NSS RESOURCE PACKET (February 2001)
WHY WE DO -- AND MUST -- GO INTO SPACE

Issue Editor: Jeffrey Liss

THE IMPORTANCE OF SPACE SETTLEMENT TO OUR SOCIETY AND TO HUMANITY

Settling space will energize our world, much as the settlement of the "New_ World" and then the "American West" energized the societies of their times,_ economically and spiritually._ Societies that have pushed their frontiers_ have prospered; those that have not have withered._ In the long term, settling space will benefit humanity in many ways._ In the settlement_ process we will learn to manage and sustain closed ecosystems._ That knowledge could eventually transform and maintain Earth as a natural habitat_ world for all species, with an indefinitely sustainable economy based on complete recycling of products and renewable energy resources._ Space_ settlement is already technically feasible, and the scientific and engineering advancements to be expected in its implementation are likely to spur the rest of our economy as space technology has done for the_ past four decades.

Settlement is energetically feasible; the energy cost of transporting people into space is modest and repaid by their absence within about 2 years._ As early space settlements become self-sufficient,_ large-scale settlements and space commerce will become economically possible.

Further, off-world settlements will provide a reservoir of civilization and terrestrial life, including vital food plant species and varieties, that no single planet-wide catastrophe can destroy, whether of natural origin as asteroid strikes, volcanic upheavals or pestilence, or of human miscalculation as nuclear or biological war or experimentation._ The solar system can eventually support a human population many times that of the_ Earth.

The space pioneer Tsiolkovskii said a century ago, "The Earth is the cradle of civilization._ But one cannot live in the cradle forever."_ To begin the environmentally and economically beneficial process of space settlement is to begin replacing a pessimistic future of "limits to growth" with a hopeful future of ample opportunity and prosperity for all.

As a first step, NSS urges NASA to fulfill the requirements of the Space Settlement Act as required by Congress in the NASA Authorization Bill for 1988, and to adopt space settlement as the overarching long-range goal of the human exploration and development of space (HEDS) enterprise.

RETURN TO THE MOON: WHY & HOW

A return to the Moon should be a high space program priority, to begin development of knowledge and industries unique to the Moon._ The Moon is a repository of the history and possible future of our planet, and the six Apollo landings only scratched the surface of that treasure._

The Moon's far side, permanently shielded from the noisy Earth, is an ideal site for future radio astronomy._ Unique products may be producible in the nearly limitless extreme vacuum of the lunar surface, and the Moon's remoteness is the ultimate isolation for biologically hazardous experiments._ Lunar resources include most if not all raw materials available on Earth, and electromagnetic catapult technology will make it possible to send lunar products to Earth without rocket transport._ The Moon can serve as a proving ground for a wide range of space operations and processes, including developments toward "living off the land" (self-sufficiency) for human outposts._

Initial return missions can be done through space operations using the infrastructure and assets developed by the shuttle and ISS programs, plus existing expendable launch vehicles, with a minimum of new R&D programs._ It would show that the routine operations way of doing business established by ISS construction and operations can be extended to human missions to the Moon, Mars and elsewhere._ Initial missions could place scientific equipment on the Moon and return samples from areas never explored, such as the polar regions.__ Extent of water and other volatiles important to lunar industrialization could be determined._ As future reusable launch systems begin operations, reducing cost and enabling higher flight rates, Earth-Moon traffic can become routine._

With humans on the Moon again, NASA's space activities would take on new vigor and public interest.

HUMANS TO MARS: WHY & HOW

In both the near-term and long term, Mars offers immense promise for our society and all of humanity.

The true legacy of the Apollo program has been the thousands of engineers, scientists, and technicians who were inspired to stay in school and achieve._ These are the high-tech dynamos that have driven our technology economy._ So, too,_ will the challenge of Mars inspire and drive the next generation._ Meeting these challenges will force us to stretch our technology, prove our talent, advance our science, and, as with every frontier, evolve new ways of thinking and living together._ No other focused effort promises so much benefit._ Further, Mars exploration will provide an increased understanding of the planet B_ how and why its climate changed over time and whether Mars ever did, or does, hold life B answering some of our deepest questions and providing timely guidance as to public policies that we may very well need in order to preserve the biosphere of our own planet. These are the short-term rationales for humans exploring Mars.

