NASA-CR-198031

(NASA-CR-198031) SPACE COMMERCE 1994 FORUM: THE 10TH NATIONAL SPACE SYMPOSIUM. PROCEEDINGS REPORT (United States Space Foundation) 242 p

N95-26583

Unclas

G3/12 0046060

WINDOWS OF OPPORTUNITY

10th National Space Symposium

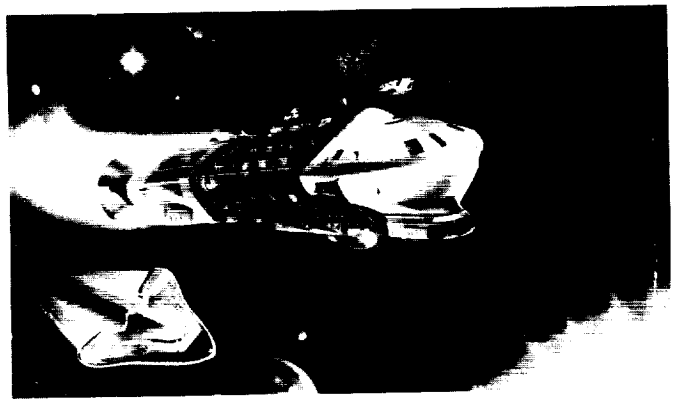
Space Commerce '94

PROCEEDINGS REPORT

April 5-8, 1994

United States Space Foundation

HARRIS



Dear Fellow Space Professionals:

At this historic 10th National Space Symposium, we are challenged by our theme, "New Windows of Opportunity." To meet this challenge, I believe we must develop a long term vision for our space program -- a vision that recaptures the "Spirit of Apollo," and globally inspires our people and governments toward a new frontier. For our previous two symposia, I have proposed a "100 Year Space Vision" for this new frontier. This vision entails three Epochs:

- Epoch I culminates with a major lunar base to mine Helium-3 that will be transported to Earth for generating non-polluting electrical energy as a replacement for our soon to be exhausted fossil fuels. Reaching this goal will require a robust near-term space infrastructure of the International Space Station Alpha, Remote Sensing and Science Missions, and enhanced and advanced launch systems.

- Epoch II is a manned tour and exploration of the solar system utilizing a Helium-3 nuclear fusion-powered spacecraft, while simultaneously, multiple large remote sensing spacecraft are scanning the closest stars searching for planets that would support life. This Epoch will set the stage for our "giant leap" to the stars.

- Epoch III, shown on this year's proceedings cover is the finale -- the Interstellar ship completes a 16-year, 25 trillion mile, half-light speed journey to a nearby star. Remote Sensors have detected indications of life and manned landers are enroute to a planet where humanity will encounter *"new life"* for the first time. However, even this "giant leap for mankind" is only a "small step for man" in the endless exploration of our galaxy and the universe.

I call on you to accept this challenging vision that recreates the "Spirit of Apollo" and rejuvenates our space program. Let us all take advantage of the "New Windows of Opportunity" in the exhibit hall and conference sessions to make this yet another great symposium.

Respectfully,

Bill Braselton

W.M. Braselton, Jr.
Vice President-Business Development
Government Aerospace Systems Division

HARRIS CORPORATION GOVERNMENT AEROSPACE SYSTEMS DIVISION P.O. BOX 94000, MELBOURNE, FL 32902 (407) 727-5115

DEDICATION

The United States Space Foundation is dedicated to the memory of Astronaut-Congressman Jack Swigert, who dedicated his life to the objectives and purposes for which this Foundation was exclusively created: to foster, develop and promote, among the citizens of the United States of America and among the other people of the world, on a nonpartisan basis, a greater understanding and awareness, through the conduct of educational programs, of the practical and theoretical utilization and enjoyment of space, for the betterment of civilization and the fostering of a peaceful and prosperous world.

All rights reserved. No part of this publication may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopy, recording, or any information storage and retrieval system, without permission in writing from the publisher.

Copyright @ 1994
by United States Space Foundation
ISBN 0-9616962-8-1

Additional copies of this publication are available from the address below.

Printed by FBPC
Published in 1994 in the USA by
United States Space Foundation
2860 S. Circle Drive, Suite 2301
Colorado Springs, CO 80906-4184
(719) 576-8000

ORIGINAL CONTAINS
COLOR ILLUSTRATIONS

UNITED STATES SPACE FOUNDATION

SPACE COMMERCE '94 FORUM
THE 10TH NATIONAL SPACE SYMPOSIUM

PROCEEDINGS REPORT

The most comprehensive compilation of civil, military, commercial, and international commentary by the key space policy decision makers.

Proceedings Editor
Beth Ann Lipskin
Director of Communications, Marketing & Development

Co-Editor
Sara Patterson
Speaker Coordinator & Development Associate

Contributing Editors
Capt. Larry Aragon, USAF
Capt. David A. Brescia, USAF
Jack Flannery
Roberty Mossey
Lt. Christopher Regan, USAF
Kurt Steeby
Lt. Stacy Suhr, USAF
Chuck Zimkas

United States Space Foundation
2860 S. Circle Drive, Suite 2301
Colorado Springs, CO 80906-4184
Phone: (719) 576-8000 FAX: (719) 576-8801

THE WHITE HOUSE
WASHINGTON

March 17, 1994

Greetings to all those gathered in Colorado Springs for the tenth National Space Symposium and Space Commerce '94 of the United States Space Foundation.

For centuries, humankind's quest for knowledge has spurred human beings to inquire and explore the unknown. Nowhere has this journey been more dramatic than in our efforts to explore the universe in which we live. In the short span of thirty years, we have come to know the planets that share our solar system, landed humans on the moon, developed a reusable space shuttle, created systems that have contributed to peace and the security of the world and, perhaps most importantly, begun to see our own planet in a new and different light from space. These achievements are the basis upon which our future in space will be built. That future is bright indeed, as we enter an era of international cooperation in developing a space station and seek to expand our "Mission to Planet Earth."

This National Space Symposium provides a unique forum to discuss, to analyze, and to share information on issues vital to our nation's progress in space. Since President Kennedy's pledge to put a man on the moon more than thirty years ago, our nation's technological innovations have amazed the world. Now, more than ever, the world needs your continued leadership to inspire our youth and forge new paths toward a successful future. I commend all of you for your efforts to open new doors of technological opportunity while helping to promote prosperity and friendship among the many nations of the world.

Congratulations on your first decade of achievements, and best wishes for many more years of success.

Bill Clinton

Bill Clinton

United States Space Foundation Week — April 4-9, 1994

Whereas, the United States Space Foundation was founded in March 1983 to open dialogue through the interaction among space professionals — civil, military and commercial — to explore alternatives and to focus the national space policy; and

Whereas, space professionals will gather at the 10th National Space Symposium to discuss changing space policies to define programs and strategies and to discover new windows of opportunity; and

Whereas, Digital Imaging and Laser Angioplasty, developed for America's space program and now widely used in medicine and industry, will be inducted into the Space Technology Hall of Fame on April 7, 1994; and

Whereas, the Space Commerce '94 Forum and Expo will highlight commercial space opportunities;

Now, Therefore, I, Roy Romer, Governor of Colorado, proclaim April 4-9, 1994 as **United States Space Foundation Week** in the State of Colorado.

Given under my hand and the Executive Seal of the State of Colorado, this eighth day of March, 1994

Roy Romer
Governor

Welcome

Welcome to the 10th National Space Symposium and Space Commerce '94 and to the beautiful Pikes Peak Region. We gather together at a pivotal time in the history of space when we are faced with extraordinary challenges and opportunities as the 21st Century rapidly approaches

With great international cooperation, increased demands for flexibility and efficiency, innovative methods for development of space oriented projects, and the immense possibilities for commercialization of space for profit and accessibility we stand at a threshold. Perhaps at no time since the beginning of America's initial commitment to landing on the moon a quarter of a century ago, have we come to a point of significant decision in space exploration and technological advancement.

Our theme for this year's Symposium and Space Commerce is "Windows of Opportunity." During the next few days, some of the world's foremost authorities and decision makers will join in the dialogue and fervent discussion on issues of space policy, the international Space Station, technology commercialization, launch capabilities and national security. And the top aerospace and technology companies will demonstrate the latest innovation to meet space commerce and government requirements.

I highly encourage you to take full advantage of all that goes on here at the 10th National Space Symposium and Space Commerce '94, from the superb speaker presentations, to the stimulating exhibits, to your own personal conversations in the hallways. Make new friends and alliances and renew old acquaintances. By simple being here, you have already announced your intention to be an active participant in space futures, not one of those who is satisfied to just be an observer.

Have a great time exploring both those individual and collective "Windows of Opportunity" you peer through at this unique meeting of professionals. I sincerely hope this week will be a memorable turning point for the future of space and all it portends for the world.

With regards

James E. Hill, General, USAF, (Ret.)
Chairman of the Board
United States Space Foundation

10TH NATIONAL SPACE SYMPOSIUM AND SPACE COMMERCE '94 FORUM

If, as our vision portrays, America is to continue to have an aggressive, successful space program leading the world ... that ensures continued American Business Leadership in Space Technology, then space and business professionals must engage in meaningful interaction at many levels. A major goal of the United States Space Foundation is facilitating this interaction among the leaders and decision makers in government, business and industry.

TABLE OF CONTENTS

Bill Clinton i
President of the United States

Roy Romer ii
Governor
States of Colorado

James E. Hill, General, USAF (Ret). iii
Chairman of the Board
United States Space Foundation

FOREWORD

United States Space Foundation
Mission, Vision, Values & Goals xii

Board of Directors & Officers xiv

Contributing Sponsors & Members xviii

United States Space Foundation Staff xxi

PAGE iv INTENTIONALLY BLANK

PRECEDING PAGE BLANK NOT FILMED

Space Commerce '94 Forum & Expo

Clearly, the trends are for private business and industry to provide the engines of economic development in using space technology and space systems in commercial applications. Space Commerce '94 was co-sponsored by NASA, Business Week, Aviation Week and Space Technology, and KPMG Peat Marwick along with the United States Space Foundation, to stimulate government and business interaction. Top business and government leaders discussed successes, challenges and new ways of doing business using space and technology.

TUESDAY, April 5, 1994

SPACE COMMERCE '94 FORUM & EXPO
Morning Session

Moderator: **Don Fink** 1

Keynote: **Congressman Joel Hefley (R-CO)** 2

Topic: BUSINESS TRENDS IN HIGH TECH COMMERCIALIZATION

Speaker: **Dr. Tom Velez** 7

Topic: HOW TO SUCCEED IN SPACE TECHNOLOGY BUSINESS -- MAKING DOLLARS AND $ENSE

Speakers: **Ronald Birk** 13
Rick Hauck 15
Randy Hoffman 17

Topic: OBSTACLES & OPPORTUNITIES TO SUCCESS IN TECHNOLOGY COMMERCIALIZATION

Speaker: **William Scott** 23

TUESDAY, April 5, 1994

Afternoon Session

Moderator: **Theresa Foley**
Senior Contributing Editor
Space News

Topic: NASA'S COMMERCIAL TECHNOLOGY MISSION — A NEW WAY OF DOING BUSINESS: POLICY & PRACTICES

Speaker: **Gregory Reck** 29

FIELD CENTER PRACTICES

Speaker: **Dr. Syed Shariq** 30

Topic: PRACTICES IN ACTION — A NEW WAY: IMPLEMENTATION & BUSINESS OPPORTUNITIES

Speakers: **Dr. Robert L. Norwood** 37
Dr. Henry W. Brandhorst 39
Granville E. Paules 41
Dr. Bert Hansen III 46

Topic: SPACE COMMERCE REVIEW

Speaker: **Robert W. (Bill) Schick** 53

National Space Symposium

The annual National Space Symposium is the premier gathering of top international space professionals to discuss and debate space policy issues. The 10th National Space Symposium marked the first public appearance together and discussion among all the space agency heads of nations committed to the international space station. Other critical issues such as launch capabilities and competition, national security, science and commercial applications were featured as well. The industry exhibit hall topped off the event with the latest demonstrations of systems and technologies.

OPENING CEREMONY

Tribute to Apollo IX 59

Speaker: **The Honorable Bill Nelson** 60

WEDNESDAY, April 6, 1994

Morning Session

Topic: WINDOWS OF OPPORTUNITY

Keynote: **Jean-Marie Luton** 63

Topic: THE INTERNATIONAL SPACE STATION

Moderator: **Nicholas Johnson**

Speakers: **Dr. Roland Doré** 67
Masato Yamano 68
Dr. Jan-Baldem Mennicken 70
Daniel S. Goldin 73

Topic: SPACE SUPPORT FORUM

Speakers: **Tom Rogers** 79
Al Richmond 85
Suzanne Whistler 87

WEDNESDAY, April 6, 1994

Afternoon Session

Topic: SPACELIFT UPDATE

Keynote: **Lt. General Thomas Moorman, Jr., USAF** 89

Topic: COMPETITIVE LAUNCH CAPABILITIES

Moderator: **Edward C. (Pete) Aldridge** 93

Speakers:
Vladimir K. Chanov 95
Dr. Bruce S. Middleton 98
Prof. Dr. Igor V. Barmin 111
Tom Rogers 112

Topic: SUPPORTING LIFE ON PLANET EARTH

Moderator: **The Honorable Bill Nelson** 117

Speakers:
Lionel (Skip) Johns 117
Dr. Arturo Silvestrini 120
Dr. Harrison (Jack) Schmitt 121
Marc Stanley 122
Linda H. Strine 124
Steven Dorfman 126

THURSDAY, April 7, 1994

Morning Session

Topic: NATIONAL SECURITY SPACE ISSUES

Moderator: **General Charles A. Horner, USAF** 133

Speakers:
Adm. William Studeman, USN 137
RADM Lyle G. Bien, USN 142
Lt/General Donald M. Lionetti, USA 144
Maj/General Robert W. Parker, USAF 148
Lt/General (Sel) Richard Scofield, USAF 151
B/General (Sel) James R. Beale 155

National Space Symposium Luncheon

Topic: NASA IN THE BALANCE

Speaker: **Dr. France Córdova** 165

Afternoon Sessions

Topic: EARTH AND SPACE OBSERVATONS — DID WE HAVE COUSINS ON MARS?

Keynote: **Dr. Edward Teller** 169

Topic: NASA: A NEW VISION FOR SCIENCE

Moderator: **John Holliman**

Speakers:
Dr. Mark Albrecht 175
Al Diaz 177
Granville Paules 178
Congressman Bob Walker (R-PA) 181

SPACE TECHNOLOGY HALL OF FAME

Speaker: **Norman Augustine** 187

Appendices:

Featured Speaker Profiles 193

Space Commerce Speaker Profiles 196

Symposium Speaker Profiles 200

Space Technology Hall of Fame 206

Symposium Volunteers 210

Participants 211

Abbreviations & Acronyms Glossary 220

Proceedings Order Form & Membership Application 223

UNITED STATES SPACE FOUNDATION STRATEGIC DIRECTION
VISION-MISSION-VALUES-GOALS

Values form an organization's code of behavior and guidelines for doing business. These are the values we identified for the United States Space Foundation:

Integrity and Fairness

Non-partisan

Quality

Innovation and Creativity

Fiscal Responsibility

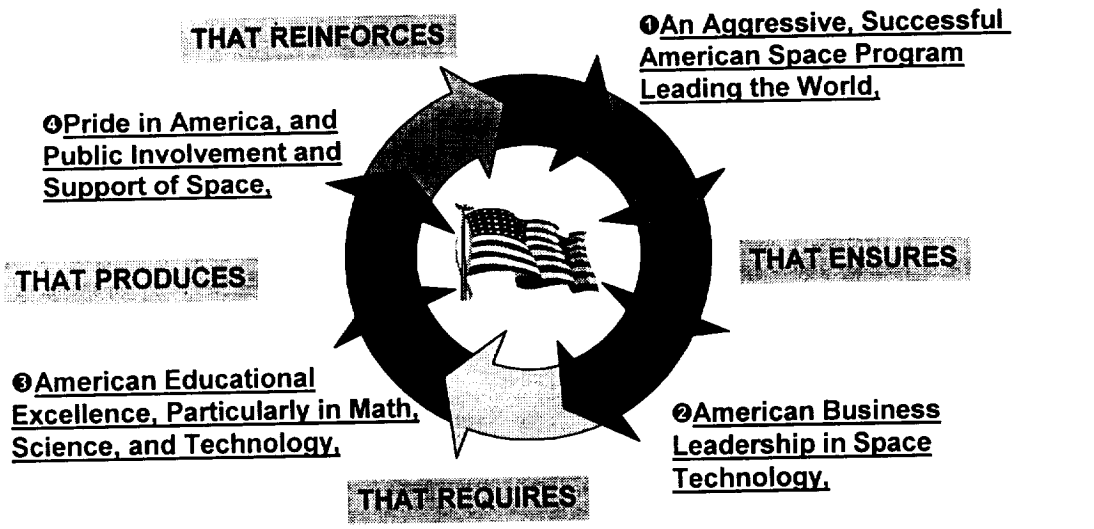
Staff Recognition

Accountability

Our non-partisan value enables the Foundation to provide a balanced and broad perspective to facilitate informed decision making. The innovative and creative values apply not only to the pursuit of space endeavors themselves, but also more importantly in the manner in which these activities are portrayed to the public. This is an area in which we believe the public is being failed. If, out of ignorance, public support wanes, then America falls from its leadership roles in space and technology and the consequences may be dramatic.

The United States Space Foundation, from the staff to the Board of Directors, has focused a great deal of energy over the last year defining this organization's strategic direction to best serve our constituencies in the future. This process has produced clarity of purpose while reinforcing our founding principles.

Our vision for the Foundation is the starting point. This vision is much larger than just our organization. It encompasses the cause we are championing and all those who are involved with it and they, in turn, are our constituents and our customers. Here is the vision. It has four elements.



A Partnership of Space Professionals, Government & Business Leaders, Educators & the Public

An aggressive, successful American space program leading the world. This is fundamental. We owe this to ourselves as a nation. Not to have this would be to forfeit all the investment and sacrifice that has come before and to foreclose the potential of the future for our children to enjoy the fruits of a great nation continuing to pursue the boundaries of new frontiers. Having this would ensure...

American business leadership in space technology. While this may not be sufficient in itself, it is an essential condition for this nation to remain competitive in the increasingly challenging global economy. To maintain that leadership edge in space technology will require...

American educational excellence particularly in math, science and technology. Excellence isn't something that is applied at the end of a process. It must be built in from the beginning. Therefore, the focus in this vision is on the formative years of K-12 and on those responsible for setting the standards – the teachers and administrators. The existence of these first three elements will produce renewed...

Pride in America and public involvement and support of space. We have all seen the results of American pride when put to the task and the broad-based support that real leadership can inspire when the chips are down. And when we have achieved that as a nation, it served to reinforce all that came before as described in this vision statement.

This vision is a partnership of space professionals, government and business leaders, educators and the public working cooperatively to achieve the four basic mutually reinforcing elements.

Mission

The United States Space Foundation can not achieve this vision alone. We see our role as but one important component. That component provides us our mission:

To Promote National Awareness and Support for America's Space Endeavors

Goals

The last element of strategic direction is goals. These identify the broad desired results we set out to achieve in the pursuit of out mission. The Foundation has adopted thise two goals:

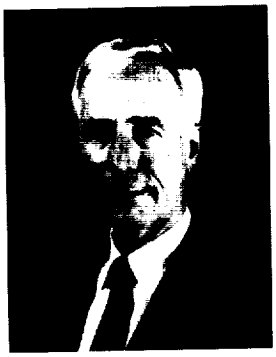
1. To provide our customers and constituents with high-quality programs and materials that optimize national awareness and support for America's space endeavors, through:

- Facilitating interaction among space and business professionals to help focus national policy.
- Enhancing teacher effectiveness in using "space" in the K-12 classroom.
- Increasing public awareness and support using education and entertainment.

2. To generate the necessary resources and reputation that will enable us to develop and implement high quality programs and materials.

We will not achieve success with this strategic direction by ourselves. Partnerships, alliances and support from government and industry are essential to achieving our mission. But in achieving our mission, we will be contributing to a continued strong America and beyond that, to a future for our heirs at least as promising as the one we inherited.

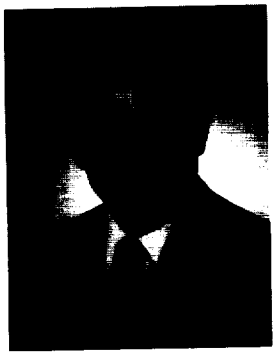
Directors



Gen. James E. Hill, USAF (Ret.)

William B. Tutt

W. Bruce Kopper, Esq.



William Hudson

Executive Committee

General James E. Hill, USAF (Ret.), *Chairman*

Gen. James E. Hill is former commander-in-chief of the North American Air Defense Command and the U.S. Aerospace Defense Command. He was a U.S. Air Force combat fighter ace in WW II and the Korean Conflict. Hill served as president of the Colorado Springs Chamber of Commerce for several years after his retirement from the U.S. Air Force and then as president of the Colorado Springs-based Olive Company. He is a graduate of the University of Maryland and the Royal Air Force Flying School in England.

William B. Tutt, *Vice Chairman*

William B. Tutt is chairman emeritus of the Colorado Amateur Sports Corporation. He served as vice president of the U.S. Olympic Committee and president of the Broadmoor Management Co. Tutt serves on the Board of Directors for US West Communications; the Air Force Academy Foundation; Norwest Banks and Colorado Interstate Gas Co.

W. Bruce Kopper, Esq., *Secretary-Treasurer*

President of the investment counseling firm Kopper Investment Management, Inc., in Colorado Springs, Kopper is a graduate of Washington University and the Washington University School of Law. He is a member of the Board of Directors and the Endowment Committee of the Colorado Springs Orchestra Association.

William Hudson, *Director*

William Hudson's entire professional career of thirty-one years was with Corning Glass Works, now called Corning Incorporated. When he retired in 1985 he was president of the Glass and Ceramics Group, a member of the Board of Directors, the Executive Committee and the Management Committee. Just prior to the Group Presidency, he was senior vice-president and general manager of the Technical Products Division which manufactured all of the windshields and transparencies for U.S. Manned space vehicles (including the space shuttle), and all fused silica ULE large mirror blanks for the space telescope. For six years Hudson was chairman and CEO of Corning's largest overseas subsidiary and joint venture with Saint Gobain in Paris, France. Hudson is currently a director of Analytical Surveys Inc. and investor/advisor in several start-up companies. He has been visiting executive to the Department of Economics at the Colorado College in Colorado Springs and is the co-founder of the Colorado Springs Total Quality Partnership, an all volunteer community-based organization. He has a degree in physics fromCarnegie Institute of Technology and attended the Harvard Business School Advanced Management Program.

Directors

Edward C. "Pete" Aldridge, Jr.

Robert Anderson

James M. Beggs

Capt. Eugene A. Cernan, USN (Ret.)

Dr. John L. McLucas

Douglas S. Morrow

Edward C. "Pete" Aldridge, Jr., *Director*

Pete Aldridge is president and chief executive officer of the Aerospace Corporation, a nonprofit organization dedicated to the objective application of science and technology toward the solution of critical national problems. Previously, Aldridge served as president of McDonnell Douglas Electronic Systems Co. He has also served in numerous government positions including Secretary of the Air Force. Among his numerous military decorations and awards are Secretary of Defense Meritorious Civilian Service Award; Department of Defense Distinguished Civilian Service Award, Department of Defense Distinguished Public Service Award, National Space Club Robert H. Goddard Memorial Trophy, Air Force Association Jimmy Doolittle Fellow, Ira Eaker Fellow, and the Brazilian Air Force "Merito Aeronautico" (Legion of Merit). He holds a B.S. in Aeronautical Engineering from Texas A&M University and an M.S. in Aeronautical Engineering from Georgia Tech.

Robert Anderson, *Director*

Robert Anderson, chairman emeritus of Rockwell and its immediate past CEO, earned a Bachelor's Degree in Mechanical Engineering from Colorado State University, a Master's in Automotive Engineering from the Chrysler Institute of Engineering, and spent 22 years with the Chrysler Corporation, rising to vice president of Corporate Automotive Manufacturing. Under his direction, Rockwell shared the 1982 Collier Trophy for work on the Space Shuttle Orbiter, awarded by the National Aeronautic Association for "the greatest achievement in aeronautics of astronautics in America with respect to improving the performance, efficiency, or safety of air or space vehicles." Anderson has served as chairman of the Business Higher Education Forum and the Board of AIA.

James M. Beggs, *Director*

James M. Beggs is chairman of the Board, SPACEHAB, Inc., and senior partner, J.M. Beggs Associates. As administrator for NASA ('81-'85) he was responsible for initiating and obtaining President Reagan's support for the Space Station program. He was administrator during 22 successful shuttle fights and, as the President's representative, obtained cooperation in the Space Station Program of the European Space Agency, Japan and Canada. A graduate of the U.S. Naval Academy and Harvard Graduate School of Business, he holds six honorary degrees and was awarded the Robert H. Goddard Trophy by the National Space Club in 1988.

Captain Eugene A. Cernan, USN (Ret.), *Director*

Capt. Gene Cernan is chairman of the Board and president of The Cernan Corporation and The Cernan Group, Inc. From 1976 to 1981 he was executive vice president, international for Coral Petroleum, Inc. Prior to 1981 he was a naval aviator and astronaut. He flew three separate space missions, was the second man to walk in space as pilot on Gemini IX, was one of a crew of three to venture to the moon on Apollo X, and holds the distinction of being the last man to leave his footprints on the surface of the moon as commander of Apollo XVII. Cernan holds a B.S.in electrical engineering from Purdue University and a M.S. in aeronautical engineering from the U.S. Naval Post Graduate School, honorary doctorates of engineering from Purdue, Drexel and Gonzaga Universities, and an honorary doctorate from Western State College of Law.

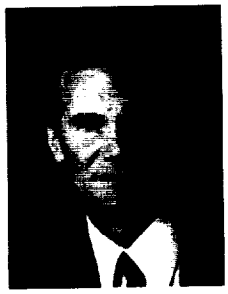
Dr. John L. McLucas, *Director*

Dr. John McLucas is an aerospace consultant, past chairman of the Board of QuesTech, Inc., United States past chairman of the International Space Year Association, and was Secretary of the Air Force from 1973-1975. He earned his Bachelor's Degree from Davidson College, his Master's Degree from Tulane University and his Ph.D. from Penn State, all in physics. McLucas has served as NATO's Assistant Secretary for Science, president and CEO of MITRE Corporation, Under Secretary of the Air Force, FAA Administrator, president of COMSAT World Systems Division and president of COMSAT General.

Douglas S. Morrow, *Director*

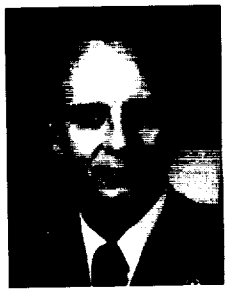
Doug Morrow, creator/producer of the Public Service Series, "Space Technology - This Is What's In It For You," is an Academy Award-winning member of the motion picture and advertising industry. He has served as a member of the NASA Advisory Council and as co-chairman of its Subcommittee on Communications. Morrow has been honored by both NASA and Congress for his contributions to the United States space effort. He was the recipient of the AIAA Public Service award in 1991. He became involved with the U.S. Space Program after climbing over 21,000 feet on Mount Everest without using oxygen, at age 71. Morrow attended Columbia and New York Universities and holds a Bachelor's Degree in Political Science, a Bachelor of Laws, and a Master of Laws.

Directors

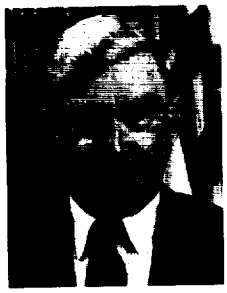


Hon. Bill Nelson

Richard D. O'Connor



Gen. John L. Piotrowski, USAF (Ret.)



Brig. Gen. Wes Posvar, USAF (Ret.)

Hon. Kenneth B. Kramer

Dr. Simon Ramo

Hon. Bill Nelson, *Director*

Bill Nelson is a former Congressman from Florida and currently serves as legal counsel with the law firm of Maguire, Voorhis & Wells, PA. He was elected to congress in 1978 and served on the Budget Committee during his first three terms. He also served as chairman of the space subcommittee and became the first member of the U.S. House of Representatives to fly aboard the space shuttle when he trained and flew as a member of the crew of the spaceship Columbia. Nelson graduated from Yale University in 1965, and from the College of Law at the University of Virginia in 1968. Following graduation he served a tour of duty in the U.S. Army, earning the rank of captain.

Richard D. O'Connor, *Director*

Richard D. O'Connor is chairman and chief executive officer of the Lintas: Campbell-Ewald Company, a director of the Interpublic Group of Companies, Inc., and vice chairman of Lintas: USA. He joined Campbell-Ewald in 1956 as a trainee on the Chevrolet account and held various positions with the company. O'Connor is a member of the Board of Directors of the Advertising Federation, and Michigan Advertising Industry Alliance. He is a graduate of the University of Michigan.

Gen. John L. Piotrowski, USAF (Ret.), *Director*

Gen. Piotrowski retired from the U.S. Air Force as commander in chief of the North American Aerospace Defense Command and the United States Space Command. The general has logged more than 5,000 flying hours, including 100 combat missions and 210 combat flying hours. His military decorations and awards include the Defense Distinguished Service Medal, Distinguished Service Medal, Legion of Merit, Meritorious Service Medal with two oak leaf clusters, Air Medal with two oak leaf clusters, Air Force Commendation Medal with one oak leaf cluster, Presidential Unit Citation and Air Force Outstanding Unit Award with three oak leaf clusters. He received the Eugene M. Zuckert Management Award for 1979. He graduated from the University of Nebraska at Omaha in 1965 with a bachelor of science degree. He completed postgraduate work at the University of Southern California and Auburn University, and attended the program for management development at Harvard University.

Brig. Gen. Wes Posvar, USAF (Ret.), *Director*

Brig. Gen. Wesley W. Posvar is the president emeritus of the University of Pittsburgh. He was appointed chancellor, now called president, of the University of Pittsburgh in 1967. Posvar is a founding member and former chairman of the Business Higher Education Forum, an organization composed of the chief executives of about 30 of the nation's most powerful corporations and a like group of presidents of the leading universities. In his capacity, he leads efforts to improve national awareness and action in such areas as capital formation, international competitiveness, science and technology research and development and regulatory reform. He is a graduate of the U.S. Military Academy where he graduated first in his class. He was a professor at West Point and the founding chairman of the political science department of the U.S. Air Force Academy. Posvar was a Rhodes Scholar at Oxford, a Littauer Fellow at Harvard and Research Fellow at the Massachusetts Institute of Technology Center for International Studies.

Hon. Kenneth B. Kramer, *Director Emeritus*

Ken Kramer is an Associate Judge for the U.S. Court of Veterans Appeals and a founding member of the United States Space Foundation. He is a graduate of the University of Illinois and the Harvard University School of Law. He served as a Colorado state representative from 1973-78 and as congressman from Colorado's Fifth District from 1979-86. Kramer also was assistant secretary of the Army for Financial Management.

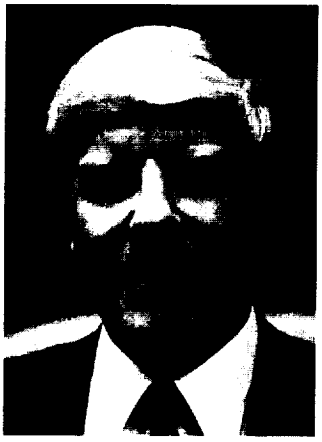
Dr. Simon Ramo, *Director Emeritus*

Dr. Simon Ramo, recipient of the Presidential Medal of Freedom, the nation's highest civilian award, is director emeritus and the "R" of TRW, Inc. He was chairman of the President's Committee on Science and Technology under President Ford, and was chief scientist in the development of the U.S. Intercontinental Ballistic Missile. He has also been a member of the Advisory Council to Secretary of State Henry Kissinger on Science and Foreign Affairs, the White House Council on Energy Research and Development, the National Science Board and the Council of Scholars of the Library of Congress. A visiting professor at Cal Tech, Ramo has been a Regents' lecturer at the University of California, a fellow of the Faculty of the Kennedy School of Government at Harvard University, and chairman of the UCLA School of Medicine Planning Committee.

Richard P. MacLeod

Richard P. MacLeod
President

Named the Foundation's second executive director in May 1985 and president in October 1988, Mr. MacLeod holds a B.A. degree in Government from the University of Massachusetts and a M.A. degree in International Relations from the University of Southern California. He is also a graduate of the State Department Interdepartmental Seminar on Foreign Policy, the Armed Forces Staff College, the National War College, and is a Distinguished Graduate of the Industrial College of the Armed Forces. Co-author of Space - A National Security Dilemma as a Senior Research Fellow, National Defense University, 1978-79, he was also Chief of Staff, NORAD 1981-84, and the first Chief of Staff of the Air Force Space Command, 1982.



Jack Flannery

Jack Flannery
Executive Director

Jack Flannery joined the U.S. Space Foundation as executive director in January 1991. Previously vice president of Flight Safety Services Corporation, he was responsible for the company's Space Training Systems and instructional Systems Divisions, providing state-of-the-art training solutions for government and industry clients. Mr. Flannery, a fighter pilot for many years, introduced new, innovative training systems for space operations missions while serving as Air Force Space Command's Director of Training, Standardization & Evaluation. He holds a Master of Business Administration from Auburn University and a B.S. in Electrical Engineering from the Air Force Institute of Technology.

Corporate Members

Corporate Members

Corporate Founder

Frank Aries

Corporate Partner

The Aerospace Corporation
Bechtel National
EOSAT
Fairchild Space & Defense
Rockwell
Space Age, Japan Inc.
Spectrum Astro
TRW Space and Electronics Group
United Technologies

Corporate Member

Ball Aerospace & Communications Group
Boeing Defense & Space Group
CTA, Inc.
Harris Corporation
INTEC
KPMG Peat Marwick
Lockheed Missiles & Space Co.
PRC, Inc.
Woodmen of the World

Corporate Associate

Current, Inc.
Double E, Inc.
GTE Government Systems
Johnson Engineering
Kaman Sciences Corporation
McDonnell Douglas Aerospace Co.
MITRE Corporation
OAO Corporation

Foundation Members

Sophron Foundation
Strake Foundation

In-Kind Corporate Members

Corporate Founder

Aviation Week & Space Technology/McGraw-Hill
Business Week
Digital Equipment Corporation
Lintas: Campbell-Ewald
Omni

Corporate Partner

Baird, Kurtz & Dobson
General Growth Properties

Corporate Member

International Robotics
Final Frontier
Hystar Aerospace Corporation
NASA Tech Briefs
Pasha Publications
Space News

Corporate Associate

Estes Industries
JKA, Inc.
Kopper Investment Management, Inc.
Life Support Systems, Inc.

Founder Members

Frank Aries
John W. Armstrong, Jr.
Edward G. Austin
Bahman Batmanghelidj
James C. Berger
Shirley Brown
Spencer Brown
Howard H. "Bo" Callaway
Robert J. Callow
Joseph Coors
J. Berry Craddock
John Denver
John Egging
Richard H. Faulkner
Jack Flannery
Dr. Brenda Forman
John E. Fuller
David L. Gies
William J. Hybl
Walter F. Imhoff
John H. James
Gilbert Johnson
Ralph W. Kiewit, Jr.
Walter W. Krueger
William H. Langenberg
O. P. LeCompte
Martin List
Richard P. MacLeod
Harry G. MacLeod
Scott A. Manatt
Eugene Mitchell
Joseph Moquin
Jerry Novak
John M. Olin
Robert P. Osborne
Janet B. Pettigrew
Harold A. Poling
A. Gary Seyster
John M. Sommer
Alvin A. Spivak
George W. Strake, Jr.
Virginia Swigert
Ruth Taylor
Vernon Taylor, Jr.
Sal J. Valentino
Jules Watson

Life Members

William D. Cammarano
Frank S. Day
Keith Ketelsen
Dr. John L. McLucas
Donald E. Smith

Event Sponsors

Tuesday Opening Ceremony & Reception

Rockwell

Wednesday Reception

LORAL
Space & Range Systems

Thursday Symposium Luncheon

COSMOS®

Thursday Reception

UNITED TECHNOLOGIES

Space Technology Hall of Fame Banquet

SPECTRUM ASTRO

Coffee Breaks

Digital Equipment Corporation
PRC, Inc.
National Technology Transfer Center

Sponsoring Publications

Sponsoring Publications contribute valuable advertisements spreading word of the Symposium and Space Commerce '94 to hundreds of thousands of readers.

Ad Astra/National Space Society

Aviation Week & Space Technology/McGraw-Hill

Business Week

Pasha Publications

Final Frontier

Sky & Telescope

Space News

Cooperating Organizations

In-Kind Contributors

Broadmoor Hotel
Cellular One - A McCaw Cellular Communications Company
Joe Ferguson Pontiac
Freeman Decorating Company
Lewan & Associates - Office Technology

Thank You To

Air Force States Command
United States Space Command
Colorado Springs Police Department
Johnson Space Center
U. S. Air Force Band of the Rockies
U. S. Air Force Academy Cadet Show Choir

Cooperating Organizations

Aerospace Industries Association
Air Force Association
Air Force Space Command
American Defense Preparedness Association
American Institute of Aeronautics & Astronautics
International Institute for Learning, Inc.
NASA Office of Advanced Concepts & Technology
NASA Ames Research Center
NASA Johnson Space Center
NASA Stennis Space Center
NASA Headquarters
National Security Industrial Association
National Space Society
Space Calendar
Space Transportation Association
Tech Transfer Society
U .S. Space Command
Women in Aerospace

BARBA ARKHON
INTERNATIONAL INC

Experts in Claims Analysis & Litigation Support

serving Government and Commercial Clients in the Space Industry

Call for our capabilities brochure.
1-800-966-BARBA

Suite 300 East
Laurel Corporate Center
10,000 Midlantic Drive
Mount Laurel, NJ 08054

Offices Nationwide

Volunteers & Staff

Volunteers

Volunteers are key to the success of many of the Unites States Space Foundation's endeavors. Hundreds of volunteers work with the Foundation throughout the year. Nearly 200 volunteers are assisting in 10th National Space Symposium and Space Commerce '94. We salute them!

Volunteer Committee Chairmen

Dave Brescia	Speaker Response Team
Duncan Fisher	Seating
Dan Jordan	Speaker Support
Bob Ewell	Q & A
Jerry Lemberger	Security
John Mims	Media/Press
Frank Ocasio	Transportation
Jim Rix	Information Booth
Pat St. John	Space Support Forum
Vic Villhard	Student Tours
Frank Wisneski	Exhibitor Support

Staff

Richard P. MacLeod	President
Pam Matthews	Executive Secretary
Constance Gelvin	Executive Secretary
Jack Flannery	Executive Director
Faye Nicholson	Administrative Assistant

Communications, Marketing & Development

Beth Ann Lipskin	Director of Communications, Marketing & Development
Barry M. Grossman	Public Relations Manager/SpaceWatch Editor
Yvette Mihaly	Marketing Associate
Sara Patterson	Development Associate/Speaker Coordinator
Paula Stiles	Communications Intern

Education

Dr. Jerry Brown	Director of Education
Darlina Swartz	Assistant Director of Education
Elizabeth Taylor	Education Administrator
Joan Lewis	Education Administrator
Michael Bashonski	Research/Resource Coordinator

Finance & Business

Holly Roberts	Director of Finance & Business
Barbara Cloclough	Finance & Business Manager
Jane Rasplicka	Staff Accountant
John Weaver	Computer Systems Manager

Operations & Administration

Chuck Zimkas	Director of Operations & Administration
Rick Campbell	Planner
Dave Bowling	Events Manager
Pat Sullivan	Retail Store Manager
Claudeen Cornelius	Registration
Aleta Fields	Receptionist
dj Mustoe	Volunteer Coordinator/Administrative Specialist
Dave Wright	Data Entry Clerk

Space Commerce '94

Don Fink
Editor-in-Chief
Aviation Week & Space Technology Magazine

Rep. Joel Hefley (R-CO)
Fifth Congressional District
U.S. House of Representatives

DON FINK: Good morning. I'm Don Fink, Editor-in-Chief of *Aviator Week and Space Technology* and the Editorial Director for McGraw Hill's Aviation Group. I am very pleased to be here this morning to chair this opening session of Space Commerce '94. I'd like to take advantage of the opportunity to make a few opening remarks.

I think first of all we should dispense with the popular cliches about turning point and water sheds and critical junctures, looming potentials, exhortations for immediate corrective action and the like. We've all been there before, and I think Tom [Velez] is going to make some remarks concerning the recycling of these old phrases and how history is repeating itself here.

The needs of this industry will not be served until this or some other forum or in conjunction with this forum is found to take the message out to a broad spectrum of industry, the American public, and especially congress.

So we have heard all of these before, many of you have used them yourselves and one or two may have found there way into news and editorial columns of *Aviation Week & Space Technology*. It might be prudent to keep a few of those in the back of our minds as we listen to the presentations today because the space commercialization business badly needs, I think, a strong dose of reality. We need to bring it into the real world. Things are not as they should be, nor, I think, as most of us would want them to be. It's admirable for those of us who are involved in one way or another in space activities to gather for serious discussions of the type we are going to have here today — assessing, if not charting the future course of these endeavors. But the word has to be broadcast, and broadcast in the broadest terms, out to the business community. As a matter of interest, I would like to do a quick survey here this morning. May I ask for a show of hands among you everyone who has a connection of some sort with the space program; military, civil, industry, journalism, alright. Thank you. How many of you have no direct connection with space or even indirect connection, and are here just as outside business people looking for information? I think we saw one or two lone hands there. Well, that tells a great deal about the audience. I want to make a point to all of us and certainly to our speakers as well, so that they know how to frame their remarks, perhaps their responses, prepare for their questions that they are going to get.

From my point of view, I think it reinforces a concern — the U.S. space community is too insular. There is too much time spent talking to each other, talking to ourselves, and too little time in educating people who are potential customers to drawing new participants into the fold if you will. The needs of this industry will not be served until this or some other forum or in conjunction with this forum is found to take the message out to a broad spectrum of industry, the American public, and especially congress. I'm very happy to have Representative Hefley here to give his perspective on this. There certainly are a number of readily identifiable issues that need to be aired and I think chief among them is the issue of resolution — namely setting U.S. policy governing the commercial sale of remote sensing imagery and data. Let's break the 30 millimeter, or 30 meter resolution barrier and get on with stimulating the remote sensing business.

Mission to Planet Earth, announced with justifiable fanfare, that it is facing budget challenges threatening to limit its scope if not its future. It's time to get aggressive with this earth-oriented effort that has immediate commercial potential exceeded probably only by the communication satellite sector. Speaking of the communication satellite, what about the financing aspects? Are we certain that the money will be there to fund such efforts as the Teledesc system recently introduced by Microsoft and the McCaw Cellular Communications Group. For that matter what about the sources for Hughes Direct Broadcast and Motorola's concept? Is the financial community being properly informed on the opportunities in commercial space?

PAGE XXII INTENTIONALLY BLANK

PRECEDING PAGE BLANK NOT FILMED

In the area of launchers and overall access to space, there is clear commercial implications of what NASA does with the space shuttle and how it and the Defense Department resolve the issues of modernizing their expendable launch vehicle capabilities. The rest of the world isn't standing still and waiting for us, as we see in the case of Europe, Japan, China, and even the Russians with a little help from their friends. The development of the commercially viable launch system, that will enable U.S. launchers to offer customers reliable and relatively cheap access to space is key to the future of space commercialization in the U.S. We need to access what the business environment is. We need to know how we're going to cope with the budget cuts that are already being enforced and are looming. What about ideas from business? What about the entrepreneurship? What about the government business cooperation, partnership that we hear the Clinton Administration saying so much about? What are business's basic needs and how can you help the government and what kind of help do you need from the government? Of overriding importance however, and I think certainly desperately needed as I said earlier on, is to find the means of getting this message of the potential of space commercialization projects properly communicated to the greater business community. And when I say properly, I mean in language they can understand. We don't have to dazzle them with the technology, and we'll hear a little bit more about that from our panel discussion this morning. With those brief introductory remarks, now let me turn to our program.

The current Administration has directed Dan Goldin to make the space program more relevant to the American people. To those people health care, crime, creating jobs, for the most part have pushed aside the idea of competition with the rest of the world.

This is meant to be an interactive session, it is not a tutorial. We don't want you to sit and gather knowledge and go home with it. So, ample time will be allowed for questions and answers. And please avail yourselves of this opportunity because we want to make this a meaningful exchange of views and ideas.

We are honored this morning to have as our keynoter the Honorable Joel Hefley who serves on the U.S. House of Representatives for the fifth district of Colorado. Representative Hefley has served in the Colorado State Senate and the Colorado House of Representatives,

The development of the commercially viable launch system, that will enable U.S. launchers to offer customers reliable and relatively cheap access to space is key to the future of space commercialization in the U.S.

and he's on a variety of committees. It's my pleasure at this time to introduce Congressman Hefley.

REP. JOEL HEFLEY: Twenty-five years ago we had Apollo. Apollo, the stepping on the moon is one of those events in history, like Pearl Harbor, when everyone of us remembers where we were where when that occasion occurred. It was a rainy Sunday afternoon for me, and I just hauled a horse to Pueblo, Colorado for the State Fair and had come back and had rushed back in a driving rain storm hoping to get back in time — and got back just in time — to see Neil Armstrong set foot on the moon.

This is one of the touchstone events of a generation. It made NASA synonymous with the can-do spirit of America. Many things have changed in the past twenty-five years. The Cold War has ended and to some extent we are still trying to find our bearings in a post-Cold War world.

To a large extent, our space program grew out of the Cold War. We set out to prove that we were technologically superior to the Soviets and we proved it. The Apollo Program pushed aerospace and computer technology to a level we are still living off of today. Now America is collectively trying to determine what things are important to it today.

The current Administration has directed Dan Goldin to make the space program more relevant to the American people. To those people health care, crime, creating jobs, for the most part have pushed aside the idea of competition with the rest of the world.

In 1993, a Gallup poll showed that 51% of the population favored cutting or eliminating funding for NASA. Data collected for the General Social Survey shows that those who feel too much is being spent on the space program rose from 41% in 1990 to 54% in 1993. Those most closely involved in the space program also appear to be struggling to find their way in the new world. A

1969 commission, headed by Vice President Spiro Agnew, recommended a lunar base by the mid 1970's and a mission to Mars by 1983. By 1986, we were still going to Mars, but then it was the end of the century we were talking about. Since 1986, we have commissioned an apparently endless series of studies while doing little to advance the cause of man's presence in the universe.

The commercial sector is going to have to look for commercial customers and not just be satisfied with the assumption that they're going to have plenty of business by selling to a government market.

This spiritual hiatus extends to our technological base. When we were using Titan IIs to launch Gemini astronauts in the 1960's, we launched one every two months at a cost of $90 million per launch. We decided such cost were outrageous. Indeed, the Agnew report pinpointed lower launch costs as the single most important challenge facing the U.S. space program in 1969. We are we today? Each shuttle launch is estimated to cost $500 million and we're lucky to get very many of them off the ground each year. The Titan IVs are estimated to cost between $250 million and $350 million per launch. This continues to one of the foremost questions facing the space program today and it has remained unaddressed in any meaningful way.

How serious is it? The cost of launching satellites for the military has risen to such a level that last year's Armed Services Report said that we should look at launching strategic assets, strategic assets, on foreign launchers.

Our share of the world commercial launch market has declined. We used to have 100% of it, now we have 30% of it. A 70% decline. Charles Bigot, the Director of Arianespace was quoted recently as saying his company was proceeding on the assumption that the United States would not be a serious player in the commercial field in the foreseeable future.

Five years ago, Alan Lovelace of General Dynamics, told Congress he expected to be out of the commercial launch business in *ten* years. He appears right since the main aerospace providers are going through a massive shake out.

Finally, there is the federal budget deficit. As money for entitlements and interest on the national debt grows, Congress is being forced to cut discretionary programs to hold down costs. Discretionary programs is another phrase for government operations which include such things as NASA and the Department of Defense. In Armed Services, we're arguing over whether our army should have 10 divisions or 12 divisions. Remember we were at 18 divisions just a short time ago. There was even a suggestion a week or two ago that maybe we could cut to eight divisions and that if we went to eight divisions, we wouldn't have to cut some of the domestic programs. The Undersecretary of the Army said if we go to eight divisions, we have destroyed the Army of the United States.

