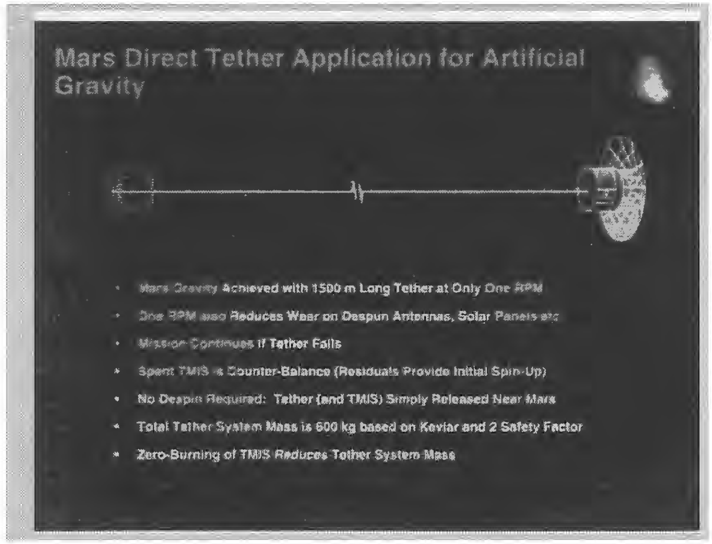
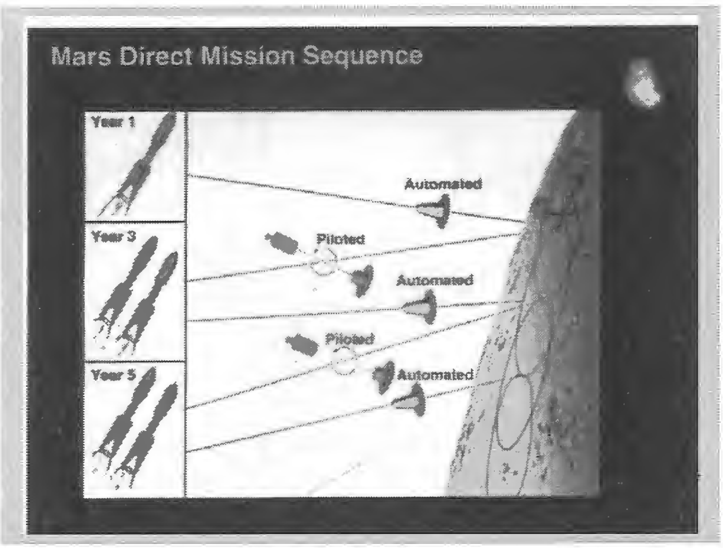

Habitation Mass Definition Sheet
Gross Mass 28.42
Main Structure 8.72
Barrel Section Wall 1.97
Decks (3) 2.53
Central Airlock/Rad Shelter 1.82
4 Perimeter Airlock Doors 0.40
Interior Fittings 5.26
Walls
Furniture
Science Equipment
Exercise & Health
Plumbing & Lighting
Replacement Air
Solar Panel 0.25
Life Support System 2.00
Consumables for Crew 8.76
(Whole Food)
Crew 0.30
Personal Effects 0.30
Space Suits 0.30
Pressurized Rover 1.60
Deployed Surface Science 0.40
Contingency 4.17
Artificial Gravity Tether System 0.60



Mars Direct Transfer and Surface Habitation Layout
Exercise/Health Room
SR-1
SR-2
SR-3
SR-4
Science
Galley, Lounge, Library



Mars Direct Tether Application for Artificial Gravity
• Mars Gravity Achieved with 1500 m Long Tether at Only One RPM
• One RPM also Reduces Wear on Despun Antennas, Solar Panels etc
• Mission Continues if Tether Fails
• Spent TMIS is Counter-Balance (Residuals Provide Initial Spin-Up)
• No Despin Required: Tether (and TMIS) Simply Released Near Mars
• Total Tether System Mass is 600 kg based on Kevlar and 2 Safety Factor
• Zero-Burning of TMIS Reduces Tether System Mass