Long-term, Mars beckons as a future home to humanity._ Human exploration of Mars is the next frontier for the new pioneers._ The overarching goal for Mars is human settlement._ While both the Moon and Mars have the natural resources for human survival, Mars' near-24-hour day_ and atmosphere offer future potential for ameliorating its harsh environment._ And as the program moves forward towards permanent human habitation of Mars, we will continue to reap scientific and technological benefits from Mars exploration.

The major barriers to Mars exploration have been psychological as much as technical._ Inflated cost estimates have been glibly popularized, and Mars exploration has been widely perceived as excessively costly relative to short-term benefits._ With new concepts, such as using resources from Mars instead of bringing them from Earth, such perceptions already lag far behind reality._ Further, Mars exploration missions described by NASA several years ago unnecessarily assumed development of expensive heavy lift launchers designed exclusively for the Mars mission._ Revised NASA scenarios already project substantially lessened costs, and new, modular and reusable technologies and modern space operations can achieve even more dramatic reductions, even to the point that human Mars missions could be effected without huge increases in NASA's budget.

To these ends, architectures for Mars should be designed in an ongoing process to incorporate advancing and reusable technology and to be compatible with reusable lower-cost launchers as they are developed. Common infrastructures for Moon and Mars activities should be adopted where practical._ These infrastructures should incorporate space operations lessons learned from the International Space Station._ Such measures will further reduce costs substantially, to levels likely to elicit the longer-term public funding that will be needed.

It should be clearly understood that obtaining much of key data we seek from Mars will require a human presence, not just robotic missions. Accordingly, recurring Mars robotic missions should be oriented towards learning not just what is scientifically interesting, but what is necessary for humans to reach, survive, explore and work on Mars._ These early missions need to include testbeds of human-enabling technologies. Deferral of these vital first steps would be contrary to, and would eviscerate much of the benefit from, a vigorous program of Mars

exploration.
A comprehensive Mars program should be promptly defined, integrating robotic and human exploration goals._ International cooperation should be sought. Mars missions should be defined in measured increments, each lasting a few years, with clear interim goals._ The Mars effort should move expeditiously to human landings and then permanent outposts.

ECONOMICS OF SPACE
SPACE PAYS / Short-Term: The Space Program Has Paid for Itself

It is a myth that "we can't afford Space."_ Confirmation that "Space pays" may be found in the 1989 Chapman Research report, which examined just 259 non-space applications of NASA technology during just 8 years, 1976-1984, and found more than:

X $21.6 billion in sales and benefits,

X 352,000 (mostly skilled) jobs created or saved,

X $355 million in federal corporate income taxes.

Other benefits, not quantified in the study, included: state corporate income taxes, individual personal income taxes (federal and state) paid by those 352,000 workers, and_ uncalculable benefits resulting from lives saved and an improved quality of life.

The 259 applications represent only about 1% of an estimated 25-30,000 Space program spinoffs.__ The benefits were in addition to benefits in the Space industry itself and in addition to the ordinary multiplied effects of any government spending._

A short article in the prestigious journal Nature (1/9/92, pp. 105-106), reported, "The economic benefits of NASA's programmes are greater than generally realized._ The main beneficiaries may not even realize the source of their good fortune."

When Space program money was spent, new industries were left behind to generate more money (e.g., computers, electronics, fabrics, composites, ceramics, metallurgy).__ Without the focus of our space goals, such cutting-edge technologies would not have emerged. When we decide where we should spend, we should give priority to spending on such industries, our "industrial seed corn."

If we ask, Can we afford Space?" we now know the answer is yes._ To the better question, "Can we afford not to invest in Space?" the answer is no.