NASA is no longer the fair-haired child spared from the Congressional budget ax. As a result, the space agency is supposed to come out of this year's budget with the first real decline ever. The agency asked for $14.3 billion dollars. It will have to fight to get $14 billion. Dan Goldin has said he simply can't cut any more without compromising shuttle safety. The space station will have to forget another year, will have to fend off attempts to cancel it as the Super Collider was canceled. And given the dynamics of the budget problem, it's not going to get any better any time soon.

So, it's a matter of critical importance that you here this week ask and answer the question, "What is America's future in space? And what do we need to do to realize that future?"

Our share of the world commercial launch market has declined. We used to have 100% of it, now we have 30% of it. A 70% decline.

Probably, a lot of you were attracted to attend the Space Symposium because of the opportunity it affords to talk to people across the aerospace spectrum, civil, military, commercial, scientific. In the coming years, it's going to be more crucial than ever that those sectors work together to develop a vision for our space future. In an environment where the government is too strapped for cash for sweeping gestures, these segments are going to have to become more self-reliant and cooperative.

NASA and DoD are going to have to pool their efforts and this time, do it seriously. Defense contractors are going to have to stop waiting for the next defense buildup and figure out ways they can prosper in a

post-Cold War world. The commercial sector is going to have to start examining how it does business and strike out on some paths on its own. By this I mean, the commercial sector is going to have to look for commercial customers and not just be satisfied with the assumption that they're going to have plenty of business by selling to a government market.

I'm trying to get people moving in this direction. As I said earlier, the high cost of space launch has been identified in study after study as being a pressing national priority. This has gone on for 25 years. In the past five years, we have spent over $3 billion on studies of how to do this and have practically nothing to show for it. Therefore, in an attempt to get this debate off the dime, I plan to introduce legislation based on the highly successful Communication Satellite Act of 1962 that would introduce market forces into launch services. The bill I'm proposing would direct the President to outline the nation's needs and goals in the area of space launch and then create a corporation to provide these services. How the corporation does that is up to the board and its customers. It may advertise for bids on a new launch vehicle, it may decide to modernize our existing launch facilities. It will have to lower launch costs, because we simply cannot compete in a world market that includes Long March or compete in a space market without a sizeable reduction in costs.

The downward trend is continuing, but if we except change and seek ways to manage and profit from it, we have the opportunity to expand employment, expand technology, and expand our knowledge of the universe.

Not everyone is ecstatic about my idea. Some think we can continue on pretty much the way we have with minor fixes, but when you consider that our most successful commercial launch providers are operating on such a slim margin, when the Europeans supposedly have contracts for more a hundred launches on the books, about four and a half years worth of launch, it's questionable how much more mileage we can get out of simply shaving millimeters off of fuel tank walls. That may be the case, but times have changed, and we have to come up with new ways of doing things that we've done in the past.

The scientific community is likewise going to have to find faster, cheaper, better ways of producing the kinds of results we've grown used to over the past 37 years. The early results we've seen from the Clementine probe seem to indicate this can be done, but it might require a cultural change in the space scientific arena. Just one year ago, a former national official said that we can not see the point in a small probe to Pluto. If you are going to go that far, you should put together a proper mission, was his way of thinking on it. We might now be able to spend so much money on proper missions in the future, but then we might not have to.

We need your help in Congress. Space is not a top priority for the average member of Congress, the 435 congressmen and the 100 senators. There are other priorities.

Change can be viewed as a threat or an opportunity. Over the past several years, businesses and state and local governments have developed new ways of doing business. Businesses have gotten leaner and meaner. Governments have started privatizing, are contracting out for services, or have tried to reshape markets and budgets to become more responsive. That need has now reached the space industry. I believe if we choose to fight change, we are going to continue in a continued erosion of our achievements in space, to the manufacturing base that supported those achievements and consequently to the aerospace employment. As I said, five years ago, the consensus opinion was we could only support one launch provider in this country. We are not down to two or two and a half years, and who knows how the new French rocket will affect that in the coming years?

The downward trend is continuing, but if we except change and seek ways to manage and profit from it, we have the opportunity to expand employment, expand technology, and expand our knowledge of the universe.

Twenty-five years ago this July, man landed on the moon. We have studied these problems long enough. There's no time like the present to pause and see where we've been, where we are, and where we're going. Looking at the roster of this year's symposium, you're just the people to do this.

We need your help in Congress. Space is not a top priority for the average member of Congress, the 435 congressmen and the 100 senators. There are other priorities. Space is not the priority for the President of the United States, obviously, either. We give lip service to it, but it's not the priority. We need your help in again, making this a priority because America's future,

to a large extent depends on what we do in space.

Thank you for coming to attend this. Thank you for spending this time that you could be spending doing all kinds of other things, but this is valuable time, this is important time, and what comes out of this conference will be important to us in Congress and the American people.

Business Trends in High Tech Commercialization

Dr. Tom Velez
President
CTA Incorporated

DR. VELEZ: Let me start off by saying I think this is an unprecedented time for us — a time of opportunity — to set the course for a marvelous future in space. And let me characterize why I say that, what I mean by that. I believe that macro-economic issues are really changing the way space business will mature in the next few years. Things like policy changes in government regulation, the deregulation of telecommunications, the lessening of export restrictions, the privatization from government to commercial owned systems, will open new markets for commercial space-based services in the future.

In the nation and elsewhere, there will be excess labor force of highly educated people particularly in the aerospace business. This means that most talented technologists on the planet will be available for new assignments, and as an entrepreneur, I see that as an opportunity.

Foreign competition will increase in most areas of technology, promoting even greater efforts by national industries to keep up, again another opportunity.

Product development cycles will continue to shorten primarily due to powerful personal workstations embedded in automated processes for manufacturing. Timelines for the development of satellites will shorten from to five years to three years to one year to perhaps months.

In the nation and elsewhere, there will be excess labor force of highly educated people particularly in the aerospace business. This means that most talented technologists on the planet will be available for new assignments, and as an entrepreneur, I see that as an opportunity.

Smaller defense markets and increasing foreign competition will continue to drive industry wide consolidations. Martin Marietta and Loral are excellent examples of this trend. I was going to start off saying that CTA finally has gotten to the point where it recognizes that Martin Marietta is now large enough to be purchased by someone like us, but I don't think you would have believed me.

The catch-22 of the consolidation strategy of these companies however, is that it opens doors for niche companies, entrepreneurial companies, to enter unhindered by the bureaucracy of massive organizations.

This is an unprecedented time for us ... to set the course for a marvelous future in space.

Besides these macro issues of the environments, there are high technology revolutions taking place, which I see as opening opportunities for us. Here are some of the major ones, the chip, the chip is everywhere, miniaturization is in all the devices we use today, data storage devices are becoming very compact, low cost. We even use this miniaturization in space. CTA recently developed and operated a constellation of seven microsatellites with one single PC.

Revolution number two, the wireless revolution. People want to take their work with them, people want to communicate with anyone, any place, at any time. You would not have had your cellular telephone and beeper three or four years ago, today you probably have at least both of these things. I can't imagine being in a traffic jam without my phone. Prestigious companies, such as Motorola, are leading us, preparing to spend billions of dollars to support this concept.

The next revolution is the video revolution. Today we have two generations of Americans who have grown up with television, furthermore there are 50 million Americans and people from all over the world who have computers, and these two worlds are rapidly converging. The new buzz word, is multimedia. It is the buzz word for PC products, which provide simultaneous video text and graphics to come to market. Along these lines, we are involved in projects with the country of Indonesia to build a small LIGHTSAT to provide tele-

PRECEDING PAGE BLANK NOT FILMED

medicine, and teleeducation services by the merging of television and computers.

And the final revolution in mind is the information, and what I call, the system globalization revolution. Programs such as the international information highway, mission to planet earth, combined with the deterioration of Cold War impediments will open new opportunities for international space cooperation, unprecedented in recent history.

So the bottom line is that the economy and environment will breed agile companies capable of seizing even creating new market niches. Companies which leverage the power of the computer and demands for wireless low cost system, in a short, a faster, cheaper, better product or service, will prevail in our economy.

Given the above conditions, "What does it take to make a profit?" is the question I keep getting asked on Wall Street. The answer is simple, invent a new innovative application for some response to market needs, develop it quickly, get it to market first, and provide a quality service. However, the implementation of such a strategy is not that simple.

On the innovation side, new application for Low Earth Orbit (LEO) systems are coming up everywhere. I'm sure most of you in the audience know a lot about these. An example from our side is our partnership with World View Corporation, to put a high resolution three meter camera in space on a LIGHTSAT. This is not technology in my view, not a technology in search of a market which has been a criticism in our industry. We believe that the market exists and at the right price, the market will mature. Other companies feel the same way, and the race is on especially with the new recent policy on remote-sensing systems.

Second, is the need for quick development. A company must retool its work force with new processes focused on the development of products driven by commercial, rather than government market economies. Integrated Product Development (IPD) Teams, Skunkworks, performance driven design concepts exemplify this trend. For example, a year ago, we designed a satellite, built it, and launched it in less than a year.

The third and most important element for success however is the human factor. People make technology happen, people make companies happen. Particularly in a down sized world, a company must provide its employees with the proper tools, training and motivation through reward for excellence. At CTA I've learned that employee ownership, for example, can be a powerful motivational tool during down times, difficult times like we have today in the industry.

To this point, I've talked about the business climate and what it takes to succeed, now let me turn to the barriers to commercialization which we all know about. In fact, in doing some research for this speech I kind of looked up some documents that are as much as fifteen years old and found many of the same arguments being said then that are going to be said today. However, things are changing and I'm going to try to characterize some of those changes.

The first barrier is the lack of low cost access to space. Small satellites require low cost launch vehicles. Otherwise, they are unaffordable. That is why we at CTA are supporting the use of small Russian launch vehicles for commercial application such as the converted SS-25.

What does it take to make a profit? The answer is simple, invent a new innovative application for some response to market needs, develop it quickly, get it to market first, and provide a quality service.

Similarly, we propose that the U.S. should also consider releasing minuteman assets for commercial applications. Such assets could jump start the U.S. small satellite industry. I believe that the more capable satellites in space, new applications will emerge much like the impact of the personal computer on market industry.

Second barrier, is a lack of venture capital. Recently, I spent significant time on Wall Street just to find the use of capital based venture. I can report to you that after decades of arguments nothing has changed on Wall Street. Investors consider the frontier too risky, the unacceptable rate of return the five to ten year windows are difficult to swallow, and as a result little known capital is available especially to the LEO systems of today, with the exception of the Geocom Business.

Looking at successful examples in this Geocom Business companies like American Mobile Satellite corporation, PanAmSat were able to attract significant public investments because the mobile, cellular, and satellite based communication markets were matured and were demonstrated. The lesson here is that in cases such as these the government played a major role in certification of the technology fundamental to the services these companies were offering.

Talking about the government in my view, the government has and should continue to have four major roles in its support of commercial development in the United States.

First, regulatory — with policies which both assure international competitiveness while maintaining international security. The recently announced remote sensing policy is an example of this. The demise of COCOM is another.

When it comes to Space Commerce '94, the theme of this conference should be clear — we, as an industry, are committed.

Similarly in my opinion, the government should consider opening new bands on UHF L and S band spectrum to give American entrepreneurs the opportunity to flourish with new communication systems.

Second, role as the certifier of technology — especially by the funding of nonrecurring engineering. The path by Greg Reck and Sam Venerri on the Small Spacecraft Technology Initiative (SSTI) program is a great example of this, Application Technology Scientific Satellite Bus (ATSSB) was another. The government needs to do much more of this, it works.

Third, as a provider of government assets for commercial purposes, which otherwise would represent major capital investments for the entrepreneur, with payback arrangements through royalties after the service is in orbit. The use of test facilities, government experts, and review panels, and launch vehicles are examples of these kinds of assets.

Let me focus on one of those, experts. The government has a marvelous workforce in its place and I would propose the government could significantly contribute to the commercialization of space through entrepreneurial leave for laboratory personnel.

An argument heard all too often it's somehow unfair for individuals who are paid to develop technology by the government to somehow profit in a private venture. This argument misses the point. Profit only comes from successful technology transfer. If we want technology transfer to happen we need effective incentives.

The government could also make it more desirable for U.S. citizens to invest capital in aerospace through appropriate tax incentives such as the once popular limited R&D partnership.

And finally, the government as a user. As we all know, the government is a major user, if not the major user of communications and remote sensing data on the planet. Its role as reliable multi-year anchor tenant with such services could provide the collateral necessary to fund necessary capitol up front costs for the system like these. An example of this was TDRSS (Tracking & Data Relay Satellite Systems) and even though these models may not be perfect, they work.

The bottom line of all of this is that government and industry must cooperate and continue to cooperate towards the development of a viable commercial space market. However, we will need to invent a new basis for a relationship which is more meaningful and amenable to the commercial investment community. In effect, we must put the relationship between the government and the industry on commercial terms.

This leads to my final point. With the growth in wireless communication demands and opportunities, the growing applications of remote sensing and desire for global position locationing in support of such activities as safety, navigation, and law enforcement, there seems to be no end to the opportunities for profitable space ventures, once the capitalization hurdle has been overcome.

We will need to invent a new basis for a relationship which is more meaningful and amenable to the commercial investment community. In effect, we must put the relationship between the government and the industry on commercial terms.

Finally, let me congratulate the NASA administrator Dan Goldin for his "faster, cheaper, better" initiative. I believe he sparked the new revolution in LIGHTSAT development enabling new commercial frontiers for space today. In the industry, we are making investments, large investments to leverage these LIGHTSAT technologies in commercial communications remote sensing and direct broadcast industries.

When it comes to Space Commerce '94, the theme of this conference should be clear — we, as an industry, are committed.

Q&A Session

DON FINK: I'd like to hear a little bit more about what happened on Wall Street. Could you be a little bit more specific in how you were greeted and what the attitude is among Wall Street investors?

DR. VELEZ: There's an interesting problem going on. On one hand Wall Street believes that there aren't

enough opportunities for investments, and at the same time, the conservatism remains. Whenever there is a failure in space, whenever there is a sense of kind of investments people have to make in insurance to cover the costs of possible commercial failures and the lengthy times for return on investment, they look at other alternatives. It's a tough sell. Irrespective of the evidence that people have that there is a possible market in all the activity going on in the industry today, I still think it's amazing how little Wall Street knows about the space business and the possibilities about commercial space. Its just amazing.

How do we know that there are enough customers out there to make money? Isn't that the real problem with Wall Street, given the fact that we don't know that there is a customer base out there? How do we know there's enough customers to serve Teledesc, and all the other things you hear that are coming along? Well, there just seems to be no end to the market for communications.

QUESTION: I heard you talk a little bit about barriers to our space program and you mentioned export control. Could you elaborate a little bit more?

DR. VELEZ: We are a builder of what I would consider to be a small light weight systems to attract a small niche market. Emerging third world nations for example, like Indonesia, are targets for our products. There are a lot of countries that fall into COCOM restrictions, or used to fall into the COCOM restriction, which would have made it difficult for us to export those satellites to those nations or put those satellites into patrol. It's in that spirit that I'm really relived that cocom is changing, the U.S. government is changing its policy of exportation of technology to other nations, and it really provides opportunities for people who have these niche products to sell, that are more appropriate for smaller markets than the United States.

QUESTION: In the early 80's, McGraw Hill had a publication called Commercial Space, and 1986 or so it went down the tubes. The environment was different then. Are you guys going to bring that back?

DON FINK: Well, it did go down the tubes, and we deeply regretted that, but it followed the business down the tubes. We are very business driven, and it being a business publication as opposed to a popular publication we were forced to follow the business. The answer to the second part of your question is yes, but we don't know what format, what frequency, what delivery system and so on. It may be electronic to begin with. I'm not certain the business is sufficiently developed or defined to support a print publication. But the answer is yes, we are reviewing all of those options, and reviewing them very seriously as a matter of fact.

QUESTION: What do think of Congressman Hefley's idea that we need a Comsat for launch vehicles established as he suggested in his speech? And my second question, you commented that a new basis is needed for the relationship between the government and industry to get your version of commercial space off the ground. Where should that reside? Is NASA the place? It used to be every agency in Washington had a commercial space policy, and now I don't know if a single one of them does. What do you think as an entrepreneur? Who ought to be leading on this stuff?

DR. VELEZ: First, on the launch vehicle. I agree that the launch industry is in crisis in the United States, and that we need to do something to push the industry forward. I'm open to almost any idea that expendable launch vehicles, especially low cost small expendable launch vehicles should be available to the industry and having more satellites launch in the industry we'll have a greater expenditure in R&D in launch vehicles and the cycle will lead to an enhanced economy. I think that the French are doing a marvelous job in supporting their industry with the help of government and I would probably look at that model for how the government and that industry has succeeded in working together as possibly a model for us. As to where the commercial initiatives reside, first of all, I think it's incumbent upon the industry to take the risk of market failure. Entrepreneurs don't want the government to cover us if we missed the market, if we don't get the product to market on time, or we missed the boat on what kind of product the market really needs. On the other hand, investment community views space as a risky venture. Things like the cost of insurance could inhibit the commercial viability of a space venture, just that alone. The government has seen its position in identifying hazardous activities in other businesses, nuclear businesses and so on. Perhaps there is a multi-agency role that can be played. I haven't really thought through the concept of how and what way should the government organize itself to support commercial space better, but the question really is what does it take a capital investor to put his money, perhaps millions perhaps tens of millions of dollars down, what kind of environment does it take. I think we have the market side covered to some extent.

I think there are lots of space ventures today funded by the community that are perhaps even riskier than a commercial space market. But it's these other things the nature of the business, the risks associated with launches, the inability for us to repair things in space, inability to adjust to service once it's in place, that makes the market resistant to this commercialization concept. And I think, there are ways for the government to perform in support of this problem, but I really don't have a good answer to exactly what the best model is, whether it should come through NASA, DOD, or some other commerce initiative.

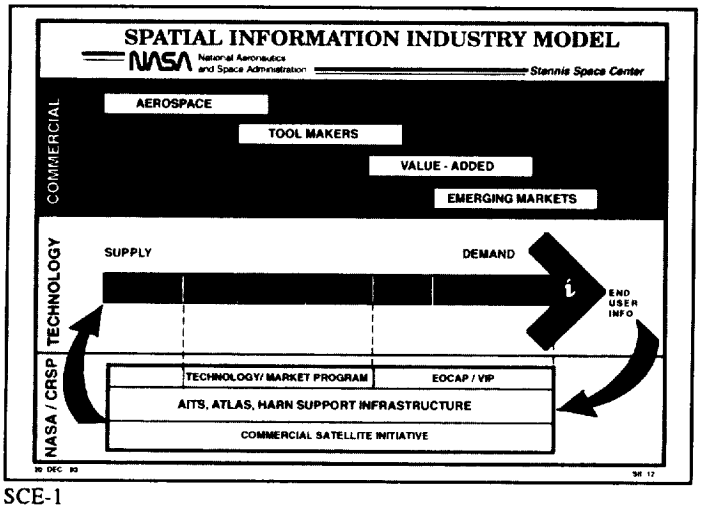
How to Succeed in Space Technology Business - Making Dollars and $ense

Ronald J. Birk
Commercial Remote Sensing Program
Sverdrup Technology, Inc.
Stennis Space Center

Rick Hauck
President & CEO
International Technology Underwriters

Randy Hoffman
President & CEO
Magellan Systems Corp.

RONALD BIRK: This presentation addresses the businesses, companies, and applications that remote sensing can serve and the opportunities in a market served by spaceborne and airborne remote sensing assets. The policy recently released by the White House represents a major milestone in the way things are changing and the way opportunities are unveiling themselves. The previous policy limited the resolution that was allowed from a commercial sector offering. The change in this restriction is a major component in fostering a viable remote sensing or spatial information industry. In addition, the policy has relevancy to major initiatives such as the National Information Infrastructure (Fig. SCE-1). These policy changes provide opportunities for defense conversion and optimization of U.S. investments in research and development in this area. Of specific interest from an industry standpoint is the potential of building remote sensing and spatial information into a $15-billion-a-year industry by the year 2000, increasing from the present $1-billion-a-year industry in only six years. Such a goal presents tremendous challenges, but ones that may be overcome by those wanting to realize the benefits of a $14 billion net difference.



SCE-1

Of specific interest from an industry standpoint is the potential of building remote sensing and spatial information into a $15-billion-a-year industry by the year 2000, increasing from the present $1-billion-a-year industry in only six years.

Spatial information is valuable to a myriad of applications. A model of the evolving spatial information industry consists of many different elements, including everything from infrastructure and sensor systems to transfer and handling (which can be referred to as communications), processing and archiving (which have their own set of technologies), analysis, and applications. This model illustrates the fact that no element exists in and of itself as a commercially viable offering. Every element has to have a supply and demand factor, and the ultimate demand has to come from the end-user community needing information. Overall this end-user community is not interested in technology, as community representatives reported very emphatically in a workshop conducted in Denver in early March. John Arvick of Monsanto and Jacqueline Crenca of CH2M Hill both stood up and made it very clear that they were willing to spend money on products, processing, and services that would make their companies more efficient and viable. Both were interested in realizing a greater bottom-line net profit, but they were not interested in the technology behind such advances. We are proud to have developed the technology to be the premier eminence in the world in remote sensing and spatial information, but the commercial sector is not interested in that pride unless it helps them realize a bottom-line profit.

Various existing industries, such as aerospace industry tool makers (computer suppliers), software Global

PRECEDING PAGE BLANK NOT FILMED

PAGE 12 INTENTIONALLY BLANK

Positioning System suppliers, and the value-added industry (the people who take the tools and data, turn them into information, and then sell the information to the emerging markets), are the components that make up the emerging spatial information industry worth approximately $15 billion. A recent OTA report stated that the government currently spends $3 billion on spatial information for the United States and another $4 billion for information on a global basis. Thus the construct that the industry could be worth up to $15 billion has some foundation in that the U.S. is currently spending $7 billion dollars for that spatial information in addition to what is being spent by the commercial sector.

Survey costs using remotely sensed data and geographic information systems technology were approximately one-third of the costs incurred using traditional survey groups.

The Commercial Remote Sensing Program at Stennis Space Center works with emerging-market companies using remotely sensed data in their everyday business dealings. One such company is Nesbit Environmental, a small company in Louisiana that sees an opportunity to provide information that leads environmental companies to the location of abandoned barges. Nesbit has determined that such operations are completed more efficiently by using remotely sensed data.

Pacific Bell, one of the baby Bells in California, is a fairly substantial company. Pacific Bell is extremely active in the National Information Infrastructure and test bed activities. The company is using remote sensing to perform some of its day-to-day change detection operation work, to see where the company should invest its assets, and to produce more accurate locational base maps to reduce the cost of supervised digging operations around cables. Such improvements are worth a substantial amount of money to Pacific Bell.

Community Coffee is a relatively small coffee producer in the New Orleans area. The company uses a particular South American bean in their blend. Given that the company's office is in New Orleans, Community has difficulty assessing the viability and the value of the coffee bean crops for a given year. Commodities in the agricultural community are distributed based on the somewhat subjective projections of the farmers. Therefore, companies like Community Coffee that have a vested interest in a particular bean to maintain their product need another source of information to determine the true status of the crops.

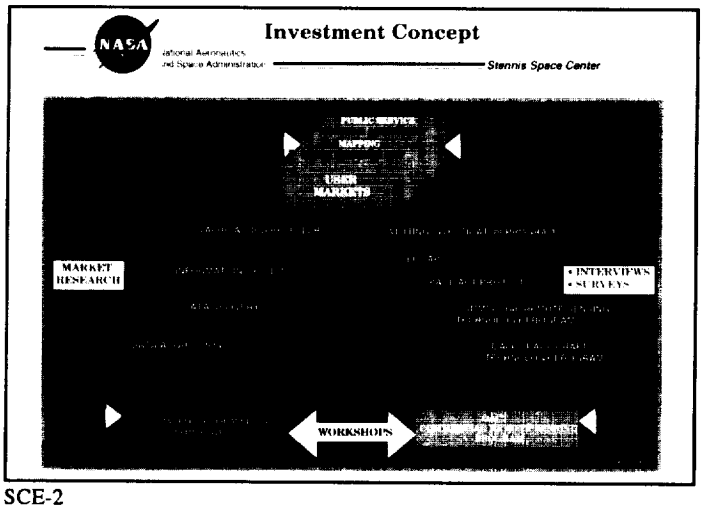
These examples indicate the breadth and depth of the different kinds of applications that space-based technology and remote sensing can serve. Two broader examples are the Getty Conservation Institute and Bechtel, whose projects represent opportunities to build huge markets. The Getty Conservation Institute is responsible for 357 cultural heritage sites around the world. Monitoring the health and status of these sites from an office in California is quite difficult. Getty, like most businesses, has a limited funding profile and is not able to send people regularly to each site to determine its status. When somebody reports a problem to Getty, such as an urban development encroaching upon a cultural site or a negative environmental effect from some activity, Getty still cannot afford to send personnel to the site until the event is confirmed two or three times. Despite the fact that Getty is responsible for these 357 sites, the company has very little ability to monitor events on a timely enough basis to affect saving the area. Getty is demonstrating remote sensing's viability towards such worldwide applications.

Another major market-building opportunity is found in Bechtel, an engineering firm. Bechtel's does business all around the world and has approximately $8 billion a year in revenue and 30,000 employees. Bechtel needs base maps for all the areas in which it is working or developing facilities, but many areas in the world do not have accurate maps, necessitating manual surveys. In one instance, a least-cost corridor analysis was performed using remote sensing and then compared to the traditional survey group methods. Survey costs using remotely sensed data and geographic information systems technology were approximately one-third of the costs incurred using traditional survey groups.

Many challenges and opportunities exist in the application of spatial information technologies. Continued policy efforts are needed to make these opportunities come to fruition. The recently released policy is extremely positive, but unaddressed policies still allow the government sector to compete with the private sector. Such policies reduce the private sector's incentives to grow and take risks to meet market demand.

Definition of standards and calibration is also seen as a major effort to overcome. In the government sector, specifications are fairly well defined for aerospace companies to bid on defense contracts. Objectives are detailed so that companies can submit appropriate proposals in response to a contract opportunity. In the commercial sector, no collection of requirements or specifications exists to allow such detailed proposal requests and achieve similar standards. User acceptance must be

developed and distribution and communication channels must be opened, as the National Information Infrastructure is doing. Acquisition technology is improving to provide higher spatial and spectral resolution data, but a slump occurs in the industry curve. The aerospace community is strong and has a large market; the community can grow on and utilize these data sources. The weakest link in the emerging spatial information industry is the middle area that accepts the data and user-driven demands, puts them together, and forms products to make a continuous change or flow through the process (Fig. SCE-2).



SCE-2

RICK HAUCK: When I transitioned from the NASA and military environments into insurance, one thing that I was assured by my mentor was that insurance is not rocket science, and in fact it's not. The objectives are very simple — to provide a service to the space industry and in so doing attempting to make a modest profit. One thing that most of you are very well aware of is that the truism of the ***cost of risk is absolute***. There will be a failure, there will be losses, it is a question of how ***you*** try to cope with the financial implications of the potential losses, how you attempt to moderate them or how you attempt to transfer them. Insurance provides a means of making that risk financially more predictable, to cut out the high points or if you look at the bottom line, the red points or the low points, and it can help you avoid the impact of some catastrophic failures. I'll focus my remarks on insuring the launch and operation of satellites.

There are very few if any commercial ventures that do not feel the need to insure that risk of financial loss. How can ***you*** deal with it? Well, those of you that have been in the business and those of you who have had to cope with it, you probably have a risk manager who will help you make some decisions. You can avoid the risk by deciding not enter that side of the business. You can avoid unproven technology. If you want to reduce it, you can add redundant systems, but it's at a cost to you. You can also increase your quality control, that's also at a cost to you. There are obviously financial tradeoffs. You can transfer it, transfer it to us, the insurance industry or you can retain it. You can take the risk that you'll be right the next time and that you won't have to pay the loss and therefore will save the cost of that premium. All of these methods are part of what should be a very well considered risk allocation program which should be at the very heart of the manner in which you set up your business plan.

I'll touch on a few classes of space insurance coverage that are available: physical or property damage, loss of property either on the ground, in flight or on orbit. Included in that would be loss of use, loss of revenue stream as a loss of that revenue producing product that you have in orbit, or extra expenses resulting from putting in place additional equipment to compensate for the loss of property. Perhaps the need to set up new ground stations or find alternative means of providing the service which you are offering. On the liability side, losses arising from exposure under torts or contracts, third party liability: your product somehow damages an individual, or another going concern and you are at risk to pay those damages and, of course, product liability. There is also insurance available for financial loss caused either by "force majeure" (unforeseeable loss) or political risk. In the latter case a business that depends upon continuing funding from the government insures against the risk that government policy or funding changes and the basis for that business disappears.

Who are the players? Of course, it's you the insured, you who need to transfer some of that risk. As I've already mentioned I would hope that you would have a focused risk manager that would develop that risk allocation program. In the space business, it is a brokered business and a good space insurance broker can pay great dividends to you. They will pair you up with those of us that offer the insurance, the underwriters. We assess the risk. We don't set the rates unilaterally, of course it is a competitive business. We develop terms and conditions with you the insured through the broker and negotiate premium rates. Every one of the launch and/or on orbit policies is a manuscript. Every major portion of the terms and conditions are negotiated with you and in the ultimate where your coverage is provide by a pool of insurers, you will have a coverage that

reflects those negotiations in the market place, terms, conditions, and rates. And of course, we lay off, spread that risk to our reinsurers as much as we can to make the potential catastrophic loss as acceptable as possible.

I'll talk specifically about some of the coverages that INTEC offers, of course those ones that I'm most familiar with.

Satellite Launch plus initial operations. You launch the satellite, you want it to be operating on orbit. We will ensure the successful launch and the operations through full checkout. Coverage will last probably 90 to 365 days. It will take you through an eclipse period when you want to check out all of your battery systems, power generation systems and of course check out all of the electronic components.

Satellite on-orbit performance. This is a life insurance policy, once the satellite is up and operating and accepted by the customer, usually placed on a year by year basis.

Tom Velez referred to the high cost of insurance. There is no question about that. We would like to see the cost of insurance go down as well, because there would be a trend towards more reliable assets. I'll take a typical satellite launched on a dedicated launch vehicle, it could be any one of a number of satellites on an Atlas Centaur or on an Ariane. That launch and satellite probably cost $200 million. It will cost between $36 and $40 million to cover the risk of loss through checkout of the satellite on orbit. That's 16% to 20%. That's a hell of a lot of money. A typical life insurance policy for a $150 million satellite at about 2% a year $3 million, $30 million over a ten year life. Thus you are paying $70 million for insurance over a satellite's life time. That is a horrendous amount of money. What's the experience been over the last decade or so? I'll call the immature phase of space insurance back in the early '80's, when you could get a launch and initial operations coverage for about 8%. '84,'85,'86 you see that tremendous increase? That's when everything in the expendable launch vehicle inventory was exploding, including the Challenger accident there in 1986. Although there was very little insurance involved in that, it also decreased the confidence that the reinsures had in the world of space technology. You see those rates have settled out (and again this is for a typical Atlas Centaur, Ariane, plus its satellite) settled out to the 16% to 21% range in recent years.

On orbit or life insurance, I mentioned, cost around 2%. You can see the history of the rates for that class of business. That was a sympathetic rise in 1985, not because of any on-orbit failure experience, but just because the space industry had brought so many failures to the insurance industry. They needed to try to recoup some of their losses in all of the classes of business and again now they've settled out at about one and a half to two and a half percent for the typical coverage.

What's the availability of insurance for proven hardware? For property insurance, a typical two satellite Ariane launch will now demand almost $400 million in coverage. You can get that, you probably pay the high end of that range, 16% to 21%. The Ariane failure that occurred in January was the biggest loss ever in the space insurance business. It was a $360 million loss. For life on orbit insurance, not quite as much is available, about $250 million, and available at the rate we've talked about, assuming a satisfactory health report.

In the last thirty years, reliability has not changed in launch vehicles in the aggregate in the macro sense.

Third party liability insurance is required by the Department of Transportation (DoT) for commercial launches and also by NASA for some of their launches. Coverage of $200 million is typically required for a DoT licensed "large" launch and is rated at around 0.1%. For launches which use government facilities where there is a risk of damaging government facilities, the government requires that insurance be placed to cover such risk. This coverage is typically rated at 1.0% of insured value.

I acknowledge that insurance is a very expensive part of your business, and it's scaled relative to the costs of your hardware. If you can bring down the cost of the hardware, if you can bring down the cost of the launch, you will bring down the cost of your insurance. How else can you do it? You can have deductibles written into your policy. For a communications company that has 20 transponders on their satellite, the designed redundancy may permit a two or three transponder deductible for example. You could ask for coverage for total loss only: you can suffer incremental losses of your capability, but only when you suffer more than a critical level of loss is there is a loss declared, that is a total loss. Rates for that would be slightly lower. Increase launch vehicle and satellite reliability. I was amazed to see a study done by NASA recently on all of the launches—military and commercial—starting in 1964. You plot on the ordinate the number of launches one by one and on the abscissa the number of failures and you can draw a straight line through it. There is no problem drawing a

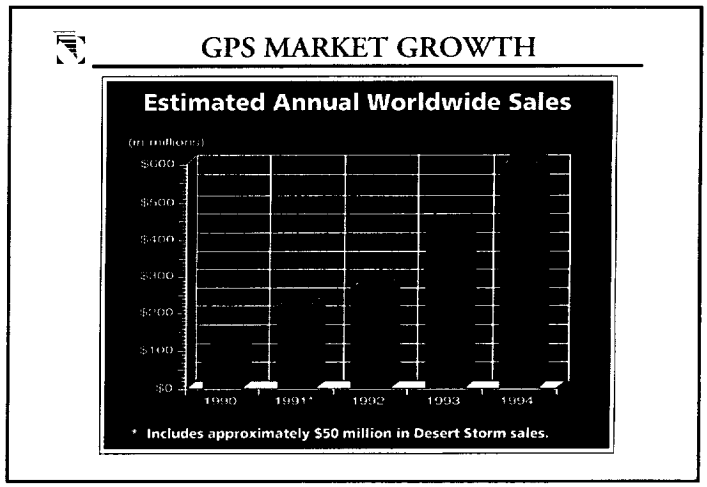
straight line through it, what does it tell you? In the last thirty years, reliability has not changed in launch vehicles in the aggregate in the macro sense. Decrease market rate volatility. When you need insurance, you probably need it within the next six months to a year. You are at the mercy of the market forces that prevail at that time, and because we are not actuarial business we respond to market conditions. It's sort of Russian roulette that maybe rates will be up at the time that you need coverage. If you're lucky, rates will be down, but that's more uncertainty than you want to have in your business. How can we help that? It's really a case of trying to get more risk into our business, to spread the risks even more. We were very please several years ago, when the U.S. Navy contracted with Hughes to launch the UHF Follow On program of ten satellites. It was a delivery-on-orbit-program and therefore Hughes retained the risk of loss up until the point where they point where they turned the satellite over to the Navy, so that risk did come to the insurance market. That's ten more satellites that help spread the premiums around to decrease volatility. One point of that, the first launch of UHF1 was destroyed, or it wasn't destroyed, it got to a unusable orbit and so that was a total loss to the insurance industry which was unfortunate, because that was they most expensive of the ten UHF Follow Ons. All of the nonrecurring costs for that program were lumped into the value of that satellite. So in effect, the insurance industry paid for the nonrecurring costs for developing UHF Follow On. No, we can't stay in the business if we do that for a number of programs, but here is a case where it really worked out for the U.S. government to have acquired, or to have procured their satellites in that manner. We recognize there are a number of other factors that go into it, but we encourage other government agencies to look at that method of procuring satellites. It will have a benefit to the insurance industry and therefore to you. One fact before I sit down. Launch and initial operations premiums collected by the insurance industry 1991 and subsequently to current day: $1.3 billion collected in premium for a net loss of $85 million. So recently, we have not been making money in the launch business. We look as do you for ways to make insurance a smaller percentage of your costs.

"The GPS industry is one in which the United States is the acknowledged world leader. By the end of this decade, as many as 100,000 Americans will be working in what will be a $5 billion industry."

RANDY HOFFMAN: It's a real pleasure to be able to share with you some perspectives on the commercial development of a dual use technology. This amazing technology is GPS. It's creating a navigation and positioning revolution and will be a key player in the ongoing wireless communication revolution that we are experiencing today. The commercial expectations of GPS are high as evidenced by the comments that Ron Brown, our U.S. Secretary of Commerce, made last August. He said, "The GPS industry is one in which the United States is the acknowledged world leader. By the end of this decade, as many as 100,000 Americans will be working in what will be a $5 billion industry."

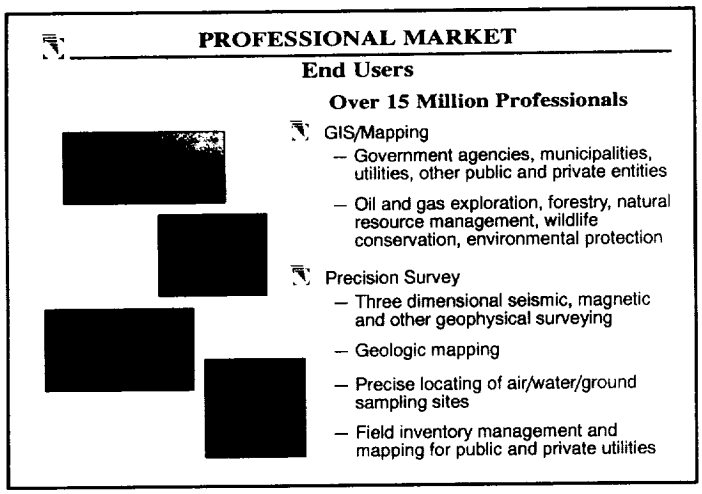
Briefly, GPS is a world wide positioning and navigation system that's been funded by the U.S. government to a tune of about $10 billion. It's a twenty-four satellite constellation which was initially a military and national defense system that was opened up for commercial use in the early '80's. This access has created a number of rapidly developing commercial markets.

The GPS industry is really made up of a number of application-specific market segments. One of the newest market segments, and this is a result of the price coming down in the technology, is something that we call outdoor recreation, it's hunters, hikers, backpackers, freshwater fishermen. You can see from the market potential slide here (Fig. SCE-3), that the number of participants in these outdoor activities is significant. So, the companies in GPS have a lot of work to do to tap into these literally tens of millions of potential consumers. Prod ucts or devices such as what you see up on the screen

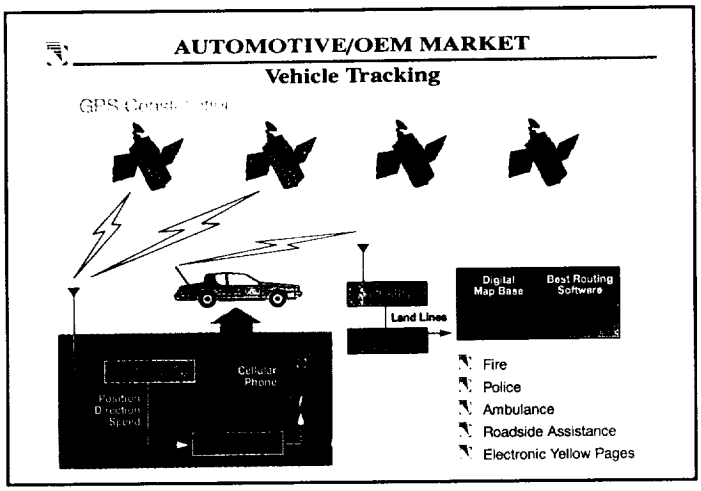


SCE-3

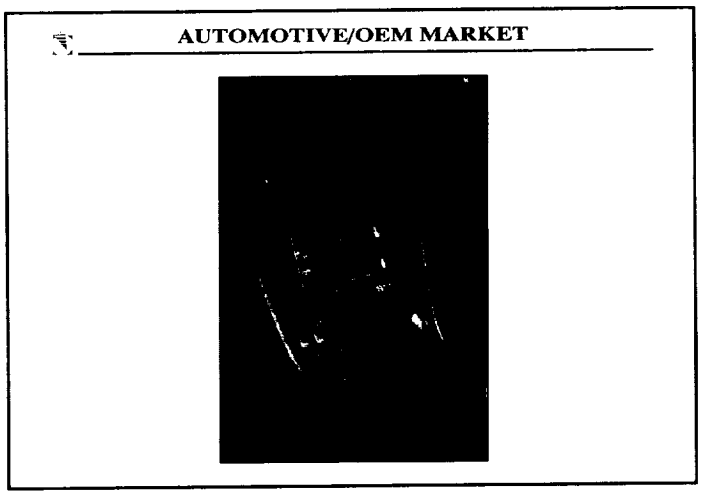
are being offered today in sporting goods stores, for under $500 (Fig. SCE-4). These products can be found



SCE-4



SCE-5



SCE-6

in your traditional sporting goods stores, such as L.L. Bean, Bass-Pro, Cabalas, Gander Mountain, and soon to be K-Mart, Walmart. You name the sporting goods channel and it's there. If you take a close look at the screen, it is not telling the user latitude-longitude, it's telling him relative position, meaning the device knows where it is and now how do I get to where I want to go? My tree stand, my camp, my truck, whatever the case may be. So, it's graphics that really are driving the recreation market, as they are many other markets.

The marine market was really the first sizeable consumer market that GPS was targeted at. It started back in May of 1989. In May of '89, there was only six hours of satellite coverage. Now, if you could imagine being a GPS company and trying to get a consumer to buy a product that costs about $3,000 that he can only use six hours a day — a very, very tough sell. Now, with full coverage, there are almost 200,000 boaters that are using portable devices like you see here in the high seas and of course this devices can also be mounted.

Probably the largest market for GPS is vehicles. There are really two applications. One is vehicle tracking (Fig. SCE-5). There are about 100 million commercial vehicles world wide. The other application is car vehicle navigation. The vehicle tracking market has really been the first to take hold because of the uses of it. Basically, vehicle tracking is: I own a fleet of vehicles and I want to know where each one is at all times. Typically — in the simplest form — you marry GPS with a low cost communications link such as cellular and report the position back to the home base! You see this used in emergency vehicles as well Brinks trucks.

The next application, which is running a little bit behind in terms of its adoption but will be here in full force, is car vehicle navigation (Fig. SCE-6). That means the user, or the driver of the car, wants to get from point A to point B. There are about 300 million personal automobiles in the world today so they represent a huge opportunity. Some of the configurations that you see are an after market system which is installed in a car already on the road. This happens to be a Toshiba system. They originally started selling for about $5,000 three or four years ago. They are down to around $2500 today. Also, there is the factory installed system and both the after market and factory installed system have been selling in Japan for over about three years now. There are about 500,000 of these systems in Japan, and they are coming to the U.S. this year. Some of you may have read the Oldsmobile announcement that in California they will soon be offering the Olds '88 with $2000 option for car vehicle navigation. The Sony corporation has indicated that they will be introducing a car naviga-

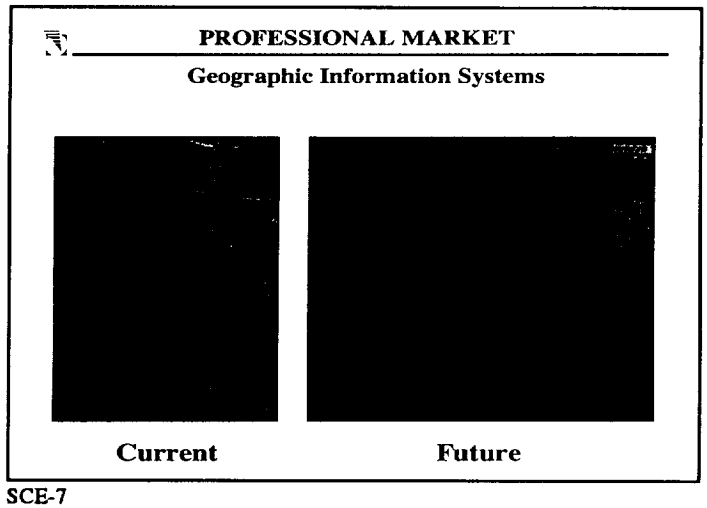
tion system into the U.S. market in 1994 for around a $2000 price. Now, these systems get their GPS data from receivers such as these, basically they are modules, an OEM market in this particular application and this happens to be a Magellan ten channel receiver. To give you an idea of the kind of focus that GPS is getting from the Clinton administration, Ron Brown, our U.S. Secretary of Commerce, visited Magellan last August. He was there to preside over a signing ceremony that commemorated an agreement between Magellan and three large Japanese companies — Toyota, Toshiba and Nissan — to develop and supply a ten channel GPS receiver specifically for car vehicle navigation. This particular deal could be worth $100 million over the next five years for Magellan alone.

Another market for GPS is the professional market, and really the professional market is composed of a lot of vertical markets. Vertical markets such as geographic information systems — you're seeing GPS being married with GIS software packages and 486 computers for cost efficient data collection. You can see the way that most municipalities under the current method store their city infrastructure and its moving to the way on the right (Fig. SCE-7). Another application is precision survey. This is typically done in differential mode on a real time or post processing basis. You can achieve accuracies down to a centimeter and actually down to millimeters in some applications. Another professional application is land and resource management, that is catching on in a big way and is tied in a lot with remote sensing.

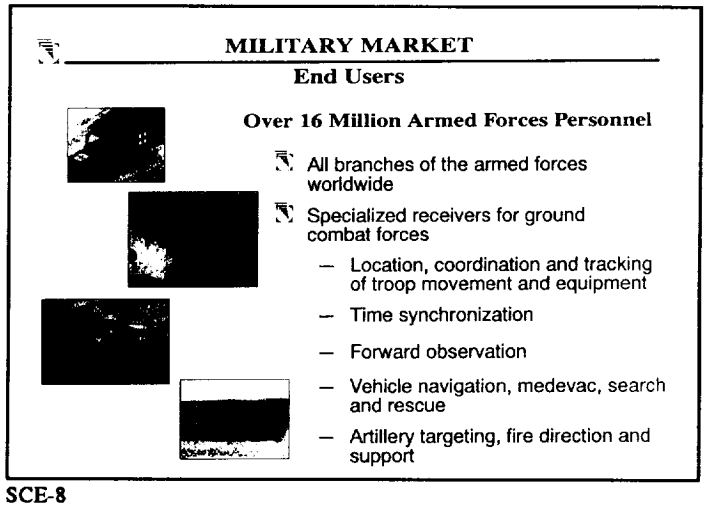
A group that has quickly embraced GPS is general aviation. There are about one million active pilots and 400,000 airplanes around the world, on any given day and what you see are several configurations in the general aviation market. You see a panelmount capability, panelmount GPS receivers in the general aviation segment (we're not talking commercial here) but anywhere from about $1,600 up to about $5,000 for those that are TSO'ed. The most popular configuration in general aviation happens to be the portable moving map products. They can be strapped to the yoke and then taken out of the plane so that the pilot can do pre-flight planning at home. This, from a volume standpoint, is significantly greater than the panelmount markets.

A large market for GPS is of course the military, both from a commercial and a defense contractor basis (Fig SCE-8). GPS receivers built on a nondevelopmental item basis or NDI, as the term is used, by commercial companies played a major role in Operation Desert Storm; Trimble Navigation and Magellan supplied it over 10,000 portable receivers for the conflict. The favorite configuration in most of the military applications is one that is portable but also can be easily mounted to a vehicle.

Now, with all this market potential, it's safe to say that GPS is very, very dynamic and having been in this market for seven years, I can certainly attest to that. Growth has been very strong. We have seen it go from $100 million to about $600 million in '94, and it is being driven by two things. First, the availability of satellites. Back in 1990, we had about eight to twelve



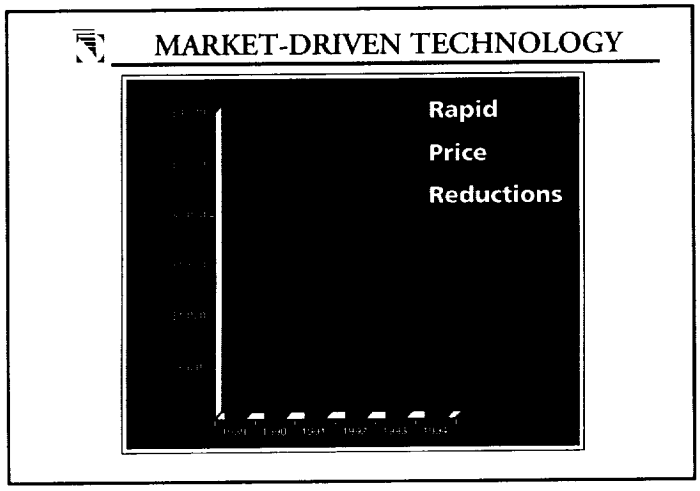
SCE-7



SCE-8

hours of coverage during a 24-hour period which restricted the market demand. Now in 1993 we have 24-hour, three-dimensional coverage on demand. Another major driving force for the market has been the decline of prices. In May of 1989, Magellan was selling marine GPS receivers for about $3000. Today, you can get a product that is smaller, lighter and has more capability for about $450, and if you were to plot this against the price declines of VCRs, personal computers and cellular

phones, you would find the decline in prices of GPS is happening much faster than these other markets (Fig. SCE-9). In fact, a ten channel GPS receiver for OEM purposes today is significantly below $200.