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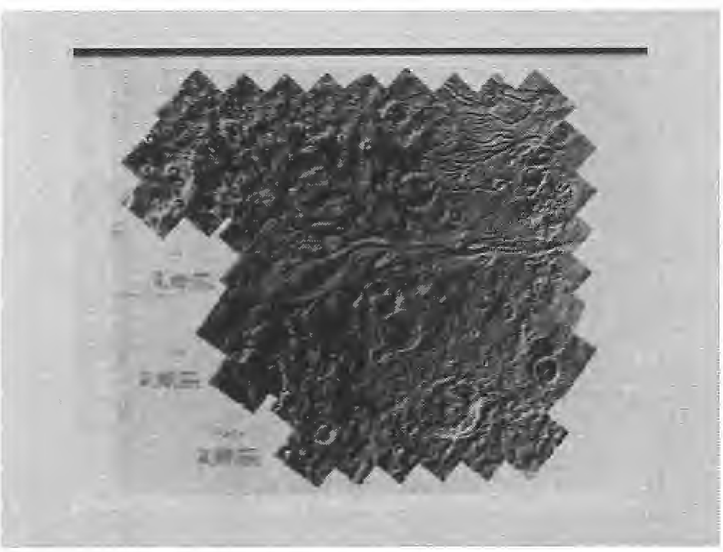
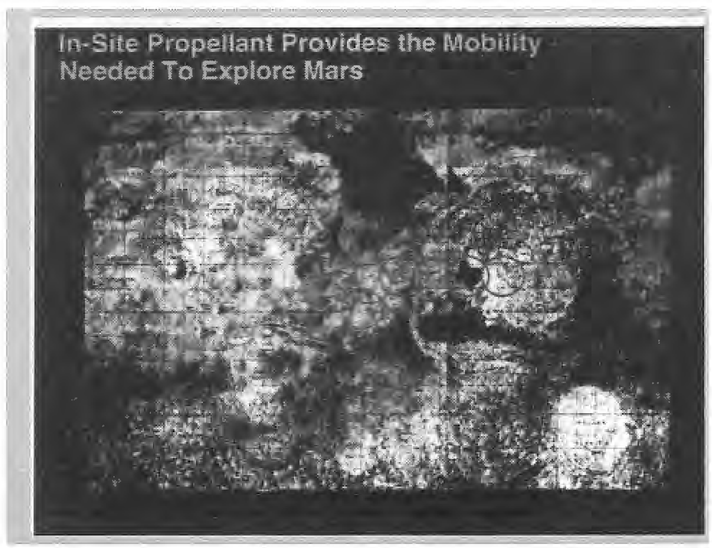
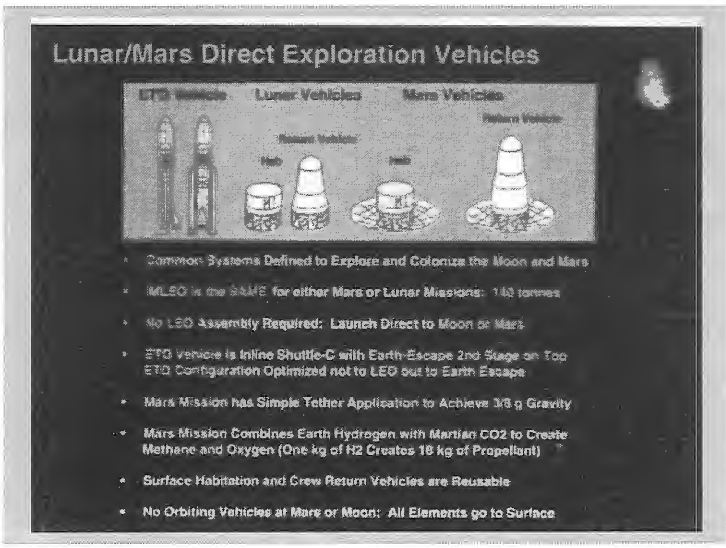
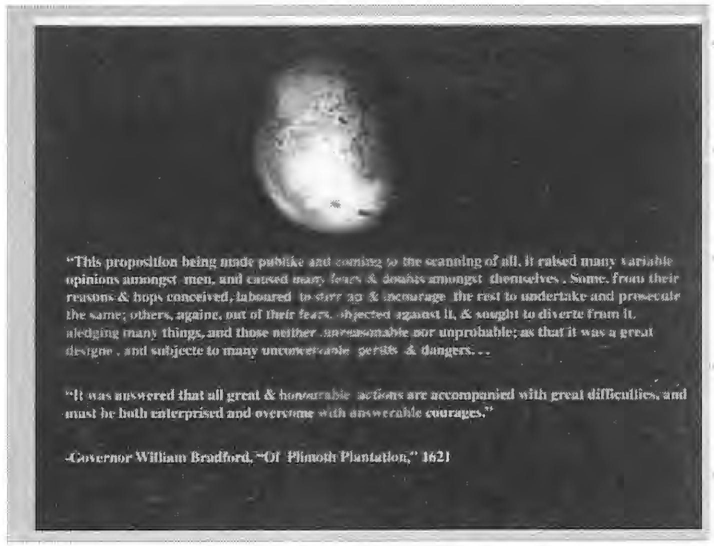




In-Site Propellant Provides the Mobility Needed To Explore Mars


Making the First Mars Settlement Using Mars Direct


Lunar/Mars Direct Exploration Vehicles
ETO Vehicle
Lunar Vehicles
Mars Vehicles
Common Systems Defined to Explore and Colonize the Moon and Mars
IMLEO is the SAME for either Mars or Lunar Missions: 140 tonnes
No LEO Assembly Required: Launch Direct to Moon or Mars
ETO Vehicle is Inline Shuttle-C with Earth-Escape 2nd Stage on Top
ETO Configuration Optimized not to LEO but to Earth Escape
Mars Mission has Simple Tether Application to Achieve 3/8 g Gravity
Mars Mission Combines Earth Hydrogen with Martian CO2 to Create Methane and Oxygen (One kg of H2 Creates 18 kg of Propellant)
Surface Habitation and Crew Return Vehicles are Reusable
No Orbiting Vehicles at Mars or Moon: All Elements go to Surface


"This proposition being made publike and coming to the scanning of all, it raised many variable opinions amongst men, and caused many fears & doubts amongst themselves. Some, from their reasons & hops conceived, laboured to stirr up & incourage the rest to undertake and prosecute the same; others, againe, out of their fears, objected against it, & sought to diverte from it, aledging many things, and those neither unreasonable nor unprobable; as that it was a great designe, and subjecte to many unconceivable perills & dangers...
"It was answered that all great & honourable actions are accompanied with great difficulties, and must be both enterprised and overcome with answerable courages."
-Governor William Bradford, "Of Plimoth Plantation," 1621