ECONOMICS OF SPACE
SPACE PAYS / Long-Term: Expanding Our Resource Base

We can't keep subdividing Earth's resource pie; we need to make the pie bigger._ It is the promise of resources from the Moon, Mars, asteroids and the Sun that makes Space such a hope for our future._ World population is likely to double within 40 years and re-double shortly after that; world resources will not._ In space, solar power is infinite (reducing the need to use forests and oil and coal merely for fuel and eliminating the pollution they cause), as are asteroid metals._ These unlimited resources would enable us to reduce the plundering of our own planet._

But to obtain these resources will require large structures in space and the rockets to get there._ Learning how to build those things to obtain such space resources is a long step-by-step process._ If we want to have those resources before it is too late, we have to start now.

SPACE ON THE WORLD-WIDE WEB

Space Societies

OASIS (L. A. chapter of the National Space Soc.) http://chapters.nss.org/oasis
National Space Society http://www.nss.org

NASA Centers

NASA Headquarters http://www.nasa.gov
Ames Research Center http://www.arc.nasa.gov/
Goddard Spaceflight Center http://www.gsfc.nasa.gov/
Glenn Research Center (WAS Lewis Research Center) http://www.grc.nasa.gov/
Jet Propulsion Laboratory http://www.jpl.nasa.gov/
Johnson Space Center http://www.jsc.nasa.gov/
Kennedy Space Center http://www.ksc.nasa.gov/ksc.html
Marshall Spaceflight Center http://www1.msfc.nasa.gov/

IVATE Launch Vehicles/Space Stations

Space Shuttle - Launches
http://www.ksc.nasa.gov/shuttle/missions/missions.html
NASA Human Spaceflight (Space Shuttle) http://spaceflight.nasa.gov/shuttle
X-33 (reusable launch vehicle prototype) http://x33.msfc.nasa.gov/
Lockheed-Martin Astronautics (Titan/Atlas) http://www.lmco.com/
Orbital Sciences Corporation (Pegasus) http://www.orbital.com
ESA (Ariane)
http://www.esrin.esa.it/htdocs/esa/ariane/ariane5.html
Boeing (Delta & Sea Launch) http://www.boeing.com/defense-space/space/
Kelly Space & Technology (Astroliner/Sprint) http://www.kellyspace.com/vehicles.html
Kistler Aerospace (K-1reusable booster) http://www.kistleraerospace.com
Microcosm (Scorpius low-cost launcher) http://www.smad.com/scorpius/index.html
HMX, Inc. (Liquid & hydrid rockets) http://www.hmx.com/
Interorbital Systems (Neptune reusable launcher) http://www.interorbital.com
Cerulean Freight Forwarding Co. (TGS _Kitten_?) http://www.thriftyspace.com
Space Station MIR http://www.hq.nasa.gov/osf/mir/
Mir Corp (book a room on MIR space station) http://www.mirstation.com/
International Space Station http://spaceflight.nasa.gov/station

Robotic Missions

Earth Observations

TOPEX/Poseidon http://topex-www.jpl.nasa.gov/
NSCAT, QuikSCAT, & SeaWinds http://winds.jpl.nasa.gov
Shuttle Radar Topography Mission (SRTM) http://www.jpl.nasa.gov/srtm/
Terra (Earth Observing System) http://pao.gsfc.nasa.gov/gsfc/earth/terra/terra.htm
IKONOS (buy spy-satellite quality photos) http://www.spaceimage.com/

Astronomy from Space

Hubble Space Telescope (HST) http://www.stsci.edu/
Chandra Advanced X-ray Astronomical Facility http://asc.harvard.edu/
ESA_s X-ray Multi-Mirror telescope (XMM - Newton) http://sci.esa.int/xmm/
Space InfraRed Telescope Facility (SIRTF) http://sirtf.jpl.nasa.gov/sirtf/
Space Interferometry Mission (SIM) http://sim.jpl.nasa.gov
Hipparchos (map the sky) http://astro.estec.esa.nl/Hipparcos/
Space Technology 3 (formation flying) http://nmp.jpl.nasa.gov/st3/
SWIFT (detect black holes) http://swift.gsfc.nasa.gov/