SCE-9

Adding to the dynamics, are a number of industry participants. Over the last two years in particular, we've seen the number of GPS products double from about 160 to over 300, and that certainly is going to continue. GPS companies come in all sizes and shapes, like stand-alone companies such as Astech, Magellan, or Trimble. We also have divisions of Fortune 500 companies such as Rockwell, Litton, Motorola and Interstate and of course we have a whole bunch of foreign manufactures from many different companies. You see companies from Japan, France and Taiwan — all are very fierce competitors. Because GPS is a dual use technology, there has been a real need to balance the commercial needs off with the defense needs, and so the U.S. industry has come together in an industry council to provide technical assistance to U.S. government policy makers. We've also seen a number of affiliated members, people or associations that use GPS, as well as governmental agencies that have a role in it.

To summarize, well GPS is a $10 billion system. It's a shining example of true dual use technology in which the commercial markets far exceed the defense markets. It is also one in the which the U.S. has been recognized as the world leader and is a technology that will participate in the wireless revolution through the integration into a variety of other technologies, applications and devices such as notebooks and communication devices. I think its very safe to say GPS is going to become a part of our daily lives.

Q&A Session

THERESA FOLEY: I think it's kind of interesting to listen to the examples that the panelists sighted of government financed technology that has been successfully commercialized or has potential to do so. I think I heard Clementine mentioned, other SDI technology and GPS. So, my question is why is it just a coincidence that all of the stuff is Defense Department technology? How come nobody mentioned anything that comes from the civil space program as being a shining example? Is there a message there?

BIRK: One of the NASA-provided technologies that has very broad commercial acceptance is digital image processing. I realize that many other agencies have worked towards that development. Digital image processing is being inducted into the Hall of Fame this week and a particular software package, ELAS, was inducted into the Hall of Fame last year. The technology to process digital imagery has spread to the medical and manufacturing communities as well as environmental monitoring facilities management and other types of communities using remotely sensed data.

GPS is a $10 billion system. It's a shining example of true dual use technology in which the commercial markets far exceed the defense markets ... I think its very safe to say GPS is going to become a part of our daily lives.

HOFFMAN: The GPS was fairly straight forward. What happened, I think it's a knowledge issue in terms of what is there, what exists, and what can I take advantage of. The U.S. government was very straight forward, they opened up GPS, they published the critical information needed to take advantage of it, and then they looked at private industry and said here it is you decide what to do with it. What happened was you say an explosion by the private sector which really we're seeing today — over 300 commercial GPS products. So, I think a lot of it has to do with just knowing that the technology is there. I know that Magellan in general has looked at a number of opportunities to commercialize technology, and it takes an awful long just to figure out

what's there and then how to go use it. GPS was a little bit different because it was so open. It was wide open.

QUESTION: If the government is going to be involved in supporting many of these space programs and the infrastructure, how do taxpayers get their investment back? I would agree that in developing new jobs and payroll for Americans certainly goes back into the pot, but for foreign companies that perhaps use GPS information to make profits on their own, it seems like the American taxpayers don't get any return on it. I'd like to discuss this as a bigger issue. If the government is going to be involved in developing the infrastructure, how do taxpayers get their investment back? If they understand that, it might help these efforts.

BIRK: That question is particularly difficult to answer. Many government investments in scientific technologies, such as global change and mission to planet Earth, are based on gaining a better understanding of the global environment. Being able to provide opportunities for U.S. companies to capitalize on these technologies is a very important aspect of the U.S. taxpayer's benefitting from the government's investment. These technologies can support and strengthen our economic base, hopefully in priority over the opportunities available to foreign governments. But space by its very nature is global, and some leakage of technology and opportunity will occur for other people to capitalize on around the world. It's very difficult to restrict the ability for other countries to gain from these investments. Hopefully, the emphasis will be on having U.S. companies and taxpayers draw the major benefits from these investments.

HOFFMAN: I think your question was a good one. Right now the Congress is thinking about what it has to do for the next GPS constellation replenishment and whether or not there needs to be a change in how we go about the procurement of that. It is a problem in the sense that it is something available to the entire world which obviously is a very nice feature, but at the same time, the U.S. tax payer is paying for that signal to be centered globally. There are suggestions for possibly putting a chip within every single GPS receiver that can be removed or blocked until you pay a fee for it. That fee would be provided to the U.S. government for example. I don't how manageable that would be from a commercial standpoint. Because there is a concern that the next constellation will cost several hundreds of millions of dollars and that the U.S. tax payers shouldn't be asked to pay for the entire system—as it will benefit the entire world—I would expect to see some sort of legislation or something within the bill that directs the Department of Defense to rethink that position and see if there is an alternative way they can do it. Clearly, it is an interesting time for GPS as it's being faced with the next procurement of satellites. There are a number of studies that are going on right now to address that question.

As you pointed out, the American tax payer is getting a significant amount of benefit in the sense that we are going to create a $5 billion year industry that in the year 2000 will create about 100,000 jobs in the United States. The companies involved in GPS are paying a significant amount of taxes. I know I write the check every quarter to Uncle Sam and my checks aren't as big as some of the other companies are. I think the key here though is what we have is an infrastructure. The United States has traditionally done this to build other infrastructures which other countries have relied upon. But I think it brings up a larger issue in that the United States GPS industry is currently the recognized technology leader. We should be put in a position to continue that leadership and I think that the proper role of the U.S. government is to ensure that we have a level playing field in the rest of the world. If we have a level playing field in these other markets where GPS is springing up, whether that's Japan or France, then we will succeed in a very big way. If we see markets blocked overseas, then I think that's where the American tax payer really takes it in the wallet.

The study I mentioned regarding putting a chip in every receiver showed that the expense of managing that program far exceeded the revenue. I guess that is a job creation issue as well, but GPS from a commercial standpoint has rapidly exceeded the expectations of anybody in the Department of Defense, to their pleasure. It now has Department of Defense national concern, as well as a real large commercial industry supporting of this kind of infrastructure.

QUESTION: How deep is the underwriter's pool? Is there sufficient coverage to protect a robust commercial space industry?

HAUCK: I think that the lesson to be learned is the one that you saw in the graph. In the mid '80's, the flight of capital away from space insurance was rather dramatic. Yes, there is sufficient capacity in there as long as there is an opportunity. No guarantee, but an opportunity to make a profit. This has not been a good business to be in recently because for the last three or four or five years we've lost money.

QUESTION: When Walmart starts selling GPS receivers, where do you see the price being? In other words, how low is that basic GPS receiver going to be in a year of so?

HOFFMAN: That's almost like trading in the commodities market, almost, you want to know where the price is going to be. I think that you will see GPS receivers in the boating market next season for about $299, but don't let that stop anyone from buying a GPS receiver today. Actually, I think the price is going to settle into the $149-$199 kind of price range. The real cost drivers of the devices themselves are no longer the actual technology it's the LCD graphic displays, the controllers, the memory, those kinds of things that bring the application specific capabilities to the product that really dictate the cost now. Just a straight GPS receiver, that doesn't have any bells or whistles or button to press on it costs less than $100 now.

Obstacles & Opportunities to Success in Technology Commercialization

William Scott
Senior National Editor
Aviation Week & Space Technology

A TIME OF CHANGE

There is no question that an end to the Cold War era has created obstacles for those who have devoted entire careers to the defense and aerospace industry. Budgets are being cut drastically, the Big Bucks government customer that kept us in business for decades is no longer interested in every clever idea we have for new weapons, aircraft and spacecraft, and we're told at every turn to change our ways of doing business or shut the doors. In the end, every executive, scientist, engineer, technician, specialist, cost analyst, mechanic, secretary, custodian, officer and enlisted person who works for an aerospace company or the U.S. military services wonders if his or her job will be the next to disappear. Even the lawyers are looking a bit concerned these days — and they thought *they* were indispensable!

But the same people that made aerospace one of the most technologically advanced businesses in the world *can* change and apply their expertise to new challenges. Of course, there are obstacles to that process, as well, and we'll look at those later.

Times of stress and turmoil, while unpleasant, can also offer new opportunities. We now have an *opportunity* to rechannel some of the tremendous expertise and technology resident in our companies, federal laboratories, weapons and spacecraft and put it to use in the commercial sector. Over the last year, we at *Aviation Week* have devoted considerable time and effort to developing new ways to facilitate that process. We instituted a new monthly section of the magazine devoted to "Technology Transfer," and we're working closely with our parent company, McGraw Hill, to develop an online database that could help industry tap the resources of federal labs.

Today, though, I'd like to look beyond tech transfer issues that Congress, the Administration and more than 700 federal labs are wresting with, and focus on nontraditional ways the space community might capitalize on its technology and expertise in this new age. There are a staggering array of opportunities for applying these resources to areas of industry and everyday life that, so far, have had little association with space. There are billions of dollars waiting out there — not just in this country, but around the world — for anybody willing to invest the time, effort and expense of developing these nontraditional markets.

NEW CHALLENGES = OPPORTUNITIES

These wealthy outlets for satellites, sophisticated sensors, launch vehicles and communications networks are all around us. But we have to take our blinders off to find them. Some of the most-obvious sectors already are benefiting from technologies that spun-off from aerospace and defense:

- Medical
- Manufacturing in general
- Retailing
- Airline
- Food processing/packaging
- Telecommunications

A lot of good tech transfer stories are coming out of these, and we'll see many more. But let's take a look at some not-so-obvious areas:

- Trucking
- Travel industry
- Railroads
- Resorts
- Ranching
- Farming
- Paper industry
- Textiles
- Recreation and Entertainment — fishing, hunting, hiking/camping, cycling, boating, skiing, flying, scuba-diving, video games, movies & television.

The same people that made aerospace one of the most technologically advanced business in the world *can* change and apply their expertise to new challenges.

Finding the space connection may not be obvious, but kick your imagination into high gear and dig below the surface just a bit. If we do a little brainstorming, we find some interesting possibilities. Let's take a couple of real down-to-earth examples: ranching and farming. How could a Texas rancher who runs a thousand cattle

make use of space-related expertise or technology? How about:

• Personal communication devices — a cellular phone/portable computer/digital video camera built into one pocket-sized box carried by every ranch hand on the spread. Here's a guy trying to figure out why several steers are dead or sick and what to do about it. With one of these Star-Trek devices, he not only can talk to the veterinarian 50 miles away, but also send video clips of the animals or surrounding plants that might be the culprit. The vet can send a data file back to the ranch hand, providing instant guidelines for things to check or step-by step- emergency treatment. Satellites, or other wide-area-network systems, provide the link.

• Tracking network — *Inexpensive* sensor systems attached to the neck of every steer and heifer automatically transmit that critter's GPS-derived position to the home facility or base camp. Presented on a graphical display of the field or pasture, icons show a rancher where all is livestock is located. Does he really care where those cattle are — at least, enough to spend money on hardware like this? Some days, maybe not. But if a blizzard is bearing down on him, knowing exactly where those cattle are can save precious time in getting extra hay to the herd, or moving it to a sheltered area before the storm strikes. That knowledge, which enables efficient action, goes straight to the rancher's bottom line if it prevents the death of 10-20% of this livestock every winter. If temperature, motion, or health-monitoring sensors are embedded in that device the steer is wearing, the rancher can tell how the herd is faring during or after the storm. That knowledge also goes beyond saving cattle. Not having to send a hired man out into a blinding snowstorm to look for, feed or car for hundreds of cattle spread over several square miles of land translates directly to a personnel safety and liability issue.

U.S. space companies have developed the best remote-sensing equipment in the world. If we're smart enough to scale it down, package it to survive out on the prairie and produce it economically, we could revolutionize U.S. agriculture, then export the same know-how.

Is there enough of a cattlemen's market out there to justify developing such devices, using technology already in our labs and on orbiting spacecraft? Well, beef is a global market, for sure. Cattle are raised in the U.S., Europe, Australia, South America, Africa, and the Far East. And beef production is a cutthroat business. If a rancher can hold his costs down, mitigate risk and improve is yield — measured as full-grown, healthy, fat cattle delivered to market — then he's interested in what you have to offer.

And, if you build these devices and the associated communications networks in a modular, easily modified architecture, that most definitely IS a huge market. A similar device mounted in every school bus in the nation might ensure the timely rescue of 20-30 kids when the bus gets stuck in a snowdrift in eastern Colorado. There are some situations where the ol' two-way bus radio may not be enough; we might like to know exactly where the vehicle is. Or consider attaching a scaled-down version of your livestock location/tracking system to a dog or cat's collar, or embed it in a bracelet each child wears to school, and you'll have every pet owner and parent in the nation paying attention — ***if its cost is reasonable.***

• Farming — it's not high-tech yet, but agriculture could benefit enormously from space systems technology. Modern tractors, combines, and planters already are outfitted with accelerometers, strain gages and microprocessors. What else could you add to make these machines more efficient? Consider those giant circular irrigation sprinklers: Is there a way, using fluid-flow modeling expertise, to redesign the nozzles and optimize water droplet size, ensuring more water reaches crop roots instead of evaporating or blowing away?

A good bit of farming involves cutting plats. How could lasers, or high-pressure-water cutters — the same ones we use to precisely trim composite materials — be used to cut weeds, wheat, corn, oats, barley, milo or other grain stalks, and do away with blades that have to be replaced or sharpened?

Any way to survey a wheat field and quickly determine if it's too green or too wet to cut? U.S. space companies have developed the best remote-sensing equipment in the world. If we're smart enough to scale it down, package it to survive out on the prairie and produce it economically, we could revolutionize U.S. agriculture, then export the same know-how. For example, mount a multi- or hyper-spectral sensor package in a drone (Burt Rutan would be glad to design and build one for you), fly it over a series of fields, run the data through a processor, and send a digital picture of each farmer's crop land to his personal computer. That snapshot shows the farmer what the moisture content is in each grid of his field; highlights areas that need another

dose of fertilizer; and alerts him that a patch of nasty bindweed is growing in one corner. That information could determine where and how much to irrigate, as well as when to spray, cultivate and plant. You build several UAVs, outfit them with space-derived systems and sell services through local farmers cooperatives. Your customers subscribe for periodic overflights and data dumps at a flat fee, and can request special flights as necessary.

Team up with the Farm Bureau and farmers' cooperatives, using their expertise to develop an end-to-end systems that will truly help their members. When you feel you understand agricultural operations and needs, approach the Case and John Deere companies. Work together to integrate your systems with their machinery and you'll both prosper while serving the farmer better.

Now your internal "Skunk Works" is on a roll. Your people are looking at far-out concepts for taking space technology down to the farm: Placing in-situ sensors in cotton fields, tuned to detect the presence of weevils while ignoring wind, dust, crickets and other distractions. Using exotic electrostatic technology to stimulate crop growth and prevent disease. Or microwaves to kill grasshoppers, cutworms, horseflies, fire ants, mosquitoes, and killer bees.

The most important thing you can do, is change some black-hole attitudes. Start breaking down the thick walls of over-classification and secrecy.

Finally, don't overlook the farmer's home-place — or your own home, for that matter — specifically the bathroom. How can aerospace technology find its way into the *bathroom* you ask? Well, Dow Chemical recently announced a new substance with minimal adhesion properties. Nothing sticks to it. They think walls coated with this stuff could cure the graffiti problem in cities. Let's take a hard look at processes for non-stick coatings we use in spacecraft or sensor production. If you find a way to treat a bathroom sink or shower wall, and guarantee that the treated surface will require little or no cleaning, you'll be the next recipient of the Housekeeper's Nobel Prize. If you can bottle the stuff and sell it in grocery stores for $4.99, you just might make enough to finance new experimental satellite ventures.

GOVERNMENT — OBSTACLE OR PARTNER?

Those of you from government agencies and the uniformed services have a vested interest in the commercial success of these companies, as well. After all, you've been **the** customer for satellite and launcher companies, and they've met the challenges you gave them. If these companies go out of business, you have fewer options — or, someday, maybe no options — for developing and orbiting advanced milsats, comsats, and earth observation systems. So, preserving the nation's space industrial base is vital to government interests.

The sooner our industry decides its future lies in the commercial world, not in lobbying congress or the Pentagon, the healthier the entire industry will be.

How can you help do that? Several ways: within budget constraints, you can support projects that demonstrate real potential for dual-use applications. Encourage modular construction from basic building blocks as opposed to custom designs. Adopt standard bus architectures. Be proactive in pushing materials and resources between military and commercial projects.

The most important thing you can do, though, is change some black-hole attitudes. Start breaking down the thick walls of over-classification and secrecy. Yes, there are projects and capabilities that have to be protected, but the pendulum has swung way to far into the black world. And it's hurting us on the economic front. Industry needs technology that's locked behind those black doors, and needs it *now*. There are two camps in the black world — proponents of carefully transferring technology to the outside, and those that say "Never." Unfortunately for the U.S. economy, the latter are still in control. And they are the ostriches that will protect every aspect of their silver bullets, even as the industry that created those bullets shrivels and dies. Let industry leverage the technologies of electrostatics, sensors, communications, software and the results of your medical research. The nation can use it to great commercial advantage, just as you have for national defense purposes.

Other government related obstacles to technology commercialization include liability laws and congressional pork. We can no longer afford either. Industry absolutely must have reasonable protection from onerous, frivolous lawsuits that sap financial strength and

inhibit risk-taking. Where would the computer industry be today if it was hobbled by the same liability threats that killed general aviation in this country? Without preemptive action, trial lawyers and their attorney buddies in Congress will destroy technology transfer and maybe commercial space before either gets out of the starting blocks. We can't let that happen.

Congressmen, the nation can no longer afford to let each of you take hugh chunks of bacon home to your districts. You, too, need to assume a new sense of responsibility if defense and aerospace technologies are to become winners in a commercial environment. Learn to just say NO to constituents that insist you throw a few government bones their way. The sooner our industry decides its future lies in the commercial world, not in lobbying congress or the Pentagon, the healthier the entire industry will be.

Nothing so effectively kills a nascent corporate culture of creative thinking and individual empowerment than a timid, no-risk, low-budget approach to new business ventures.

COMMERCIAL OBSTACLES

To prosper in today's economy, aerospace companies have no choice but to change and do it quickly. Some actions we must take:

- Up-end the stale, conformist, hierarchial organization of the typical defense/aerospace company.
- Tap the imagination and creativity of our people. Change our cultures to encourage innovation and a commitment to cost-effective, quality approaches to every daily activity.
- Restructure our systems of incentives and rewards to meet these goals. Reward our people for their ideas up-front. Don't wait until the ideas become a new product or business. Intel Crop. immediately pays its employees for ideas that look promising, whether they actually pay off later or not. Result? Intel people come up with a lot of new ideas. And the company stays ahead of the pack in developing microprocessors, one of the most competitive businesses on Earth.
- Give our staffs the time and freedom to think. Discard useless paperwork and "production output" matrices. Instead, encourage new-idea generation.
- Look for ways to adapt our existing technologies or expertise to new applications. Send your scientists and engineers out to learn about other industries. Let them ride the highways in a tractor-trailer 18-wheeler for a few days. Spend some time with a rancher, farmer, road construction worker, railroad engineer, and nurse. Northrop and the Air Force sent engineers to North Dakota in the winter to see how flightline troops maintain bombers. What they learned resulted in very practical changes to the B-2 bomber design. Your people will bring back the same practical understanding of real-world trucking, farming, etc. Of course, checking out the travel, resort, and recreation possibilities might require the expertise of top managers and chief engineers, I suppose! You never know what terrific applications for high data-rate burst communications you'll find in Aspen or Vail!

The sooner our industry decides its future lies in the commercial world — not in lobbying congress or the Pentagon — the healthier the entire industry will be.

- Be willing to risk. Nothing so effectively kills a nascent corporate culture of creative thinking and individual empowerment than a timid, no-risk, low-budget approach to new business ventures. If the mahogany-row chicken-littles, lawyers and chief financial officers have the final vote on bold initiatives, you might as well close the doors and retire now. There's no such thing as a sure-deal when changing from a single-customer, meet-the-spec-and-get-paid, cost-plus environment to the rough-and-tumble, run-faster-than-the-other-guy world of aerospace we compete in now.

GOOD LUCK!

Q&A Session

QUESTION: What are the mechanics? How do they get out? You say we should get people out of industry out into other areas. How do you do that?

MR. SCOTT: I think we just have to pick an area that we think might have potential and start talking to people in that industry. As Dr. Mary Good, Undersecretary of Commerce for Technology, has said time and again, we have heard it over and over. Tech transfer right now anyway is still a contact sport. You have to get out, talk to these people. It is a very uncomfortable thing for us to do. We are much more comfortable talking to each other because we all talk the same language, but new

markets really aren't developed that way.

QUESTION: In this market that we see here today obviously there's no customers, no products and that's the philosophy most of the commercialization would like to take. However, what do think in terms of an overall percentage investment into initiative, should go into identifying with the customer, generating the requirements of the very bottom line, and then propagating that back into your product?

MR. SCOTT: I don't have an answer on what the percentage should be. I've seen a number of targets different companies are using some that probably are proprietary. It is an individual decision, because you will have to weigh the corporate culture in terms of what risks you are willing to take how much under the gun are you? Probably when times are gone, it's easier to devote those resources, but typically we don't during that time. Typically we are to worried about getting the product out the door in one form or another. There is no easy answer to that. I think you have to stay right at home. I think you have to decide those things inside.

NASA's Commercial Technology Mission — A New Way of Doing Business: Policy & Practices

Gregory M. Reck
Acting Associate Administrator
Office of Advanced Concepts & Technology
NASA Headquarters

Syed Z. Shariq, Ph.D.
Director, Office of Commercial Technology
NASA/Ames Research Center and
Deputy Chair of NASA Commercial
Technology Management Team.

Gregory M. Reck, NASA acting associate administrator for the Office of Advanced Concepts and Technology chaired the Space Commerce '94 session on NASA's Commercial Technology Mission - A New Way of Doing Business: Policy and Practices. What follows is a summary of Reck's opening comments.

Reck told the audience that NASA was merging the Office of Space Development with the Office of Advanced Concepts and Technology. The merger actually began six months ago and the proposed NASA Fiscal Year 1995 budget reflected the merger.

Post-Cold War changes around the world have impacted "every aspect of what we do." Every new project has to be evaluated on how it impacts the global economy - not only scientifically but economically. NASA needs to evaluate those impacts as the agency structures research and development programs and that NASA officials aren't sure how evaluations will be handled.

The Clinton Administration has changed his office's framework and priorities - changes reflected in the Fiscal Year 1995 and 1996 budget process. He sees a shift in priorities from defense missions to civil missions. "We can anticipate a balancing in the budget from a disproportionate share towards the defense mission objectives toward more of a 50-50 balance with the civil agency programs."

The future of technology programs in an era of diminishing budgets may depend on dual use applications. "Virtually every new initiative we put forward - even as a proposal at this point - is immediately queried by the perspective industry. Will industry support this? Is this the kind of program they are going to find useful?" Customer service and customer satisfaction are now major concerns in NASA.

The federal government "is going to have to figure out new ways to work with state and local governments." NASA looks for more local resource involvement and the participation of local economic development organizations which seek "opportunities transferring our technology, using our technology and moving it into a broader spectrum of applications."

NASA is actively working with the defense community to identify space technology in all defense agencies. This is "very helpful in looking into and identifying where the federal investment and R&D is going."

National laboratories - energy labs and even NASA labs - are struggling and being re-evaluated for strengths, weaknesses and core capabilities. Research universities face new challenges as NASA curtails funds for those activities and seeks new ways of supporting universities. "We are going to have to look for other ways and other means of assuring that we have a continuing flow of skill and talent into our programs in the future."

The Civilian Industrial Technology subcommittee of the White House Office of Science and Technology Policy is concerned about the space communications industry, specifically the part space-based assets play in future information infrastructure and communications structure. The subcommittee is interested in dual-use programs, tech reinvestment programs and manufacturing activities. The subcommittees are going to have an increased role in both oversight and coordination of new budget cycles and new budget initiatives of agencies like NASA. This involvement will focus on how federal research and technology dollars are impacting the economy and other priorities identified by the Clinton Administration.

NASA's recently released National Performance Review contained five or six recommendations. One principal recommendation dealt with technology transfer and contained "a number of very specific recommendations." Action plans have been developed and NASA is pursuing those recommendations. One of those, based on earlier comments from the Clinton Administration, directs NASA and other federal agencies to devote 10 to 20 percent of their research and development efforts to partnership with industry. One change will involve providing NASA research centers more flexibility in dealing with technology transfer and commercialization

PRECEDING PAGE BLANK NOT FILMED

PAGE 28 INTENTIONALLY BLANK

activities.

NASA's vision is to pioneer, with industry, the development and use of space technologies to secure national economic competitiveness and to support space missions. The agency also is working towards national economic competitiveness, including technology transfer. Technologies that could benefit from this new policy include space communications, expendable launch vehicles, and emerging or growth industries such as earth remote sensing and microgravity materials processing biotechnologies. "The mission is to stimulate the development and transfer of space technology to promote the creation of new knowledge in support of NASA mission jobs, products and industries in support of the commercial and economic goals."

Our challenge at NASA is to identify commercial applications of new and existing technologies and the industrial partners needed to bring these technologies to the marketplace.

NASA has three objectives: to develop new and innovative space technology to improve the performance and lower the cost of future space missions; to enhance established and growth commercial space industries by proactively developing, demonstrating and transferring NASA technology to aerospace and non-aerospace customers; and to develop technology to revitalize access to space.

In line with these objectives, the NASA Technology Investment Act of 1994, recently introduced in the Senate, will strengthen the link between NASA's aeronautical and space programs leading to jobs for Americans and economic growth. The highly successful Space Hab missions of 1993 and 1994 are good examples of how industry can work with NASA.

Another NASA program being closely reviewed is the Centers for the Commercial Development of Space. The program review focused on the commercial support each center receives and the role and extent of industry involvement. The outside review identified "centers that fell short" and weren't worth rebuilding. The Fiscal Year 1995 budget cuts funding in some CCDS programs, but it includes "about $70 million worth of new work in it."

"I think we are moving forward in other areas and I think those are going to be important to commercial applications and commercial industries that can form the core of a new commercial space business in the future."

NASA is trying to find cases where the return on the dollar is less than it should be and reinvest that money into programs it feels will be productive in the future.

Several of the topics Reck addressed in his opening statement are covered in greater detail in the following pages.

DR. SYED Z. SHARIQ: *Field Center Practices*

We at NASA are beginning to focus on the economic contributions of NASA developed technology to the national economy at large. In the past, our technology transfer efforts were primarily after the fact. The longer we looked at the process, the more apparent it became that our approach was reactive in nature. In the post cold war era, it was clear that this was not sufficient. So, in November of 1993, we pulled together a group of people from the across the agency to form the NASA Commercial Technology Management Team (NCTMT). What follows is a summary of the accomplishments and goals of this team as well as a list of those involved and what we are up against in the future.

Greg Reck, Acting Associate Administrator for Advanced Concepts and Technology at NASA Headquarters has pointed that there are many changes facing NASA and its counter parts in the private sector. Our challenge at NASA is to identify commercial applications of new and existing technologies and the industrial partners needed to bring these technologies to the marketplace. In doing so, we can improve national competitiveness, improve the quality of life for everyone and create new jobs. This is especially true today when so many companies are downsizing and facing increasingly tough competition.

This is really what the NCTMT is doing, seriously looking inside the agency at what our role is and how we can contribute to the economic security of the nation. The team membership is representative of practitioners of technology commercialization and technology transfer from all ten NASA field centers and six program offices. These team members were selected by their center directors or associate administrators to speak for their organizations. Additional contributions were provided by headquarters staff with many years of experience in technology transfer and related issues. We also brought together a dedicated staff to work with us.

Since beginning this activity under the leadership of Greg Reck, we have moved fast to develop an understanding of the commercialization process and a response that can be implemented without delay. One unique characteristic of this team is that it's strong bias

for action. We have not just put ourselves to task to study things but have committed to implement what we can right away and, at the same time, plan for further implementation down the road. We have completed what we call Phase 0 which included study, analysis, planning and some implementation. Additional plans have been laid out for Phase 1, which runs through the end of this fiscal year, and Phase 2, which is fiscal year 1995 and beyond.

NASA must purchase as much technology as it provides to the outside world for commercial purposes. So we must think about commercial technology as a two way process.

We are also thinking about our role beyond the next couple of years and beyond our traditional customers. The major challenge before us is how can NASA contribute to national economic strength while performing its mission to explore space. With somewhere around a few billion dollars in annual revenues, the space industry is only a small, yet still important component of the well over $6 trillion national economy. Clearly, therefore, if we intend to maximize NASA's national impact, we must consider our relationships with many non-aerospace industries as well as those with our traditional partners.

There are a multitude of NASA-developed technologies and world-class facilities which can contribute to the creation of competitive products and services and, ultimately, lead to job creation. NASA has an arsenal of brain power both within the civil service and from our contractors. NASA has a broad portfolio of world-class research and test facilities, many of which are one of a kind. Across NASA, we manage more than $14 billion a year in technology investments. The questions is how to make all of these assets successful in making a difference? Our answer has been the old technology transfer paradigm as described by Greg Reck, reactive and as an after thought.

To be sure, NASA's primary responsibility is to explore space, in all connotations of that phrase. In the past, we first do the mission, then the tech transfer. We think that there are more efficient ways to do this. Often, much of the technology is not even commercially relevant because by the time NASA has finished development, it is either obsolete designed such that the necessary re-engineering to make it marketable is cost prohibitive. What we want to do is change the whole "post development diffusion" approach. We want to think about commercial technology not just technology transfer.

NASA must purchase as much technology as it provides to the outside world for commercial purposes. So we must think about commercial technology as a two way process. This is the commercial technology mission. It is not just a transfer mechanism, but the way the we conduct our business. So clearly, the new way of doing business must incorporate practices that are acceptable and relevant to the private sector. We have given a lot of thought to six new practices which will perform in this way and we are now implementing them.

Another major difference between the past and the future is a clear acknowledgment that NASA cannot create jobs. With NASA-industry partnerships, however, jobs will be created in the private sector. The private sector is really a partner in the business process to raise capital, to hire people, to manufacture products, to provide services, to sell these offerings and to perform all other aspects of the free market system. NASA cannot efficiently perform these tasks but we can play a significant role in technology development.

In the past, our practices were responsive to private sector in a way that private sector was treated as a supplier to NASA. We would buy goods and services, and that approach made the private sector serve us. The future will be different. In the future, the private sector is an equal partner. The private sector must bring its expertise not only in technology development but also into the early planning process through product development and marketing. This is a collaboration as reflected by the new practices.

Most of this work that we are doing will require us to think differently about technology commercialization. Within NASA, we must understand how and why a profit is made. Few would be surprised to know that there are not very many people in this agency that can evaluate a business plan. Not very many of us have gone to business school. That will have to change if we are going to work with the private sector as an equal partner. We need to understand how the private sector thinks and how it lives from quarter to quarter and year to year with the financial commitment to its shareholders. We have to understand that language. Once we start looking at the infrastructure of these business practices, we realize that this will require a systematic look at and change of many of our current practices. Practices like dual use technology development or industry partnerships are easier said than done. Unless there is institu-

tional infrastructure throughout the agency to support this mind-set, these new ways of doing business will always be done on the margin. And if we keep doing things on the margin, we will simply repeat history and not be responsive to the challenges ahead.

In the marketing area, we looked at how NASA can be more relevant to non-aerospace industries.

To develop a successful plan of action and begin implementing it, we created six sub teams within the NCTMT to look at specific institutional infrastructure requirements for these new business practices. These six teams developed implementation plans for; marketing, metrics, policy, training, electronic network and commercial technology practices. The activities of each of these teams follows along with a status of their activities.

First we looked at the advent of Internet and likely evolution of information systems and technology. We found that we need to be linked with our customer and they to us so that information can be disseminated very quickly. We know, for example, that some of the information NASA generated in the past has literally taken years to get into the hands of our customers. That kind of delay is not only unnecessary but unreasonable and unacceptable. We put together an in-house group of people who could demonstrate a new way to provide information to our customers. They were able to very quickly create a system which provided information on the NASA SBIR (Small Business Innovation Research) program, technology licensing, NASA publications and many other programs. In the near future, we will use the Internet and the NASA commercial technology network to solicit proposals, receive bids, collect metrics data and other business activities. Collectively, we refer to these practices as "electronic commerce." They offer a multitude of opportunities to improve the quality and quantity of NASA's offerings to the country. This activity represents the very essence of the Administration's national information infrastructure policy and can serve as an implementation prototype.

In the marketing area, we looked at how NASA can be more relevant to non-aerospace industries. We have diligently supported our aerospace industry customers in the past. There have always been, are now, and will always be significant opportunities in the aerospace industry for NASA to make a positive contribution. However, there are many exciting opportunities in other industries where NASA developed technology or NASA facilities offer unique capabilities. The question is, how can we proactively approach these opportunities in a systematic way? Our team is now in a position to deploy resources from across all NASA centers enable us to meet the needs of non-aerospace industry. For instance, we have already put together a
response to the health industry in this area. This cooperative venture offers potentially huge cost savings to the nation in the years ahead.

In the metrics area, we are very conscious of the fact that we must measure our progress. Measuring the work we do is only a start. We must also link our commercial activities to job creation, productivity improvements and economic competitiveness. This requires development of a process to systematically collect information and then use it to make informed management decisions about the allocation of scarce resources. It is essential to the success of NASA and each of our programs that management decisions are made with the benefit of quantified data. As our plan begins with information collection, it continues with development of a economic model to forecast the impact of various investment plans. This will aid in making investment decisions where there is no existing data to use.

In the policy area, our customers have indicated their desire to see some new partnership agreements materialize very quickly. As we brought these agreements into effect, it became clear that our system was not geared to respond quickly to some of the emerging questions. In response, we developed a policy document which clearly explains the significant attributes and implications of several key agency policies regarding commercial technology. This collection of policy represents an institutional innovation as well as a reference document that will be kept up-to-date for quickly answering questions.

Regarding partnership practices, it is very clear that the dual-use partnerships are going to be a key means for NASA to imbue the benefits of its knowledge with the private sector and vise-versa. To do so, we must first make our potential partners aware of existing opportunities for cooperation. We are working to identify current program partnership opportunities and disseminate this information. Along with partnerships, we are also looking at small business development. We are trying to strengthen the NASA SBIR program where selection criteria will be balanced between technical as well as commercial merit, including the ability to follow through with product/service marketing. One other among many practices worth briefly mentioning is referred to as contractor-grantee technology commercial-

ization. About 80% of NASA's funding goes to directly to the private sector. It is critical that the technology developed by contractors and grantees has commercial applications identified early in the design and development process.

Finally, the Vice-President's National Performance Review rightly noted the need to train people inside NASA to understand better the business world and train them in the commercialization process. In this regard, we have a commercial technology guidebook drafted to be distributed to NASA and contractor employees in addition to a thorough training program. We simply cannot expect people to understand and effectively use new resources and tools without training. The new commercial technology mission requires that a portion of the workforce be provided with skills that they have not previously needed. This training program aims to do just that.

Without question, we have a great deal to do. However, we have already accomplished a great deal in the last six months. We have put this together and we will be going forward and making it richer, and also useful in the sense of electronic commerce. Also, each NASA center has already or is in the process of setting up an organization dedicated to lead these activities. Each with their center director's attention and support. More than one hundred individuals are already on board. We are on our way and look forward to continuing to fully exploit the potential for NASA's contributions to the nation's economic security. The NASA Commercial Technology Management Team demonstrates that this agency can pull together to do the job that needs to be done.

Q&A Session

THERESA FOLEY: Both of your presentations were very interesting, but it seems to me that the emphasis was very much on management and process and in trying to listen to some tangible description of what the end results would be, I had a hard time honing in on that. So, I thought I might ask either of you, could you perhaps project yourself out one year from today coming back next year, what will you have done that will have made you relevant to the U.S. economy in the next year in a way that encourages these policy makers to give you another $600 million in the '97 budget?

RECK: Certainly an important part of what Dr. Shariq has described and in the other aspects of the commercial space mission, we are trying to develop metrics that we think are sensible and realistic. Metrics that indicate intermediate positions and progress that is going to be indicative of the fact that we are moving along in making progress and will secure we hope future budgets. Certainly, from the standpoint of budgets, the budget pressure is not going to get better, it is going to get worse and we all know that. We are going to have to be able demonstrate to people that were have goal that they can relate to and then demonstrate that we are making progress along those goals. We are trying to establish what we think are reasonable metrics associated with the tech transfer activities that Dr. Shariq has described, that will include more than just counting the number of agreements, but will get into the value associated with agreements. We will get into the amount of outside investment and participation that we have in those agreements, as well as beginning to track the number of jobs,

About 80% of NASA's funding goes to directly to the private sector. It is critical that the technology developed by contractors and grantees has commercial applications identified early in the design and development process.

products, revenues that are associated with those as well. In fact, part of the national performance review recommendation associated with tech transfer has in fact told us that we are going to be putting those metrics and systems into place. A part of what our team is doing is developing a process that for the first time is going to be uniform across all the centers and we have now done that. We have put the algorithms in place that are really going to be required so each center is doing its bookkeeping in a consistent way. Many of the centers have done this kind of thing in the past for tech transfer, but in fact we need to have it done consistently across the agencies so we can report results in a consistent manner. To the extent, that we can make projections on those, I think we will try to do that. The team hasn't reached a point yet as saying we expect to double or 50% in increase specific metrics next year, but I expect that very shortly we are going to try to develop those kind of figures based on what we feel is realistic. We have started progress and started efforts along a number of areas that Dr. Shariq or myself have not time to comment on, but we think we will be able to project those to identify when those are actually going to materialize into technology efforts, so that we will be able to

put numbers down on that. In the commercial areas, it is going to be more difficult as I indicated and have been trying to work to convince people. I think that in times in the past and we have talked about space commercialization from the standpoint of new business in particular that we have been perhaps a little ambitious in predicting in just when new products are going to materialize. Perhaps to enthusiastic, in promising when the business would flourish. In fact, we have seen some limited progress against goals and we are putting road maps in to place for each of the CCDS products that we have identified and we have identified those in biotechnology, materials processing, electronic components and materials and in each of those cases, we are identifying where we think the programs are in the proof of concepts stage, where they are in the development stage, or where they are in the productization stage. So, we have also been able to identify what we think are timelines associated with that so we will be able to predict if we are successful and if we get the funding, and if we get the access to space that we need, when those products will actually mature into space products. It is not at the rate of a dozen next year, it is not at the rate of twenty or thirty in the next year or two, but we do project that over the next five years we are going to see a significant number probably on the order of five to ten products that will rely on a space environment one way or another, that will materialize from the programs that we have underway at the centers, and especially in the center of commercial and development of space. We are going to try to lay a timetable out for those, publish that timetable, publish those plans, let people know when we think it is going to mature. I think that is the only way we are going to be able to sell that part of the program if we can really demonstrate that we are on a track, the track is projected and we are moving down that particular track with those products. We are going to try to do it there and as I mentioned we have to do the same things in the communications area. I think that is a very sensitive and very difficult area, but that's another question.

SYED: Just to add to the accomplishment to date, I think what Greg was talking about what can be expected as we move forward, but already these practices in the last four months have shown results. We have data on queries of Internet. I don't it with me right now, but several thousand people have already accessed information real time, that was not available previously. We have already moved on to alliances with a consortium in health care industry as well as in manufacturing, we are working on that. These things are indicative that new business practices and the way we are moving forward are being welcomed by the private sector, suggesting this is the way we are to go. We intend to learn and improve. We are putting in place everything as we are doing it as well.

QUESTION: A lot of the discussions have been very product oriented, I am wondering how much of the commercialization mission may be service oriented, providing launch services, launch vehicles, orbiting platforms for commercial production and that sort of thing. Is that a subset of your three main missions, or is that going to be another tact that you will take some other time?

RECK: That is a part of what we view, that providing services and the infrastructure we believe is a part of the established commercial space industry, which are needed for the new and emerging industries. We have been looking and working with the office of space development in the transportation area to try to seek new approaches that we will improve the position with regard to providing launch services. And to work with the ELV industry in responding to challenges that put in front of us. The Comstat advisory committee that represents the commercial ELV industry over a number of years has provided recommendations on technology needs and other needs associated with that industry some that go into insurance areas, and sorts of things that we have earlier today as well. Also, the Aerospace Industries Associations through its technology roadmaps has provided another industry viewpoint. We have had a number of inputs in the past in the launch services and transportation services and I think that we have provided a number of plans that will respond to various aspects of that, either application of technology to current ELV systems, to current vehicles, or looking at the next generation of either cargo delivery or human transportation system. We know the technologies that are going to be required to do those things. What we need now is a national plan, national strategy, for what will be done and what the administration and congress are going to be able to support. I think that is what OSTP is wrestling with right now. The Moorman report is going to help provide and provide some input and certainly the studies that have been done jointly between the Department of Defense and NASA in the access to space area looking at least three option and in fact more are also providing some additional fuel for trying to determine just what the next transportation strategy should be. At this point in time, I can't tell you what that picture is going to be. We are hoping that in the next several months, the administration OSTP is going to develop a

uniform position that services and NASA and everyone can support from the standpoint of transportation. If I can get into a couple of other areas, you are going to hear from Sam Venneri a little bit later with regards to some of the things that we think can be done form space craft platforms and in terms of communication services. Again, getting into other elements of commercial space industry, but I think we have a very active support program there. In fact, you look at the kind of support that we are providing for space craft and communications, if you look at those collectively, it is nearly half of the resource that we are talking about in the $500 million. I think the real advantage of bringing the two programs together last year, is that we don't have this little piece of a commercial office that is sitting here with a $30 million budget plus a couple of big flight projects that are dissociated from the rest of NASA and the rest of the technology program, but now we do have a $600 million program that is attempting to focus all of those technologies into areas where there is considerable overlap between commercial needs and NASA needs. In fact, in the future, where they may be one in the same. I'm really enthusiastic as we begin to learn how to merger the two programs and capitalize on those joint resources, that we are going to see a lot more progress in the transportation services, in the infrastructure, in the communications industry, in the space craft industry across the board.

QUESTION: First of all, I would like to applaud NASA and Mr. Reck here for the comments about our cooperative efforts, I'd like also to dispel a myth. SpaceHab is a successful commercial application. For one thing, on its own raised $100 million from the private sector, to proceed into a cooperative effort with NASA. It has gone through two highly successful missions, as it was stated here they were flawless missions that came on time and on budget. In addition, the experiments that went on and the onset now of more frequents access have products in development. There are five or six products that are going to the patent office. There are areas within the pharmaceuticals field including time-release insulin. What I wanted to do is basically, put an upbeat to the conference. There are things going on in commercial space, there are activities that will amount to billion dollar opportunities I think for American industry. I think we all have to bring in the customers, that is people from outside who will be recipients for these benefits and we have to be able to better promote and advertise to them what is going on.

Theresa Foley: I don't know Greg, maybe you would like to comment on what the problem has been with the policy. I guess SpaceHab has been up and down at the agency because of these questions about whether they have been able to sign on customers and there has been a lot of reporting in the press at least that there is a lot of skepticism about the commercial viability. Would you like to respond?

Reck: Well, I have been reading about that in the press, that's true. Within the agency there has been considerable support for SpaceHab and I think that we have been able to work out an agreement with SpaceHab that was necessary because of change in the funding profile that now we are both very please with. It gives us our full utilization, it is an interesting experiment in anchor tenancy. It's a case of there are opportunities we believe in the future and certainly from the standpoint of some elements from commercial programs it clearly has demonstrated success in terms of partnership agreement. We are all very anxious to find more customers and develop that industry. I think we are working collaboratively to do that. I think it is in NASA's best interest, and we feel it is going to be an extension, and in fact a the sort of things we anticipate doing, hopefully in a larger way, in space stations in the future. I don't understand quite what you mean by all of the controversy and all of that. SpaceHab, I believe, at this point is very sound in terms of the flights that NASA is going to be using and we are all working very hard to develop the sort of business enterprises that are going to use it on into the future.

Practices in Action - A New Way: Implementation & Business Opportunities

Dr. Robert L. Norwood
Director
Advanced Concepts Division

Dr. Henry W. Brandhorst
Chief, Power Technology Division
Lewis Research Center

Granville E. Paules
Director, Technology Innovation & Advanced Planning Office
Mission to Planet Earth, NASA

Dr. Bert Hansen III
Technologist
Microgravity & Science Applications

DR. ROBERT L. NORWOOD: The remarks that Greg and Shariq just gave a few minutes ago, set a complete foundation for the program I am going to describe to you briefly. This program is one that is newly formed and will be newly executed by NASA this year and FY '94. It is called the Aerospace Industry Technology Program.

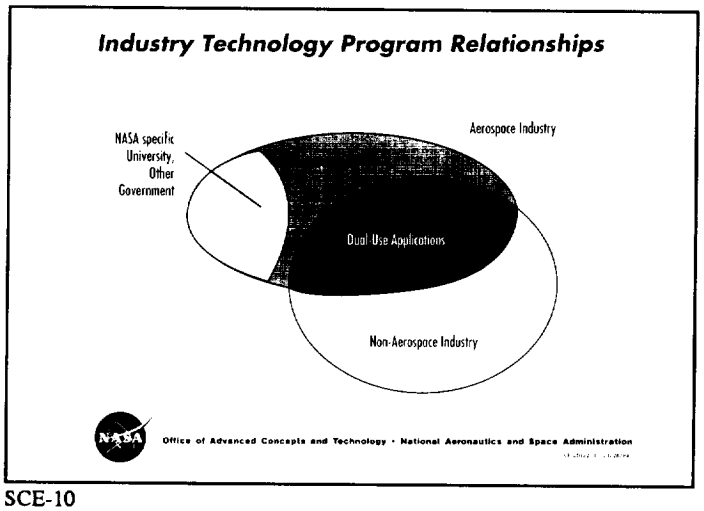
Basically, this program is based on the national technology policy that I presume you are familiar with and in the title, even though it says Aerospace Industry Technology Program, the "Aerospace" should really be with a small "a," in that, we are not restricting participation in this program to the traditional aerospace industries only. We are providing the field of regard for this program to include not only the traditional aerospace corporations and businesses, but also the nonaerospace commercial industry businesses who we feel could provide technology to the aerospace community and who could reap benefits from aerospace.

This program creates a new opportunity for conducting R&D that meets the needs of aerospace/nonaerospace commercial sectors, as well as NASA. Note that NASA is last in the pecking order here. It is at the bottom of the food chain. The clear focus for this program is industry, it is not NASA nor NASA's missions. This program will focus on pre-competitive development efforts for leading edge technology with high payoff applications, and applications is the key area that will support the nation's technology policy.

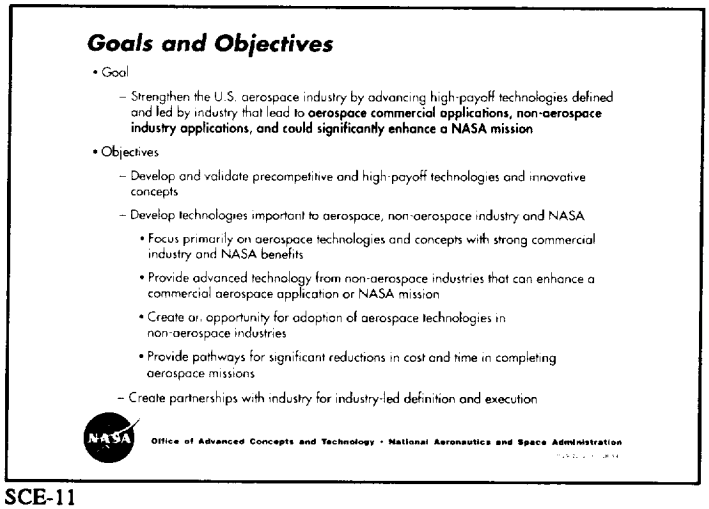
One of the key elements of this program is that we intend to involve and have involved industry, both aerospace and nonaerospace, in all aspects of this program from forming the program to having industry participate and lead in identifying and proposing projects.

One of the main objectives of this program is to focus on building partnerships between NASA, the aerospace industry and nonaerospace industry for the future, so we can have a much broader technology base, as well as new technology products.

The next two charts talk about goals and objectives (Fig. SCE-10 & 11). The chart on the right side is sort of a pictorial description of the goals and objectives. Basically, what we want to do is strengthen the U.S.



SCE-10



SCE-11

PRECEDING PAGE BLANK NOT FILMED

PAGE 36 INTENTIONALLY BLANK

industry by leading in aerospace commercial applications, nonaerospace industry applications to aerospace, and those technologies that could significantly enhance a NASA mission.

The context of this program is commercialization of technology and within that context, we are focusing on dual use. Dual use meaning commercial aerospace and noncommercial aerospace being joined in terms of technology development and particularly the application. We are really trying to focus on three general things. We want to focus on those technologies with strong commercial interests, we want to provide advanced technology from nonaerospace industries that can enhance a commercial aerospace application that is spin-on, we want to create opportunities for adoption and adaptation of aerospace technologies in nonaerospace industries, that is a spin-off technology, and we clearly want to provide pathways for significant reductions in cost and time in accomplishing aerospace and NASA missions.

We expect that NASA will not necessarily get direct benefits from any of these projects that industry proposes, but we do expect to do two things. One is to broaden the base of technology for NASA and aerospace missions in the future, and also to provide future technologies such that as NASA missions are developed and promulgated in the future that we will have a broader technology base to choose from, and secondly we really want to create partnerships with industry, lasting partnerships, so that we can expand the base of aerospace technology.

The overall approach of this program is that industry is going to provide and propose and NASA will support a diverse set of projects that exhibit a mix of technology development and tech transfer. The tech transfer in this context is really one element in the process of commercialization so tech transfer is not the end goal, it is merely a means. The specific projects will be defined and lead by U.S. industry. NASA will do the competitive selection based on technical merit and strong commercial potential.

In general, we are going to rely on industry led consortia or teams. I don't mean consortia in the legal sense, but only in the figurative sense, for planning and execution of the projects and will require cost sharing. We are going to try and use some innovative management techniques, some of which Shariq talked about.

We want to focus on reducing the agreement time, that is the time between selection of the winning time and the time that our actual instrument, in this case a Chilles Act cooperative agreement, is signed between the government and industry.

We want to be interactive with industry and responsive to their needs, so we are trying to take a lot of the normal bureaucratic time out of the process. We use the Chilles Act cooperative agreement because it is a more flexible instrument and it is easier to handle in certain cases.

The overall approach of this program is that industry is going to provide and propose, and NASA will support, a diverse set of projects that exhibit a mix of technology development and tech transfer.

In addition, we are preparing a model, what we will call a model cooperative agreement for industry to review so that you will know the framework and format for the particular agreement that we are talking about. If you consider the continuum of activities, leading from basic research all the way to having a bar coded product on the shelf, we are clearly looking at that middle ground. We are looking at what we call precompetitive technologies that are innovative and preproduct prototype projects. They will be industry-lead, either by aerospace or nonaerospace industries, and we will offer the partnership of NASA, universities and other government agencies as is appropriate.

These are clearly not basic research projects that we are looking for. We really want the projects to have a strong commercial base upon which they will be judged. The individual projects will be industry lead and industry proposed with industry timelines, milestones and industry proposed development projects.

On February 4, NASA sponsored an industry conference where we brought in representatives of aerospace, nonaerospace industry, large businesses, small business, universities and other government people, and we asked them for their comments on the program on the program structure and some of their most important considerations. We took those to heart, and we have made changes in the way the program is structured, based on their input. The evaluation criteria will include technical merit in business planning, sound business planning and overall commercialization is very important.

We are offering as a major element of this program, the cooperation of NASA resources particularly through the centers. If you recall, Shariq talked about a center structure as being the core part of his commercialization team. We intend to use that team, we intend to use that structure to implement, evaluate and finally help in the

selection of these projects. At the same time, we offer the cooperation of those centers, researchers and research facilities to be a part of any industry team, but it is not a requirement. We are not asking that any member of a NASA center or staff be on any one of these teams, nor are we suggesting it. We are merely offering the NASA expertise to help out where it is of interest to the industry team and central to their efforts.

This program has been appropriated in FY94 at $20 million and the President's budget for FY95 contains roughly a similar amount of money, so we are looking for a two year program at least of $20 million. There will be a cost sharing requirement for this program. We are going to require at least 50% cost sharing. That is for every dollar NASA puts in, industry must put in a similar amount.

We are considering three different mechanisms or three different categories for the industry contribution. One of course is cash, that is always good. The next one is IR&D. We are in the process of getting authority as in the TRP project which some of you may be aware, for NASA to use IR&D as a cost share in this program. I know this is one of the particular elements the industry representatives wanted out of the result of our industry forum and so we have taken active steps to make this happen so they can leverage their considerable IR&D resources and join those resources with the NASA funds and in the event that it is appropriate, the NASA R&D programs.

The other category is in-kind. That is where an industry team might bring either a unique piece of hardware or expertise. I might say that is a much more difficult area to consider in terms of cost sharing and it is the least favorable of any of the three. A typical project would be on the order of three years and for a few million dollars. I'm not saying that it is a requirement, but we would not be surprised if that is the type of project that we did get. We could get those that are larger or considerably smaller. There will be time limits on the programs. Basically, we are going to judge each program on its merits and we will see how far each one goes. We are looking for the broadest program participation that we can get.

I mentioned that we are going to leverage the NASA center programs with partnership and outreach to industry. We will encourage their participation, but their participation will not be required. Industry teams however will be required. I think given the experience of programs that have some similar characteristics, that is the NIST Advanced Technology Program (ATP) and the multi-agency TRP program, that partnering and teaming relationships among industry — in either horizontally or vertically integrated terms — have well known and very strong benefits. For this program, we are going to require a partner. It will be a two stage process, and this program we are going to offer industry teams to send in white papers in the first half of the solicitation period for review. NASA headquarters and centers will organize a team to be able to review these white papers and give a very brief and direct response to help the industry focus on areas where they feel their chances are best.

Rather than having specific themes as we had in the TRP program or a wide open competition, we are sort of going to take a middle ground. The base of the program is going to be open, but we will identify — via a program information package and via the Internet system — we are going to offer several technology themes that we think best give leverage and help the aerospace community. So, while the competition is open, we are going to recommend people propose in those areas.

Question: I'm having a little difficulty understanding where TRP and the ATP and the other government agencies cooperative things differ or are similar to what NASA is doing. Could you briefly comment?

Dr. Norwood: There are a couple of similarities in partnering and in cost sharing with both programs. Regarding differences, you'll recall that because of the way the congressional legislation was provided TRP had several separate programs and eleven technology focus areas. We do not have the constraint, if you will, of having appropriated various programs. Our $20 million is available to be spread and arranged over any of the proposals as they are competitively selected. In addition, we will not have anywhere near the eleven technical focus areas that TRP. Likewise in the early stages of ATP, they had a wide open competition without any technology areas, but their focus was perhaps a little different. We are clearly looking at a base of aerospace technologists, so that is where our program differs.

DR. HENRY W. BRANDHORST: I'd like to start by giving you an overview of the Aerospace Technology Directorate. It's mission is to enable advances in aerospace power, propulsion and communications technologies which strengthen NASA's future mission and U.S. industry competitiveness. The center of our focus is on customer needs surrounded by three strong pillars of technology and then disciplines surround that to further

give the skill base that we need to advance the technology. I'm going to move from theory into practice because what you have heard so far is a lot of philosophy, a lot of policy and a lot of theory. When we look at this vision and mission statement up here, it sort of reminds me of the next slide. That is also fairly typical of how things used to be in the old days of NACA or NASA, where it was sort of the field of dreams: "if you build it they will come." That changed in the late 60's or early 70's into the: "we're going to do good technology and we're going to sell it to our mission offices, our mission centers and the industry—they will use it and it will be wonderful."

The industry estimates the $10 million NASA investment in arc jet technology has leveraged $1 billion in spacecraft sales. Now, that is the kind of technology transfer and change and impact that we are about.

Smarting from the absence of the overwhelming success from that approach, we now have evolved to the current state where: "we do good solid R&D that meets NASA needs and other customer needs." This approach pulls in user needs and requirements at the very start, does analysis and identification of options, then moves to technology readiness. Breakthrough concepts may also come along and make successes easier, but we must go to technology readiness and then transfer the technology to the user. This may appear sequential, but in reality, much of this process is parallel. Furthermore, it is a lot more complicated because we find that transfer to the user—as Mr. Scott said—"is a body contact sport." It doesn't happen just by wishing for it to happen and it doesn't happen by talking to one another. In fact, we find must parlay multiple funding sources, multiple partners and strong customer interaction to make sure it happens. If we don't, we find out that often times we come up with miscommunications and erroneous products which we wish to avoid. I think all of you have been in that situation at one time or another.

When it works right, you have a win-win situation. A premier example is our on-board propulsion activity, where, after very carefully building trusting relationships with the industry (and I stress that), leveraging multiple funding sources, doing the technology NASA is best suited to doing, and solving user needs and concerns using government facilities and capabilities we were able to successfully transfer this arc jet technology to the industry and allowed them to win several spacecraft competitions. Thirteen spacecraft carrying this technology have been ordered to date (five satellite series). It certainly has influenced major international spacecraft and launch vehicle competitions. The industry estimates the $10 million NASA investment in arc jet technology has leveraged $1 billion in spacecraft sales. Now, that is the kind of technology transfer and change and impact that we are about. This technological advance allows you to step down a launch vehicle class in appropriate cases, you can successfully compete with the preferred launch location of Ariane (in French Guiana). Also, depending on the competitive market, you can choose to increase the satellite lifetime or increase the payload with the mass advantages you gain. How the industry chooses to use these options to their competitive advantage is up to them. However, we stand together in partnership each doing what they do best to advance in competitive positions.

Now, how does the Aerospace Technology Directorate work? We are very strong in our collaboration with the industry and have a long history of it. It is not something we just do. We currently have 262 agreements in place: cooperative programs, interagency agreements and space act agreements. We find these are vital to success. I said before, and I will reiterate, our interagency agreements oftentimes allow us to leverage other government agency resources to accomplish important commercial goals. As you can see, there is a diversity of activities in which we are involved and they are not all aerospace applications. Mr. Scott also said you need "stimulating creativity." About five or six years ago, one branch chief asked his branch members to bring one new commercial idea to their weekly branch meeting. This terrified the folks. It was really hard and it ruined a lot of weekends (because they had their staff meeting on Mondays), but after a while it came easily and right now that group has two licensed patents, and is the most productive commercial competitive group at the center. Indeed, it is also branching out into the medical community and has worked with them to know their needs. You will see some of things later on that this group has done, but the point is they get to know diverse customers across the community and they learn what their needs are. We also spin-off new companies. We have currently spun-off three new companies in these activities. One of the spin-off companies includes one that is doing diamond coating for sunglasses. Diamond coated sunglasses might also work for helicopter transparencies and automobile windshields—because they are more slippery so you don't wear out the washer

blades. So, there are numerous commercial applications coming from that group. Ion beam sources are also being spun-off and they are currently working to do some very interesting things. Examples include baby bottle nipples and surgeon gloves—it makes them less sticky. In the art community, ion sources can be used to quickly and successfully restore old paintings. There is a conference going on in a few weeks on that topic. So, there are many applications and spin-offs of these technologies.

Technology aimed at the space station has led to a multi-billion dollar commercial business in power transistors. Other examples are arc jet we mentioned before, travelling wave tubes, and optical receivers for advanced communication systems that reduce their size. We are actively working with a variety of the new communication satellite corporations, not only the GEO satellite companies but the mid-altitude/low altitude satellites as well.

One branch chief asked his branch members to bring one new commercial idea to their weekly branch meeting ... after a while it came easily and right now that group has two licensed patents, and is the most productive commercial competitive group at the center.

Let me talk a little bit about business practices and how government and industry can work together. I think all of you are painfully familiar with this process with a normal government contracting thing where there is lots of paperwork that flows back and forth to the system integrator and down to all the subcontractors and this is what projects live by. Actually, one part doesn't know what the other part is doing and it is the square peg in the round hole syndrome. We have been working a project that has deliberately sought to change that approach and has implemented an entirely new process. It is a project with five commercial organizations as well as several organizations at NASA Lewis. The government is in the main line of the project. This project is built upon trust, it is built upon open communication with cross functional teams and involvement of everyone everywhere. It is all TQ stuff. It works, it pays off, there is ownership; there is responsibility. Certainly there are mistakes that are expected and are allowed for and solved. The project is the 2kw Solar Dynamic Ground Demonstration test. It is currently nine months ***ahead*** of schedule and within cost and this is a cost capped program. There were innovative things done to incentive the contract that helped teamwork happen. This project is laying the baseline for the future US-Russian solar dynamic flight experiment. We have cut the cost of advanced solar simulator by nearly a factor of ten with a new innovative design. So, things work. They work very well, but you have to look at the process you use.

We are out west here and I know that all of you have read "The Guide to Western Stuff" and you all know how to stop the runaway stage by leaping onto the horses' backs and courageously stopping the team. This is much the same way we do business: we have done business in a certain way with flight hardware. That's the way it is, that is the paperwork. There is a simpler way to stop runaway teams—shoot the horses! Maybe we have to look for simplifications like that in the work we do. It is the responsibility of each of us to look for simplifications in our work. Just as I said, technology transfer is a body contact sport. It is the responsibility of all of our engineers at Lewis. We are giving them business training. We are teaching them to go out and talk to one another and to their customers. We are doing surveys of our top fifty customers to get feedback and indeed the Centers for the Commercial Development of Space (CCDSs) play an important role and I invite you to talk to Texas A&M—an exhibiting CCDS—and find out how strong partnerships and relationships between the government and academe pay off.

Over the past 20 years or so, NASA Lewis has won 63 R&D 100 Awards for top 100 new innovations entering commercial availability. In 1994 Lewis was also awarded two of 27 National Excellence in Technology Transfer Awards (out of 700 Federal Laboratories). Thus, we see a new NASA, we see a NASA that is doing new things in a new way and it is paying off.

GRANVILLE E. PAULES: I have come to talk to you about one of the enterprises that Greg Reck mentioned to you, the Mission to Planet Earth. Probably, more of you in the audience are familiar with that program than any of the other programs in NASA. I know many of you are performing projects related to what we are doing. I am going to talk first about our mission for those of you that are not familiar with it. Then I'll talk about why I think there is a good role for a very mission oriented program within NASA to work towards greater partnerships. Our real mission is to understand the earth as an integrated system (Fig. SCE-12 & 13).

MISSION TO PLANET EARTH

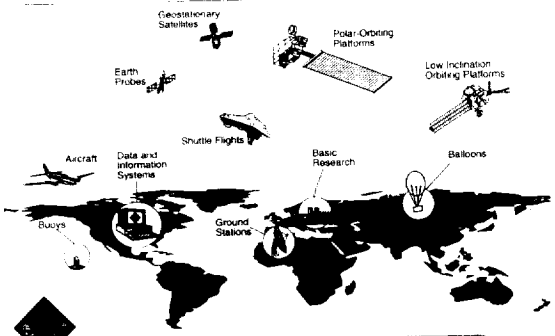
MTPE Objectives

- Understand the Earth as an integrated system
- Observe and characterize the entire Earth using satellites, aircraft, and associated research systems
- Characterize and understand natural and human-induced change on global and regional scales, with an initial emphasis on climate
- Help identify and predict the consequences of these changes for human health and welfare
- Contribute to the creation of wise and timely environmental policy

SCE-12

MISSION TO PLANET EARTH

Mission to Planet Earth Elements



SCE-13

MISSION TO PLANET EARTH

Scientific Assessment Areas

- Stratospheric Ozone Depletion
- Natural Hazards
- Natural Resources
- Biodiversity
- Global Warming
- Sea Level Rise
- Water Resources

SCE-14

MISSION TO PLANET EARTH

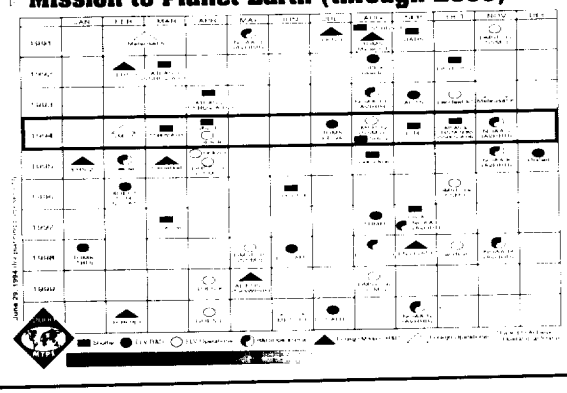
Approaches

- Promote deep international cooperation
- Cooperate with other U.S. Government agencies
- Contribute to national and international assessments of the environment
- Strengthen environmental education and public awareness
- Make data, information, and understanding widely available through the National Information Infrastructure
- Seek or develop advanced technologies that lead to new science investigations or that reduce program cost
- Transfer relevant technologies to industry, to strengthen American economic competitiveness

SCE-15

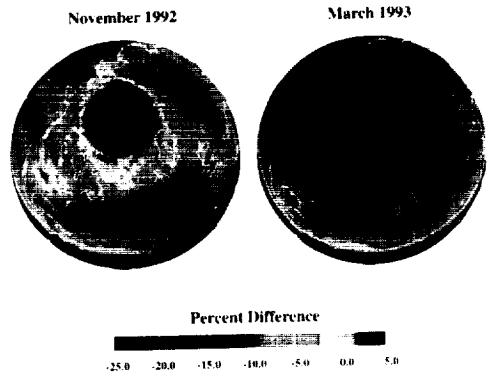
MISSION TO PLANET EARTH

Mission to Planet Earth (through 2000)



SCE-16

TOMS Ozone- Difference from Climatology



SCE-17

We use every resource we have to do that. It goes beyond just understanding natural phenomenon. It looks at the effects of human induced change, both at a global scale as you will see, and down at the regional and local scales in some cases. We then predict the changes to the environment and how that will affect the long term human health and welfare. The goal is to create wise and timely environmental policy. Our new associate administrator, Dr. Kennel, and the Office of Science and Technology Policy committee that Greg mentioned on environment and natural resources want our program to be a major contributor to the way environmental policy in the U.S. and around the globe is developed. This goes beyond just global climate change (Fig. SCE-14). We are also looking at ozone depletion — we are most well known probably for that. We study natural hazards like volcano, earthquakes, and the effects of large scale flooding. Our work supports the study of bio-diversity. For instance If the environment changes on the ground, what does that do to the mixture of flora/fauna and what is the potential for long term life and lifestyle changes, global warming, and sea level rises.

The bottom line probably of interest to you is the push to transfer the relevant information to industry for further applications. This represents large scale data use of artificial intelligence in managing large databases.

We are dealing with very large amounts of data (Fig. SCE-15). Much of that data has to be archived for access by both scientists and other users. Big issues are in data managements. Much is done in modeling. A comprehensive infrastructure is required to pull all this together. I think most of you know that this is a big international effort. We have a major involvement in the Global Change Research Program. It is a major U.S. government cooperative venture with considerable international cooperation. We deal with assessments on a global scale. Air quality impacting effects from one country on another become international issues. We try to study these as joint ventures. We push hard on environmental education and public awareness — our budget permits for that.

We are very tightly tied to the National Information Infrastructure in order to get this data into the hands of scientists or anyone else that might need it. Developing advanced technologies — I think this speaks for itself. It takes technology breakthroughs in order to get at some of this data. The bottom line probably of interest to you is the push to transfer the relevant information to industry for further applications. This goes beyond hardware and space craft technology. This represents large scale data use of artificial intelligence in managing large databases. NASA is interested in the in-transfer as well as the out-transfer of that sort of technology. This is a big year for the program. The following illustration makes the point (Fig. SCE-16).

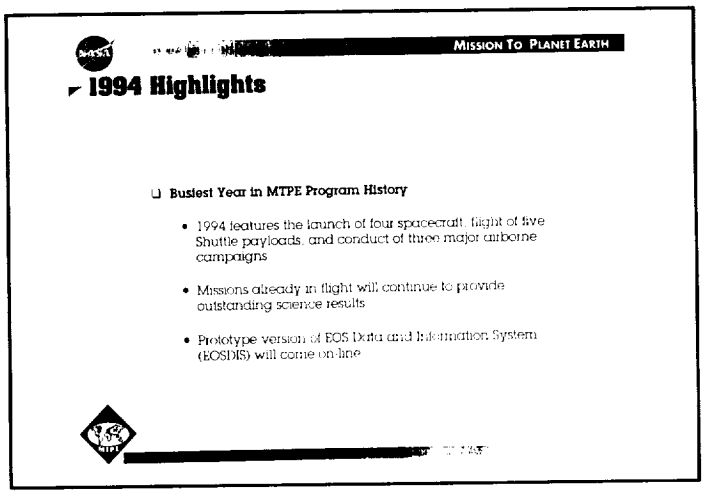
Ozone depletion, we talked about. The only point I want to make here is that it takes a lot of information and multi-spectral data providing details on a number of different atmospheric constituents in order to get a sense of how the ozone hole is changing from one year to the next and to understand the effect of chlorine, in this case, on the ozone levels (Fig. SCE-17). It took a considerable amount of data from space to pull this whole story together and show from where the differences come. This covers just one mission. There are a number of missions that are dealing with the effects beyond that for chlorine. For instance, other aerosols create similar problems for the ozone layer. One of the scientist's problems and challenges is to decide which of the atmospheric constituents caused these sorts of problems. Are they short term anomalies, a year or two, or are they long term situations that we really need to be concerned about? For instance, the Pinatubo eruption created a plume several hundred miles across. This was a very large cloud of multiple complex aerosols that went into space. In the last year, the effects of Pinatubo on the ozone hole were significant, yet this was a fairly short term effect as it turns out. The longer term effects of chlorine and some of the bromide compounds, are what we need to spend more long term effort to understand.

Next, I am going to show what you can do and see from space with the kinds of instruments we have up there. The detail is phenomenal (Fig. SCE-18 to SCE-20). It comes from the use of multi-spectral instruments — complex instruments that look at some small level of detail and then use computers to make the transition from a thirty kilometer level of detail to a smooth large area image. It is important to know that the commercial remote sensing industry tends to be looking at much finer resolution. Much information can be gleaned from space-based or aircraft-based remote sensing instruments. Information we collect on our earth resources is basically data that could then be used for second purposes, value added purposes, to look at moisture levels, for example, in farm lands and so on. There is information

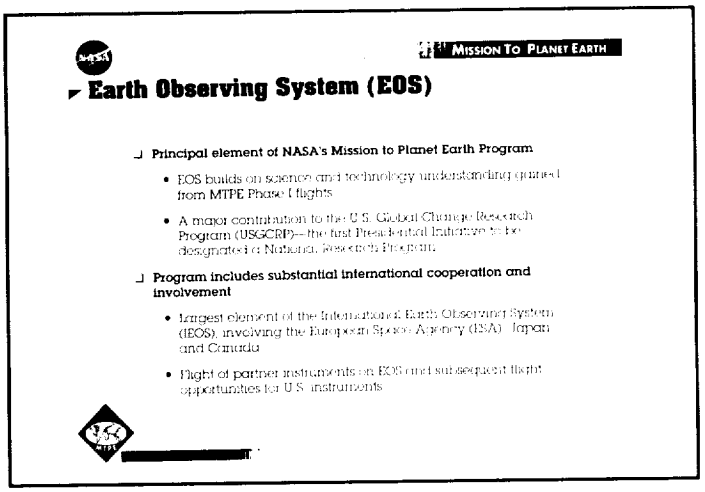
SCE-18 Forest fires in Yellowstone National Park

SCE-19 Hurricane Bonnie

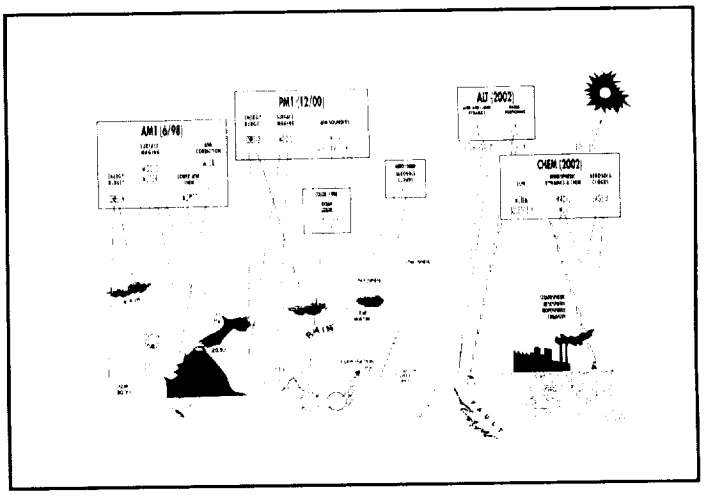
SCE-20 Dust Storm in Red Sea, Saudi Arabia



SCE-21



SCE-22



SCE-23

at good levels of detail. Often local planning agencies want data with which to make decisions. People making land use decisions and policies can use this kind of data, they can "zoom" in on certain areas and make a variety of different decisions.

Our 1994 highlights (Fig. SCE-21) are that we have four spacecraft flights — these are big flights for us. A number of flights are already in process. EOS is coming on line as Version 0. With it in place we start opening up access to all the EOS data for secondary value-added users, and for any others that want to complement it with their own remote sensed and other data. In any case, it is a big year and it has shuttle-related and ELV-launched probes and lots of aviation campaigns.

The EOS is our long term program (Fig. SCE-22 & SCE-23). It consists of focused platform activities over many years. Looking passively at the earth with different lighting conditions is an important aspect of the program. With AM/PM platform coverage, we are looking a number of things. With these, we are looking at atmospheric energy budgets, ground surface warming, ocean warming, and different aspects of the atmosphere and ocean working together. Also, there are the solid earth issues dealing with movements of tectonic plates and the associated relationships with volcanism. The CHEM (chemistry) mission is focused much more on the complexities of atmospheric chemistry. All of these require a significant number of technology development efforts the benefits of which can be shared by joint ventures with industry.

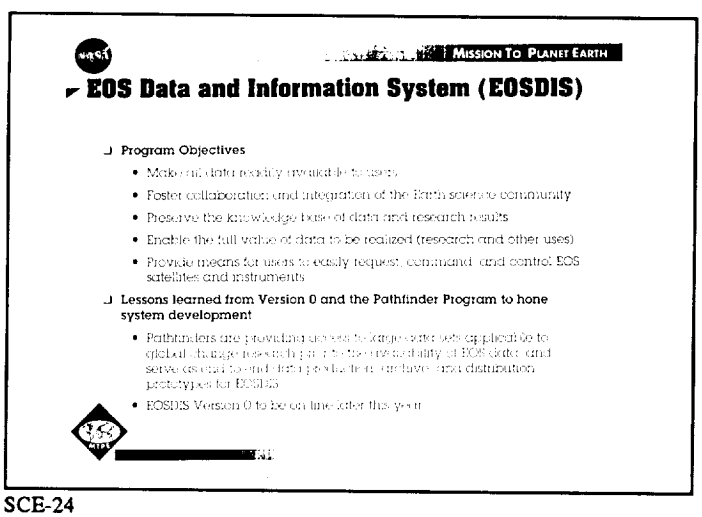
The EOS is a major piece of the Mission to Planet Earth program (Fig. SCE-24). We are trying to make sure that the data are available, that access is user friendly, and that the format is designed for users other than the internal NASA program people. It is mostly for scientists, but it is going to be available to any user that wants to buy the data at the processing cost for that data. Much of the data are not at the resolution that

The EOS is a major piece of the Mission to Planet Earth program. We are trying to make sure that the data are available, that access is user friendly, and that the format is designed for users other than the internal NASA program people.

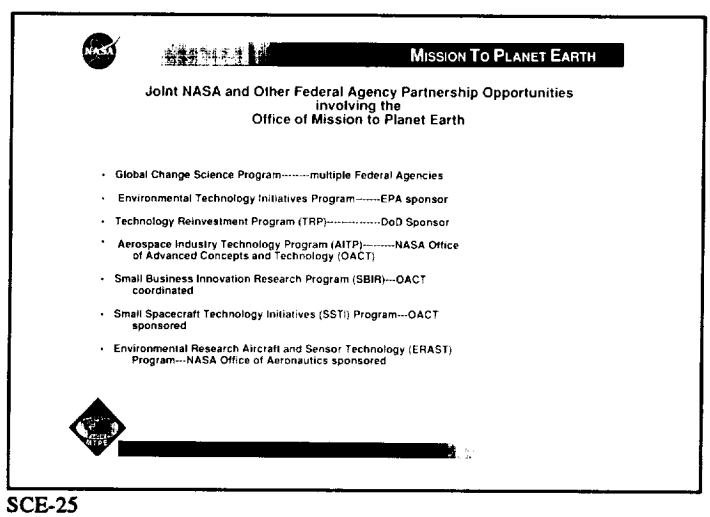
many of the planning agencies want and that the local and regional planning agencies need, but it does provide the ability to expand from a fairly fine resolution data, available from other sources, to a global and regional context.

Illustrated here are programs that we are working on in the context of new business, the ATP and TRP (Fig. SCE-25). The EPA initiative is a fairly new one — it has been going on for about a year and will continue through these external joint ventures from Mission to Planet Earth. Internally, we are working with both OACT and the Office of Aeronautics. We intend to do a lot with the unmanned aircraft vehicles, especially flying instruments at very high altitudes to test high performance engine emissions. We participated in the selection of instruments they carry to do data collection.

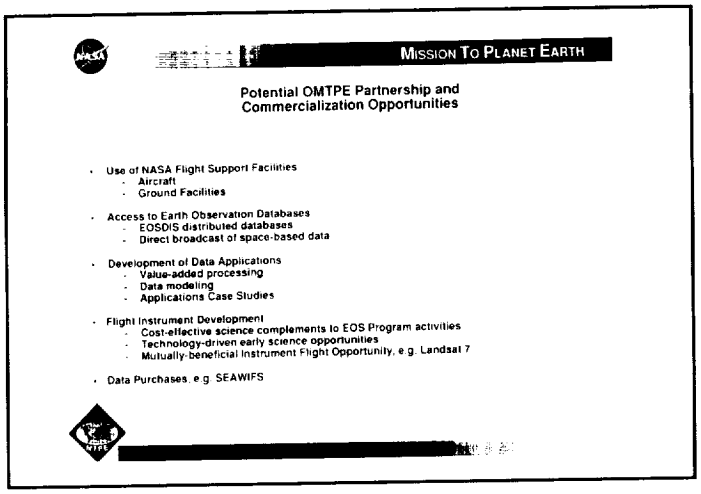
In summary (Fig. SCE-26), all of these are programs are planned. We will take advantage of existing state-of-the-art technology, much of which will probably be done in partnership with industry. Many opportunities relate to our program, which is a mission-oriented, science-based program. We will use advanced aircraft to validate instruments and establish widely available facili-



SCE-24



SCE-25



SCE-26

ties with expertise in calibration and validation of multispectral instruments. Earth observation databases will be made available to anyone needing them. Data applica tions is a very large area for partnerships because of the complexity of designing and dealing with large scale data models and for developing techniques to search through the databases. With regard to flight instrument development, there are plans for an instrument flight opportunity on the Landsat 7, a program being brought in house from DoD. Finally, the use of data purchase concepts is a new change in NASA's way of doing business. Thank you for your attention.

DR. BERT HANSEN: As you can see from what everyone has said this afternoon, NASA is hip deep in the arduous process of changing its culture, its way of doing the aeronautics and space business. In particular, the science offices have taken up the challenge of technology transfer along with the Office of Advanced Concepts and Technology. We now no longer just do our science and hope for technology spin-off, but are giving specific attention to the transfer of technology we use in our science programs. That specific attention includes committing resources to technology transfer as well as including commercialization considerations in our decisions for new missions.

I am with the Office of Life and Microgravity Sciences and Applications and our technology activities are representative of the other science offices at NASA Headquarters. In this program we study laboratory science in reduced gravity environments - we study physics, chemistry, biology. Specific disciplines include combustion science, materials science, fluid physics, biotechnology, biological processes, human physiology.

Therefore, for our experiments, we measure phenomena, store and transmit data, create math models to better understand the events. These are all acts performed in industry as well as the research laboratory and therein lies a tie to technology transfer and commercialization. In addition, to fly these experiments in space, the equipment needs to be light weight, small size, use little power, and be automated to some extent. Characteristics that are usually very desirable to industry and their customers.

I could list off a number of successes and anecdotes and try to give the impression that we are doing great. But that would miss the point of why we are here today. It's important for us to establish a number of processes that are used to accomplish technology transfer. We need to focus on the processes, not the anecdotes. There is a phrase associated with technology transfer that I'm surprised I haven't heard today. That is the technology transfer gap. That area where the development organization thinks they are finished and the user doesn't yet see the technology as useful. The existence of this "gap" is one of the main reasons for failure of technology transfer. It is one of the reasons we need to examine the various processes available for implementation. But at the same time, remember that we need to monitor the results of these efforts.

I also just want to mention that our job at NASA Headquarters is to establish policy and process. It is the job of the NASA Field Centers to do the real work. We need to support them in providing resources or interfacing with other elements of the government. But the real technology transfer occurs at the Centers.

There are five different approaches we are using in the microgravity science program that I want to touch upon briefly. Now, an important part of all these processes is the dissemination of information; letting companies know what is available, letting the developer know what is needed. But it is important not to stop there. Dialogues need to begin, partnerships need to be formed, agreements need to be signed, an exchange of ideas needs to take place.

The first process is to try and fix our internal technology transfer problem by working with the technology side of the house, the Office of Advanced Concepts and Technology. This is similar to any new product development effort within a company and the difficulty of communication between Engineering, Manufacturing and Marketing. Each of the three NASA science offices have set up customer teams with OACT and each meets once or twice a month, depending on outstanding issues. We communicate our technology and science needs and review each others programs. To deal with the technology trade off, we are implementing jointly funded pro-

jects, with both developers and science users working together to integrate a new technology into a mission or experiment. Hopefully, this will help eliminate both the "throwing the technology of the fence" phenomena as well as bridge the "gap."

The second process we use was recommended by Dr. Brian Daily from Lockheed, and that is making the facilities and expertise in our research and technology program available to companies. Industry personnel come to a NASA lab and work with our researchers to learn new methods and techniques, use our computer simulation facilities, etc. Besides a transfer, this is where better understanding of the two cultures, the federal lab and commercial company, begins to take place on both sides. This is perhaps the easiest and fastest process we have available.

A third process of technology is transferring into Space Shuttle combustion experiments, diagnostic methods and instruments that have been developed in a research laboratory. Here we've collocated the technology developers with the scientists studying combustion. There is a constant dialogue between the developers and the users. The transfer of a new diagnostic instrument into an experiment is essentially seamless, but not effortless! Besides the combustion research program, instruments and facilities from this program area have found use in environmental monitoring and protection, law enforcement, the automotive industry, just to name a few. This is an example of traditional spin-off and dual use that Dr. Norwood discussed.

A fourth process of technology transfer is one of taking existing laboratory equipment and adapting if for flight use by making it smaller, lighter, more flexible, etc. Then a search begins for new uses of the redesigned system. We have done this with current laboratory equipment used in light scattering applications. Light scattering is used in fluid physics to measure particle densities and distributions in solution. A creative example of particles in solution is cataract formation in the lens of the human eye. This instrument has been used to test quantified characterization of human cataracts. A program to evaluate the instrument in clinical trials is being planned with NIH and others. The overall goal would be early detection of cataract formation and development of treatment programs resulting in less need for surgery. All of this was possible because of an increased emphasis on finding "non-traditional" uses of the technology shared by both the developer and management.

The fifth and newest technology transfer process I wanted to mention is where we are totally converting a technology development effort to a commercialization project. We have a rather extensive technology development laboratory associated with our containerless processing research. This research program is being reduced in scope and we can't justify supporting the technology development lab to the same level as in the past. Rather than just shut it down, we are financing it for a year to two to establish industry partnerships for the services they can provide, mainly in the measurement of the thermophysical properties of materials. If successful, the lab will continue through support of those interested in its services and products.

I also just want to mention that our job at NASA Headquarters is to establish policy and process. It is the job of the NASA Field Centers to do the real work ... the real technology transfer occurs at the Centers.

In summary, the science offices at NASA are accepting the responsibility to identify and exploit possible commercial use of the technology developed for our science missions and experiments. We feel it is imperative to make better use of our resources and work closely with OACT both for acquiring the technology we need and to use their technology transfer mechanisms. We feel it is important to use more than one process for technology transfer and we are always on the watch for something new to try.

Q&A Session

THERESA FOLEY: Is this really fair what you are saying about who you used to be and who you are now? How much of this is new packaging? And how much of it is really new?

RECK: I think that there is a very significant change that is taking place as a result of a very significant change in our environment. I did not get to hear all of the panel speak this afternoon, but I know all of them and they all subscribed to doing things differently in many different ways. That is not an indictment of the past that the environment has changed as I say in many ways. In today's world, we have to adapt to today's situation. I believe the changes we are making are consistent with the new environment and policies we are working within, but I think those changes are very profound and very significant and they range all the way from new direc-

tions we are taking in tech transfer, new directions we are taking in technology, new directions we are working in partnership with industry across the board. I believe that and I know personally from working in the past, the environment was different with regard to industry partnerships. Specifically as an example, the expendable launch vehicle technology program that we tried to carry through with a few years ago, met with a great deal of resistance. The effort in that program was to establish a source of funds that we could use to match with industry in space act agreements and joint technology programs. We eventually did succeed in getting it through. It met with great support from the legislature, but it was very, very difficult and the environment was very negative against those kinds of programs. Today, that is not the case. The environment has changed, policies have changed with the appropriate programs done in the appropriate way. It is a virtue of a program today to be in partnership with industry and to share funds. We are looking at all of our programs for some element of that. So, clearly it is not a situation where we have simple taken and painted a new face on the way we were doing business before and called it new or a case where there was something wrong with the past environment. The environment has changed and I think we have changed dramatically in response to that.

VENERRI: One other issue that I think is important, you don't just have headquarters folks from NASA talking about this. When I go out into our center complex and I got branch head levels and below, the message has gotten down to them and they have as many ideas as we do of how they need to look at their job differently as civil servants within a federal laboratory structure. They understand that there are 700 and some federal laboratories in this country. With the Clinton administration policies out of OMB and OSTP, not all of these federal labs are going to continue to exist if it becomes one of a 1950 mindset. The world has changed, the way the government needs to look at working with industry. Basically, our people are starting to understand that. They are starting to come up with ideas of how they can work more effectively in their job and partnerships and leveraging dollars with the external world. We have metrics and I didn't have time to get at it, we are asking our people to come in and tell us how many jobs have they enabled, how many industrial based activities are they actually fostering and moving forward with. We are trying to get it down to the grassroots level and that is true whether you are industry or government. If you don't get the people that number one understand and number two take proactive roles to do things differently, and both of those characteristics are slowly happening within the NASA centers and to me that is a success in its own right. We are talking with companies of moving people on one to two year assignments, moving some of our people into industrial sectors and visa versa. That is the way you make technology transfer happen. You don't put charts up and do process, you do it with people. We are looking at ways of making our folks at all levels understand that process, and it is happening. And yes, that is a change.

DR. SYED: Just to add to that, definitely there is change in more than one way. Perhaps the question that was asked by Theresa isn't all context. I think we are not just looking at $500 or $600 million, we are looking at the whole agency, and if you look at the whole agency, there is about $7 to $8 billion in research and development. So, the role is not just aerospace customers. It is to really benefit a broader economy. The agency of today is looking at how to respond to economic benefits and job creation and other things that we need to do to transfer technology in a larger context. That does not take away from successes of the past. They were well earned and deserved. I think what we are building, what we are doing is on the foundation of the past. For example, in my research center at Ames we have a new center director. He has made a personal commitment to make our center into a premier center in tech transfer and commercialization. We have an office that reports directly to him. We now have a group of people whose job and performance in science and technology depends on how effectively they transfer and commercialize the technology. This wasn't even possible twelve months ago. So, I think the change is real. It is quality responding to a new mandate and expanded mission for the agency. It really is not limited to space, it is beyond space and aerospace and whatever we can do to help our economy.

FOLEY: Are NASA employees legally entitled or allowed to get financial gain from having an idea commercialized or spun into a product? Has that been resolved? I know it was a legal question about two or three years ago.

DR. SYED: Yes, in the technology transfer act employees are allowed to earn royalties, but aside from that they cannot take stock ownership in a company or other such things that are clearly not permissible. But, from the inventions and discoveries they are allowed to benefit. There are guidelines for that and this has been im-

plemented and an incentive. In fact, we would like to make sure more employees and agencies know it, deploy it and use it. It has been a really successful incentive at NIH, has done quite a bit there to promote the product development which commercially has been very successful.

QUESTION: It seems to me that you are in a precarious position, sort of a convoluted organization I'd say. Because you are marketing to industry, but yet the people who will actually be paying the bill is Joe six pack out in front of the 7-11 with a sack of donuts. What is being done to market the achievement, the depth of thought, the future forecasting, all of those kinds of things. Why don't we see some ads on television. I like what I hear, but the guys who are really going to pay for it really aren't the guys in this room. It is all of us. What are you doing to sell this? This is great stuff, but I'm don't hear any selling.

RECK: That is a common theme that we have heard often in the past and I have heard at NASA for a very long time, ever since we have begun to get into trouble with our budgets. Going around to the town meetings last year, that was one of the clear and consistent themes at virtually every town meeting visit that we went to. The expression that, I have heard about great things, wonderful, very interesting things that do touch peoples lives and do impact their daily activities and help the nation as a whole. While we do everything that we can, that is not area where we are going to be able to totally resolve ourselves. We are bound in some respects in what we can do in terms of advertising directly. Certainly some of the contractors that we work with and some of the other portions and sectors are not bound by all those restrictions, and you are beginning to see some changes in that direction. We are beginning to see space station ads and have seen for some time on television. We can't do all of those things ourselves. But, we have been trying to do more in getting the word out to groups to speak to nontraditional audiences, to work through our field centers in that way, to work through all of the networks that we establish in that way and to provide more information to the system in a more readable fashion. The administrator at his level does everything he can to get out and inspire and talk with people and seek wider audiences on television on talk shows and that sort of thing. He works with us constantly to give him examples that he can use to touch everyone's everyday life in health care, environment, food, agriculture, and in all those areas that people worry about and deal with on a day to day basis. So, we are always looking for those kinds of examples from our centers, employees and everyone else to use in this forum. The only way that I know that we are really going to get this word out is to pick the right examples, let people know what we are doing and for people tell it in their style to their community in environments where they work. We don't have a good mechanism for advertising or soliciting or going to Madison Avenue hiring people to do that, but we can try to do that through the opportunities that are provided by the media if we have the right examples. We have to do more work there and we are challenging our public affairs office to do it. As always, we accept the criticism and would certainly like any suggestion of we could do it better.

QUESTION: Next year, what are you going to be doing to answer the question: "So why do we get another $600 million" or whatever the number happens to be at that point?

FOLEY: I think part of the answer to your question is that they are restricted by law from engaging in some of those activities. So, there are only a certain number of things NASA can do with appropriated funds. If they had money from some other source, they might be able to do that.

RECK: Typically, we have some restrictions in doing direct advertising as most federal agencies do. You can do it for recruiting purposes. If you refer to the Space Act, you can find within NASA's charter that we are able not only to collect scientific information but to disseminate it. A great deal of work is very important, is justifiable in disseminating the results of our information. So, we do try to generate things that would be readable, not in jargon or scientific detail, but would be readable and understandable to people who don't have our expertise. We just literally have to do a better job of that. We have to do a better job of what we are going to say we are going to do next year, what accomplishments are we going to have, what are we going to deliver with the advanced communications technology satellite that demonstrates all of the industrial and commercial opportunities that you can use satellites for and use high data rate satellites for. What are we going to do in terms of new products that are going to come about as a result of SpaceHab and the work that we do with commercial space processing and materials processing. Very recently, CNN ran a short clip from a press conference that we held in Washington on the results of SpaceHab 1. That actually got pretty wide attention, and I had a lot

of people talk about later the gas permeable experiments that were run that could lead to longer wearing contact lenses. We have yet another experiment in the schedule in this coming year on the next SpaceHab flight that should answer the questions whether this is a viable, value added commercial product that is going to go on to be used.

VENERRI: Let me just say a little bit more directly, your question is something that we have been thinking about this year. Let me tell you how we are going to get at it. Putting out brochures, is one aspect of communicating. We also thought of a more direct way. What we are doing is getting local towns and high school student involved and let me just give you an example. We are looking country wide, remote sensing, imagery sensing from space is needed for art work. We are going into high schools and saying we are going to give you images of your community. You can do things as part of your science class to do watershed management, provide information back to the department of agriculture. This stuff is coming from NASA. It is not talking about brochures or benefits. You get whole communities understanding. The kids go home and tell their parents. We are going to have to take that initiative. We are doing that in remote sensing and space communications. We have a spacecraft up there now, the ACTS program. We have mobile vans. We have systems that are on the cutting edge of where industry is going to be on personal or mobile communications over the next five years. We are going to go to rural communities and show how medical treatment can come from a major hospital in a major city back into their communities. It is up to us to do that. The only way that we are going to get that grassroots understanding is as the Nike commercial says, "Just do it." We are looking at how to do things that will touch everyday life in the community. That means that we NASA has to go out into the communities on a state wide basis and generate those programs. We are in the process of doing that now in areas, in particular where we can touch the young people and get the community understanding the benefits from the space program into the community. You can do it in personal communication, remote sensing, telemedicine. We are doing those things now. You can talk about all the marketing in the world, but this is the most effective marketing that we can think of and that is what we are going to do.

QUESTION: It seems to me from my involvement with the Space Engineering and Research Centers and the closures, there is such a outreach in terms of interface between government as well as industry in developing sort of frontier areas of industrial technology transfer. This is one of the few areas that I would hate to see closed that seems like it should be supported more heavily. That may not be true across all the eight or ten that you have, but it seems to me that it should be more selective because that is one area that needs to have a second look. I think that it is the kind of place, a stepping stone between industry and universities that is really going to be helpful in the years to come, that probably shouldn't be closed down. There probably has been more thought that has gone into this, but I am saying from the standpoint of the Air Force as well as industries involvement with the SERC in Albuquerque, this is one of the enlightening areas of NASA's outreach that I hate to see closed.

VENNERI: We closed down an entitlement mindset in the budget that set aside X amount of money for universities. That is not to say what they were doing is good, bad or indifferent. In fact, some of them were excellent, and University of New Mexico is one of the more success stories. We are very familiar with that. What we have done, is we have met with all directors. We told them the situation, and basically said we are no longer setting aside money for activity for the sake of it whether it is good, bad or poor. But, that you are going to compete on a levelized playing field with our total budget and here are the rules of the game. Basically, if you have something that does what you just described you will be a part of our program. But as far as having a separate budget set aside, it is no longer 1989, it is 1994 and our situation demands more of an even keeled basis. What will be maintained are the best ideas in all of our programs, not just set aside of a 10 million aspect here and a 10 million aspect here. We are putting everybody, including our centers, on a levelized playing field of doing business the way we described the process.

QUESTION: We have no moon-mars program. The space station doesn't look like it is producing a lot of spin-off technology. The shuttle has been around for about twelve years, I would think you have spun-off about all that you can spin-off from that. What happens as NASA's budget continues to shrink and you don't have new starts? What are you going to spin-off to these people? Isn't that sort of what we are talking about, a lot of management stuff, but isn't the key to getting this technology having programs.

RECK: We still have as we suggested several times today, a strong program at $600 million which is producing on a regular basis, every year, a variety of technology products. We haven't gone into the details this afternoon of all of the discipline technologies and all of the various spacecraft technologies areas that we are supporting there, but across the spectrum of materials, structures, sensors, robotics, information systems, recorders, propulsioned power. We have active programs underway in industry, at universities and at the centers that are producing on a regular basis advances in those areas. We are doing a better job of coordinating with other organizations in trying to develop a better picture of how those will focus on more product lines in the future, but that program is continuing to produce results and those are the technologies we are trying to capitalize on in the tech transfer areas that we have been talking about. In addition to that, we mentioned the $6-7 billion within the NASA budget that is focused on R&D: mission to planet earth, space science, astrophysics, mission to the planetary exploration, aeronautics which still has a very health budget and is focusing on a number of very basic technologies that have applicability to a wide spectrum of commercial industry. So, there is a very active program within NASA. We haven't taken the time today to detail all of the various technology areas that are underway and that is the sort of thing to do when we have time to do it. To talk about some of the products that are coming out of that, and the areas we are having success. Unfortunately, we have focused today I think, not unfortunately, on more of the changes and what we are trying to do better to capitalize on those ventures. But there certainly is another day's worth of time that could easily be spent talking about what we are doing in those programs and how you could all benefit from those too.