Planetary Missions

Ulysses (Visit the Sun_s poles) http://ulysses.jpl.nasa.gov/
Galileo (Explore Jupiter) http://www.jpl.nasa.gov/galileo/
Deep Space 1 (Ion Propulsion) http://nmp.jpl.nasa.gov/ds1/
Stardust (Bring back comet dust) http://stardust.jpl.nasa.gov/
CONTOUR (Comet nucleus tour) http://www.contour2002.org/
Cassini (Explore Saturn) http://www.jpl.nasa.gov/cassini
Near Earth Asteroid Rendezvous (NEAR) http://near.jhuapl.edu/
Near Earth Asteroid Prospector (NEAP) http://www.spacedev.com
MESSENGER (explore Mercury) http://sd-www.jhuapl.edu/MESSENGER/
Lunar Prospector (Found Water!) http://lunar.arc.nasa.gov/
SMART-1 (ESA to the Moon with ions) http://sci.esa.int/home/smart-1/index.cfm
Genesis (Measure solar wind) http://genesismission.jpl.nasa.gov/
Voyager (Visit the outer planets) http://vraptor.jpl.nasa.gov/voyager/voyager.html
Pluto/Kuiper Express Project http://www.jpl.nasa.gov/ice_fire//pkexprss.htm
Europa Orbiter Project http://www.jpl.nasa.gov/ice_fire//europao.htm
Solar Probe Preproject http://www.jpl.nasa.gov/ice_fire//sprobe.htm

International Space ProgramsInternational Space Programs

European Space Agency (ESA) http://www.esrin.esa.it/
Space Research Institute(IKI) [Russia] http://www.iki.rssi.ru/Welcome.html
Russian Space Science Internet http://www.rssi.ru/
Centre National d_Etudes Spatiales (CNES) [France] http://www.cnes.fr/WEB_UK/index.htm
British National Space Centre (BNSC) http://www.bnsc.gov.uk/
Italian Space Agency (ASI) http://www.asi.it
German Aerospace Research Establishment (DLR) http://www.dlr.de/DLR-Homepage
Nat_l Space Development Agency of Japan (NASDA) http://www.nasda.go.jp/index_e.html
Canadian Space Agency (CSA) http://www.space.gc.ca/welcomee.html

Neat StuffNeat Stuff

Space Calendar http://www.jpl.nasa.gov/calendar/
Astronomy Picture of the Day http://antwrp.gsfc.nasa.gov/apod/astropix.html
RAWHIDE Space Page (Vandenberg launches)
http://ourworld.compuserve.com/homepages/rawhide_home_page/
The Aerospace Corporation (military space) http://www.aero.org/programs/
Encyclopedia Astronautica (all about rockets) http://www.rocketry.com/mwade/spaceflt.htm
International Space University (ISU) http://www.isunet.edu/
National Air & Space Museum http://www.nasm.si.edu
NASA Photo Gallery
http://www.hq.nasa.gov/office/pao/Library/photo.html
Planetary Photojournal http://photojournal.jpl.nasa.gov/
NASA Space Art Home Page http://vesuvius.jsc.nasa.gov/er/seh/spaceart.html
NASA Space Hotlist http://www.hq.nasa.gov/osf/hotlist/
StarWatch (check star-gazing conditions near you) http://www.intellicast.com/Star/

MARS MISSIONS

Mars Exploration Program *http://mars.jpl.nasa.gov/*
Mars Exploration Rover *http://mars.jpl.nasa.gov/mep/missions/announce2.html*
Mars Pathfinder *http://mars.jpl.nasa.gov/default.html*
Mars Global Surveyer *http://mars.jpl.nasa.gov/mgs/index.html*
Mars Surveyor 2001 *http://mars.jpl.nasa.gov/2001/*
Planet B (Nozumi) *http://www.planet-b.isas.ac.jp/index-e.html*
Mars Express/Beagle 2 http://beagle2.open.ac.uk/