QUESTION: So, it is not going to hurt the technology pipeline that the NASA budget is going down. That might be one interpretation of what you just said, but I don't think that is what you meant to convey.

RECK: Listening to the sort of discussion we have had today, the NASA budget has only gone down very slightly this year. In fact, I think we are doing business better and we are talking about techniques and approaches that are going to use money that we get more efficiently and capitalize on more resources in the program. I think a large point that we have been trying to make is that we think we can do a better job in the future than we have been perhaps in the past in doing business differently. I think that we have more promise in the future of actually getting results and influencing the economy as well as NASA missions with what we are doing. NASA is still in the space business. We are still in the missions we talked about in our enterprises in science and so forth. NASA is going to be judged on those missions, and we are still focusing on in a very strong programs in each of those areas. At the same time, the administrators established that there is another mission that is equally important to all of those. That is probably the most important policy direction that we have had in the last year. In a policy directive from the administrator, he clearly identified the commercial mission of equal importance to the others. Those are the changes taking place and we are capitalizing and providing ways of utilizing and transferring those technologies and taking the best advantage of them. So, I think it is a stronger program.

QUESTION: Looking across the different agencies around the world, everybody has been critical, but do you think there are any other agencies or organizations doing better technology transfer? If so who, and are you looking at them?

DR. SYED: We have been looking at all of the federal government agencies and how they are doing. We have studied and incorporated some of the methodologies, techniques and approaches that the Department of Commerce's Advanced Technology Program used to deploy resources to small manufacturers and businesses. I think we are not closing ourself from learning from other people and their experience, to the extent that the experiences are there and since they are there, we are building on it and going beyond it. Clearly, all of the agencies DOE, Commerce and DOD, everyone is trying their best to do the job most effectively. They have different tools and techniques. For instance, at NASA we have the fortune of having the Space Act, which is a much broader and comprehensive legislation that allows us to experiment and do things that are more innovative and proactive. So, even though other agencies are doing it in a way they are legally allowed to do so and they are succeeding at some levels and we are succeeding in other levels.

QUESTION: You have told us about a change in attitude in government about working more towards partnerships. What evidence do you have that there has been a similar change on the part of industry, or does industry simply regard this as a new song and dance they

have to go through to a get money from the government?

RECK: I think there are many faces in industry. This morning we heard many nuggets of the things that have been reinforced this afternoon. We heard about trying to search out and identify new business opportunities, nontraditional opportunities, new ways of working. I think industry is feeling the pressure, and in many cases even before NASA. Given the current constraints on budgets and the economy, it is conducive to look at the new opportunities and resources they offer. I think we found industry to be very receptive. As we demonstrate success in these programs I think it is going to turn around even more. I think industry is very anxious to see government invest its money wisely in ways that it can help.

QUESTION: One thing has been puzzling me about this new satellite program. Your objective is to develop a satellite bus that you can buy for less than $20-25 million. I am aware of at least three companies — they may be small and they may not build they slickest satellites in the world compared to some of the things that NASA is used to flying — but they produce satellites today that are flying in space now for $3-15 million. So, I don't really understand why NASA has to prove why it can be done for $20-25 million. Why don't you just buy one of the cheap ones that have already been proven?

VENERRI: I am aware of some of those same companies. We wouldn't do this program if we just wanted to maintain the state of the practice in spacecraft design and integration of advanced computer chips, memory, looking at on-board processing as a norm of information instead of sending 1's and 0's back. We are also looking at advancements across the subsystems into not only silicon based arrays, but array systems that can be folded up like saran wrap and have higher efficiencies than what we are flying today. The bottom line is if we just wanted to procure spacecraft, there are a host of companies, both big and small, that we could buy systems from. We are looking at moving into state-of-the-art — what we would call the next generation of small spacecraft — to demonstrate a higher level of technology insertion and, more importantly, how a much higher level of integration of the payload instrumentation will result in a reduction in the problems we are currently experiencing. If you look at the way we structured the proposal, a low ball cost will not win you this program, so it goes beyond state of practice as of today. We are looking at the next generation of systems including a much higher degree of integration design and pushing technology across every subcomponent that goes on that bus — including the way we can do the design an qualification of that technology.

QUESTION: So, the Air Force STEP program does not satisfy your needs or the work that Phillips Lab is doing? They want to become a supplier; they want to have a program to do small satellites as well. The Air Force has already done that with STEP. I'm sure you are aware of that.

VENERRI: Yes, and in fact, we have a few of the Air Force people on our evaluation board because they are interested in coordinating what their needs are into what we are doing. NASA is not doing this without Air Force involvement. The Air Force is integrally involved with structuring this program. In fact, Jean Geon out at Phillips asked if I could put another Air Force person on our evaluation team, simply to help him over the long run. NASA and the Air Force are totally linked together over what we are going to do over the next five to ten years in spacecraft technology.

DR. SYED: Going back to the question earlier that you asked about doing a better job in promoting space, I just wanted to mention that NASA is an agency which is in public service. If there is a will on the part of the public to have a space program in the future, then clearly we are there to help and do the job. The possibility exists for defining new frontiers in space that belong to all of us. It belongs to all of you as well as the next generation. I think it will take us doing what we are doing at NASA, and we can do more.

It is also clear that organizations outside have a role too. I had a discussion at lunch with Jack Flannery of the U.S. Space Foundation. He was talking about how the U.S. Space Foundation is thinking about promoting and doing things in a way that makes sense, and that those ideas are being pursued. I just wanted to let you know that we all need to do it, and it is clear that it will take all of us doing it in order to succeed.

Space Commerce Review

Robert W. (Bill) Schick
Senior Manager
KPMG Peat Marwick
Mr. Schick is now Cheif Operating Officer at Magnet Interactive

BILL SCHICK: In the years past, we thought of commercial space as a novelty. There were visionaries, opportunist, and then there were a few scam artists that led the way. Speaking with Tom Velez of CTA last night — you heard him this morning — he indicated that he recently reviewed a variety of policy and industry discussions than were developed about ten years ago. He noted that they are they same issues: financing, launch costs, multi-year government financing or funding, all the familiar issues. But listening to today's sessions in which industry provided their perspective, and NASA discussed a new approach for technology conversion, I am encouraged that there are new opportunities emerging. While many of the old issues still do remain, we see a convergence and an increase willingness to take risks, both in government and industry. In the past, commercial space was an isolated outpost. There existed a few narrowly defined programs in the launch business, on-orbit services, materials processing in space, remote sensing and satellite communications representing the essence of commercial space. However, many of these market areas are becoming more mainstream and now you hear a different term used, now it is called dual use technology; it is called defense conversion; it is called government infrastructure investment and other terms like that. But yet skeptics say, that there are no good examples, there are no success stories, but maybe I'll take a second and show a few and take a stab at providing some examples.

Before I do that, Theresa Foley mentioned a study that we did in concert with *Space News,* this was called Space Business Review. It discusses several of these industries. Let me start by talking about communications. There are a lot of people who don't view communications as a commercial space industry. I guess because it is successful, so therefore it does not count. Every dollar spent to send a call over a GEO satellite by AT&T, or who ever is using the PSTN to link up to the satellite to go overseas is a dollar spent on commercial space. Every dollar spent on satellite development, or building, or launching for what we consider pretty mainstream, such as watching the Olympics, watching the Super Bowl and so on is an investment in commercial space. NASA ACTS program, talked about earlier, clearly has a commercial focus to much of its technology. Again, not all communications satellite projects will win, but the ones that do should be considered commercial space successes.

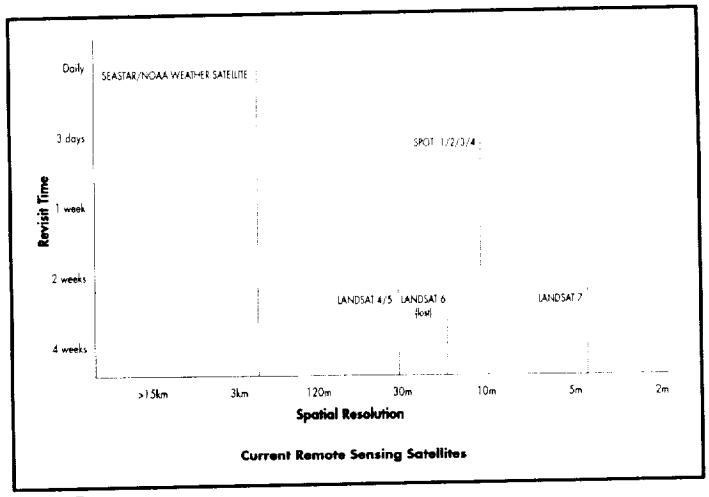
I also want to talk a little bit about GPS. We heard this morning from Randy Hoffman that Magellan is approaching the K-Mart market. This is certainly more mainstream and is a great example of commercial space success. Consumer markets in boating, hiking, IVHS applications, position location and so on representing commercial success. What you see is that there are a lot of players in the industry, and a lot of people come and go but there are many players in the industry investing, making money, and trying to make a business out of GPS. Rockwell has a significant amount invested in GPS and there are others. This is not a complete list, this is just a sampling. There are a lot of markets that are considered. There are a lot of potential applications. It is satellite based, it is GPS, it is a commercial space success.

To continue, I will talk about direct broadcast for a moment. First, let me ask a question. We have heard a lot of information on the information superhighway. What is that? Yes, fiber optics play a key role. The RBOC's, the Regional Bell Operating Companies are playing a lead role in developing this future commercial gold mine. But, investments in space technology are in fact a part of this information highway. These are real, just like fiber, and they will become more real as some of the mobile satellite communications technology takes hold. Real investments like TCI, such as TCI and the Bell Atlantic merger which subsequently failed, will continue and will include consideration for satellites. For example, a subsidiary of TCI has a real investment in direct broadcast satellite technology. Rupert Murdock and 20th Century Fox have invested millions of dollars in direct broadcast satellites overseas. There are content providers exploring all avenues. In fact I worked with a company called Magnet Interactive Studios. They are an interactive multimedia developer that has spoken to a variety of satellite companies to find ways to put their interactive products on hundreds of channels that will be available in years to come. They are also looking at NASA virtual reality technology and considering how to

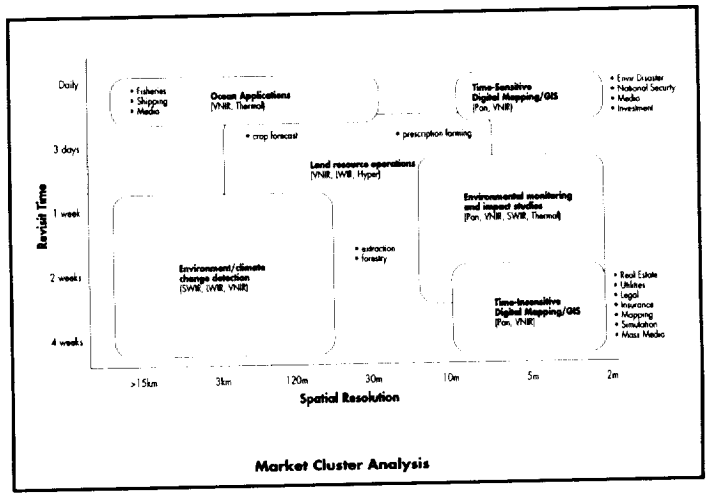
take NASA derived virtual reality technology and turn it into the next set of games, the next set of corporate interactive tools and so on. Let's talk about where the market is going, and why remote sensing is all of a sudden developing some appeal where for years it has been a moving target.

If you look at a lot of the current satellites that provide or maybe would some day provide commercial remote sensing imagery, you can see some of the weather satellites, Spot 1-2-3-4, (Landsat 6 is taking images of the ocean at this point), Landsat 7 — who knows what new opportunities continue? The point is, based on the chart (Fig. SCE-27) with re-visit time and spacial resolution being the two axis that there are current markets being served. Now, let's take a look at the market (Fig. SCE-28). If you look at the market, and this data comes from a variety of studies that we have done both for NASA and for other agencies and for some private companies that are interested in this area, you can see the market falls in a variety of patterns. Without going into detail, it runs the full gamut of spacial resolution, again these are only two axis, you could look at this from spectral requirements, you can look at this in a variety of ways. When we overlap the two, what emerges is an unmet demand (Fig. SCE-29).

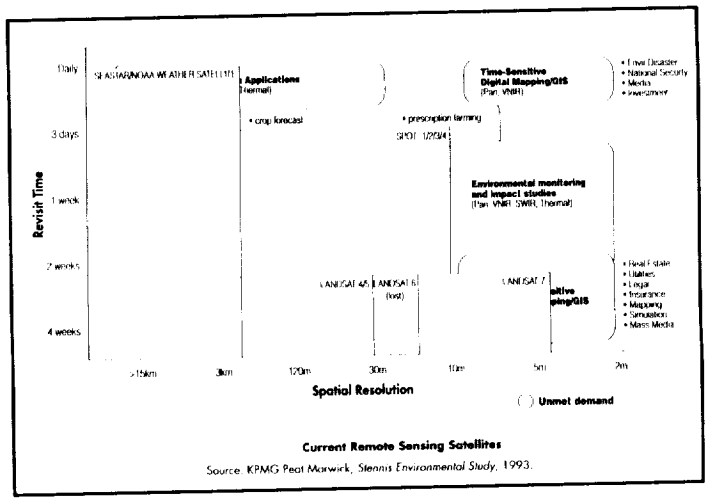
Now, the importance of that chart, I think is underscored by what Brian Dailey said this morning about the policy. The fact that the policy has come through in favor of allowing high resolution systems being deployed by commercial operators essentially opens up that far right hand side of the market. Another key issue is timeliness and revisit and a lot of other business factors that I think up to this point we have forgotten traditionally in the industry. It has been a technical solution. Everything has a technical solution. Let's face it, it is a business solution when you come right down to it because the technology is doable. But the point is, there is an unmet demand that will be met by a variety of players in the market. We don't know who will succeed and who will not, but somebody will. If you look at the list of satellites and sensors, you have three players out there that are seriously considering investing a lot of money in tackling these particular markets, Lockheed, Orbital Sciences' GDE and ITEC initiative called the Eye Glass, and then of course you have the WorldView satellite working with CTA. There are other programs that I am not at liberty to talk about, but some of which you may know about that haven't been announced yet. The Russians may get into the market with ALMAZ 1B. So, there are a variety of opportunities looking at that particular demand.



SCE-27



SCE-28



SCE-29

Also, talking about the Stennis Space Center again, here is a good example, I think, of government and industry working together to stimulate a commercial interest. NASA commissioned a fairly detailed market study of the commercial remote sensing industry. It wasn't a study on technology, it wasn't a study of specific spectral bands and so on, it was a study of end user needs for observation activities, observable insights that an end user might use to run a more efficient farm, to build a new shopping center more efficiently, any number of application. Some of which won't be handled by remote sensing from satellite absolutely. Some of which will be handled by aircraft for now and forever,

Government investment programs talked about this afternoon are now using terms like return on investment, dual use, shared risk, nongovernment market, and others that apply real interest to economic competitiveness and commercial payoff.

but many applications that can be met by some of these proposed systems that are being talked about now and developed. The defense Landsat program office and their studies for the advanced land remote sensing system which some of the companies out here probably know of are looking at commercial requirements in addition to the DoD requirements. They recognize that the commercial application helps to justify programs and so on.

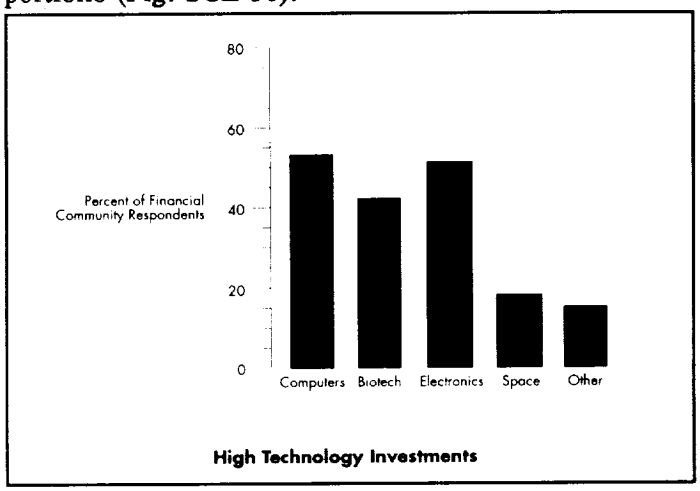
Next, let's move to launch, a sore subject by some. Launch costs are still high, not much commercial activity going on to justify large investments in new launch systems. However, I think as you will hear later in the week by General Moorman's panel, the government and industry are looking at how to get this done, how to be innovative, how to find new ways of getting vehicles that make the U.S. competitive again in this area. I think you will see more of that in the panel that will follow General Moorman's remarks too. But even here, there are some examples of risk taking. Granted, not without government support and government funding, but yet there are beginning to be new ways of thinking, the Lockheed launch vehicle, the SSTO, DCX Project, they are government funded and they represent positive change. But the point is, that people are trying to explore new ways, trying to look at new opportunity. Taurus' successful flight is another example of some risk taking and some commercial vision.

On-orbit opportunities, while not currently commercial, provide an R&D focus to that activity. Materials processing in space for years has been the genie of commercial space that has never appeared. I think there are some examples where given time, some of this will materialize, but again would I rest my entire investment future on on-orbit services and materials processing in space? Probably not. Is it worth pursuing at some level? Yes, I think it is. There are some good examples. For example, the Wake Shield program got some bad press. It was a failure, but it wasn't a total failure, it was a first in an attempt to develop a new capability. It had some success along with some failure, but the point is that the team learned from the failures and are developing changes, they are fixing the systems for the next time — and there needs to be a next time. They did get some good results and it did have a marginal degree of success to build from and try again. Protein crystal growth, another area that people have heard about, while not tomorrow, or a week from tomorrow, but there is real potential there. There is a new public biotech company called BioCryst in Birmingham. They have compounds that are getting ready to go into the animal and human trial, to get FDA approval. Some of these compounds were developed through the advantage of crystals grown in space. So, here is an example. Does that mean that there will be a revolution in the pharmaceutical industry because of this? Probably not. Over time there will be changes and benefits made from this kind of technology though.

Government investment programs talked about this afternoon are now using terms like return on investment, dual use, shared risk, nongovernment market, and others that apply real interest to economic competitiveness and commercial payoff. I think as you heard Sam Venerri say, government agencies have to compete for federal dollars, and the competition is going to based on economic reality. Quite frankly, I think it is a wake up call to everyone that we have to think differently in the way we consider commercial space or should I say space commerce, to broaden the term. As budgets decline, shared risk is more important. Industry is going to be asked to step up to the table more. The industry is going to have to consider its position, are you ready to step up to the table? Some companies may not be, some may be dependent on your own corporate health and interests. The investors are still skeptical, no question. They are starting to listen, however, and ask more questions. There are real markets and people are making real money and starting to take notice. I have a friend

from Dillon Reed — an investment bank — who called be a couple days ago and asked me about three companies. I had heard about everyone of them, and knew each very well. That struck me as interesting because this individual had never before had anything to do with space, could care less about space, in fact he was in health care. But now, there are some big deals crossing his desk that he is interested in, so he asks.

What I would like to do now is very quickly go through the summarization of the results of the study we did with the investment community. It is not scientific in the sense that I won't stand here and tell you that it is statistically valid, but yet it does provide some interesting insights. Many investors, and I am talking primarily the financial markets now, invest in a high technology portfolio (Fig. SCE-30).



SCE-30

Now clearly, evidence does not show space as one of the leaders, but the interesting thing is that space is considered at all. I think there are probably a lot of people who would say that there is no interest at all, but I think this shows that is not the case. However, computers, biotechnology, and electronics are still high on the list. One thing to remember though in this broader context of dual use tech conversion and so on, if we are smart we are going to stop being space purists and start being high tech providers of products and services, and the merger of these space commerce areas, will converge and you won't have technology differentiation that stigmatizes the industry. Investors, those who have been approached, and have some knowledge of space, see the potential payoff for space base investment in large comsats. That is traditionally, they have been investing in that area, doing lease deals and project financings for years. So clearly, that is still high on the list. Global positioning is viewed as an area of the near future where a lot of investment is being made right now. Also high on the list, small launch vehicle market. That is tied to the perception of the LEO (Low Earth Orbit) communications satellite market and the potential that might appear in this area. This does not imply that people are making lots of money yet in these areas. This is the potential, where they think some potential may lie in the future. Big LEO comsats and the little LEO comsats are exciting areas for investment.

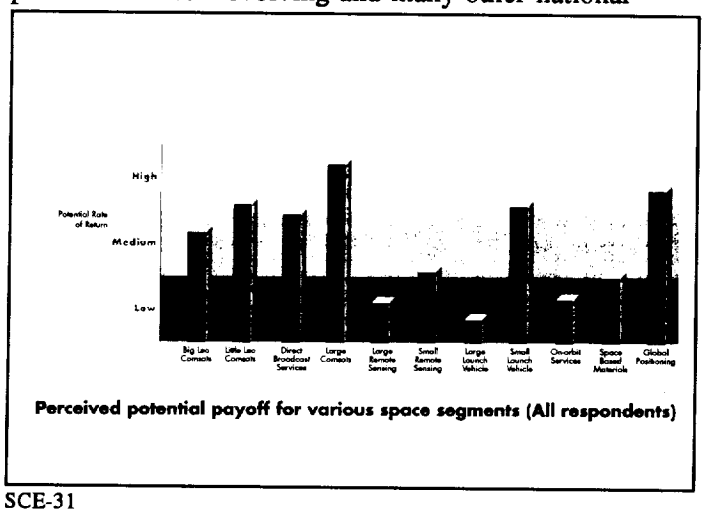
Looking at the payback period, large remote sensing satellites right now have the longest payback period, ten to twenty years is the perception. But on the contrary, small remote sensing systems, ones that are dealing with niche markets that are economical, that are cost effective, that are focusing on the business aspect of remote sensing have a better payback period (Figs. SCE-31 & SCE-32). It is still not tomorrow or next year, but it is five to ten years which is not inconsistent with several high-tech venture portfolios contrary to what many people think regarding traditional venture financing where you are putting money into something that has a large payoff down the road and is high risk.

There is also significant investment in other countries (Fig. SCE-33). By and large, a lot of the investment that goes into space from these other countries are commercially or economically motivated. So, where we have a national budget for space, percentage wise it is probably a lot larger percentage economically motivated by space ventures.

Let me conclude by just saying, this symposium that begins tonight will focus on the windows of opportunity, that is the theme. While the vision of space commerce is only now beginning to expand, albeit slowly, more private, corporate and capitol market investment is materializing. While many national space issues still exist, and there are still many problems ahead like multi-year government financing, shared risk, declining budgets and other issues that have been talked about throughout the day and over the years, there actually are some shining stars, windows of opportunity and visionary first steps in the works. This conference will begin to open the window to new opportunities for commer-

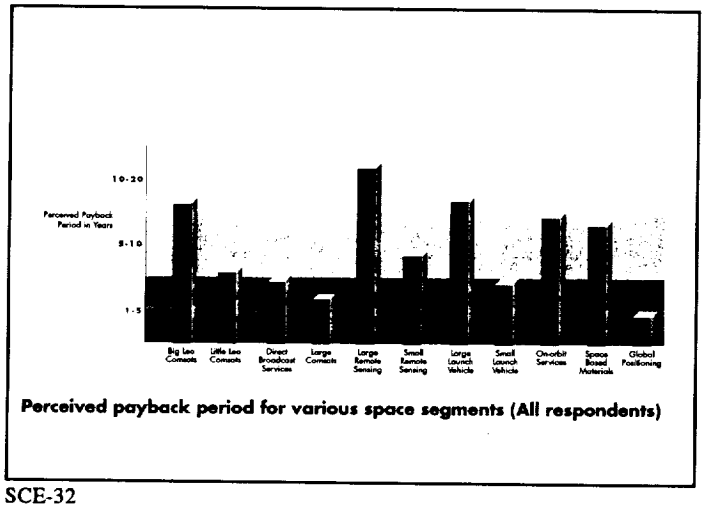
...if we are smart we are going to stop being space purists and start being high tech providers of products and services, and the merger of these space commerce areas, will converge...

cial, dual use, shared risk, space commerce or whatever you would like to call it. It is true that government priorities are still evolving and many other national



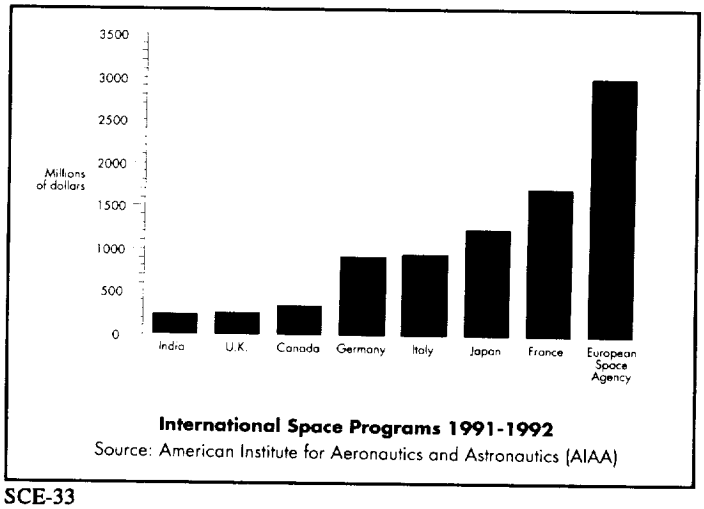
Perceived potential payoff for various space segments (All respondents)

SCE-31



Perceived payback period for various space segments (All respondents)

SCE-32



International Space Programs 1991-1992
Source: American Institute for Aeronautics and Astronautics (AIAA)

SCE-33

problems exist that are monopolizing the Administration's attention, but we did hear from Greg Reck and Sam Venerri that NASA is changing, while time will tell of its success, real money and effort is being made. Other agencies like DoD, DoC, DoE are actually investing in technology. However the industry, and now primarily the people out there who have to make these business decisions must continue the trend towards becoming more competitive and self sufficient. Again, according to Brian Dailey, he spoke of a trend in merger and acquisition activities adjusting for supply and demand. In closing, to echo this common theme, the companies and the industry
must continue to evaluate the risk and reward of applying the vast resource that you have to a new global economy where everyone benefits from what I consider to be a growing opportunity. For those staying on, you will hopefully see this theme carried on throughout the rest of the symposium. Thank you.

Q&A Session

QUESTION: Someone from the previous session brought up the issue of marketing with the space program. I would suggest that we all reread the U.S. Space Foundation's vision and its goals, they are very simple. The vision is an aggressive, successful American space program leading the world. The mission is to promote national awareness and support for America's space endeavors, and it does that by providing customers and constituents with high quality programs and materials that optimize national awareness. So, the simplest thing we can all do, both government and industry, is simply up our support to the U.S. Space Foundation.

THERESA FOLEY: Bill, you put up the chart of all the foreign space agencies that invest more directly in commercializing their industry. It is my impression that when ESA awards a contract for example, communication satellite technology, they really sort of put the money into Aerospatiale or Matra's pocket, with the idea that the company is going to go out and take on everybody else as soon as they do the program. But, if NASA put money in Rockwell's pocket or Lockheed's pocket with that idea, it would cause a terrible uproar in the industry. Should that be part of the Clinton administration's change in policy? What we are hearing NASA say, is that the proposed changes are nothing along the lines of emulating what goes on in other countries to be competitive.

SCHICK: You raise an age old problem of do you subsidize or not subsidize. My personal opinion is that in fact we are engaging in a form of subsidy through a variety of programs that are on going now in TRP and ATP and some others. It may not be direct slipping money into the pockets of the companies to go out and be commercial and take on the world, but it is money going directly into the pockets of those who hopefully invest some of their own money and resources and over time will be able to do just that. So, it is a matter of degree I think, in how one interprets grants, contracts, TRPs and so on. Is it equal, is it fair, is it the same? I don't know. So, it is a good question, but I don't have a good answer.

10th National Space Symposium
Opening Ceremony
A Tribute to Apollo IX

Apollo IX Crew: James A. McDivitt, David R. Scott, Russell L. Schweikart

At precisely 11:00am, March 3, 1969, Apollo IX roared into space atop its Saturn V launch vehicle. Eleven minutes later the Apollo IX space craft entered a near-perfect circular orbit 103 nautical miles above the Earth. For the next 10 days, Commander James A. McDivitt, Command Module Pilot David R. Scott and Lunar Module Pilot Russell L. Schweikart would put the Lunar Module through a grueling series of tests. Data form this mission would prepare NASA engineers for the eventual first landing on the moon with this craft, only four months later. Considered a "flawless performance," President Richard Nixon congratulated the astronauts personally declaring: "The epic flight of Apollo IX will be recorded in history as 10 days that thrilled the world."

Apollo IX was the first space test of the third critical piece of Apollo hardware checking out the lunar module in Earth orbit. The crew put all three Apollo Vehicles through their paces, undocking and then redocking the lunar lander with the command module, just as they would in lunar obit. Schweikart and Scott performed a spacewalk. Schweikart checked out the new Apollo spacesuit, the first to have its own life support system rather than being dependent on an umbilical connection to the spacecraft. Apollo IX gave proof that the Apollo machines were up to the task of orbital rendezvous and docking.

Present at this evening's tribute were Jim McDivitt, Dave Scott, Rusty Schweikart, Pete Conrad and Dick Gordon.

The Honorable Bill Nelson
Maguire, Vorhis & Wells, PA
Former Congressman and Astronaut

BILL NELSON: Space exploration, like all pioneer work, demands more than physical courage and finances. It calls for a willingness to stretch the limits of one's horizons and stretch beyond our little worlds of comfort and fear in which we all live. This means we explore not only space and the unknown, but the possibilities of working with all those who share a common goal for a grander purpose of "peace on earth to men of good will."

The cost of space exploration is high — yet no greater, relatively speaking, than the sum provided by Queen Isabella of Spain to finance the trips of Christopher Columbus in 1492 and following years.

We would hope that most thoughtful Americans understand this, and are willing to help foot the bill. But do most Americans in 1994 really support us? I believe deep within their hearts is a special excitement for space adventure, but with crime, healthcare, poverty, education and jobs commanding center stage, will not the competition of other problems crowd out the space program?

It will ... unless we change some things.

What is America's primary mission in space? Do we have a defined goal, a vision for the future? And what can we do to implement it?

The Ride Report, *Leadership and America's Future in Space,* analyzed four future goals for the space program:

Studies of earth, exploring the planets, a moon base, and a manned trip to Mars. Are these recommendations relevant?

In our democratic system, any program as big as NASA and military space is bound to find itself bogged down in compromise, bureaucratic red tape, and the struggle to flow with political and economic trends. That's not necessarily bad. The democratic process, as cumbersome as it is, demands that NASA keep its structure flexible and expandable. Now, NASA is being forced to re-examine its goals and is, perhaps for the first time in a long time, forced to look to the American people for direction.

Given these difficult times, I would like to offer some suggestions:

1. Articulate a set of clearly defined goals, so that the American people can understand them. Studies of the earth, exploring the planets, a moon base, and an eventual manned mission to Mars are a good place to start.

2. Marry the space program to the environment. Mission To Planet Earth should be emphasized. The environmental community doesn't even know anything about the Earth Observing System. And there should be closer ties between NASA and EPA.

3. Forge alliances with international partners. Cooperate with all nations, including the Russians, including the Space Station. The use of Russian hardware should be incorporated with a fallback position. Mission *From* Planet Earth will include many nations and is of political importance to the United States.

What is America's primary mission in space? Do we have a defined goal, a vision for the future? And what can we do to implement it?

4. Explain our space and technology accomplishments by communicating more effectively to the public. For example, the role of space in any war. Declassify some systems so Americans will better understand space's application to defend. Explain how space technology applies to our every day lives.

5. Be credible, realistic and honest in our answers. We should not give explanations built on deception and exaggeration.

6. Then urge the President and Vice President to lead, and, as they do, support them.

Bill Clinton is a space enthusiast. I know him and I know that to be true. But we need to give him some political capital by helping the American people to understand and approve of a vigorous space program. Only the President can lead, but especially when the nation's finances are tight, he needs the support of the American people and the support of their representatives in Congress.

It may shock you to know that space may not be relevant in the minds of many people. This year we are celebrating the 25th Anniversary of Apollo, but did you know that millions of Americans have been born since we triumphantly landed on the moon? Furthermore, did

you know there are 110 freshmen Members of Congress who were elected to bring change to the Nation's agenda, and rarely does their definition of change include space?

After this year's election of another 100 new Members of Congress, over half of the House of Representatives will be young and bright and eager and many will have no personal recollection of Apollo XI's landing on the surface of the moon.

Make it relate to the American people's hopes and dreams and the space program will become relevant to the Congressmen as an appropriate answer to the Clinton Administration's yearning for new investment, environmental protection, math and science education, defense conversion, and global economic competition.

Times have changed, and we who are inspired by a future in outer space better change with the times. These times are more fiscally constrained. NASA cannot realistically even expect a budget that annually keeps up with inflation. These times are more partisan in the attitude and actions of our leaders while the space program begs for bi-partisanship. These times are more complicated since we don't have a rallying point around a cold war competition.

These times are more difficult to get decisions that stick, since the power to decide has been dispersed among many committee chairmen, agency heads, and executive branch staffers.

These times are more frustrating because not all of the news reported is good, and occasionally some of the news about space is slanted to the negative. And media communication is pervasive, constant, and is a big business that looks at the bottom line. Be honest and straightforward with the media and take our licks along with the praise. But let the free exchange of information occur and the truth will win out.

And these times are more challenging because we cannot take the U.S. space program for granted anymore. Today the national space agenda must be fought for line by line, dollar by dollar, mission by mission. But it is worth fighting for!

So Madam Engineer, Mr. Technician, Mr. Military officer, Mr. Aerospace Executive, you had better call your Congressman and get to know him or her personally. You need to attend his town hall meetings. Set up a tour of your plant operations. Let him look into the eyes of the people who work there. Tell him how many are employed. Get your spouses and uncles to write about the nation's civilian and military space program.

Make it relate to the American people's hopes and dreams and the space program will become relevant to the Congressmen as an appropriate answer to the Clinton Administration's yearning for new investment, environmental protection, math and science education, defense conversion, and global economic competition.

After we get over this present hurdle, we will eventually reach out to colonize other world's with human civilization.

Man is evolving into space and is going to operate there. Regardless of the problems, space is our next frontier. To neglect it would be as foolish as saying to Lewis and Clark, "We have everything we want back east. There's no need to go beyond the Mississippi."

The American adventure is a story about heroes, about discovery, about exploration, about people who forge ahead. That is the nature of our country. We have always been a nation that is restless unless pressing the unknown. We have always had a frontier to expand: westward, inward and upward.

Nothing has symbolized the character of the American people as explorers, as discoverers, as adventurers, like the space program. If America ever abandoned her space ventures, then we would die as a nation, becoming second rate in our own eyes as well as in the eyes of the world.

If America ever abandoned her space ventures, then we would die as a nation, becoming second rate in our own eyes as well as in the eyes of the world.

I believe our next major space goal should be the completion of the Space Station, while exploring the heavens and studying the environment with the Earth Observation System, then colonize the moon, and then on to Planet Mars with humans in the next century.

So it is time to move beyond our insecurities and missteps to the expected triumphs of the future — to articulate our major goals and enter into a national resolve to build on our experience and explore the unknown.

Thank you.

Windows of Opportunity

Jean-Marie Luton
Director General
European Space Agency

I would like to thank Mr. MacLeod, the President of the United States Space Foundation, for again inviting me to Colorado Springs to be part of this highly productive and stimulating series of symposia which brings together space policy leaders from around the world. As you may know, this is the second time that I am joining you, and it is an honor and great pleasure for me to have the opportunity to deliver the keynote address at this year's symposium and to discuss with you space policy issues, program and strategies as seen from a European perspective.

I believe that this dialogue is essential for all of us if we want to maximize the benefits of each country's space endeavor. The past conferences in this series have been very valuable and fruitful events for promoting and strengthening the cooperative spirit among space agencies and for helping to build bridges between those countries engaged in space activities.

This morning I would like to take the opportunity to focus on the European Space Agency's participation in the planned international space station project as well as to address international launch issues, two subjects which ESA (and our member states) follows very closely and, I must add, not without concern, in particular as regards the fate of the space station. This is in the light of the bouts and reservations expressed by some influential policy makers in Washington who, until recently, were among the leading supporters of the project. You all know that since 1988 the space station has represented an important element in Europe's cooperative undertakings with the United States, Canada and Japan and is an integral element of our international space cooperation program through our enlarged partnership with Russia.

First however, I would ask you to go back with me to twelve months ago. Since I was here last April to inform you of the decisions taken by our ministers in Granada, much has happened in Europe. The primary task for ESA during the past year has been to implement those decisions and to initiate the programs with our partners in industry. I can tell you that we have worked hard to obtain the necessary financial coverage for the approved programs which, in a time of continuing recession, was not easy. It will not be a surprise for you to hear that NASA's budgets are not the only ones not increasing. Some major contributors like Germany and Italy have made significant reductions in their space budgets compared to the Granada plan and have thus been forced to reduce their contributions to the Agency's programs as well.

In addition, a major preoccupation during the intervening twelve months has been the exchange rate problem affecting some of our member states' capacity to finance the programs decided in Granada. The sinking currencies have meant that subscriptions to international scientific organizations such as ESA have become more expensive for those countries affected by their currency devaluation. This was another factor which contributed to a delay in the start-up of the programs decided in Granada.

I believe that this dialogue is essential for all of us if we want to maximize the benefits of each country's space endeavor.

But in spite of the unfavorable economic climate which has prevailed over the past year and notwithstanding that nearly all the ministers responsible for space from the major countries have changed, some of them even twice, meaning that those who made the decisions are no longer in office, we have been able to achieve a great deal.

Following the latest Council decisions of December and the beginning of this year, ESA has been able to secure the go-ahead for its future Earth observation program which comprises Envisat-1, an environmental mission to be launched in 1998, and preparatory activities for Metop-1, a mission dedicated to operational meteorology and climate monitoring from polar orbit. This latter mission, to be launched in the year 2000, will be carried out in partnership with EUMETSAT, the European Organization for the Exploitation of Meteorological Satellites.

In addition to the polar missions Envisat and Metop, we have also an agreement to start the Meteosat Second General program, the prototype satellite which will be jointly financed by the Agency and EUMETSAT. This

PRECEDING PAGE BLANK NOT FILMED

and the ensuing EUMETSAT program will guarantee a continued service for the meteorologists and make Europe a major player in global Earth observation systems.

Europe will be reviewing its options to be sure that its contribution is unique and valuable to all the international partners, taking into account not only Europe's requirements and financial capabilities, but also the contributions from the other partners.

It also means that the European Earth observation community can now look forward to an ambitious program and a perspective of stable long-term funding similar to ESA's Horizon 2000 program in space science which, according to the magazine *Science,* is attracting a growing number of proposals from U.S. researchers lured by its coherent structure and stable funding.

If stability is the biggest attraction of ESA's long-term science plan, this unfortunately cannot be said of another project which is at the center of international collaboration.

This leads me to the main subject of my intervention, namely Europe's participation in the International Space Station. Since I talked to you last April, a series of events has fundamentally modified the context within which the program was being planned.

The redesign effort on the International Space Station which took place last year in the United States invalidated to some extent the ministers' decision in Granada and also created doubts about the leading partners' political will to continue the program. As a result, we at ESA were thrown into a new debate as to whether Europe should participate in the project or not.

During this period, however, we continued to work very closely together with the other international space station partners to validate the space station concept.

After some time the whole picture changed again with the extension of the partnership to Russia. From an overall political point of view, the involvement of Russia is indeed welcomed by everybody in Europe. It is clear though, that such a change also has a profound impact on technical issues which are being solved now and I hope that we shall soon see Russia fully integrated into the International Space Station.

Let me say a few words about Russian/European cooperation in the context of the International Space Station.

In '92 ESA and RSA had envisaged that Europe participate in the development and operation of the planned Russian MIR 2 station. The fact that the Russian space station elements initially foreseen for MIR 2 are now intended to join the Russian segment of the International Space Station prompted RSA and ESA to review the situation. We came to the conclusion that the new concept of one International Space Station did not change the basis of the existing Euro-Russian cooperation and that items developed by ESA should continue to be considered as part of the Russian segment of the International Space Station in the same way as they were formerly considered to constitute an integral part of the Russian MIR2.

Among the items under consideration in this context are the joint RSA/ESA development of the spacesuit EVA 2000, the supply by ESA of an external telemanipulator arm ERA, ESA participation in the modernization of the Soyuz and Progress vehicles and supply by ESA of the Data Management System for the Russian segment of the International Space Station.

At the same time the technical work on the International Space Station has proceeded at breakneck speed, and I am happy to say that a number of technical and political issues that have been on Europe's mind have found a solution. I am pleased to thank NASA for the remarkable work which has been achieved during the last month. Here I am especially thinking of the roles and responsibilities for the partners, at least for Europe, both in operations and utilization which have been defined in a satisfactory manner. With this I mean in particular that the overall approach today is a much more decentralized operations concept whereby, under

The redesign effort on the International Space Station which took place last year in the United States invalidated to some extent the ministers' decision in Granada and also created doubts about the leading partners' political will to continue the program.

NASA leadership, the European laboratory (the Columbus Orbital Facility) would be controlled from Europe. That is to say, the partners take full responsibility for their elements, not only during development but also in operations, so that each partner is contributing to the whole of the space station for the benefit of the others

by managing and sustaining their respective elements.

Furthermore, as regards the logistics of the space station, it pleased me that Ariane-5 now has a clearly identified role for the benefit of all partners leading to a more balanced and robust logistics scenario by relying on several transport vehicles.

We are experiencing an economic climate in Europe which has not been seen since the 30's. Against this background, space endeavor, and in particular, human space exploration, are an obvious and easy target for savings.

Such a scenario, where the financial burden is shared by supplying services for common use, is a sound concept because the notion of exchange of funds - which is always a difficult matter between government space agencies - can be kept to a minimum or disposed of altogether.

Having said this, I must add that the redefinition of Europe's participation and contribution to the space station has still to be finalized with the consequential financial commitments from the European governments. This is foreseen to happen at a ministerial conference in 1995. During this time, Europe will be reviewing its options to be sure that its contribution is unique and valuable to all the international partners taking into account not only Europe's requirements and financial capabilities but also the contributions from the other partners.

However, at the last Council in February, ESA's members reaffirmed their political will and determination to play a major role as a partner in the space station project and decided on an Act which explicitly lays down that "the mainstay of Europe's contribution to the development and exploitation phases of the international space station program will mainly consist of the supply of a significant in-orbit element and in a substantial involvement in exploitation operations for the whole international space station, using the Ariane-5 launcher and associated transport elements." So the details of implementation and required financial commitments have still to be decided and this, of course, in conformity or by taking into account the other partners' agreements which are, at present, in the process of being reviewed.

We are experiencing an economic climate in Europe which has not been seen since the 30's. Against this background, space endeavor, and in particular, human space exploration, are an obvious and easy target for savings. And this regardless of the fact that the actual amount of money going into space is not a major factor in the overall economic system.

Therefore, in times of tight budgets and when daily life requires such sacrifices, it is always difficult to argue for investments in the future. It is our task to make governments and Parliaments aware of the importance of supporting long-term science and development projects which are fundamental and of great value to society. We should try to tell them why we should keep these investments for the future. As everyone knows, any company which meets the daily difficulties by abandoning investments for the future is irrevocably sawing off the branches it is sitting on.

It is against this perspective that Europe and also ESA had to trim its sails of its human spaceflight program and had to come up with a plan which safeguards the future but, at the same time, relieves expenditure in the next years, looking forward to more promising and better economic conditions in two to five years from now.

This situation could be made easier if there are no more doubts about the objectives and the political will to carry out a program that we see in the political debate in the United States, the leader of this effort.

It is well understood that a program of this size and importance needs to be constantly scrutinized and debated. But there comes a time when you have to decide on whether you want the project or not.

I think we have now reached this point. Let us concentrate henceforth on the constructive debate of making the space station a technical, scientific and political success!

As everyone knows, any company which meets the daily difficulties by abandoning investments for the future is irrevocably sawing off the branches it is sitting on.

Before I conclude, I should like to make a few remarks on another critical and sensitive issue which we in Europe are following with great interest and which is of concern to us because of the implications for our launcher industry. That is the challenge we face with Russia, China and Japan.

I believe that everybody recognizes that it is in the

interest of all parties to rapidly come to a solution on this issue if we want to avoid serious problems for our space industry resulting from unfair competition. There is no doubt that a viable and competitive launch capability is regarded by our governments as one of the most fundamental building blocks for our future space endeavor which must be preserved.

We have a situation of a Western space launch industry already having an overcapacity relative to the projected launch rates and that will get worse in the future. According to Arianespace estimates, the number of commercial satellites to launched from 1994 through 1996 is about 23 to 25 per year. From 1997 to the year 2000 some 16 to 19 satellites are expected to be launched per year. Beyond the year 2000 the market should stabilize at about 15 to 17 satellites to be launched per year. This is not even sufficient for two launching systems, as unfortunately neither Russia nor the Ukraine, nor China contribute to the commercial satellite market.

In my view the first priority must be to work toward a balanced agreement from all parties on a modus vivendi which preserves the interests and competence of our space industry whilst allowing the new players to enter in a controlled manner the commercial marketplace without disrupting this fragile market.

Let me conclude by stressing that we in Europe are prepared to play a constructive part in that process and that ESA supports all endeavors to work out appropriate and balanced principles to ensure that the interests of all parties are safeguarded and that competition among the various players in that market is fair.

Thank you.

International Space Station

Dr. Roland Doré
President
Canadian Space Agency

Masato Yamano
President
National Space Development Agency Japan
(NASDA)

Dr. Jan-Baldem Mennicken
General Director
Deutsche Agentur Für Raumfahrtangelegen-Heiten
(DARA) GmbH

Daniel S. Goldin
Administrator
National Aeronautics & Space Administration
(NASA)

DR. ROLAND DORÉ: *"Canada and the International Space Station"* Ladies, Gentlemen and Colleagues, I am very pleased to be among you today to talk about Canada's involvement and longstanding commitment to space initiatives and most specifically, the International Space Station project.

Canada's involvement in space grew out of the need to communicate over large distances and to manage a vast land sparsely populated. Our territory occupies half a continent, borders three oceans and spans five and a half time zones. It is also the only country in the world with a magnetic pole which often affects electromagnetic communications.

In 1962, Canada entered the space age and became the third nation, after the USSR and the USA, to send a satellite, Alouette I, into orbit. In the 70s, Canada became the first country to use a domestic geostationary satellite telecommunications system for commercial purposes. In the 80's, Canada proved its expertise in the field of robotics with the unparalled success of the Canadarm. It was the most complex space robot ever constructed. The Canadarm has performed flawlessly on numerous shuttle missions. The 80s also saw Canada join the International Partners in the greatest ever conceived international scientific endeavor: the International Space Station.

There is no doubt that Canada is committed to a strong space program; one that meets ongoing needs of Canadians; one that allows us to retain and enhance our space industry; one that provides for international partnership and cooperation; and, one that is within our financial means.

As you know, Canada is currently negotiating, with NASA and our other International Partners, a reduced contribution to the International Space Station and a lesser role in the operations and utilization of the Station. These discussions were triggered by the very difficult financial situation that we have now to face in Canada. Our government has recently showed its long term commitment to space activities but with an important reeducation in the yearly budget allocated to space.

Canada has been heartened by the support it has received from all Partners who have pledged their continued support and who have indicated their wish to see Canada remain as a participant in this major international project.

We see the acceptance of Russia to become a partner on space station as a major positive change. It provides all of us with a real live experience and know-how on long-duration flights as well as the existence of some components required to build the station. There is no doubt that this is not only a step in the right direction but a tangible demonstration of an international will to complete this project.

The 80's also saw Canada join the International Partners in the greatest ever conceived international scientific endeavor: the International Space Station.

I think one very simple question bears being asked: Why is the International Space Station project good for the world? Obviously, the first reason which comes to mind is the technology thrust associated with such a project. Consider the technological leaps made over the last thirty years; many can be traced directly to the space age and the same can be said of future technological changes.

Secondly, there is also the benefit of a space lab which will permit the advancement of knowledge

through science in space. The zero-g environment of space offers researchers the unique advantage of modifying or improving the properties of materials. Scientists have discovered that purer materials, larger crystals and new metal alloys can be created in space, perhaps leading to the development of new drugs and goods. There is no doubt that the creation of new products and services based on the exploitation of the station's microgravity environment could generate substantial scientific, industrial and economic spinoffs.

Thirdly, it can lead to a definite development of the space industry in partner countries as well as in many others as the station develops new uses over the next century. Canada's space industry has reached an enviable position. Our expertise in vital areas is world-class; our reputation for excellence is well-known and our industry is competing successfully in global markets. We intend to remain competitive. It is the role of the Canadian Space Agency to develop the vision, the strategies to our goal and to map out the road to future success for Canada in space.

I would be remiss in not mentioning the important leap forward our industry took with the outstanding success of the Space Vision System, tested by Steve MacLean during his flight on the orbiter in 1992. Designed to act as an eye for high-tech robots, like the Canadarm or the Mobile Servicing System of Space Station, the SVS instantly provides a three-dimensional computerized map of the position of the object being looked at.

The International Space Station project is visionary; a vision which is part of the evolution of humankind. Evolution relies on continuity; we must ensure that this project is continued, developed, perfected to benefit all of humankind for centuries to come.

Fourthly, but not least, it is a model for international cooperation. Never before have so many countries been willing to cooperate and share their knowledge and expertise. However, as some of my colleagues have already alluded to, we must recognize that this endeavor is not without its problems and... yes, they must be addressed if we want to see this project come to fruition. Management improvements recently implemented by NASA have already yielded results leading to increased efficiency. This is a concrete example of cooperation. We have built a relationship which leads me to believe that by honestly confronting the issues we will find solutions that we can support. This is and will remain an unprecedented example for the world.

In conclusion, let me say that the International Space Station project is visionary; a vision which is part of the evolution of humankind. Evolution relies on continuity; we must ensure that this project is continued, developed, perfected to benefit all of humankind for centuries to come. Thank you.

MASATO YAMANO: Ladies and Gentlemen, I would like to express my sincere appreciation for being invited to participate in this historic and authoritative National Space Symposium of the United States Space Foundation. I am especially pleased to be in beautiful Colorado Springs surrounded by the majestic Rocky Mountains.

It is really a treat for me to meet so many leaders and key persons in space activities from all over the world. It has been my privilege to continue a dialogue about the international space programs with these distinguished persons from a global point of view.

On this occasion, I would like to speak about the status and conduct on international cooperation for space development in the National Space Development Agency of Japan, NASDA, including cooperation in the international space station program.

NASDA was established as an implementing agency for space applications, in 1969 when Apollo 11 placed human beings on the moon's surface, in contrast to the Institute of Space and Aeronautical Science which was established for space science research. This year, NASDA celebrates the 25th anniversary of its founding.

I would now like to briefly introduce NASDA's space programs.

First, let me introduce Japan's launch vehicle and satellite development. Since its establishment, NASDA has been developing launch vehicles and satellites with an increasing percentage of systems produced domestically but based on technology transferred from the United States. In this way, Japan was able to launch a series of communications satellites, broadcasting satellites, and Earth observation satellites. However, since the launch vehicle is a basic element for space development, NASDA was tasked about 10 years ago to develop the H-II launch vehicle. This effort was motivated not only by Japan's desire to pursue its own autonomous course in space development but also to be able to contribute fully to cooperative international projects by providing this worthy technology.

Last February, NASDA successfully launched its

first H-II. We understand that this is only the first launch success and that there will be many hurdles to overcome. We will therefore continue making our best efforts to advance technology and improve reliability. NASDA has also initiated research and development on an unmanned shuttle vehicle which we call HOPE.

This summer, on the second H-II flight, we will launch Engineering Test Satellite VI, ETS-VI, to facilitate our efforts in establishing 2-ton class geostationary satellite technology.

In the field of satellite applications, NASDA has given high priority to Earth observation activities to investigate Earth environmental problems. In this regard, NASDA has been promoting Earth observation satellite development and data utilization in coordination with other countries through the Committee on Earth Observation Satellites, CEOS, and has been cooperating with southeast Asian countries from our geographical location.

At present, mankind is facing numerous problems arising from the Earth's limitations. These limitations cause environmental issues and shortages of resources and energy. We believe that space development will be a possible and very effective way to solve such problems as we explore extraterrestrial regions. This is an activity for the benefit of all mankind. It is also sure to be gigantic in scale. International cooperation in this area is therefore both important and indispensable.

NASDA is, as I have already mentioned, actively cooperating with other countries in conducting Earth observation and in promoting the international space station program. In the future, we would like to conduct most of our activities around a central core of international cooperation.

Having given you a brief introduction to Japan's space activities, I would now like to turn to the main theme of today's symposium, the space station program.

In 1984, President Reagan announced the international space station program and invited the international partners to participate in it. This program has great significance in Japan not only because it promotes space science, Earth observation, and space environment utilization, but also because it enhances related advanced technology and contributes to the international community. These are the reasons Japan has decided to participate in this program. This will be the first time in the history of space activities that nations worldwide have bonded together multilaterally to implement a large-scale project. As such, its importance as a precursor for future international cooperative programs like Moon or Mars exploration cannot be overlooked. In this regard, we in Japan have been promoting this space station program as our highest priority project.

The space station redesign directed by President Clinton last year was intended to reduce development and operation cost. Japan has been actively supporting this activity since it is worthwhile to reduce operations cost and benefit all participating countries equally.

With regard to each partner's contribution for space station operation phase, the European Space Agency is proposing to supply launch services using its Ariane-V and communication services using its Data Relay Satellite. Japan has similar intentions for its H-II launch vehicle and data relay satellite for space station use.

This program has great significance in Japan not only because it promotes space science, Earth observation, and space environment utilization, but also because it enhances related advanced technology and contributes to the international community. These are the reasons Japan has decided to participate in this program.

Japan entered the detailed design and development phase of the Japanese Experiment Module in 1989 and has since made contracts for more than half of the total estimated cost. We therefore emphasized that the redesign should be performed efficiently and so that it protects previous investments. Last September, after the redesign, all partners agreed upon an improved space station plan.

During and after the redesign, Russian participation in the program was coordinated and agreed to among the partners to construct a genuine, international space station by utilizing Russia's excellent technology and ample manned flight experience. This could be a major step toward ensuring program success. In addition, Japan concluded an agreement with Russia on space cooperation last fall. Therefore, we sincerely welcome this historical event.

Although constructing one unified space station is idealistic and marvelous, we must recognize that there could be some potential programmatic and technical questions to be resolved. To realize such an ideal, we must work hard and tolerate compromise. We should recognize that constructive cooperation to resolve these questions is required now more than ever.

I strongly expect that the experience we gained from the redesign activities, such as pursuit of common bene-

fit for all partners, close dialogue among partners, and extensive coordination through established procedures, will serve us well in future international projects as lessons learned.

NASA, with participation of other international partners, has now completed the system requirements review, and system design review and has baselined system and interface technical requirements based on a program which envisions Russian participation. We thus believe that technical aspects of the program have stabilized.

In the area of space station utilization, Japan's first announcement of opportunity for space station utilization was issued in 1992. More than two hundred applications were collected, demonstrating high interest among users. Fifty themes were eventually selected for initial JEM utilization. Japan has also been considering international cooperation with Asian researchers who may wish to participate in space station utilization.

To strengthen multilateral cooperation and to secure the benefits of space development for all mankind, we must take practical steps to provide a basic infrastructure for improved cooperation, instead of just dreaming glorious dreams.

Since a delay in the space station schedule, if it were to happen, would adversely effect user interest and since the user community strongly desires early opportunities to conduct experiments, Japan has begun discussions with the US about the possibility of such early utilization.

So far, I have primarily discussed the Japanese space programs and the space station program and have pointed out the importance of international cooperation. I would now like to touch on the strategy of international cooperation. This is a most important area, but I feel that there are many obstacles to be overcome on the way to achieving meaningful international cooperation because space development is a rather new and unique field.

For example, in the current framework of international cooperation, there is no robust and responsible forum in which to exchange information and coordinate plans. In addition, concluding an international agreement requires much hard work due to legal systems which differ among the countries involved and which take no account of the uniqueness of space activities.

Without resolving such problems, it will be impossible to smoothly conduct a fruitful international project. Therefore, I presume that we need to seriously discuss a framework of multinational cooperation, for example, establishing a space summit for information exchange and project planning, developing common principles of cooperation and creating an appropriate implementing structure for large projects such as Moon or Mars exploration which should obviously involve multinational participation.

To strengthen multilateral cooperation and to secure the benefits of space development for all mankind, we must take practical steps to provide a basic infrastructure for improved cooperation, instead of just dreaming glorious dreams.

DR. JAN-BALDEM MENNICKEN: It is an honor and a great pleasure for me to address this distinguished audience. I'd like to thank Mr. MacLeod, the President of the United States Space Foundation, for inviting me to share with you some considerations on the international space station.

Jean-Marie Luton outlined in his keynote the actual situation in ESA and has mentioned the further steps that are ahead in the European decision-making process.

As he highlighted, the ESA council and the Member States party to the International Governmental Agreement on Space Station, decided in this context to pursue with regard to the space station three lines of activities. These three lines are:

First: To review the European contribution to the space station.

Second: To negotiate and agree among the partners and Russia on amendments to the Space Station Agreement; and to discuss and agree, in particular with NASA, on certain European requirements such as the inclusion of Ariane 5 the space station's operations.

And thirdly: To come to final conclusions in space station related cooperation with Russia.

Complementary to the political overview given by the Director General of ESA I should like to elaborate somewhat more in detail on these different lines of activities, as well as a representative of a Member State contributing about 38% to the European Columbus Program as the main contributor and as the Chairman of the European IGA Coordinating Committee.

Let me start with the European contribution to the space station, what we now call the Columbus Orbital Facility — COF. As you may be aware, the original European element to the station — as referred to in the

IGA and the MOU between NASA and ESA is an attached pressurized laboratory mainly for material and life sciences — the so called APM. This baseline configuration which — let me mention that explicitly — ESA ministers agreed to develop at the Grenada Conference in Fall 1992, was first put into question in the wake of the space station redesign process started in early 1993 in this country. In that exercise, the main point was to reduce cost of development and operation. With the decision to enlarge the partnership by Russia, however, additional considerations need to be taken into account. These are, in particular, the new orbit of 51.6 degrees and additional laboratory capacity provided by Russia. The new orbit will provide further possibilities for utilization, such as earth observation. Additional laboratory capacity, however, raises the question how this fits together with the original plans. Clarification is needed on how to avoid duplication and overcapacity. In general, our view is that the space station should provide a multidisciplinary utilization capability in the fields of:

- life science and material science
- earth observation
- space science
- and technology development and demonstration.

Further elements that will have to be taken into account in the ongoing optimization process for the Columbus Orbital Facility are cost of development and operation, schedule, Ariane 5 launch capability and interaction with European based ground segments.

And last, but in no way least, the Columbus Orbital Facility will have to be seen as part of a coherent concept for European manned space activities. This concept will include as Jean-Marie Luton mentioned, utilization, space station participation and transportation. The program proposal that will have to be submitted to European Space Ministers for adoption next year, accordingly will have a broader programmatic scope.

It is obvious that such an overall concept for manned space activities, with the space station as the basis, can only be realized step by step. The funds that will be available in the forthcoming years will not be sufficient to do everything at the same time. Priorities will have to be determined and a logical sequence will have to be established. This, too, will have to be discussed with the space station partners. We will have to find a common understanding on the optimal approach to building the space station and to getting the system operational.

Let me conclude my first point by summarizing that the ongoing redesign of the European contribution to the space station is directed by enhancing utilization, reduction of cost, that COF shall be part of an overall concept of manned space activities, using European launch capabilities and with a goal to optimizing the space station as a whole, not only in our interest but to the benefit of the partners.

The second line of activities concerns the negotiations with the partners and Russia for adaptation of the IGA. This does not only involve, as you know, ESA as Europe's cooperating agency but also the governments of ESA Member States party to the IGA. At an IGA meeting in Paris last month — at which — for the first time — a delegation from the Russian Federation participated — an agreement was adopted on how these negotiations will have to be conducted; further, a legal framework paper was agreed to among the current partners and recommended to Russia as a basis to the necessary amendments to the IGA.

The Columbus Orbital Facility will have to be seen as part of a coherent concept for European manned space activities. This concept will include utilization, space station participation and transportation.

The Paris meeting was an excellent beginning. We need now to proceed expeditiously and to keep up the momentum. I know that, in particular in this country, there is a very tight schedule due to the budgetary process. It is our, the European partners, intention to support the envisaged schedule; that is, to conclude negotiations by June. But on the other hand, we have to proceed carefully and we need to make sure that our interests in the context of the space station are adequately taken into account. Further, it should be well understood that Europe's final approval is dependent on the ratification of the amended IGA by the respective authorities and on the program approval by the Ministerial Conference in 1995.

I'm very pleased that an agreement was reached by an exchange of letters between the European partner and the United States on how to proceed with negotiating the European requirements. I understand that recent discussions between ESA and NASA have been going very well and that agreements could be reached on important issues. So again, in this respect, in my view there is reason to be optimistic that we will achieve our goals.

Let me now turn to the third line of space station related activities in Europe. This concerns Europe's

cooperation with the Russian Space Agency. As you may recall, the European Space Agency Member States took in November 1992 at the Ministerial Conference in Grenada the decision to cooperate with Russia. Projects were defined, funds earmarked and practical work begun. (By the way, so ESA has already spent about $75 million in such cooperative projects.) As Jean-Marie Luton explained, most of those projects were designed in the context of the then still planned MIR 2 station. Against that background it is only logical that we — Russia and the ESA Member States — consider these cooperative projects also in the context of the so called Phase 2 of the Space Station Agreement between the USA and the Russian Federation.

These lines of action are interdependent; they focus on the participation in the space station, they all will have to be treated in a rather narrow time frame; and they all can only successfully be concluded in a real international partnership and with the clear intention to succeed.

In this connection, I may well add that the European nations are interested to participate in the early phase of the space station. We don't want to wait until the year 2000 or even beyond; we need early utilization to keep scientific interest alive.

We need preparation of the space station. You may be aware that my country organized two successful space lab missions — D1 and in 1993 D2 — in cooperation with the USA and other countries. We just presented the results of the latter to the public. But we can no longer afford such missions on a national basis only. IML is an important next step, but we need more such missions and flight opportunities to prepare the station. I feel that more attention should be paid to this element of the space station cooperation.

Let me sum up: three different courses of action are being proposed by the European partners to the space station. First we are redesigning our contribution to the station. Second, international negotiations have started to amend the IGA to include Russia in the partnership. In parallel, discussions are going on to accommodate European requirements. And thirdly, ESA will prepare a decision on joint projects with Russia in the framework of the space station cooperation to be made in a Council meeting in June. These lines of action are interdependent; they focus on the participation in the space station, they all will have to be treated in a rather narrow time frame; and they all can only successfully be concluded in a real international partnership and with the clear intention to succeed.

Let me conclude my intervention with a more personal remark. I have been involved in the space station program since 1984 when President Reagan issued the invitation to become a partner to the space station. This was a great initiative. The invitation was accepted and Europe has supported the station since. ESA and its Member States dealt with the issue at various Council meetings at Ministerial level. In Rome in 1985, in The Hague in 1987, Munich 1991 and Grenada 1992. My government decided at least three times on the substance of German participation and in addition approved every year the space budget. The German parliament ratified the IGA and has provided the funding, about 1.2 billion DM since 1987. Engineers and scientists and space managers have been working with dedication to help realize the station, but no other international project has been reviewed and modified as often as the space station. Doubt and enthusiasm, criticism and program support have frequently changed since the beginning of the program ten years ago.

Why do I call this to attention, what has to be concluded from this story?

I would like to offer two considerations. First: it must be something around the station that is fascinating, that is compelling, and that makes it so resistent against all these reviews and questioning. I think this is due to the station's technical challenges and scientific possibilities, due to the vision of humans in space and due to its very international character.

My second conclusion is: we, the space community, have to do our best, to make the station a success. I'm very well aware that we still have a difficult way to go; that we are now in a decisive phase. In today's budgetary environment, in most countries there are funding problems. There is further a problem of priorities among the various space applications, and we are only at the beginning of the IGA Amendment negotiations.

We need a convincing program to build and operate the station; we need a solid concept for utilization to attract science and technology development to be competitive with other space applications; and cost of development and operation to all partners have to be reasonable and calculable. And the station has to be a real international endeavor.

If all this is achieved, and I'm confident it will be, the political decision makers in governments and parliaments will entrust us, I'm sure, with the realization of the station.

DANIEL S. GOLDIN: We have spent a century working on technology — different groups against each other. But the technology was for weapons of war. Now, we have a window of opportunity, and I want to emphasize it.

It is a window of opportunity that will last maybe another six months, where we could truly have a coming together of the nations of the world in the largest technological project in the history of this planet. We actually can go ahead and do something positive for our societies, our countries, and learn how to work together to make this planet a better place. Unless we start engaging each other, and stop being afraid of who is in charge and who might have what problems at home, we are never going to change this very, very bad cycle.

We have spent a century working on technology — different groups against each other. But the technology was for weapons of war. Now, we have a window of opportunity, and I want to emphasize it.

It is exciting that at the turn of the century we will have the Space Station completed, and maybe this will be the symbol that humanity needs so we don't have to go back to where we were. I spent twenty-five years of my career in the defense and weapons business and I am very proud of it. I won't apologize for it because it was necessary, but now I think what we are doing now is even more necessary. I am not afraid. We are going to have an international Space Station.

I was just saying to members of the press that America spends more on taco chips and twenty times more on beer to wash it down than we are going to spend on building a Space Station here in this country.

Let me now paint the vision for you of what is going to happen and it has been moving at record breaking speed. Almost exactly a year ago, President Clinton asked us to redesign the Space Station, and everyone prophesied doom and gloom. We have withstood thirteen votes on the Space Station in the American Congress. We have been successful and their is no reason we won't be successful this year because I think there is going to be increased confidence in what we are doing.

We started to redesign last year; we started to talk to the Russians in August. We concluded an agreement with the Russians on a technical approach in November. We held a system requirement review in December and we held a system design review just last week. We held to every single date and we did what we said we would do. Let me tell you at the system design review on Space Station Freedom, there were over 2,000 open issues when thousands of people spent weeks to get that design review done. At the system design review, because of integrated product teams, because of the trust it had built among all the partners, we had only seventeen open action items. The design review took eight hours, we planned for twelve. It had 200 people, not 2,000, because we went to a new operating mode and the old operating mode is gone. The old mistrust is gone and we are going to trust each other, and that has made a difference.

Every single element of this thing is moving along. We also told people to take risks because we are going to reward them when they fail. You cannot be successful if you try to protect yourself with ultra layers. So given that we have done those things, we started the process on February 3 when the Space Shuttle took of with the Russian cosmonaut, Sergei Krikalev for the beginning of a gradual coming together of the space programs of the world.

Two weeks later Bonnie Dunbar and Norm Thagard went to Russia to start training in Star City. We just sent them off, and we are entrusting them to our Russian friends. Norm Thagard will be taking off in April in the Soyuz vehicle to go up to the Mir 1 Station.

Then in about July of next year, the Space Shuttle will go up to the Mir Space Station and start one of the most complicating things we have done since Hubble or going to the Moon, the rendezvous and docking of a quarter of a million pound Space Shuttle with a quarter of a million pound Mir Space Station — both orbiting the Earth at seventeen thousand miles an hour.

We have withstood thirteen votes on the Space Station in the American Congress. We have been successful and their is no reason we won't be successful this year because I think there is going to be increased confidence in what we are doing.

John Pike has suggested as the two vehicles come together, we play the Blue Danube Waltz. Very appropriate because that is where we are going, ladies and gentleman. We are a space faring society.

Then we will have up to ten flights up to the Mir so

we can learn how we can really put the Space Station together. We had too many ground simulations. We have to work out operations, logistics and communications. We have to work out reducing the acceleration forces to get the microgravity down to the right levels. We have to understand large structural dynamics, we have to understand robotics issues, we have to understand how we work and play together.

The object is to put humans and material in space so that we can learn how humans can live and work in space. We will conclude the Space Station in the year 2002.

I heard the challenges from our partners. This is the so called Phase 1 of the program, which right now is bilateral between the United States and Russia. We have invited our Japanese friends, our European friends, our Canadian friends to work with the United States and Russia so we can get the utilization going and, Dr. Mennicken, we are committed to doing that because this is the right thing. It is important not just from an interest level, but we just can't put up 20 thousand pound satellites every month and expect to assemble them with two to four astronauts if we don't get some experience together up in space. So, this is very, very crucial to where we are going.

Based on the knowledge we gained from Phase 1, in Phase 2, which will start at the end of 1997, we will start construction of the international Space Station. We are going to put hardware in space and stop having design reviews on the ground.

The object is to put humans and material in space so that we can learn how humans can live and work in space. We will conclude the Space Station in the year 2002. It will be successful because it is an international partnership and in 2002, the world can look with pride to what we have done together, because there will be incredible benefits from that.

Probably the most significant benefit will be the understanding of how humans can live and work in space. With the scientific knowledge and the instrumentation that we are going to put on the Space Station, we will understand the debilitating effects of space that could occur. What happens in gravity, the gravity force is probably the single largest force in the operating of your body.

One of the significant findings that we had out of the space program is we used to think that the neurological system was inelastic that by the time you got to be four years old, all the neuro connections went together and then you live with that for the rest of your life. It turns out in zero gravity, an amazing thing happens. The number of neurological connections go up. Maybe that is why astronauts are so smart, I don't know. On the other hand, since that time we have learned that when you have a high G Force, the number of neurological connections goes down and maybe we have so much trouble with our pilots for that reason, I don't know.

People look upon space as people going up and down, but there is fundamental scientific knowledge to be gained. The structural system, bone loss, muscles atrophy, loss of sensors, loss of mobility of lymphocytes, loss of generation of red blood cell, an inability perhaps for the bones if they break in space to recombine, build-up of kidney stones, these are the type of things that are going to be addressed scientifically in the Space Station.

When you think about it, the possibilities of knowledge combined with the knowledge on ground is unbelievable. Dr. Mickey LeMaistre who is the head of the MD Anderson Cancer Institute in Houston, Texas has said, this may be the next major step in complimenting the work on the ground to make some more breakthroughs in understanding the treatment and the basis of where cancer comes from. Space will give us the opportunity to build three dimensional tissue outside of the human anatomy, which you can't do effectively on the ground because of the sedimentary forces because of the convector forces.

We have developed the bioreactor, which is now becoming a tool common to the medical research industry. People have built three-dimensional tumors of ovarian cancer outside the human body and have begun to interact those cancers with lymphocytes to understand how we can begin attacking some of these female diseases.

This is what the Space Station is about in addition to all the other things. We don't have convection, and we don't have buoyancy, so we can get to the fundamentals of phase changes or transitions. We have run experiments already; the results are absolutely astounding. We

It turns out in zero gravity, an amazing thing happens. The number of neurological connections go up. Maybe that is why astronauts are so smart, I don't know.

are validating some Noble Prize-winning theories.

So, the first issue is science. The second point is we are a space-faring society. With a Space Station, we could develop techniques for regenerative life support systems, we don't know how to do that yet. We cannot go off to another planet if we are going to consume tens of gallons of water a day per person. It is physically impossible. We just can't carry all the gases with us for the sustenance of life.

Perhaps the most important barrier we have to travel beyond is, can the nations of this world work together? We have a pretty sorry record. Here is an opportunity

We have to figure out how human beings could be screened before a flight because if you are gone for three years, you cannot afford to have a crew member come down with cancer or heart disease. It will be unacceptable. It will destroy the mission. We get into genetic screening.

There are a whole host of problems that have to be solved, the dynamics of large structures, microthrusters, a broad range of space faring technologies. We can't just say that we are going to stop doing research because we can't afford it, because we are going to leave the bounds of Earth's gravity and we are going to be able to go out to the planets and ultimately the stars. This generation shouldn't be so arrogant as to say we are going to put off the future.

There are a number of thresholds we will have to overcome before we go to the planets, but the Space Station is the place to do it. Perhaps the most important barrier we have to travel beyond is, can the nations of this world work together? We have a pretty sorry record. Here is an opportunity, where we have invited people in to work together instead of being exclusionary.

It is not just a technological test bed, but as Mary Goode pointed out during one of our review meetings, this is an international test bed. It is a test bed where nations can work together. It is not easy; it is very stressful. My peers and I have been through some very difficult times. As they say, there have been frank and candid discussions, but this is good because we have been forced to work together.

So, these are the issues that we have to work with. I have nothing but hope and optimism because of the wonderful relationship we have with our international partners. I would like to say that without the international partners, I don't believe that there will be a Space Station. So, under the leadership of President Clinton, we have reached out and as part of the redesign, he asked us to invite the Russians and ask for the concurrence of our international partners.

He asked us to focus the Space Station on being a platform for science and technology and not a political statement that we could build something bigger and better than the Russians. Again, our international partners are very sensitive to utilization. We have to be there too.

As we go through this restructuring, I would like to give you some of the principles used and some of the principles that are going to apply. First, we are not going to have management — we are going to have leadership. Leadership has the self-confidence to say we can work with others and we can trust them and we will have a shared responsibility and a shared risk.

Team work is essential to the future. The concept that time is money, no more slips. I know it gives stress to you, Dr. Mennicken, that we have a tight schedule, but since the President challenged us to redesign the Space Station we have missed only one milestone by seven days and we were upset about that and, yes, it makes stress for all of us. We had over 3,000 on the American side in management and integration. We are now down to about 800 and are still dropping. It is not the cost to pay the salaries of those people, it is all the extra work that they inflict on each other. By causing people to have schedules that are impossible, the human spirit is beyond belief. We are going to use the concept, time is money, and a new business manager calculates how much it costs us when we spend an extra hour in the meeting for the program and he tells us verbally what that is. That is what we all have to work at.

We had over 3,000 on the American side in management and integration. We are now down to about 800 and are still dropping. It is not the cost to pay the salaries of those people, it is all the extra work that they inflict on each other.

Another key factor is accountability. There was no one human being responsible for that Space Station. We had five senate directors, we had task team leaders, we had working meetings and we had thousands of people

having dinners all over the world together in good fellowship and friendship, but they weren't making progress. You can't have a critical design review with a thousand open action items. We cannot tolerate it. Technical excellence and managerial excellence have to dominate our thought process, and it has to be a peer process of review where each person is worried about what the other person is doing. We have to take risks and encourage our people to take risk. When they fail, we have to give them a hero's badge, as long as it is not an ethical or moral breakdown. We have to reward our people when they fail.

And finally, we have to do what we say we are going to do. We can't make excuses, and if we don't do what we say we are going to do, we have to say we failed and fix it. So far, I am very proud to say that we have done what we said we were going to do. In the recent review, the system design review in Houston, the review by the members of the Vest panel, that came individually, verified that fact. I believe that we are on track and are going to do wonderful things. We should have the confidence in what we are doing. We should not respond to the naysayers, who would like to try to drive the space budget down. You could take the space budgets of the world and sum them up in total and cancel them today, people would have a feeding frenzy in the press and establish how they saved their nation's money, but I cry for future generations. We have to keep our minds on that, we have to be zealous to make sure that this world is not going to temporarily shut down the space program for ten or twenty years in order to consume and survive. Life is more than consumption and survival. It is inspiration, hope and dreaming dreams.

I would like to leave you with this thought, I was just down in Anaheim, right by DisneyLand, at the National Science Teachers Association, 20,000 wonderful human beings. I heard this poem: "When you wish upon a star, makes no difference who you are, when you wish upon a star, your dreams come true." We are going to make dreams come true for the people of this world.

Life is more than consumption and survival. It is inspiration, hope and dreaming dreams.

Q&A Session

QUESTION: Why are American expendable launch vehicles currently excluded from participating in the international Space Station program? Are American expendables under consideration in a contingency role?

MR. GOLDIN: We haven't excluded American expendable launch vehicles, but the fact of the matter is we just can't have a launch vehicle without a logistics capability. We do not have an automatic rendezvous and docking system for certain payloads. If we had to go make an expenditure for those particular elements, it probably would be more money. Secondly, expendable vehicles only have up cargo, not down cargo. We don't have that capability yet either. Thirdly, we have a number of international partners that are making contributions to the program and one of the major findings of the Vest panel was that we should have multiple launch sights, multiple communications systems and multiple redundances built in because this is a very precious asset in terms of financial investment and human survival. Those are the considerations. I don't think we ever made a conscious effort to exclude expendable launch vehicles, but we haven't seen any approaches where we would save money. If somebody has the ability to come in and show us how we would save money, we will do it. We are not going to spend money to wave the flag. Time is money. We are going to build the Space Station on time, but if there is a way of doing it for less money and better we are always open to new ideas.

QUESTION: How would you compare the popular support of space expenditures in Canada compared with the support of the United States? In your presentation, you mentioned a three-year effort to develop contacts with users and customers for your space station initiatives. How do American efforts compare, and where can we learn from your success?

DORÉ: Regarding the popular support of Canadians for these space activities, there was a national survey done last year on this subject by a renowned survey company in Canada. We had a major surprise. The positive support for space activities was 85%, so we thought that it was tremendous. We had another surprise. There was a question related to the knowledge of specific activities being pursued by Canada in space and 85% of the respondents didn't know anything about these activities. I cannot compare with the United States, unfortunately, since I don't have the figures for your country. There is probably one explanation for this dichotomy in the point of view of Canadians. It is obvious that it would be impossible to link all the Canadian communities if we did not use satellites. I am talking here about basic

telephone communications.

If you look at the model of Canada as a country, it is like an elastic band that you stretch 4,000 miles with 92% of its population living within 100 miles from the border with the U.S.A. But, we have 8% of the population that is disseminated in the vast country north of this 100 mile strip. In the late 1960's, the Canadian government issued a policy to link with a communications system the communities of northern Canada with those of southern Canada. The only way to do it was to use satellites. This is one reason why Canadians are supportive of the Canadian Space effort. However, they don't really know exactly what is our contribution in the world effort.

On the second question, I cannot compare the effort in the United States and the effort in Canada in the development of user community for the Space Station. There is certainly a great interest in Canada in this area. Canada has a small population and its scientific community is very well linked together and internationally. This community profits from every opportunity to link with international partners, in particular in space activities. Our space scientist look south of the border for their cooperation projects. They have also good linkage with Asia, principally Japan, and Europe. Canada is an open country.

QUESTION: NASA has had a less than enviable relationship with Europe on many space projects. While this relationship is improving, what would you suggest that NASA do to obtain the fuller trust of ESA?

LUTON: If I remember, last year we already addressed this issue and I told you that cooperation should be based on trust and confidence. Such confidence, however, cannot increase if you don't make a permanent effort to maintain the commitments you have entered into with your partners.

We have had about thirty years of cooperation with the United States, thirty years of very successful cooperation. The benefits of this cooperative relationship are so evident that unfortunately nobody speaks of the successes.

We were twice confronted with the question as to whether NASA would honor its commitments. First, at the beginning of the 1980's in the International Solar Polar Mission (ISPM) to which NASA was to contribute one of the two spacecraft and a new Administration decided not to go ahead with the US satellite. And the second time has been the uncertainty surrounding the International Space Station.

If you take the long-standing and extensive cooperation we have had with NASA in the fields of space science and Earth observation, including the recent example of the Hubble Space Telescope, this cooperative relationship has been most fruitful for both parties. We are therefore confident that our good relationship with NASA will continue.

I think the problems we have sometimes, are more of a political nature. Every time you have a new Administration in the United States, you have to make sure that continuity of the past commitments is preserved. In Europe, we have the same problem when the government of one of our Member States changes or when a new minister comes in. We have to convince them anew of our programs. Last year, when the new U.S. Administration decided to review the space station, also some governments in our Member States changed. The new governments reacted in a different way to the project and to the commitments that had been given by their predecessors.

QUESTION: In general, what mechanism would you like to have in place to manage international projects and to share information? Would doing this through the United Nations be a good idea?

YAMANO: I would like to stress that, to promote a large scale project like space development, it is really necessary and important to establish a strong political will based on a national consensus within each individual country. To obtain such national consensus, it is not enough to discuss and coordinate the necessity or benefits of space development among the space related people, but it is important to make the best efforts to get the understandings of all people nationwide through supporting their own comprehensive debates.

To proceed with large scale international cooperation, it is necessary to establish an arena where it is possible to coordinate the political will of every participating country. In my last speech, I raised an idea of space summit as an example. It was my intention that this should be a meeting convened by ministerial level of governments.

I also proposed an appropriate structure to implement the projects. By saying the appropriate structure, I do not mean that it is going to be a part of the United Nations. On this issue, I just raised the question without any detailed concept, but I think that it should be extensively discussed further.

QUESTION: When you spoke of utilizing the space station, what areas of particular interest are there to the

German space community?

MENNICKEN: There is a very high interest in space observation in my country. This is a political priority. What we are considering is whether the Space Station, with its new orbit of 51.6 degrees, can be utilized for earth observation. We have developed optical instruments, such as MOMS that flew on the D-2 mission, and will again fly on the Russian Module PRIRODA in 1995-96. We consider the Space Station, if it realizes its orbit and is geographical possibilities, to provide a new opportunity for instruments of this kind.

The second interest is material science and life science. I mentioned that the German D-2 mission — which we realized in cooperation with the United States — was flown last year. The D-2 mission had about ninety experiments, most of which were in the fields of material, biological and life sciences. The results are so promising, that there is quite a wide spread interest among the community to be able to experiment on a more continuous basis. Rather than be dependent on infrequent flights of limited duration — one 8- to 10-day flight every two or three years — scientists would like to have a laboratory where they can work, repeating experiments until they are satisfied with the results, much the same way they now do on Earth. Again, this area of material, biological and life sciences is very attractive. We are considering now the most suitable configuration for the European laboratory against that background.

There is also certain interest and support among the extraterrestrial and astronomers community in developing the Space Station. However, they prefer, if they had a choice, to go on as they normally do with dedicated satellites and platforms. They are, however, attracted by the possibility of having a permanent experimental facility available also for their purposes.

Let me conclude in underlining the high interest in the utilization aspect in the space station cooperation. ESA is organizing a workshop in Europe in April, and I understand that representatives from all our partners will be there to discuss, in length, all of these utilization aspects.

QUESTION: How will the international Space Station be named? Will there be an international competition in selection?

GOLDIN: I believe there will be an announcement pretty soon on the name of the Space Station. Just look for it.

QUESTION: Given the lessons learned on Space Station, do you believe a new international program for example to Mars or the moon for exploration is viable in the next decade?

GOLDIN: I don't think a human piloted mission is possible in the next decade for a number of reasons that I discussed. But there will be, in my mind, ample opportunity for a variety of planetary astrophysical and earth science missions. Before we could send humans out of Earth's orbit, we have a responsibility to make sure we could safely send them outside of Earth's orbit. We have a responsibility to make sure we could do a program that doesn't cost a quarter of a trillion dollars that could be done for 10's of billions of dollars. We also have an obligation to make sure that we can do it in eight to ten years instead of two to three decades. These are the issues that we have to get beyond so we get beyond dreams, wishes, hopes and prayers. Thirdly, we have to figure out how we can do it internationally, because I don't believe a human piloted mission outside of Earth's orbit is going to be feasible unless it is an international one unless we want to revert back to where we were and show macho. Finally, the economy of this planet has to be in some healthy situation, because it would be irresponsible to move forward on such a mission with a difficult economic situation. So, I think those conditions say it is going to be outside of the ten-year window, but certainly not outside of the twenty-year window.

C-2

Space Support Forum

T.F. Rogers
President
Space Transportation Association

Al Richmond
Space Station Advocacy External Affairs Office
Boeing Company

Suzanne Whistler
Marketing Manager for the
ClearLake Economic Development Foundation
National Keep it Sold Space Station Task Force

Four years ago several space advocacy organizations came together in a series of meetings to dispel the perception that the space support community was so fragmented as to be dysfunctional. Those meetings came to be known as the Space Support Forum — an informal gathering of the leaders of various space oriented organizations. There is no formal structure — no bylaws, no specific goals and objectives, no designated leaders. Meetings are typically held in conjunction with other space related conferences such as the National Space Symposium and the International Space Development Conference. The agenda at these meetings is open and serves as an update on participating organization's activities and plans as well as a forum for discussing current space related issues. To date, the Space Support Forum has been quite successful in achieving its purpose.

A significant result of the formation of the Space Support Forum is a statement of common belief and agreement to work together to support a strong space program. Nineteen leaders of space support organizations signed this agreement called *A Commitment to the Nation on Space*, July 20, 1989. The document was presented to the President of the United States as an indicator of cohesiveness among the space support community.

T.F. ROGERS: Our Federal Civil Space Program: What Went Wrong?

Preface

This talk is intended to contribute to the national discussion on an important issue now facing our Country. I am expressing my own personal views.

Our Federal program of civil space activities, once a matter of great challenge, satisfaction, excitement and pride to America, in many respects is now in decline and borders on disarray. And the space area, generally, is not being exploited to our Country's advantage to nearly the extent that it could, and should, be.

If the Federal program is to survive, and if it is, again, to be thought of as helpful to our national purpose in an important way, it must be changed. Here I will inquire into what caused this sad turn of events.

For, as we search for changes in what we are now doing in order to correct our mistakes, it is imperative that we be confident that we know what those mistakes were in order that the changes we adopt be appropriate and effective.

Our Federal program of civil space activities, once a matter of great challenge, satisfaction, excitement and pride to America, in many respects is now in decline and borders on disarray.

We should base our future space activities and Policies on facts, however unpleasant, and not on wishes, however appealing.

I will then suggest, in outline, how this decline can be arrested and our nations, civil space posture reinvigorated.

Introduction

Let me start by commenting on two recent statements about civil space:

a) "Despite gold-ribbon panels and glossy reports, NASA still hasn't defined the overarching themes that will shape its goals for the 21st century." Clark R. Chapman; *The Planetary Report;* November/December, 1993.

Chapman completely misses a most fundamental point: it is *not* the responsibility of a Federal executive branch agency to "define" our Country's "overarching [space] themes" and "goals". That is for private citizens to do and, only to the extent that their attainment requires law and/or public funds, for the Congress to articulate. Turning to an apparently ever-wealthy government about civil space matters, a government which either does not listen to the American public, or does not accept what it says, has been and continues to be a singularly grave mistake.

But now it is clear that the Federal civil space program is in serious jeopardy. If it is too sharply curtailed America could lose much of the potential tangible and intangible value created from our having spent over ½ trillion public dollars, and some of our best scientific, technology development and engineering brains, on it.

Unfortunately, inasmuch as many who are seriously concerned about civil space issues, policies and programs are also directly or indirectly employed by the government, they hesitate to insist that the government do what most of our people want the government to do when the government doesn't do so.

b) " ... Its hard to come up with something brilliantly new in discussing the [Federal] space program. I have been participating in discussions on [it] since the mid 1960s. I don't think there ever was any serious difference as to where we were going." Rep. George E. Brown, Jr.; *Aerospace America;* January/February, 1994.

If Representative Brown believes that everyone agreed "as to where we were going" for the past decade or so, he can only be seen as correct if we leave aside the interests of the great majority of our fellow citizens. Otherwise, the NASA budget would be increasing, not decreasing.

It is my contention that our Nation's most fundamental post-Apollo space interests have been known reasonably well for some time. However, they have received little more than rhetorical attention from the government in general, and NASA in particular.

But now it is clear that the Federal civil space program is in serious jeopardy. If it is too sharply curtailed America could lose much of the potential tangible and intangible value created from our having spent over ½ trillion public dollars, and some of our best scientific, technology development and engineering brains, on it. And as the encouraging economic use of space in several information-related areas (communications, navigation, position-fixing, and remote sensing) suggests, we could miss other large and important space business opportunities.

Therefore, fundamental change must finally be brought about in the civil space area. Or it will gradually die.

This change must respond to the expressed Interests of our general public, and involve our space-related commercial, industrial and financial communities, the Congress, the President, NASA, and other space-interested Federal offices, especially Commerce and Transportation.

We must articulate a very few sensible goals and objectives that are widely accepted, and they must be "brilliantly new" enough to elicit the intellectual, financial and political support needed to attain them, soon.

Therefore, fundamental change must finally be brought about in the civil space area. Or it will gradually die.

Today's Circumstances

Recently, three U.S. leaders of our civil space area have made their views about the Federal program known widely and in explicit terms.

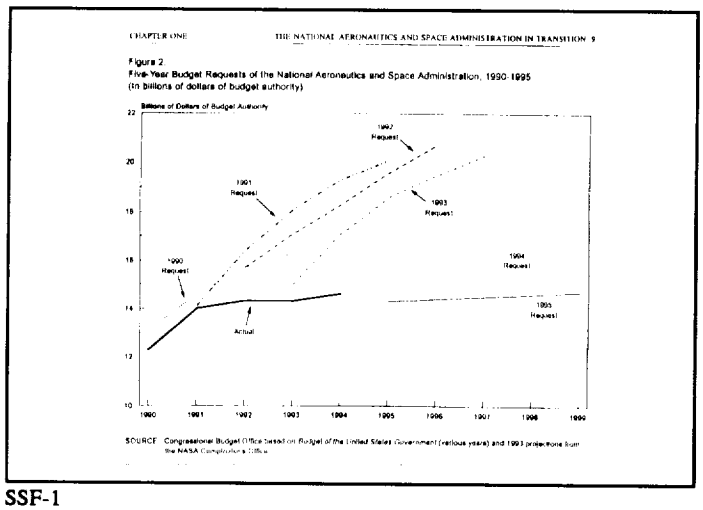
They are all intimately familiar with the Federal program; they all hold senior space-related positions; they are all fully committed to a vital, continuing, set of publicly supported activities in space. Their observations provide clear evidence that our Federal civil space program has come upon parlous times. And, by implication, they suggest the fundamental reason why this has come about.

a) Norman R. Augustine, the Chairman and Chief Executive Officer of the Martin-Marietta Corp., was the Chairman of the Advisory Commission on the Future of the U.S. [Federal] Space Program; the Commission produced a report of this title in December, 1990.

The Commission observed that it expected to see 10% per year real growth in the Federal program in the ensuing decade. This would have provided it with some $70 billion more than would have been available if its

then budget level was simply maintained, adjusted only for inflation.

However, reality stands in sharp contrast to this expectation: in testimony before the Subcommittee on Science, Technology and Space of the U.S. House of Representatives on November 16, 1993, Augustine observed: "...civil space activities no longer seem to enjoy the broad support they embraced in earlier periods. ... the [NASA] budget has declined in real terms for the last few years, and the outlook for the future appears equally austere." And he said that the earlier 10%/year real growth conclusion was " ... based on discussions with virtually every decision maker then responsible for the nation's [Federal] civil space program ... ." (Fig. SSF-1)



SSF-1

b) Daniel S. Goldin, Administrator of the National Aeronautics and Space Administration, made the following observations at a press conference on February 7, 1994, the day on which President Clinton's FY95 budget request was sent to the Congress:

"Compared to our Fiscal Year 1994 appropriation of $14.55 billion, this budget is ... almost $650 million below it in buying power [ie., nearly a 5% cut.] ... We [will] reduce [our] staff levels by more than 3,000 ... . But this is it. We can't get any closer to the bone." (And the will of the Appropriations Committees is yet to be worked.)

c) Representative George E. Brown, Jr., Chairman of the House Committee on Science, Space and Technology spoke at the Goddard Memorial Symposium on March 2, 1994. He observed that "... this year marks a disquieting milestone for NASA and the [Federal] civil space program ... . [While] about half of all Federal programs will decrease under this budget ... half will increase [and] NASA finds itself among the lower half

None of them consider, for a moment, that what is being done and not being done in the Federal civil space program has any connection at all to its lower Priority and, therefore, to its budget cuts! *Amazing!*

[with,] by definition, a lower priority. ... Clearly, the Administration has defined a more favorable strategic growth path for many other Federal programs this year. ... [Therefore, this NASA cut] has nothing to do with the deficit, it has everything to do with priorities..."

(In contrast to the NASA budget situation, it should be noted that technology development focussed upon civilian/business use is highly favored by this administration. For instance, the budget submitted by the President for the Department of Commerce was increased by $1 billion for FY95 - an 18% increase over the final submission by the previous administration.)

The most curious and unsettling feature of all of these remarks is that none of them ask: "Why has the Federal civil space funding request been reduced? Why does the Federal civil space program have a lower priority? Why has its funding been cut " ... to the bone.?"

None of them consider, for a moment, that what is being done and not being done in the Federal civil space program has any connection at all to its lower Priority and, therefore, to its budget cuts! ***Amazing!***

By implication Augustine notes that virtually every space leader with whom his Commission spoke about a crucial element of the program was wrong. Wrong! Nearly everyone!

Brown seems to believe that the present program, without its space station element, would be immune from further cuts. But how does this explain the President's reduction in priority for civil space this year while, at the same time, he endorses the space station program?

Goldin observed that "We have a balanced space ... program ... . It works; it makes sense; it supports meaningful science and technology that will make a difference in people's lives ...[we] are talking to and listening to Americans, and they love our space ... program."

Well, the Americans that he has been communicating with may well have left him with this impression. But the reduced national priority and budget cuts make it objectively clear, *coldly clear,* that those particular

Americans simply do not reflect the views of the majority of the electorate. Indeed, anticipating the FY96 budget circumstances, and seeking ways to avoid further cuts and/or to ameliorate their effect upon the program, Goldin plans to " ... set up a series of interchanges with the CEOs of NASA contractors, ... the science community [and the] Congress ... ." Unfortunately, for the most part these are the very people who have participated in the decision-making that led to today's sorry circumstances. Only secondarily does Goldin expect to have exchanges " ... with the public ... ."

Unfortunately, for the most part these are the very people who have participated in the decision-making that led to today's sorry circumstances. Only secondarily does Goldin expect to have exchanges "... with the public ..."

Indeed, in sharp contrast to the "they love our space program" view, the objective and conclusive observation re today's Federal civil space circumstances was laid out in a December, 1993, letter to its membership by the National Space Society. A letter signed by "Buzz" Aldrin, the second person to set foot onto the Moon 25 years ago, stated that " ... opinion polls conducted over the past several months reveal that, for the first time since Apollo, a majority of the American public no longer supports space exploration."

The Reasons For The Federal Program's Decay

Why this sorry state for civil space? Why are so many now convinced that its prospects are bleak? There are four fundamental reasons:

1. There is no compelling evidence of life, nor little expectation of finding life, elsewhere in the solar system, or perhaps anywhere else in the universe. The planets and moons have been found to be essentially dead rock, some with noxious atmospheres. There are no human beings, no birds, no trees or grass, not even lichen.

Generations of speculation that we might not be alone are seen to be incorrect. An immense body of science fiction that imagined people or people-like forms of life beyond Earth has been found to be just that: fiction.

By and large, people relate to other people more than to anything else in the world. For generations we have speculated that we might not be alone. But now the hopes and apprehensions that supported our robotic surveys of the other planets have been resolved: there is no life there.

The Federal program cannot be faulted for finding and reporting on what is there. It was a masterwork. But it now suffers from the understandably sharp loss of public interest in finding out more about what it did find - dead rock - especially since there are so many other things of *interest and value that can be done in space.*

(Someday reasons for our inhabiting another solar system body will become persuasive. But, given the great cost and the marginal value of doing so in view of this great cost, it is not likely to happen tomorrow.)

2. A quarter of a century ago the government, industry, and university participants in the extraordinary tour de force that saw our people stand on the Moon and return safely were treated not simply as heroes but as demigods. From that day a new expression entered into the American lexicon: "If we can go to the Moon, why can't we ... ?"

Perhaps it was too much to expect of human nature that, after a reasonable interval spent on savoring their well earned adulation, they would have begun to focus upon America's main stream of interests and concerns, and begun to imagine how the inherent qualities of space could be used to ease the human condition. But, with few exceptions, that did not happen.

While they were always more than willing to inform the general public about what they were doing, and why, most were rarely interested in listening to the general public when it suggested what the government should be doing.

Indeed, very many in our civil space community began to exhibit the appearances of institutional schizophrenia: "A disorder of the mind ... characterized by chronic social withdrawal, illogical thinking and disregard for the external world."

Only recently have some of our civil space leaders (not all, but a rapidly growing number) begun to appreciate how the professional and social isolation that they

By and large, people relate to other people more than to anything else in the world. For generations we have speculated that we might not be alone. But now the hopes and apprehensions that supported our robotic surveys of the other planets have been resolved: there is no life there.

assumed, i.e., their hubris, has hurt the prospects for America's future in space and their own professional prospects. Hopefully, this severe self-assumed government restriction upon the relevance and utility of our civil space activities will soon be put behind us.

But, however fundamental these "no other life" and "hubris" reasons are, the former is "water over the dam;" and the latter is being corrected.

Therefore, let me now turn to today's "show stoppers" - the other two matters that continue to weigh so very heavily on the Federal program.

3. In laying out the "Why ?" of large-scale, continuing, Federal civil space activity we can now see that our civil space leaders and their advisors made a grave error

While they were always more than willing to inform the general public about what they were doing, and why, most were rarely interested in listening to the general public when it suggested what the government should be doing.

- they simply failed to take into consideration a most fundamental element of our American character.

In Justifying the Federal program's goals they emphasized such themes as "national security", "space is the last frontier," "we must demonstrate space leadership," "we must exhibit our technological prowess," "the solar system is our extended home," "because its there,"... .

Without denigrating any of these reasons, we should note, keenly, the absence of reference to the one American attribute that would provide the most powerful and continuing reason of all: *we Americans are determined, more than any other of the world's peoples, to participate directly and personally in any public activity that we judge to be interesting and/or important to us - especially if it involves the government that we elect, tolerate and pay for!*

This is what we do about our schools; the financing of our housing; the delivery of our health services; our local land zoning; the location and use of public transportation; ...

It is simply not enough, at all, in our democracy to have a few elite astronaut heroes visiting space. It is not enough to have a Senator, a Representative and an Arabian Prince taken to space. Or a culturally narrow ensemble of scientists and engineers.

At the end of World War II Vannevar Bush noted "It has been basic United States policy that government should foster the opening of new frontiers ... It is in keeping with American tradition - one which has made the United States great - that new frontiers shall be made accessible for development by all American citizens." ["Science, the Endless Frontier"; quoted in *The Economist,* July 25, 1992; page 21.]

When polled in the 1980s, a very large fraction, 40%-45%, of our adult population expressed a desire to visit space, i.e., more than 80 million Americans!

Our Federal government and our space industry have ignored them. They continue to ignore them today. It is my view that this most fundamental rejection of public interest borders on the criminal. Or, rather, "It [is] worse than a crime, it [is] a blunder".

4. Although still relatively small, purely private sector space-related business revenues continue to increase at an encouraging rate. Over the past half decade the average annual growth rate has exceeded 10% per year. The Department of Commerce reports that last year they increased some $1/3 billion re 1992's $5 billion. The DoC now projects that they could grow another $1.2 billion this year, i.e., to some $6.5 billion.

But, however encouraging the rate of growth, in absolute terms our enormous public expenditure on civil space has done little to speed the economic growth of our country — we would have done as well or better if, speaking strictly in economic terms, we had "put our money in the savings bank." All of the "commercialization of space" rhetoric, and all of the "spin off" and "trickle down" anecdotes, however interesting, simply cannot deny the fact that our $1/2 trillion so-called economic investment in civil space can be seen by the public as now providing only a 1%-3% percent/year return. ***And this after 35 years of experience!***

It is simply not enough, at all, in our democracy to have a few elite astronaut heroes visiting space. It is not enough to have a Senator, a Representative and an Arabian Prince taken to space. Or a culturally narrow ensemble of scientists and engineers.

Too, all of this business is concentrated in such information-related areas as communications, navigation, position-fixing and remote sensing, and their asso-

ciated satellite launch businesses. However, except for early R&D expenditures on satellite communications and, later, on remote sensing, only a fraction of this business can be traced to Federal civil space spending. The Department of Defense, the National Oceanic and Atmospheric Administration and our private sector also spent large sums in these areas, and the DoD spent further large sums on expendable launch vehicles, launch sites and range instrumentation.

"The support of the American Public is the most critical resource of the U.S. [Federal] civilian space program. It is the people who elect the leaders who, in turn, establish national priorities and allocate funds ... ."

And by far the greatest spending in the Federal civil space program has been concentrated on "human space flight": Mercury, Gemini, Apollo, Skylab, Shuttle and Spacelab. Yet there has been essentially no economic return from these enormously costly, astronaut focussed, assets and activities. And little, if any, can be expected of a Space Station that will see only a few astronauts employed in LEO at a cost of $ billions/year each.

In brief: a March Congressional Budget Office report stated "... economists have rejected the argument that ... contribution[s] to the economy ... would justify NASA's program ... ." ["Reinventing NASA"; March, 1993; page 21.]

A decade ago, in the light of the large continuing public expenditures on civil space and the importance of relating them to the economy, the 1958 Space Act was amended to read: "The Congress declares that the general welfare of the United States requires that the National Aeronautics and Space Administration [should] seek and encourage, to the maximum extent possible the fullest commercial use of space."

Yet, a decade later, there is not even a line item in the NASA budget that is explicitly addressed to our country's economic growth, or to space commercialization or to private business encouragement. And even if it is assumed that the entire sum budgeted in FY95 under the line item "Advanced Concepts & Technology" is to be used, directly, to speed U.S. economic growth, this would amount to less than 5% of the total. Are we to understand that this is the " ... maximum extent possible ... " required by Federal law?

Clearly, the law is not being obeyed. The Executive Branch ignores it and the Congress, which has oversight responsibilities, overlooks it.

And where were our Departments of Commerce and Transportation while all of this was going on ? Except for some modest influence at the margin, they were absent.

Today it is most instructive to retread the 1986 Report of the National Commission on Space (the Paine report) entitled "Pioneering The Space Frontier", particularly that section that deals with "The American People And The [Federal] Space Program". [See its page 176.]

The initial sentence of this Report reminds us that: "The support of the American Public is the most critical resource of the U.S. [Federal] civilian space program. It is the people who elect the leaders who, in turn, establish national priorities and allocate funds ... ."

The Commission conducted 15 Public Forums throughout the Country during 1985-6. In this manner (and by other means) the Commission solicited the widest public views on civil space. The Report's summary of this information gathering process observed that:

"In ... creating the Public Forum concept ... a major step [was taken] in addressing a frequent desire by the public - to Personally Participate in [fashioning] the future of the space program."

"[From] the total scope of comments heard during the Forums, several themes were brought forward repeatedly." Seven are described:

[The first was that the public wanted] "...to assist in shaping the fate of the Program."

[The second was that the public expressed] "A desire for the creation of a lottery in which the prize would be a ride aboard the shuttle to galvanize public interest in the spaceflight experience and [to] initiate a space travel industry."

Thus, a decade ago a broad cross-section of our People made quite clear that: We want to be involved, directly and personally, in civil space activities. We

Thus, a decade ago a broad cross-section of our People made quite clear that: We want to be involved, directly and personally, in civil space activities. We want to go to space ourselves. And we want to see our private sector construct large businesses there.

want to go to space ourselves. And we want to see our private sector construct large businesses there.

But, incredibly, the Commission then went on to ignore what it had highlighted on the first page of its report, i.e., "The support of the American public is the most critical resource of the [Federal] space program. ... ." As though it were advising the government of the former Soviet Union or today's Peoples Republic of China, it simply paid no attention whatsoever to the clearly expressed, and eminently reasonable, civil space interests of the majority of our electorate. Rather, the Commission opted for a 35-year "Exploring And Settling The Solar System" program at a public cost of at least one trillion dollars. The latter was what our government-related space industry, our government-related space science/exploration community, and NASA wished to do - never mind what the public wished to see done!

The post-Apollo Federal civil space program must be viewed, on balance, as a failure. I cannot think of any American historical analogue to this extraordinary fall from grace, within a generation, in the eyes of the public of such a highly thought of, richly endowed, and initially so very successful public enterprise.

Well, our public is participating in the program now. It's turning it off! Now our space-related government offices are experiencing what inevitably follows when the will of our electorate is ignored. First they begin to lose their constituency. Then they begin to lose financial support for their programs. And then, If they persist in their obduracy, they begin to lose their jobs. And so NASA is now planning to lose some 3,000 of its staff - for starters! And our space industry, many more.

When a government agency can no longer convince the country, wholesale, of the value of its activities then, because of the employment and contracts it provides, it can attempt to survive by convincing the Congress, retail. This, of course, is the road to staff and program decay which, at best, only buys time - how much time is left to the political process to determine.

Thus, the post-Apollo Federal civil space program must be viewed, on balance, as a failure. I cannot think of any American historical analogue to this extraordinary fall from grace, within a generation, in the eyes of the public of such a highly thought of, richly endowed, and initially so very successful public enterprise.

This is the sad era that we are now well into. Sad. And distressing because of the space-related opportunities that could be lost to our country.

What to do? We must start by admitting that the space age is over for the United States. Over! At least the first space age is over.

If we are to have a rejuvenated second space age we must admit to our past mistakes and set about seeing two things done to correct them:

1. Our people, in large and ever growing numbers, must have access to space to do there whatever they wish to do and, as long as it is not illegal, immoral or fattening, do so whether the government cares for it or not! As soon as possible!

Nothing will stem the loss of general public constituency except to have the Federal program do what the general public wants to have done: allow and assist them to visit space and to see space become a U.S. economic engine.

2. And the space area must become one that adds importantly to our country's economic growth and competitiveness! And again, as quickly as possible!

Very little else will make any difference to the continued survival of the Federal civil space program. Not the space station; Not a "balanced program," Not space science, Not robotic planetary exploration.

Nothing will stem the loss of general public constituency except to have the Federal program do what the general public wants to have done: allow and assist them to visit space and to see space become a U.S. economic engine.

AL RICHMOND: My purpose is to give you an idea of what the Boeing Company is doing with respect to Space Station Advocacy and an idea of what you can do to help us. I apologize for Mr. Nick Steele who would have been here today, but he is entertaining guests from the congressional staff that are down visiting the program as they seem to be constantly doing and he felt that was extremely important to be there to get some votes.

Space Station advocacy from the standpoint of the Boeing Company is a very focused process. As an

example of what we have done, we have taken all of the external affairs operations within the company in the Houston area, have them reporting to Mr. Steele who reports into the program vice president. It includes marketing, customer relations, public relations, community relations and congressional relations. So we have managers working all of those different areas; they're focused on pulling the program advocacy effort together.

The theme and messages that we have focused on with respect to Space Station are: Space Station: It's About Life on Earth.

Basically the purpose of the program is to ensure annual funding which means we need the votes and we need the program support to do it. Our approach to getting that funding is very focused; we're focusing on three things: a consistent and simple theme and messages for the program, we are developing and working with an advocacy network that will distribute and disseminate the information that those messages will purvey, and we're attempting to create a positive image campaign that will take the information that's provided and disseminate it to you so that you can help us.

The theme and messages that we have focused on with respect to Space Station are: Space Station: It's About Life on Earth. And you'll see that message and theme in all of the advertising and in all of the materials we will be providing. So consistently we will be talking about the fact that Space Station is about life on earth. There are three messages that go with it: it's a laboratory in space, it enhances global cooperation and it's an affordable investment in our future. Those are the messages that will be delivered with the program. Understand that these are the focuses and the messages of the advocacy network that we have developed and are working with. At Houston we have a focus office that consists of Boeing and NASA; it works next with our first-year subcontractor's Rockwell, McDonnell Douglas and the Boeing Huntsville work package. And they then work outward through their second tier subcontractors and then in the further ring we have all of our advocacy organizations that we will be working through, such as *Space Week, Space Cause* and all of the chambers and so forth. Our approach is to work through the organizations, with these organizations and to develop the things that you see with respect to the public relations campaigns, advertising campaigns, educational initiatives, working the congressional affairs activities and things of that nature.

Our image campaign, uses the database that we're developing and have available with respect to jobs, congressional districts, and things of that nature. With respect to the team that we have working it, and the material that we're developing and I can go into a long list of things that we will be having, but I'm sure you've seen some of those down at the booth, and so forth. We'll use that material and disseminate it through the advocacy networks such as this, through our public relations campaigns, through our exhibits and marketing-type campaigns and through our congressional campaigns. And those are some of the ideas of the messages and things that we're promoting. As an example: the first part of May we're planning to get together all of the subcontractors and prime contractors and their subcontractors at Washington and have a meeting where we bring in all those people, show where those jobs are created, have them visit their specific congressional districts and representatives in Washington and show where the jobs are coming from and the companies that are there to support them. So it'll be a very focused, business-oriented type campaign in support of the program. And that'll be the first part of May.

There are three messages that go with it: it's a laboratory in space, it enhances global cooperation and it's an affordable investment in our future.

With respect to our grass roots support: one of the organizations that we're working very closely with is the National Keep it Sold organization which is founded by the ClearLake Economic Development Foundation in Houston and it consists of a number of chambers and other advocacy organizations throughout the country. Suzanne Whistler who will follow me is going to speak for that organization. Basically our approach to working with advocacy organizations is to provide all of the data that you're going to need with respect to the program, and to disseminate through your networks to your advocacy constituents. We will maintain and report to you our program status, we are developing the advocacy materials, we are developing and have available all of the congressional vote counts and who's doing what and who's the one through five's and those types of information. We'll have that correlated with jobs and indus-

tries in different districts and I'd recommend that since we're developing it it's not necessary for you to develop that type of information. The role that we'd like for grassroots organizations is to expand your advocacy networks, provide us a conduit for disseminating that advocacy material. Above all, maintain a close coordination with the program so that the messages and the views of the Station and things that are being disseminated are consistent and support the program. And above all, provide us feedback to the program because it's essential that we know from the grassroots end of things what you need and what the people out there are most receptive to and we'll prepare that material for you.

Now, this will be in the handout. This basically is the managers of the Advocacy group in Houston, this is where you can get the information, these are the specific people that you'll contact and I'll leave these charts with you to follow up on contacting us and getting with us. Above all, we want to work with all advocacy organizations that we can and we need your support and as you've heard Mr. Goldin and others speak, the program needs your support as does space. Thank you very much.

SUZANNE WHISTLER: I'm the Chairperson of the Keep it Sold Space Station Task Force for our foundation. I'm also one of several co-chairpeople for a National Keep it Sold Space Station Task Force which has developed on its own over the last four or five years and now we're trying to better organize it.

The mission of National Keep it Sold Space Station Task Force is to gather and activate a national grassroots support network for full funding of the Space Station, the Shuttle and manned space exploration. As background information on National Keep it Sold, five years ago our foundation, the ClearLake Economic Development Foundation, created an Aerospace Advisory committee to watch over the best interests of the ClearLake area. That committee is comprised of the top management of the aerospace contractors in ClearLake, as well as other interested participants such as developers, brokers, restaurant owners, personnel agencies, whoever has an interest in the space program. The aerospace advisory committee created a working group, a subcommittee called Keep it Sold which is comprised mostly of marketing, external affairs and communications people from the Aerospace Advisory committee companies, as well as interested volunteers from the community. After frequently going to different seminars and symposiums across the U.S., our particular Keep it Sold group kept running into other people from other parts of the U.S. who also were interested in saving Space Station, who had a great interest in it for the medical and scientific benefits, as well as economic benefits. One of these was the Cocoa Beach Chamber of Commerce which is led by Sue Muncie in Florida and the other was Huntsville Alabama Chamber of Commerce and Mike Ward is their Vice President of Governmental Affairs there. So these three groups: ClearLake, Huntsville and Cocoa Beach got together and formed National Keep it Sold.

One Congressman said, "Now what is this thing you're talking about?" And we, our team, explained to him that it was about the Space Station — "Oh, do we have one of those in my district?"

For awhile each group kind of did its own thing and just kept in touch and alerted one another about what was going on, but now we've formed a cohesive unified front. We've had a National Keep it Sold meeting this February to plan our 1994 activities. Last year in 1993 we got together and were able to accomplish what we feel were some pretty good things for the program. We've even been featured on CNN and PBS, so word's getting out that we exist even though we're a small organization to date.

We're growing rapidly, we've brought in several other states which I'll put up on a map for you in just a moment. We began with just Texas, Florida and Alabama and now we've grown into Connecticut, Boston, Massachusetts, Pittsburgh, Pennsylvania, Washington D.C., northern and southern California and we're targeting additional areas as well. Some of our members — you have a list in front of you — but in addition to chambers of commerce, we have organizations such as the Aerospace States Associates who are appointed by the governors of their states, the Bay Area Economic Forum of San Francisco which is responsible for supporting nine different counties in the Bay Area, the state of Florida's Chamber of Commerce, *Space Week, Space Cause,* National Space Society, Space Center Houston, United States Space Foundation and a relatively new foundation called the United Space Foundation.

In 1993 for the first time the National Keep it Sold went to Washington as a unified group. We took about 70 grassroots citizens in June to visit the House. We

made 183 visits in 2 1/2 days. A lot of those visits were with staffers because the Congressmen were busy, but we did have a reception so we could talk to them that evening as well. We got a lot a feedback that we were surprised about. One Congressman said, "Now what is this thing you're talking about?" And we, our team, explained to him that it was about the Space Station — "Oh, do we have one of those in my district?" These people don't know. A lot of them don't know what a Space Station is, why should they vote for it? Another staffer of a Senator, a really prominent Senator which surprised us, said, "Oh, we're not voting for that Space Station, or that Super Collider 'cause that Super Collider's going to radiate all the ground in Texas and kill all the trees and give the people cancer." That scared us. These people were not informed. So our objective for the two visits we made to the House and the Senate were strictly to educate, to give them the correct numbers. Lots of erroneous numbers were flying around through the media that were not correct. We wanted to give them benefits and spinoffs that they enjoy in their daily lives. Let them see how they already are benefitting and living better because of the manned space program.

Another accomplishment that we instituted last year was a 1-800 number, a hotline number for space. It's called 1-800-84-SPACE. It's based in Cocoa Beach, Florida. Citizens can call this number and their names and addresses and zip codes are taken down and data is sent to the representatives and senators to let them know how many constituents have called in — who all is interested. It gives them names, home addresses, phone numbers, everything. So that the staffers can contact them again. We've had a billboard campaign where we put out 500 free billboards nationwide on billboards that were not currently under contract for paid advertising. And this year our goal is to branch out to 1,000.

Hamilton Standard developed a spinoffs brochure which is included in your packet. This is really a grassroots effort, the secretaries of Hamilton Standard in Connecticut put this together. It's very simplified; it's not technical like some of the other spinoff documents that you've seen before. It's colorful, it's attractive, it's small, easy to read. And currently they are revising this now for 1994. Hamilton Standard also had a traveling space suit display where they went to all the capitals in New England and took a truck around with an astronaut's space suit. Had an exhibit and used that as an attraction so that they could get people down to talk to them about Space Station.

We've done public service announcements. We've attended trade shows with booths. We've held receptions for congressional representatives, staffers, dignitaries. We've had letter writing kits passed out all over the U.S. to try to get grassroots citizens to write or call or fax their congressional leaders.

In 1994 we're going to continue these efforts. We again are going to the House and to the Senate. We're continuing our letter writing campaign. You have a copy of that in your packet; it should be the last sheet in your packet. The sheet that you have is generic on the back; it just has Washington's addresses, the House, the Senate. We have those customized for all the states, so if you want to contact our office if you'd like to have a copy of that for your state then we can get that to you. We again will expand our billboard campaign, place opinion editorials and we're trying to place the Space Station cause on several major agendas such as the U.S. Chamber of Commerce and the National League of Cities meetings.

You can help our efforts by signing up today, to join, to be a part of National Keep it Sold. It does not cost anything, the only commitment is that we would like for you to help us be an active advocate. There's a sign-up sheet in here, you can fax it back to our office and then we'll forward your name on to the closest co-chairman in Florida, Alabama, Connecticut, California, where ever you're geographically located. You can call the 1-800-84-SPACE number and you can get the people in your organization to do so as well. You can volunteer to speak on behalf of Space Station at speaker's bureaus for different organizations and associations in your town, your areas, or where ever you travel. Write letters to the editors, to the Congressmen, if you can place magazine articles that would be great. And you can even start a Keep it Sold taskforce in your area if you find the interest strong. Thank you.

Spacelift Update

Lt Gen Thomas S. Moorman, Jr.
Vice Commander
USAF Space Command
(General Moorman is now Vice Chief of Staff, U.S. Air Force)

L/GEN MOORMAN: It is an honor to speak at what has become our nation's, if not the world's premier space symposium. It is also an honor to be here today to pinch hit for Secretary Widnall. Last year, General McPeak, our Chief of Staff, used this forum to identify his vision for space. In the intervening year, the Air Force has been busy attempting to fulfill that vision -- controlling and exploiting the full potential of space for all warfighters. Numerous organizational changes, such as the creation of 14th Air Force, the setting up of the Space Warfare Center, and continued emphasis on space applications demonstrate how effective we have been. Both he and Secretary Widnall have been vocal advocates for space. You are going to hear a lot more about providing space support to the warfighter tomorrow during General Horner's panel. So I want to dwell on that good news story.

Today, I want to focus on one issue — correcting our launch deficiencies. A great many studies have been done over the last decade, by some real talented people — Norm Augustine and Pete Aldridge, to name two — but solutions to this problem have been elusive.

As you are probably aware, I have spent the majority of 1994 in the Washington area doing a launch study for the Department of Defense -- specifically for Mr. Deutch. While this launch study was focused on defense launch requirements and solutions, we worked hard with the intelligence, civil and commercial space sectors to build consensus about how America should approach its national launch problem. In the few minutes I have available today, I will highlight my insights into what my boss, General Chuck Horner, CINCSPACE, calls a major national problem.

BACKGROUND

The original tasking for this study was spelled out in the 1994 Defense Authorization Act. This law directed the secretary of defense to:

1) develop a plan that establishes and clearly defines priorities, goals and milestones regarding modernization of space launch capabilities for the Department of Defense or, if appropriate, for the government as a whole.
2) Consult with the Director of the Office of Science and Technology Policy.
3) Submit a plan to congress concurrent with the submission of the next future-years defense program.
4) Identify launch requirements for new launch vehicles.
5) Study the difference between U.S. and foreign launch vehicles. (This part of the study is due to congress by 1 October 1994.)

Discussion on national security strategy draw an analogy between the high seas and space. Both the sea and space have been and will continue to be major economic and political arenas for exercising American leadership and enhancing our prosperity.

Before I address the scope and nature of our study, I must provide a few caveats. Since the study is on-going, I will not address its final conclusions or recommendations. It would be inappropriate to discuss the report until it has been signed off and submitted to congress. The executive summary will be completed by mid-month and will go through the normal staffing process. Second, I want to emphasize that as the chairman of this study group, I worked for the Undersecretary of Defense for Acquisition and Technology -- not the Air Force. So the results will reflect a DoD Response -- not a service position.

ROLE OF SPACE LAUNCH

Discussion on national security strategy draw an analogy between the high seas and space. Both the sea and space have been and will continue to be major economic and political arenas for exercising American leadership and enhancing our prosperity. Recent discussions about the "information highway" also reflect the central position occupied by space-based communications, data transfer, and environmental monitoring. I mention these two areas to establish a common foundation for the value of space operations today.

Yet, it is clear that before a nation can exploit space, it must have a capability to launch satellites. As this audience knows well, our current launch systems are basically ICBM derivatives employing 1960s-1970s technology. Each launch can be preceded by long and expensive delays — the launch systems are not always responsive. Moreover, as the number of satellites on-orbit has come down, the cost of launch is rising. The fixed costs of standing armies is spread over too few launches and is eating our lunch — and our launch. For example, a single Titan IV launch, depending upon the configuration, runs between $200-300 million and could become more expensive in the future. While the Air Force's primary interest is to serve its military customers, an unfortunate ancillary result of increased launch cost is that the U.S. commercial space launch industry is becoming increasingly non-competitive in the international marketplace. Consequently, our U.S. market share has steadily declined since our near monopoly 10-15 years ago.

Moreover, the steady decline in our budgets will necessitate a team approach — which might require compromise by all participants — to solve our national launch problem.

Mr. Deutch asked the Air Force to provide a study director and Secretary Widnall selected me. Although the direction was to the Secretary of Defense and the focus was on national security needs, it was entirely appropriate that the study be expanded to address NASA and commercial needs as well.

DEFINING THE LANDSCAPE

Building consensus in the space community is especially difficult. Each part of the community — civil, commercial, intelligence, and military space — have differing missions, different requirements, and diverse expectations about what is the optimum way to approach this problem. Just defining the dimensions of the problem was a challenge. Each stakeholder places emphasis on different objectives:

The Department of Defense believes any new launch vehicle must improve cost effectiveness and operability. Medium lift is sufficient in the long term to fulfill most requirements. Although DoD desires a new system, funds are not available today to independently start such an effort. This basically was the conclusion of the bottom up review.

The intelligence community tends to focus more on the payloads which do the missions — not so much on the boosters. Launch vehicles are viewed as transportation — like airlift for conventional forces — to deploy resources. Thus, continuing heavy lift systems are essential if they are to be able to conduct their mission. They also are skeptical of promises of low cost and high launch rates — in that community, the STS experience is not forgotten.

In the commercial sector, international competitiveness, government investment, low priced launch options and schedule dependency are the key criteria. A medium lift or smaller capability best meets their needs.

Finally, the civil sector, through NASA, stresses human access to space. NASA sees a shuttle replacement as the best option for cost effectiveness and safety and to support long-term space station resupply.

From this brief synopsis of the corporate views of the major space sectors — one can see that building consensus on the future course of launch modernization is a daunting task. One could argue that the executive branch's inability to achieve consensus has been a major impediment in sustaining support for past efforts — ALS, NLS, spacelifter.

Moreover, the steady decline in our budgets will necessitate a team approach — which might require compromise by all participants — to solve our national launch problem. Space launch is also inherently an expensive business. Current manned and unmanned systems and infrastructure must be maintained through any modernization period. As many of you are intimately aware, the Air Force has expended about $500 million over the past few years to improve our launch infrastructure at Cape Canaveral and Vandenberg, reflecting the Air Force commitment to increasing range reliability and safety, upgrading launch pads, and replacing obsolete equipment. The Air Force also has been a key participant in the creation and operation of spaceports at Vandenberg and the cape — including directly asking the civil and commercial sectors to help identify ways to improve our launch process and capabilities. While these initiatives will dramatically enhance our customer support, and will improve our reliability, maintainability, and sustainability of our current launch infrastructure, they will not drive launch costs down sufficiently to make America more internationally competitive in space launch

With that as a backdrop, let me review the details of the study — or said more simply, how we went about our task.

The study's goal has been to develop a plan to im-

prove how we accomplish the nation's space launch mission through an ***integrated, efficient*** and ***balanced*** space launch program. The adjectives in this goal statement are important — **integrated** means addressing the needs of all sectors; **efficient** means cost effective and operationally capable, And finally, **balanced** means developing options that have an appropriate mix of funding for infrastructure/sustainment, technology, product improvement and new development.

The study's goal has been to develop a plan to improve how we accomplish the nation's space launch mission through an *integrated, efficient* and *balanced* space launch program.

To help keep us focused on this goal, the study has been overseen by a 13 person steering committee of senior officials and general officers representing the various space launch stakeholders in the executive branch including NASA, the NRO, departments of commerce and transportation, office of the secretary of defense, JCS, ARPA, BMDO and the services. I should also note that we have been in close contact with the office of science and technology policy, which is developing a series of policy recommendations on space launch for the Clinton Administration. As a matter of fact, I just met with Skip Johns this morning.

On 5 January, I began the study with a panel of 40 people. This group represented the Air Force, Navy, US Space Command, joint staff, the intelligence community, office of the secretary of defense, ballistic missile defense organization, advanced research projects agency, NASA, departments of transportation, and commerce — everyone we could think of that had a role to play was invited to participate and be a partner in the activity. Frankly, I was very pleased with the quality of the people that the various agencies provided.

From the outset, one of our goals was to be comprehensive in capturing the state of play in the space launch business. Accordingly, we invited industry, the government, academia, international consortia, state spaceport authorities and congressional staff and members. Anyone who wanted to talk was welcome. Ultimately, over 130 briefings were presented to our group. These briefings covered the waterfront from launch concepts; future payload options; innovative funding sourcing; launch technologies, capabilities of foreign systems, low cost propulsion technologies, hybrid propulsion; and process improvements for all facets of space launch operations. We tried to make sure no rock was left unturned as we attempted to identify good ideas, creative thought, and innovative approaches from all corners of the space community.

We divided the study into three parts: Phase I was the data gathering that I just mentioned. During Phase II we conducted the analysis, had long debates and drafted the findings and recommendations. Finally, Phase III, which is on-going, includes documentation in an executive summary, panel annexes and a comprehensive data base. It also includes briefings to the principal stakeholders within the executive branch.

Overlaid with the phased approach I just mentioned, was a cross matrixed group of panels. These panels covered operations, technical solutions, requirements, business and management, and environment. Each panel consisted of experts from across space sectors. To ensure this study was not overly biased towards the defense perspective, I appointed panel chiefs from the civil and intelligence sectors. Panel size varied from eight to ten people.

We tried to make sure no rock was left unturned as we attempted to identify good ideas, creative thought, and innovative approaches from all corners of the space community.

One area I would like to highlight is the requirements work accomplished by the study. Speaking with one voice on space launch requirements has always been a problem. In fact, we have difficulty across agencies in defining what we mean by requirements. This is another reason why it has been so difficult to speak with one voice on our needs. Using a total quality technique, the requirements panel integrated and synthesized a set of national needs. The team, comprised of NASA, DoD, and NRO representatives, proved that it is possible to establish a first order cross-sector consensus on requirements. I believe this will be a major by-product of this study and should be the basis for further cross-sector cooperation.

The technical panel assessed the various concepts presented to the study group and determined the maturity of the various space launch technologies associated with each of these concepts. Additionally, they assessed

the necessary funding to mature the technologies to the proper readiness level. Finally, the panel identified the need for a core space launch technology program independent of any concept or option. Even if there is no decision to proceed with a space launch option today, we must preserve the capability to make a decision in the future -- this requires a healthy technology base.

The business and management panel looked at innovative methods of funding a new system to include hearing from wall street investors. Additionally, this panel examined what the proper relationship between NASA And DoD should be -- a constant theme was the need for better coordination particularly in the area of technology.

The operations panel primarily focused on DoD space launch operations at Vandenberg and Cape Canaveral. The emphasis was to first document our processes and the resources required to launch our satellites. With this data as a baseline, we looked for near term efficiencies. One of the more interesting findings was that while there was a great deal of data available — it wasn't readily accessible and it wasn't in the most usable form.

For the first time, a consensus was developed within the space community about a national set of requirements for launch.

We also have a standardization problem between the Cape and Vandenberg. We can fix those two problems within Air Force Space Command. A fallout benefit of the operations panel work was to provide a foundation for the follow-on comparative analysis with foreign systems due by 1 October.

During the data call in Phase I, a series of study objectives evolved:

1) To establish a comprehensive space launch database
2) To understand and synthesize space launch requirements
3) To identify deficiencies in our current and planned capabilities
4) To determine and assess technical, operations, management and funding opportunities and innovative approaches
5) To develop space launch modernization options and associated road map
6) To create an integrated strategy with decision points
7) To make selected recommendations

The study developed four options ranging from continuing with today's systems to a new reusable system. In the case of the reusable option, we relied heavily on NASA's recently completed "access to space study." Each option was analyzed separately in great detail — schedule, cost, requirements satisfaction and all the rest. More importantly, however, the options were overlaid onto road maps — permitting the decision makers to see all of the critical decisions associated with the option. The road maps show decision makers how it is possible to integrate desirable elements from several options — a weakness of previous studies is the options were often done in a stove piped manner. We addressed the possibility of embarking on expendable options while at the same time preserving the capability to move to a reusable option in the future should the technology permit this.

SUMMARY

The launch study was intended to build consensus within the whole space community — I hope that we accomplished that goal. For the first time, a consensus was developed within the space community about a national set of requirements for launch. From this consensus, American leaders can better define coherent space policies and visions for space, direct budgets from a macro approach to space needs, inject advocacy for technologies that will improve our space launch process, And create a solid foundation from which america can exploit the "common ground" offered by space in the next century.

This study has been a major effort which I believe will satisfy the congressional intent. As you are all aware, reaching and sustaining consensus among the various space sectors on space launch has been an elusive goal over the past decade or so. Certainly, Pete Aldridge, our launch panel chairman, can testify to that fact. The recommendations of his 1992 launch review still remain to be implemented. Accordingly, we have worked hard toward establishing and maintaining consensus within all parts of the space community in this study, and on this point I'm am hopeful. Now we need to build on that consensus and turn study recommendations into action.

I thank the Space Foundation for permitting me to share a few of my observations with you today.

Competitive Launch Capabilities

Edward C. "Pete" Aldridge
President & CEO
The Aerospace Corporation

Vladimir K. Chvanov
First Deputy General Director & General Designer
NPO Energomash, Russia

Dr. Bruce S. Middleton
CSIRO Australia

Prof. Dr. Igor V. Barmin
Chief & General Designer
Design Bureau of General Machinebuilding
(DBGM), Russia

Tom Rogers
President
Space Transportation Association

PETE ALDRIDGE: Welcome to the session on "Competitive Launch Capabilities." We have a distinguished group of panelists that can give us tremendous insight into the competitive space launch capabilities of the world.

Before I introduce the panel members for their presentations, I would like to set the stage for our discussions and stimulate your "mental juices" in preparation for your questions to the panelists.

As I look at the world's space launch systems and the expectations for these systems in the future two things become very apparent.

First, the space launch industry of the world lives in an environment of *overcapacity in a declining market.* You would never know this today because we have a backlog of satellites waiting to be launched resulting from failures in Titan, Atlas and Ariane launch vehicles. After this near term backlog gets worked off, the number of government programs, especially in the national security arena, will be declining, thus reducing the number and rate of government space launches. Satellite technology is permitting spacecraft missions to last longer on orbit, further reducing launch rates, and is permitting satellites to become smaller reducing the need for the larger, heavy lift versions of space launch vehicles. Lower launch rates drive space launch vehicle cost higher and reduces production efficiency and the profit margins for corporations whose business viability depends on a profitable product.

At the same time we see more space launch players entering the worldwide marketplace. On the U.S. side we see continued production of Delta II, Atlas II and five versions of the Titan IV. We are continuing to fly the converted Titan II and we have introduced a new version of the Atlas, the Atlas IIAS. Pegasus and Taurus are now viable small launch vehicles, along with Conestoga. The potential of using excess Minuteman vehicles for this mission also exists. We continue to fly the Space Shuttle about 7-8 times a year for manned missions, but it is not used in a "competitive" sense at this time. In spite of this overcapacity, U.S. companies are looking to introduce other launch vehicles into the marketplace, such as the Lockheed small launch vehicle family, based on the Castor 120, and a possible space launch capability using derivatives of the Titan IV SRMU.

In the international arena, we see the Ariane V being developed as a follow-on to the very successful Ariane IV. The Japanese are developing the H-II, the Chinese are continuing to produce and launch versions of the Long March and the Russian Proton is being marketed throughout the world along with small payload versions of the Russian mobile ICBM.

First, the space launch industry of the world lives in an environment of *overcapacity in a declining market.* ... The second item deals with how nations and the satellite and launch vehicle manufacturers are becoming *more interdependent.*

I simply cannot see how all of these players can be participants in the launch business in view of the projected launch requirements without one or more things happening—continued subsidies by governments, low profits or losses by commercial launch vehicle companies, mergers to reduce the number of individual com-

panies, and everyone, government and commercial companies, paying higher prices than necessary for space launch. I really believe that *all* of these things are happening.

The second item deals with how nations and the satellite and launch vehicle manufacturers are becoming *more interdependent.* Many years ago, before the successful development of Ariane, there were many in this country, me included, that did not want to see Ariane succeed. We were at a point in time where the Shuttle-only policy had wiped out the expendable launch vehicle industry, the Shuttle had not proved that it could be an economic competitor with an expendable launch vehicle and we could clearly see that the economic incentives for commercial satellite manufacturers were forcing them to lean toward the Ariane solution.

I would propose that we initiate an international cooperative program for the development of a truly reusable space launch system. ... Why couldn't we pool those resources to develop a common vehicle for the common good that would otherwise be unaffordable by a single nation?

The world has changed and that type of thinking is now obsolete. About 50% of the U.S. built satellites will be launched on Ariane. The new small satellite communication systems, being considered for worldwide communication, plan to fly on a variety of U.S. and foreign boosters. Future communications for the U.S. military will depend on commercial communication satellites, many launched by foreign boosters, to complement the military communication systems. It may come to pass that the Ariane V, the Proton and the H-II will fly components to the international space station.

What all of this means is that we cannot hope for delays or failures in the launch vehicles of others in order that any of us would be more competitive in the space launch business. Our success in space mission accomplishments will depend on the success of us all to launch with confidence and reliability. We are truly becoming more interdependent for mission success in space.

You should be asking at this point: "Okay, what do we do about all of this?"

All right, I will propose a possible solution.

First, let's set some goals for whatever the solution might be. We need to reduce the cost of launch, then we can build the incentives for those who want to explore or exploit space with new and expanded missions, and thus build a larger market for future space launch capabilities. We need to build a future space launch capability that is reliable. In spite of our best efforts we will have some failures and therefore we must design our systems with the necessary robustness and instrumentation so that we can be less sensitive to component failures in flight and we can return to flight after failure with a minimum amount of delay.

Second, in the near term, we must let the free market pressures "weed out" ineffective and inefficient launch vehicles. We must let the market provide the incentives for the launch vehicle manufacturers and/or governments to invest in cost reduction measures on their existing vehicles or in new vehicles to make them more competitive in cost, reliability and responsiveness to the spacecraft users—the ultimate customer. It should be noted that simply offering a cheap "price" to fly a payload, irrespective of cost, does not necessarily ensure success in winning a customer. The payload user must also consider the logistics to deliver the payload to the launch facility, the cost of integrating the payload to the new launch vehicle (a non-trivial and high cost item), the cost of insurance (which is running 16-18% of the launch value), especially for a non-proven launch vehicle, and the ultimate reliability and timeliness of putting an expensive and income producing satellite on orbit. Even if the launch vehicle was "free," it does not mean that the economics would dictate its selection.

Third, I would propose that we initiate an international cooperative program for the development of a truly reusable space launch system. Although it was not proven in the Shuttle, the prospects for making a major reduction in the cost of future space launch appear to be in the area of reusability. Let me be clear—I'm not advocating Single Stage to Orbit, or any other currently popular "point" solution, but rather any system concept based on reuse of the components, whether single stage or not. Furthermore, worldwide use of such a vehicle would dictate the purchase of a sufficient number to further reduce its initial investment. The tremendous cost burden of its development would be shared across multiple nations who wanted to participate. Many space faring nations, and those who want to be, are looking at spending resources on new launch vehicles for the future. Why couldn't we pool those resources to develop a common vehicle for the common good that would otherwise be unaffordable by a single nation?

Such an effort could be divided into two phases. The

first phase would develop a reusable space launch vehicle that would be of sufficient size to lift the medium class payloads—say about 20,000 pounds to low earth orbit. This phase would take about 10 years to complete. Most of the payloads projected in the future are in this range and it is feasible that a space launch vehicle could be developed successfully in the international environment.

The second phase would develop the more demanding heavy lift version—say 50,000 pounds to low earth orbit—that could replace those classes of expendable launch vehicles, like Titan IV and the Space Shuttle in the 2012-2015 period. I would hope all of these concepts would use "airline type" operations, which we have demonstrated very successfully in the international environment.

I am not that naive to assume that this type of cooperative development would be easy or without technical and management difficulties and it certainly would be influenced by international politics. But the idea deserves some consideration and exploration as we face a more cooperative and much more competitive world, especially in space launch.

Now let's hear from the real experts:

We have already heard from Lt. Gen. Tom Moorman, Vice Commander Air Force Space Command, on the approach to the current space launch study.

Our first presenter will be Dr. Vladimir Chvanov, First Deputy General Director and General Designer, NPO Energomash in Russia. I am sure Dr. Chvanov will have some interesting views on the international competition for space launch.

Next on the agenda will be Dr. Bruce Middleton, formerly Executive Director of the Australian Space Office, who has been working on expanding Australia's role in the worldwide space community. I am sure that he has a very different perspective on competitive space launch activities.

Next is Dr. Igor Barmin, General Designer and Director, Design Bureau of General Machine Building in Moscow. Dr. Barmin's main areas of design and research include power systems, launch facilities, space experiments and space materials.

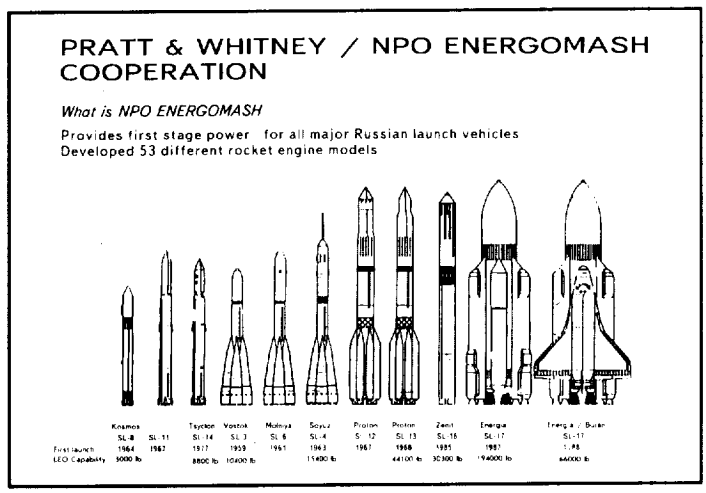
Last, is Tom Rogers, President of the Space Transportation Association, representing companies and individuals in the United States who have been advocating a more aggressive approach to developing a new U.S. space launch capability. Now to Dr. Chvanov.

VLADIMIR K. CHVANOV: Distinguished guests, ladies, and gentlemen. It is a great pleasure for me to be here in Colorado Springs to address this prestigious forum—where one can hear the full spectrum of space policy issues addressed and discussed. This is the second opportunity for NPO Energomash to meet with you, and I would like to thank Dick MacLeod and the Board of Directors of the Space Foundation for their invitation. Today, I would like to talk to you briefly about the engines developed and produced by NPO Energomash and about the plans of Energomash to participate in international space programs.

NPO Energomash was founded in 1929 by Valintin Glushko, a member of the USSR Academy of Sciences. This year, we celebrate our 65th continuous year in the rocket engine business. During this period, Energomash has developed 53 models of liquid rocket engines.

In addition, Energomash is involved in the modernization of existing Russian space launch vehicles and is actively participating in the development of a new Russian launch vehicle. Energomash provides all the first stages and most second stages for all Russian launch vehicles.

On the screen you will see (Fig. CL-1):
Energia - we provide first stage RD-170 boosters
Proton - we provide first stage RD-253 boosters
Soyuz - we provide RD-107 and RD-108 engines
Zenit - the RD-171 and RD-120 engines
Cosmos - the RD-214, RD-216, RD-119 and
Cyclone - the RD-219



CL-1

NPO Energomash is vertically integrated with 10,000 employees and two and a half million square feet of manufacturing area on 350 acres. We have 83 component test positions and 4 full duration fire test positions — two for liquid propellant engine tests with a thrust of

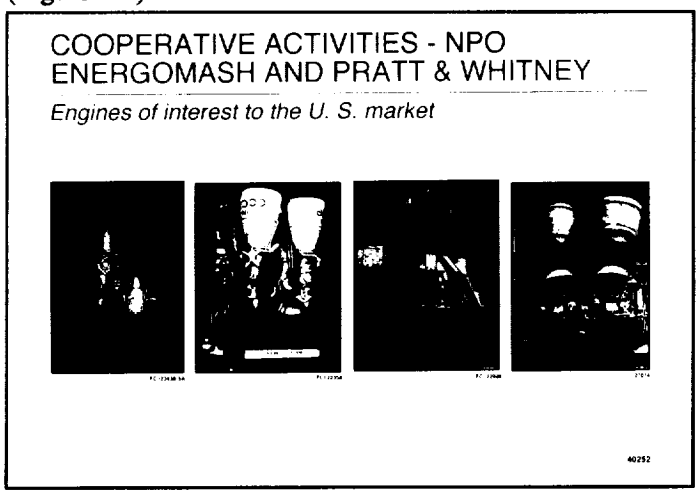
up to 1000 tons (1,000,000 kgf).

Now I would like to tell you about the history of the development of liquid propellant engines with high pressure in the combustion chamber. This history covers a 30-year period—from the early 60's until the present time. It began with the development of the RD-253 for the "Proton" launch vehicle which became the first staged combustion engine. This configuration made it possible to achieve a combustion chamber pressure of 150 atm. The development of this engine began in 1961, and first flight took place in 1965. All the successors of this engine also had a staged combustion cycle configuration—that is, after burning oxidizer rich gas. One of the engines recently developed by Energomash is the RD-170, in which the combustion chamber pressure of 250 atm is combined with extremely high thrust 806,000 kgf in vacuum as well as reusability. It is designed to make 10 flights. The RD-170 is the most perfect design for today in the same way the RD-253 was ideal for the early 60's.

At the present time, NPO Energomash is developing tripropellant engines of the RD-700 family with combustion chamber pressure of 300 atm. These next generation engines will be based on the experience of all previous engines, from the RD-253 to the RD-170.

Pratt & Whitney and NPO Energomash have entered into a long-term and exclusive joint marketing and technology licensing agreement. The agreement covers oxygen/kerosene and tripropellant engines developed by NPO Energomash. Our agreement was signed on October 26, 1992; and we have just completed our first market evaluation and planning cycle.

There are currently four engines of primary interest for the U.S. market and they are pictured in this slide. (Fig. CL-2)



CL-2

RD-170/-171

The RD-170/-171 is a mature high performance LOX/-kerosene rocket propulsion system with operability and reusability features not previously demonstrated by propulsion systems. The engine is designed to provide a minimum of 10 reuses. The RD-170 and its derivative, the RD-171, have fulfilled 29 flight missions within the Energia-Zenit program. The ability of the RD-170/-171 to start without special prestart service is a main contributor to the 2-hour timeline of the Zenit launch system that is measured from the beginning of transportation to the launch pad to launch. This a major advantage of these engines. The engine has a 10% higher specific impulse than any U.S. LOX/kerosene booster and has a fully operational advanced health monitoring/life prediction system.

High combustor pressure in 4 combustion chambers driven by a single turbopump unit provides s specific impulse of 337.2 seconds in vacuum. The engine has minimal size and lowest weight of any gimbal joint. Fire tests began in 1980, and the first flight took place in 1985. More than 900 fire tests have been made until now, with total duration of more than 100,000 seconds. Maximum life time demonstrated is 17 flights.

RD-180

The RD-180 is a two-chamber base derivative of the RD-170, with one half the thrust. This engine has incorporated about 80% of the RD-170 components. The derivatives of this engine are considered as candidates for use as boosters in various programs—Atlas, Spacelifter, Space Shuttle, and others. This year, Energomash is planning to issue a full set of design documentation for this engine.

RD-120

The RD-120 was developed concurrently with the RD-170. The RD-120 uses the same technologies which are found in the RD-170 to achieve high performance (187,400 pounds thrust, 350 seconds ISP) and operability. It is currently operational as the second state of Zenit. The option with a shorter nozzle (RD-120K) for first stages is being developed on the base of the RD-120 engine.

RD-704

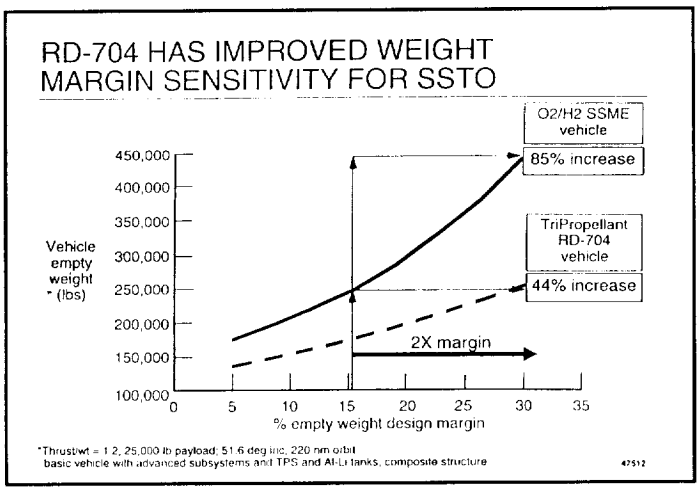
The RD-704 is a single chamber, dual mode, tripropellant, staged combustion cycle engine. Thrust in vacuum in the first mode is 200,000 kgf; in the second mode—80,000 kgf. Three propellants (oxygen-kerosene-hydrogen) are used in the first mode. Oxygen and hydrogen are used in the second mode. The propellants are

BOOSTERS & MAIN ENGINES

LOX/RP investment applicable to all options

Booster & Main Engines	Small Vehicle	Upgrade LLV	NGLS ELV	Upgrade Shuttle	Leap Ahead Vehicle
RD180		X	X	X	X
RD120 (RD120K)	X	X	X		X
RD704					X
Other NPO EM Engines	X				X
NPO Technology	X	X	X	X	X

CL-3



CL-4

burned within the same chamber. This engine is a derivative of RD-701 which was designed for the "MAKS" spacecraft launched from the Antonov-225 airplane. The RD-704 is under development now. Energomash intends to complete research on tripropellant combustion in 1994. The engine is developed based on the experience of RD-170 and existing oxygen-hydrogen engines.

Coming back to how we see Energomash engines applied to U.S. launch systems, I will use the chart you see on the screen. (Fig. CL-3) Reading across the top of the chart are the opportunities:

— small launch vehicle
— upgrade of existing expendable launch vehicles
— next generation launch system
— upgrades to Space Shuttle
— leap-ahead vehicle (most often described as a single-stage-to-orbit vehicle

Reading down the left column, we have listed possible uses of NPO Energomash engines and technologies:

— RD-180
— RD-120 (RD-120K)
— RD-704
— Other engines
— NPO technology

We have marked with an "X" the intersections of our engine capabilities and the opportunities. It is possible to have multiple uses for one engine, for example, the RD-120 and the RD-180. There is a one-point solution that has attracted much attention—the match up of the RD-704 and the leap-ahead vehicle. I would just briefly like to address the advantages of tripropellant engines for SSTO vehicles.

Research made in the United States, Russia, and other countries has shown considerable advantages of tripropellant engines as compared to any other type of engines. For instance, for different single-stage launch vehicles, the use of tripropellant engine allows to increase payload by approximately 30% as against an oxygen-hydrogen engine. This is due to the fact that a tripropellant engine provides the best trade-off between fuel density and specific impulse. Only the use of such type of engines makes the development of single-stage-to-orbit vehicles—both expendable and reusable ones—a realistic task.

I would like to note: 1. NPO Energomash has developed 53 models of engines for different propellants with different schematics and designs. This company has a unique experience in rocket engine manufacturing.

2. All Russian and former Soviet Union liquid vehicles delivering payloads into space are equipped with engines developed by NPO Energomash. In particular, the Cyclone, Proton, and Zenit launch vehicles. The engines for these rockets are constantly being upgraded.

3. NPO Energomash is developing some advanced liquid rocket engines—the basic oxygen-kerosene RD-180 engine, the RD-120K engine, and the basic tripropellant liquid rocket RD-704 engine. (Fig. CL-4)

In conclusion, ladies and gentlemen, I will touch on an issue of political importance. I want to assure the audience that the capabilities and technologies about which I have spoken are available to the U.S. market. I want to emphasize that the Russian and American governments support contacts at the level of companies as was enunciated in the Joint Statement of Commission on Economical and Technical Cooperation following the Gore/Chernomydrin Summit and, in particular, recognize the NPO Energomash/Pratt & Whitney Marketing and Technology Licensing Agreement. (fig. CL-5)

"Governments of the USA and Russia recognize and support the cooperation between US and Russian companies in the area of space rocket engine technologies."

US - Russian Joint Commission on Economical and Technical Cooperation

CL-5

DR. BRUCE S. MIDDLETON: *The U.S. Commercial Space Launch Industry: Policies for Survival*

SUMMARY

The United States commercial space launch industry is in jeopardy. Compared to foreign counterparts, American launch systems cost more to build and their operational manpower requirement and cost to orbit are significantly higher. Their market share is low and they face increasing non-U.S. competition. There is an urgent need for review of U.S. Government policies intended to foster this industry. The objectives of these policies - space transportation leadership, assured access to space, and substantial long-term economic benefits to the U.S. - have not been satisfactorily achieved, and some are no longer appropriate.

American launch service providers will not regain commercial competitiveness through marginal improvements in practices, manning levels and technology. Nor is government investment likely on a scale sufficient to regain competitiveness. A commercial solution is proposed, based on acquisition of a capable state-of-the-art foreign launch system, to be used at a new near-equatorial site in a country whose MTCR and COCOM credentials raise no issues with respect to shipment of satellites or technology transfer, namely Australia. A competitive, capable and well-located launch operation involving participation by the U.S., Japan and the Commonwealth of Independent States (CIS) would provide formidable competition for the Chinese and Europeans, and may well be the best chance for survival of an American commercial launch service in the medium term.

Since the demand for launches on large expendable launch vehicles (ELVs) is not expected to grow significantly over the next decade, but the supply of launch services is growing, the issue needs to be addressed in the short term of the 80% of the potential market protected as national payloads. It is proposed that new launch service suppliers from non-market economies be required to free up some of their own protected markets. The launch of some payloads in their national programs should be opened up for international bidding, the number being equal to the number of payloads for which they are permitted to contract in the international market.

The U.S. derives much more economic benefit from satellite manufacture than from commercial launch services. If the cost of putting payloads into orbit could be reduced substantially there are prospects for further growth in the payload market. However, for over thirty years the U.S. Government has not been prepared to commit sufficient resources to develop a next-generation launch system. It is proposed that international collaboration be sought to develop leapfrog technology at the pre-competitive stage, perhaps with the Japanese and others.

... for over thirty years the U.S. Government has not been prepared to commit sufficient resources to develop a next-generation launch system. It is proposed that international collaboration be sought to develop leapfrog technology at the pre-competitive stage ...

INTRODUCTION

In May 1994, ten years will have elapsed since the world's first truly commercial launch of a satellite, by an Ariane rocket from Kourou. Although non-government satellites had previously been launched on the shuttle, this marked the first direct contract between a non-government launch customer and a vehicle manufacturer. Although the first US commercial launch did not take place until August 1989, throughout the decade since 1984, the US Government has had policies intended to foster the development of commercial launch services. These policies aimed to maintain US leadership in space activities; this objective alone makes a review of U.S. policy important.

Another reason for focusing on American policy is that over the last five years the U.S. has taken the lead

in seeking international agreements constraining the behavior of certain new participants in the commercial launch services market. It has sought to enforce those agreements through its legal power to refuse the export of satellites containing U.S. technology. This is a misuse of that power which is to the potential disadvantage of U.S. satellite manufacturers, who control about 70% of the commercial communications satellite market worldwide.

After ten years of policies to foster the commercial launch industry, no-one is making much money. Customers complain that prices are too high, and insurers (who also are making no money) know that reliability is too low. New non-U.S. launch service providers are competing in the market to launch telecommunications, earth observation, weather and scientific satellites, a market which is not expanding significantly. At the same time rationalization is taking place. It is not surprising that many in the U.S. have been urging a reconsideration of policy.

THE POLICY BACKGROUND

The Reagan administration released its policy on the commercialization of ELVs in May 1983, following promulgation of its national space policy in July 1982. The context was competitive, for in March 1980, Europe had established Arianespace as its commercial launch service provider, following the first Ariane launch in December 1979. The policy objective was the maintenance of *space transportation leadership*. It was intended to maintain a high technology industrial base, provide jobs and thereby add to the tax base, strengthen the U.S. economy and improve the balance of payments, spawn spin-offs and supporting activities, strengthen the U.S. position in a growing commercial market, and thereby provide substantial long-term economic benefits to the United States.

In support of this policy, the Commercial Space Launch Act was passed in 1984.

Notwithstanding, the intent of the 1983 policy to encourage and facilitate private sector entry into the space launch market, the shuttle continued to be available to commercial users, both domestic and foreign. Moreover the government actively promoted the shuttle in the international launch services market. This proved to be a serious error. Attempts by private American companies to commercialize their ELVs were blocked, and production was suspended. The commercial market was effectively left to Ariane and the shuttle.

It was surely an expression of the frustration of the U.S. industry at the success of Arianespace that in 1985 an action was mounted, under Section 301 of the Trade Act of 1974, alleging that subsidy by the European competitor was unreasonable and a burden on U.S. commerce. The action was unsuccessful, and immediately afterwards the U.S. Government stated its intention to seek international discussions aimed at establishing appropriate guidelines for the commercial launch industry. Today international guidelines remain a hope, despite years of intermittent discussion and negotiation.

An updated U.S. policy on space and the space industry was announced in February 1988. The Presidential directive stated that space leadership continued to be a fundamental objective guiding U.S. space activities.

The 1986 Challenger accident brought commercial launches on the shuttle to a halt, and the dominant market position which Arianespace acquired in consequence remains today.

An updated U.S. policy on space and the space industry was announced in February 1988. The Presidential directive stated that space leadership continued to be a fundamental objective guiding U.S. space activities. Key elements of the policy focused on promoting a strong U.S. commercial presence in space, on assuring access ("a highway") to space through space transportation systems that provided sufficient resiliency to allow continued operation despite failures in any single system, and on building a solid technology and talent base. While leadership did not require the U.S. to aspire to pre-eminence in all areas and disciplines of space enterprise, it did require pre-eminence in key areas critical to achieving national security, technical, economic and foreign policy goals.

The period immediately following this announcement brought new developments which the policy appeared not to have anticipated. In 1988, China secured three contracts for commercial launches on its Long March family of ELVs. The three satellites were built in the U.S. by Hughes, and therefore required export approval under the Arms Export Control Act. As a precondition to that approval, which was eventually given in December 1989, the U.S. in December 1988 concluded an agreement with China limiting the Chinese to nine Western commercial payloads over six years, with the launches to be spaced evenly. It required that, after the introductory launches for which discounts applied,

prices would be on a par with prices prevailing in the international market for comparable commercial launch services. The agreement, which expires on 31 December 1994, was seen by the U.S. industry as an ad-hoc response from the U.S. Government, in the absence of guiding policy.

Just as the agreement with China was being concluded the Soviets entered the commercial launch picture. In 1987 they had signed contracts with an American company for the launch of two communications satellites on the Proton in 1989-90, but the deal was blocked by the denial of export licenses. U.S. policy at the time was firmly to deny exports of satellites and satellite components to the Soviet Union. Since U.S. technology was ubiquitous in the satellites for which the Soviets might bid, the policy effectively barred them from the market.

However in late 1989 the Cape York proposal surfaced in Washington, based on the use of Soviet-built launch vehicles owned by a private Australian company to provide launch services from Northern Australia. USBI Co, a subsidiary of United Technologies, applied in October 1989 for approval under the Arms Export Control Act to participate in feasibility studies for the project. Suddenly Soviet entry into the commercial space launch market became a serious policy issue. In February 1990 the CEOs of the three big U.S. launch service providers intervened, writing to the Vice President (who also chaired the National Space Council) to express concern at the effect of non-market competition on the U.S. launch services industry, and proposing that export approval be deferred until a commercial space policy was established. In March 1990 the National Space Council also advised the President to defer the USBI application until the Council could complete a review of U.S. launch policy, especially as it related to market entry by competitors from non free-market economies. The review had been requested by the Congress in the National Space Council Authorization Act 1990, which required the Council to report by 1 August 1990.

The result of that review was the policy for the commercial space launch industry announced in September 1990. The principal objective had shifted, in response to the Chinese and Soviet developments, to seeking "a free and fair market in which U.S. industry (could) compete." In the near term the U.S. sought trade agreements to limit "unfair competition." In the longer term the policy sought "technical improvements to reduce the cost and improve the reliability of U.S. launch vehicles." (In 1994, more than three years on and after ten years of commercial launching, these remain amongst the principal issues.)

By way of implementation, the policy

- continued to reserve for U.S. manufactured vehicles the business of launching U.S. government satellites, unless specifically exempted by the President;
- foreshadowed negotiations with ESA, its member States and others on principles of free and fair trade in this market;
- foreshadowed the imposition, during a transition period, of special conditions on the entry into the market of launch service providers from non-market economies, and
- noted the requirement for effective enforcement of international agreements relating to space launch goods and services.

The announcement elaborated on the sensitive issue of the entry into the commercial market of launch service providers from non-market economies, with special reference to the Soviet Union. It confirmed the long-standing U.S. policy to deny, except in extraordinary circumstances, exports of satellites and satellite components to the Soviet Union. It sought to reinforce this ban by requiring the USSR, in return for U.S. agreement to the use of a Soviet launch system at a single, mutually agreed location outside the USSR, to forego commercial launches of Western satellites from within its territory. This concession by the U.S. was conditional on technology transfer safeguards, and on enforceable agreements related to free and fair trade and to ballistic missile non-proliferation. The policy foreshadowed that the U.S. would seek agreement that launch services offered commercially be in compliance with a common approach to the entry of competitors from non-market economy countries.

Two weeks prior to the September 1990 policy announcement, and consistent with it, the U.S. Government announced its approval for USBI to participate in Australia's proposed Cape York project. The approval was subject to prior agreement being reached to ensure that:

(a) the USSR would provide launch services (boosters, equipment, technology or training) only from Cape York or any other single location;
(b) the USSR and Australia would observe the Missile Technology Control Regime (MTCR), and
(c) U.S. regulations on technology transfer to the Soviet Union would be observed.

The United States sought agreement with the Soviets on the "single location," to run for ten years after the date of the first launch of a Soviet-built booster from Cape York. Bilateral discussions on this matter continued for a year after release of the policy, but when it

appeared that the Cape York project had lost momentum these discussions were subsumed into wider negotiations concerning MTCR adherence and the terms of U.S. agreement to Russian commercial space launches from the soil of the former Soviet Union, discussed later.

Reference in the September 1990 policy announcement to negotiations with ESA and others was the signal for a renewal of bilateral discussions which had started following the 1985 Section 301 case. These focused on the issue of subsidies, and the differences of view were wide. The U.S. perceived as subsidy the support of European governments, through ESA, for the development of vehicles for commercial use. Europe, which has a much smaller demand than the U.S. for military launches, identified subsidy in the manufacture of vehicles for commercial use in plants meeting U.S. national security orders. The U.S. declined to allow onto the agenda the issue of European access to the business of launching U.S. Government payloads not classified as national security. Some of the ideas which the United States advanced were in the realm of trade policy. Since ESA had no mandate in these matters, the European Commission had to become involved. The talks proved difficult and inconclusive.

Late in 1991 the Soviet Union fragmented into the CIS. Its space launch capability was inherited by Russia, which had several large rockets and one operational launch site (Plesetsk, at 62 degrees North), Ukraine with rockets but no launch site, and Kazakhstan with a launch site (Baikonur, at 45 degrees North) but no rockets.

The fundamental objective of U.S. space leadership, which had not been prominent in the 1990 announcement, resurfaced in the February 1991 statement of U.S. commercial space policy guidelines, which had been in development in the National Space Council in parallel with the 1990 launch policy. Harking back to the 1983 statement, the guidelines sought economic benefit from the commercial use and exploitation of space technologies and systems. One of the five markets which the guidelines addressed specifically was the private development, manufacture and operation of launch vehicles, and the marketing of space transportation services. The guidelines re-committed the U.S. to work towards the establishment of an international trading environment, operating under principles favorable to private investment and market development, in which direct government subsidies and unfair competition by governments were eliminated.

RECENT DEVELOPMENTS

Since the first U.S. commercial launch in 1989, the international political and commercial environment has undergone profound changes which impact on U.S. policy.

The Soviet policies of perestroika and glasnost drew a response from the West within COCOM, which in 1990 eased certain restrictions. As part of the change the U.S. in November 1990 undertook a comprehensive review of all space-related articles controlled on the U.S. munitions list, resulting in the majority of commercial communications satellites being removed from the list. Space launch vehicles and their components however, remained restricted on the munitions list.

Late in 1991 the Soviet Union fragmented into the CIS. Its space launch capability was inherited by Russia, which had several large rockets and one operational launch site (Plesetsk, at 62 degrees North), Ukraine with rockets but no launch site, and Kazakhstan with a launch site (Baikonur, at 45 degrees North) but no rockets. Further complicating the picture was the dependence of Russian and Ukrainian rockets on components supplied from other States of the CIS. The space dimension of the relationship of Russia and Ukraine with the West was linked with the future of the nuclear arsenal of the former USSR, and of its delivery systems. Both Russia and Ukraine announced their intention to ratify the START treaty, setting a positive and constructive environment in which Russia's ambitions to become a significant player in the world of space commerce could be pursued.

The first relaxation of the long-standing U.S. policy to deny exports of satellites and satellite components to the (former) Soviet Union came in an agreement signed between Russia and the United States at the Washington summit in June 1992. The U.S. stated its willingness to consider favorably a decision expected by Inmarsat the following month (and subsequently taken), to launch from the territory of the CIS an Inmarsat-3 satellite manufactured in the U.S. The U.S. and Russia agreed to enter into negotiations to develop international guidelines concerning competition in the commercial launch market.

In December 1992 the Lockheed Commercial Space Company received approval from the U.S. and Russian Governments to enter into a commercial partnership

with Khrunichev Enterprise, the manufacturer of Russia's Proton launch vehicle. The new venture was to market the Proton worldwide. In September 1993, Space Systems/Loral announced that it had contracted with the venture for one firm launch late in 1995 and four options for 1996-8.

The Vancouver summit in April 1993 gave further impetus to negotiations for a U.S./Russia commercial space launch agreement, which was eventually signed in September. The agreement had been conditional on Russia undertaking to adhere to the principles of the MTCR, an undertaking given in July when Russia announced its intention to become a full member of the MTCR in 1996. The commercial space launch agreement, which runs until 31 December 2000:

- limits Russian launches of commercial satellites to GEO and GTO to a total of eight (not including the Inmarsat 3 satellite already contracted) through the end of the year 2000, with no more than two in any twelve month period;
- requires Russian pricing to be similar to Western pricing, and provides for consultation between the parties if Russia was to tender a launch price which is more than 7.5% below the lowest Western tender;
- allows Russia to contract for up to three launches to LEO for the Iridium system;
- sets other LEO launches aside for consideration on a case-by-case basis, and
- makes all Russian launches subject to a bilateral safeguards agreement.

The similarities with the China/U.S. agreement of December 1988 illustrate what the U.S. meant by the "special conditions" it sought to apply for the entry into the market of launch service providers from non-market economies. In essence these agreements impose numerical limits on market share, and require pricing to be close to market trends. They are linked to the MTCR guidelines and, because the U.S. reserves the right to consider on a case-by-case basis each application for approval to export a satellite containing U.S. technology to these countries for launch, they are enforced through the Arms Export Control Act.

A similar European Commission/Russia agreement was reached in June 1993, although it was not signed at the time because Russia wanted to extend the negotiations to achieve better access to EC markets. The EC/Russia agreement would allow Russia twelve commercial launches (eight to GEO/GTO and four to LEO) between 1995 and 2000, and contains provisions to avoid excessive concentration on any specific customer area or more than three launches in any two year period. It is understood that this agreement is regarded as being in force on a de facto basis, and may be signed as part of a broader "Pact of Partnership" with Russia.

Changes in the commercial environment over recent years also have implications for the direction of future U.S. policy. A series of mergers and acquisitions has increased the size and level of integration of some of the major manufacturers, and has resulted in companies formerly involved predominantly in either satellites or launch vehicles becoming stakeholders in both parts of the civil space business. In Europe, Deutsche Aerospace and Matra Marconi Space were established, and there occurred a series of mergers and redistributions among the aerospace companies in Italy, which are mainly State-controlled. In the U.S., Loral acquired Ford Aerospace and more recently Martin Marietta absorbed GE Astro. Martin announced in December 1993 that, subject to government approval and certain assurances, it is acquiring the Atlas business of General Dynamics. In March 1994 it was announced that Martin will merge with Grumman.

Huge sums were spent on the development of missiles, and from them of space launch vehicles. The ability to put men into space, on the Moon and in orbiting space stations was the stuff of political prestige, and clear evidence of military capability.

The Atlas sale is particularly significant, because for the first time a single business will offer to commercial customers both satellite manufacture and launch services. It will be interesting to see how Martin Marietta balances the commercial success of its Atlas launch business with the marketing attractions which lower launch prices may offer for its satellite manufacturing. Given the extent to which U.S. launch systems are now uncompetitive, Martin may be looking for a commitment from the U.S. Government to develop a new launch system which can compete in a commercial environment. If that commitment is not forthcoming, the possibility must exist that the attractiveness of manufacturing satellites will crowd out its commercial launch business.

Compounding the pressures in the commercial space launch market is the prospect of the entry of Japan with its new indigenous launcher, the H-2. The new venture Rocket System Corporation was established in July 1990, by a consortium comprising 77 of the companies

involved in Japan's space program, for the purpose of offering the H-2 for commercial launches. Several unsuccessful bids for launch contracts were made prior to the maiden flight of the H-2 in February 1994, the first as early as 1991. However the protracted development of the H-2 and appreciation of the Japanese currency have resulted in projected charges to launch service customers being more than double the $US65M originally targeted. At present it is estimated that launches on the H-2 cost $US150M, a figure the Japanese will be working to reduce to $80-90M.

A successful Super 301 action in 1990 by the U.S. against the Japanese Government, which forced Japan to procure commercially the CS-4 communications satellite they had planned to build as a government-funded project, was a significant setback to what many believe to be the Japanese strategy to offer a bundled package of satellite, launch and finance. Not only did the outcome remove from the Japanese Government program the development of several communications, broadcasting and meteorological satellites, but their launch also became a commercial matter. Nonetheless, studies from Europe and the U.S. released in 1993 predict that Japan will enter the commercial communications satellite market within a decade.

This then is the political and commercial context in which the success and relevance of U.S. policies for its commercial launch industry must today be assessed.

OUTCOMES OF U.S. POLICY

The principal stated objectives of U.S. policy for the commercial space launch industry over the past decade have been:

- U.S. space transportation leadership,
- assured access to space, and
- substantial long-term economic benefits to the United States.

These objectives have been pursued through a variety of measures, including requiring government agencies to utilize commercial products and services, promoting the transfer of technology from the public to the private sector, making unused government infrastructure available for commercial use, and working towards establishment of an international trading environment which encourages market-oriented competition.

In order to consider future prospects and policy options, it is necessary first to assess outcomes against these objectives.

POLITICAL and STRATEGIC LEADERSHIP

The political and strategic dimension of leadership in space was the prime driver of the United States space program, and those of other countries, from the end of World War II until the end of the Cold War in 1991. The technologies of space transportation are also those of strategic missiles, and rocketry was at the forefront of the competition in which leadership was seen as vital to the national interest. Huge sums were spent on the development of missiles, and from them of space launch vehicles. The ability to put men into space, on the Moon and in orbiting space stations was the stuff of political prestige, and clear evidence of military capability. In most areas, but not in manned space stations, the U.S. did indeed achieve and maintain leadership measured on this criterion.

The question now however is whether this objective is useful and appropriate for the future development of the U.S. commercial space launch industry. The Cold War is over, and it is not at all clear that any nation will in the near future be prepared to invest substantial sums in significant improvements in space launch systems.

It will be suggested later that it may be counterproductive to continue to proclaim space transportation leadership as a primary objective of U.S. policy on commercial space launching.

Indeed, it is doubtful whether the multi-billion dollar European investment in Ariane 5, and the Japanese investment in the H-2, would be approved today if those decisions were on the table. In the U.S., all attempts over recent years have failed to secure continuing support for projects aimed at reducing the cost and complexity of access to space. The Advanced Launch System, the Advanced Manned Launch System, the National Aerospace Plane and its precursor X-30, the National Launch System, Spacelifter, and the DC-X have all failed to secure sufficient support to become funded programs with target end dates.

It will be suggested later that it may be counterproductive to continue to proclaim space transportation leadership as a primary objective of U.S. policy on commercial space launching.

TECHNICAL LEADERSHIP

Technical leadership for U.S. launch systems would imply that they are the world benchmark.

The Delta, Atlas and Titan launch systems are essentially those which were developed three decades ago as military vehicles. Each is integrated in the vertical using

a mobile tower, and occupies the pad for an extended period before launch. Launch systems are complex and launch crews are numerous. None of the three has benefitted from a generational upgrade over the last decade.

Europe on the other hand is developing the Ariane 5 as a leading edge launcher for commercial use beginning in 1997. Some of that investment (as capital, the cost of which is borne by ESA and not by Arianespace in its commercial cost structure) has been used to reduce further the level of manpower required in launch operations (the cost of which is part of Arianespace's costs). In this way a greater subsidy has been provided. Ariane 5 will spend only a few hours on the launch pad, and a high rate of launches will be possible through the use of two launch platforms and two control rooms.

The Ariane 5 pad itself is relatively simple, and less susceptible to damage from an accident than has been conventional. Fuel and oxidant bulk containers are mobile and there is no permanent storage within the hazardous launch area. A launch accident at or near the pad would therefore not cause major interruption to the schedule of launch campaigns.

The objectives of the Ariane 5 program included reducing the cost of a launch on Ariane 5 to 10% below the cost of an Ariane 44L launch, thereby reducing the cost per kilogram to orbit by 45%. Recent reports have quoted the companies building Ariane 5 estimating a launch cost about 13% higher.

Ariane 5 however, will not be state-of-the-art. That accolade belongs to the Ukrainian Zenit which, as Zenit 3, has a capability of delivering around six tons to GTO from a near-equatorial launch site, this offers a performance close to Ariane 5. Zenit uses a low hazard fuel, and has no strap-on SRBs. It has a highly automated launch system, including a fast automated fuelling system which is safer and less labor intensive. In consequence, the size of the Zenit launch crew is relatively small. Turnaround at the pad, using only one transporter erector, can be less than 24 hours, and no refurbishment is required between launches.

Both the Ariane 5 and Zenit systems are advances on Ariane 4, which in turn is well ahead of U.S. launch systems in terms of commercial considerations. The Ariane 4 launch crew is one third that of Delta, the U.S. launcher with the smallest crew. It occupies its pad for less than half the time used by the Delta. Total staffing at Kourou is less than 10% of that at Cape Canaveral Air Force Station. Compared to foreign counterparts, American launch systems appear to cost more to develop, build and launch. The manpower required is substantially higher, and the construction and launch phases require longer times to achieve. Not surprisingly, the cost to orbit of U.S. launchers appears to be significantly higher than Ariane, Zenit or Long March.

The U.S. cannot, on these facts, be said to hold technical leadership in the commercial space launch business.

Both the Ariane 5 and Zenit systems are advances on Ariane 4, which in turn is well ahead of U.S. launch systems in terms of commercial considerations. ... The U.S. cannot, on these facts, be said to hold technical leadership in the commercial space launch business.

COMMERCIAL LEADERSHIP

The success of U.S. launch service providers in the commercial market can be assessed both retrospectively, in terms of recent launches, and prospectively, in terms of orders. With respect to recent experience, in 1992 and 1993 (the period since the breakup of the USSR) there were 62 payloads launched outside the CIS, 27 of which were "commercial" in the sense that the launch service provider was selected through an open international bidding process. In terms of market share, Europe launched 17 (63%), the U.S. 8 (30%) and China 2 (7%) of those payloads.

As to the future, 31 (57%) of the 54 civil satellites contracted as of Spring 1994 for launch within the next three years will ride on an Ariane rocket, 21 (39%) on American launchers, and two (4%) on Long March.

Individual U.S. companies do not appear to have enjoyed much commercial success in terms of profits. Faced with limited orders, Martin Marietta effectively vacated its Titan commercial business in 1989. General Dynamics' Space Systems Division lost money over the past several years, and its Atlas/Centaur suffered three mission failures since 1991. Subject to government approval and certain assurances, the business (in which General Dynamics invested a total approaching a billion dollars), is being bought by Martin Marietta for $US200M. Even McDonnell Douglas with its reliable Delta is known to have found the commercial business difficult.

On these figures a claim cannot be sustained that the U.S. holds commercial leadership in the space launch business. Market leadership belongs to Europe.

ASSURED ACCESS TO SPACE

Since 1988, U.S. policy for its space industry has had assured access to space as an objective, to be achieved through systems that provide sufficient resiliency to allow continued operation despite failures in any single system.

The logic of the relevance of this objective to commercial space launching bears examination. Resiliency presumably refers to the availability of sufficient diversity of launchers that a failure in one system could be covered by another system, achieving continuity in access to space. Since the Delta vehicle is not large enough to serve as a backup for Atlas or Titan class payloads, Delta can logically be excluded from this consideration. Equally, Atlas is not large enough to serve as a backup for Titan class payloads, though it can carry Delta business. Titan, as the heaviest launcher, can back up both Delta and Atlas (at a much higher cost, of course). Thus while Titan is flying this resiliency exists with respect to Delta and Atlas class payloads, and Atlas adds the luxury of an extra layer of resiliency with respect to Delta class payloads. Titan has not been marketed commercially since 1989, and its availability (and the existence of the required backup capability) is solely dependent on government business. The fortunes of Delta and Atlas in the commercial market are, on this logic, substantially irrelevant to maintaining assured access to space.

The strategic dimension of assured access to space bears on the ability of the U.S. to launch its own national security satellites. For the objective to be relevant to commercial business however it is necessary to demonstrate a causal connection between a healthy commercial launch sector and the ability to deploy national security satellites. In fact nineteen of the 36 spacecraft launched in the U.S. over the last two years were for national security purposes, and only eight launches were commercial. Since there does not appear to be official concern that access to space has been endangered by commercial business representing such a low fraction of launch activity, it would seem that it is the national security launch requirement, rather than the commercial, which assures the availability of a launch capability. Commercial business would appear to be relatively unimportant to preservation of the ability of the U.S. to place satellites into orbit.

Moreover while the shuttle remains in flight readiness there will always be the required resiliency for any payload denied an ELV launch, provided it is of sufficient national importance to warrant the expense and risk of a shuttle launch. The U.S. "mixed fleet" has both shuttle and Titan (both sustained by government business, not commercial orders) providing resiliency in the event that a failure in the Delta or Atlas system delays the launch of a nationally important payload.

It is concluded that commercial space transportation has marginal relevance at best to the maintenance of assured access to space for U.S. national security payloads, which depends ultimately on the availability of launch systems which are sustained at government expense.

LONG-TERM ECONOMIC BENEFITS

Throughout the decade of commercial launches the achievement of substantial long-term economic benefits to the United States has been an objective of its commercial space launch policy. The direct economic benefits, judged on the launch record of the past two years, has fallen somewhat short of that. The fees for the eight commercial launches in 1992 and 1993 are likely to have grossed around $US500M over the two years and, since only four of these payloads were not owned by U.S. customers, the export income (from three Delta missions and one Atlas) was something less than half this sum.

The modest success of commercial U.S. launch service providers, in a limited market which is not growing, inevitably raises the issue of protection. Economists argue that any market which is not subject to the full discipline of market forces will exhibit higher prices and inefficient business practices. By any measure the U.S. domestic market for launch services is highly protected, for 28 of the 36 spacecraft launched in 1992 and 1993 were reserved for launch by American companies. If there was any competition for these launch contracts it was between services on ELVs which are, by their capability, clearly differentiated from each other and not really in competition. It can be assumed that the U.S. taxpayer paid more for these launches than would have been the case had full international competition been used to select the contractor in each case. It is not therefore surprising that the Senate Armed Services Committee proposed in 1993 that the Pentagon study the implications of launching national security payloads on foreign launchers, on the grounds of cost.

Of course, the U.S. is not alone in the practice of reserving government payloads for "flag carriers." ESA payloads normally fly on Ariane under the terms of the original agreements surrounding the creation of Arianespace, and ESA member States are expected to favor the European launcher for government-funded payloads. Moreover, pressure is placed on European PTTs and international organizations such as Eumetsat and Eutelsat to use Ariane. However of the 20 payloads launched

by Arianespace in 1992 and 1993, only three would not have been considered for another launcher. No doubt there was pressure for another five (which were substantially European) to choose Ariane, but in reality seventeen contracts were won by Arianespace in international competition, a rather better record than the U.S. over this period.

Like the U.S. and Europe, Japan also reserves government payloads for national carriers. It will not be surprising if, in anticipation of H-2 being handed over to Rocket System Corporation for commercial use, non-government satellite owners in Japan are coming under pressure to use the flag carrier, as is common in Europe. Preference by private Japanese satellite owners for the H-2 in future would however be contrary to the 1990 U.S.-Japan Trade Impediment Initiatives agreement.

There is general agreement amongst those forecasting the future civil satellite launch market (covering telecommunications, earth observation, weather and scientific satellites) that demand is most likely to remain relatively flat over the next decade.

Finally, the Chinese and the Russians have to date managed to reserve 100% of their (government) payloads for flag carriers.

The impact of these practices on the commercial space launch market should not be under estimated. A measure of the extent of protection is seen in the launch statistics for 1992 and 1993. Some 140 major payloads and single-payload equivalents were launched worldwide of which, as noted earlier, only 27 were the subject of international competition for a launch contract. In other words 81% of the market was protected in one way or another. It would be foolish to expect the benefits of market forces in a market which is so protected.

The costs of this protection may not fall evenly on all the players. Satellite manufacturers have complained for years that the price of launches is too high and acts against growing their market. In 1990 it was estimated that satellite manufacturing in the U.S. achieved revenues of $US2.5B, and enjoyed two thirds of the world market. The high levels of protection in most segments of the international launch market, and consequent lack of effective competition, reveal why it would be optimistic to expect more than marginal improvements in either launch price or reliability in the foreseeable future. To the extent that high prices and unsatisfactory reliability hinder new satellite sales, the U.S. probably incurs these costs of protection more than its competitors.

It must be concluded that the United States has not enjoyed substantial long-term economic benefits from its commercial space launch industry during the ten years in which this market has existed.

POLICIES FOR SURVIVAL

Policies which have been in place for ten years without achieving their objectives need to be reviewed. Prospects for the commercial launch industry suggest that a review is not only necessary but urgent. Without action there is a real possibility that one or more American companies will leave the industry. The share of the commercial market which they have won in recent years has been between 30 and 40%, and future orders indicate little change.

There is general agreement amongst those forecasting the future civil satellite launch market (covering telecommunications, earth observation, weather and scientific satellites) that demand is most likely to remain relatively flat over the next decade. Arianespace, the market leader, sees 16 to 22 satellites per year available for international bidding, which are to be launched from 1994 through 2003. The expected deployment by the end of this decade of LEO communications systems will not add much. They may produce a modest once-only addition to the market for large vehicles launching multiple satellites, but maintenance of the LEO constellations is likely to be served by the smaller launchers now being developed, such as Taurus and LLV-1, and perhaps the Russian START.

There has however been a surge in supply of capability to GTO with the Chinese and Russians entering the market, and launch capacity will be further increased by 1997 when Ariane 5 becomes operational and the Japanese join in. One estimate is that there is a potential for 179 tons of launch capability to GTO to be chasing a market of 60 tons.

In such a market the uncompetitive U.S. launch vehicles are likely to lose out badly, particularly as Ariane 5 widens the competitiveness gap. Worse, a trend to heavier satellite weights will exacerbate the problem, as payloads move beyond the capability of Delta, and some of Atlas. Arianespace expects 80% of satellites launched in 2000 and later to weigh 2.5 tons or more.

The industry is aware that it is in serious jeopardy. The U.S. Government may have to decide if it will sustain production of both Delta and Atlas purely for

government business, at prices which must rise as costs are amortised across a smaller number of launches. In the budgetary climate of the 1990s the answer to that question is far from a foregone conclusion.

There are however some policy options which could improve this prospect.

RESTORING U.S. COMPETITIVENESS

Given that the Delta, Atlas and Titan launch systems are no longer competitive in commercial terms, the agreements which the U.S. has struck with China and Russia can be seen as an attempt to preserve market share until the United States makes the national investment to develop a competitive system. The problem with this strategy is that there is no basis in the experience of the last thirty years for confidence that the investment will be made. The strategy is therefore fatally flawed, at a cost both to the customers of uncompetitive U.S. launch services and to the United States in the damage done to its standing in international forums where it argues for free trade.

The quest for more competitive launch systems has both a medium-term and a long-term dimension. In the medium term the U.S. industry needs to catch up with best practice if it is to preserve and enhance its commercial position. Marginal improvements in current U.S. launch systems and practices are unlikely to overcome the generational advantage held by the Europeans. In the absence of a commitment by the U.S. Government to bridge the gap with new investment, one way to tackle the problem would be to buy an advanced launch system.

The strategy is therefore fatally flawed, at a cost both to the customers of uncompetitive U.S. launch services and to the United States in the damage done to its standing in international forums where it argues for free trade.

The accolade of state-of-the-art belongs to the CIS Zenit, which will remain the leader even when Ariane 5 becomes operational. Despite efforts dating back to 1988 to sell the system in the West, the producers of the Zenit have not yet been contracted and are available to negotiate. The opportunity therefore exists for an aggressive U.S. launch service provider to strike a commercial deal giving access to a state-of-the-art launch system.

The capability of Zenit for launches to GTO/GEO would be inadequate if operations took place from Baikonur, 45 degrees North of the equator. Moreover commercial launches from Baikonur will in the foreseeable future involve the risk of denial of U.S. export approval, and since the breakup of the USSR doubts have been expressed about the maintenance and operational standards at the facility. Commercial Zenit needs a new, near-equatorial, launch location, in a country which poses no MTCR or COCOM difficulties.

A counterpart to Kourou in Northern Australia may well be the best opportunity for the survival of an American commercial launch service in the medium term. It warrants examination.

Studies undertaken in 1991 on the commercial prospects of Zenit , which were based on a new site on Cape York in Northeastern Australia (at twelve degrees South) using private funds, indicated good commercial prospects. Australia in fact fulfills more of the criteria for the location of a fully commercial launch business than any other country, including MTCR and COCOM credentials, political stability and relations, geography, infrastructure and climate.

A Zenit-based launch service at a remote site need not be expensive in manpower terms. If the launch service at the site was confined to fuelling, integrating and launching pre-processed payloads, much on the model of Arianespace operations at Kourou, on-site manpower required for a launch service based on Zenit would be less than 400, eliminating one of the major factors in the uncompetitive status of current U.S. launchers.

The proposition has a useful political dimension. The market leader, Ariane, is backed to a degree by the resources of European governments who are members of ESA. The remaining 40% of the commercial launch market is divided between the U.S., China and Russia, and Japan has aspirations. A state-of-the-art launch service which combined U.S. technical and investment leadership with CIS technology and Japanese investment, located at a privately-owned site which minimized sovereign risk, would give the Europeans and Chinese a formidable competitor. A counterpart to Kourou in Northern Australia may well be the best opportunity for the survival of an American commercial launch service in the medium term. It warrants examination.

The venture could be commercial with no investment from governments. It would be bound to receive the encouragement of the Australian Government and those of Russia and Ukraine, but the active support of the U.S. Government would also be essential for success. Investors would require assurances that approvals would be granted, both for U.S. corporate involvement and technology transfer, and for the subsequent export of satellites containing U.S. technology to Australia for launch. They would need to be convinced that, once the venture had satisfied legitimate security concerns, the Arms Export Control Act would not be invoked to the detriment of commercial success.

Investor concerns about the attitude of the U.S. Government within the MTCR would also need to be addressed. One view in the U.S. Government is opposed to any transfer of space launch technologies to countries which do not have them, whether or not they adhere to the Regime. While the underlying logic may have some relevance to countries suspected of military ambitions, opposition on those grounds to the transfer of Zenits to Australia would be inconceivable. The MTCR guidelines were not designed to impede national space programs or international cooperation in such programs, as long as such programs could not contribute to nuclear weapon delivery systems. Australia's credentials in this respect are impeccable, and investors should be entitled to relevant assurances from the U.S. Government.

INCREASING THE SIZE OF THE AVAILABLE MARKET

Amongst the most pressing policy issues in the short term is market size and the growing imbalance between supply and demand for launch services. If the size of the available market is not likely to grow through customer demand, attention must shift to growth through measures available to governments. The obvious area for examination is the four-fifths of the total market which is protected.

Since the supply pressure added to the market for launch services has come from the entry of two new service providers from non-market economies, who themselves have significant protected domestic markets, one issue for consideration is whether the privilege of access to others' markets should require an element of reciprocity.

It could, for example, be a condition of market access for these new service providers from non-market economies, whose launch capability reflects a substantial national space program, that they free up some of that protected market. Arianespace has, in a rhetorical way, floated the proposition that if the Russians are given access to the Western launch market, then the Russian market also should be open to Western competitors. Such a total change is clearly impractical and unlikely. What might be possible is to require then to open up their markets for international bidding for the launching of some payloads in their national programs, the number to be equal to the number of payloads for which they are permitted to contract in the international market. In this way the imbalance of supply over demand would in principle not be exacerbated, because demand would increase at the same rate as supply.

In setting numerical limits, account would have to be taken of the nature of payloads on the relevant national program, for no national security payloads would be contributed to the market pool. The policy might require the new player to bring to the market either all non-national security payloads, or a number equivalent to the number for which it is permitted to contract in the market, whichever is the smaller.

In the early stages of such a policy it could be expected that this potential new business would nonetheless be won by a service provider of the relevant country, not least because of low cost, compatibility, and the comfort factor. However over time costs are bound to rise as the host economies become more exposed to world markets. Moreover performance standards required of domestic launch service providers in those countries will be pushed upwards, as the customers become aware of Western practices and require some of them at home. Costs will rise as standards do.

Moreover the transparency which is a necessary part of the bidding process may have some advantages for Western bidders in understanding how things are done in the space industries in these countries.

The capacity to pay in hard currency for a launch provided by a foreign contractor is a potential constraint. For the Chinese, who in the past two years launched two commercial as well as three national payloads, this should not pose a problem. For the Russians, the requirement to earn hard currency by competing successfully outside Russia would be a good discipline. If they were unable, because of foreign currency availability, to fund more than one or two launches of Russian payloads on foreign ELVs, the policy might limit their access to the Western market to a similar number of payloads.

The value of such a policy might well lie less in the new business available to Western launch companies than in the constraint on new launch capacity permitted onto the market. At the very least it would provide practical limits, soundly based on the principle of reciprocity, to the market share to which these new entrants

might have access. It would also add pressure for transparency, and the introduction of commercial practices in the businesses of the new entrants.

Given that the U.S. already has bilateral agreements with both China and Russia, difficulty might be anticipated in introducing this additional requirement of those two countries. However the European Union has yet to sign its commercial space launch agreement with Russia, leaving open the opportunity to renegotiate to include this change. The current China/U.S. agreement expires in December next, providing a parallel opportunity to ask China to contribute to the available market in the negotiations expected to commence in April.

In the long term, the issue for commercial satellite manufacturers and launch service providers is whether advanced technology can be developed which will achieve an order-of-magnitude reduction in the cost of access to space, and a quantum improvement in reliability.

Such a policy would inevitably increase the pressure on the U.S. and Europe to loosen their protection of government payloads not classified as national security and, in the case of Europe, their pressure on other satellite owners to use Ariane. The proposal that the market be freed up has already been raised by Europe. A 1992 communication from the European Commission to the Council and the European Parliament noted that, in entering into negotiations for liberalization commitments for the space launch services sector, the Commission would continue to seek the opening of public procurement of satellites and launch services. For the U.S., the essence of this issue would involve a judgement on whether the benefits of competitive pressure in reducing service costs to government and private customers, and the flow-on advantages for satellite manufacturers, outweighed the cost to the launch industry of having to compete for about one-third of its formerly-guaranteed business.

ENFORCEMENT OF AGREEMENTS

The shares of the international commercial launch market for which the new competitors from China and Russia can now compete are currently defined in their international agreements with the United States. The power which the U.S. is using to enforce those agreements is potential denial of approval for the export of satellites containing U.S. technology to relevant countries for launch. That power is however both limited and a two-edged sword.

The purpose of the export control contained in the Arms Export Control Act is strategic, not commercial or political. It is intended to prevent the sale of militarily useful technology to potential adversaries, not to enforce fair trade rules or deter competition which the U.S. may unilaterally judge to be unfair. Moreover COCOM (of which export approval is a part) is a coordinated arrangement, not a unilateral power of the U.S. Should the U.S. be judged by its COCOM partners to apply the Arms Export Control Act for commercial reasons, then its influence in that forum is likely to be weakened. This is a constraint on the wrong use of this power over competitors in the commercial space launch market.

There is another constraint. If non-U.S. manufacturers of communications satellites are able to offer very competitive satellite-and-launch packages, using launch services for which the U.S. refuses to guarantee an export license if the satellite is built in the U.S., then U.S. satellite manufacturers (whose contribution to the U.S. economy outweighs that of the launch industry many times) could be severely disadvantaged in their marketplace. Underlining the risk, it is reported that $US80-100M in export sales have recently been lost to Germany and Brazil because of uncertainties over export approval. Damage to the prospects of U.S. satellite manufacturers would be particularly unfortunate at this time, when forthcoming deregulation and privatization in Europe is expected to erode the privileged supplier position which their European competitors have had in the regulated European telecommunications sector.

These considerations support the argument that the U.S. should desist from using the Arms Export Control Act to enforce these agreements with China and Russia on commercial launching.

A NEXT-GENERATION LAUNCH SYSTEM

In the long term, the issue for commercial satellite manufacturers and launch service providers is whether advanced technology can be developed which will achieve an order-of-magnitude reduction in the cost of access to space, and a quantum improvement in reliability. Success in that quest should increase markets where most money is being made, in the design and manufacture of satellites.

The scale and cost of the R&D effort required to bring to practical fruition such advanced launch technology is a major barrier to progress As noted earlier, in the new world order it is not at all clear that any nation

will in the foreseeable future be prepared to invest substantial sums on its own to achieve significant improvements in space launch systems. An analogy might be drawn between the huge cost of developing an advanced launcher and that of developing a very large commercial air transport. The best prospect may be for international collaboration, at least in the pre-competitive stage of the R&D effort, to prove the best technology in working models.

International collaboration on such a project would require careful selection of a partner or partners. For reasons concerned with security, technology transfer and the proliferation of missile capability, it is difficult to see either the Chinese or the Russians in this role at present. Both the Europeans and the Japanese have developed their own launchers in order to have access to space independent of the United States. While at first blush this mitigates against either being a potential partner with the U.S. in a project to develop advanced launch technology, there has to be some prospect that the Japanese could be attracted. Given the high cost of their new H-2 launcher and its limited capability relative to Ariane 5, the Japanese may well be prepared to share the cost of developing new technology which leapfrogs those in service and under development. In the future there may be prospects for expansion of the sponsorship of the effort, perhaps to include the CIS if political developments permit it. However the investment in Ariane, and its market position, render prospects for West European involvement in such a consortium improbable.

It would not therefore be helpful to the prospects of cementing such a collaboration, for the United States to continue to proclaim space transportation leadership as an objective of launch policy.

It is however unlikely, in the light of experience with the international space station, that any country would agree to collaborate with the United States on terms other than as equals. Support for this view was strong at the American Institute of Aeronautics and Astronautics' international conference in Hawaii in December 1992, which concluded that seeking international cooperation on space projects led by individual nations was a recipe for continuing the difficulties of the past. International partners would no doubt seek an arrangement in which control was shared. It would not therefore be helpful to the prospects of cementing such a collaboration, for the United States to continue to proclaim space transportation leadership as an objective of launch policy. In any event, it has proved a somewhat elusive objective anyway.

CONCLUSION

U.S. participation in the commercial space launch market was disadvantaged from its outset by the mistaken policy of marketing the shuttle in competition, and the companies involved have struggled for profits since. The 1989 withdrawal of Titan and the 1993 sale of Atlas confirm how tough the business has been. The U.S. industry has failed to live up to the expectations of its investors or to deliver the outcomes sought by the government policy makers. Moreover it disappoints its customers in terms of cost and reliability.

The reasons are not hard to find. The industry is both subsidized and highly protected. In consequence it is not innovative and its technology is old. Its costs and manning levels are high, and it is increasingly uncompetitive. American companies are poorly placed to meet the challenge of increasing supply competition in a stagnant market, particularly as some of their competitors are soon to be equipped with advanced launch systems.

The pressure on U.S. commercial launchers is likely to see a reduction in their market share in the next few years, leading to the withdrawal of one or even both American companies from the market. If this is to be avoided, new policies are required urgently.

Solutions to the dilemma must address both the pressure in this market and the outdated launch systems being used. There is little prospect that the demand for commercial launch services will expand significantly in the rest of this decade, but the supply is expanding. Some of the market, which is currently inaccessible because of protective government policies, needs to be opened up in concert with the expansion of launch capability. This would stabilize the market pressure.

Medium term survival for at least one company lies in the acquisition of a state-of-the-art launch system which offers capability, reliability and low costs. Acquisition of a competitive launch system will not be achieved through marginal improvements in technology, practices and manning levels for current launch systems. Moreover the U.S. Government is highly unlikely, on its record, to fund the development of an advanced system, and even if it did the system could not become operational in time to compete effectively with Ariane 5. The solution may lie in the acquisition of a foreign launch system, to be operated from a near-equatorial

The industry is both subsidized and highly protected. In consequence it is not innovative and its technology is old. Its costs and manning levels are high, and it is increasingly uncompetitive.

country whose MTCR and COCOM credentials raise no issues with respect to shipment of satellites or technology transfer. The leading launcher is the Zenit and the obvious country is Australia.

In the long term the real reward for patient investment is market growth. On present expectations this will not come from traditional markets, nor is the additional business of deploying new LEO mobile communications constellations likely to be more than once-only and last only a few years. Nor can a surge in government business be expected, in the light of the international economic and political context. The opportunity lies in new commercial markets developed in consequence of orders-of-magnitude reductions in the cost of access to space. Only advanced launch technology, yet to be developed, holds prospects for cost reductions of this magnitude. Infrastructure investments of this nature may be attractive to governments, but it is unlikely that any single space program will be able to shoulder the cost alone. The answer may lie in international collaboration.

Competition in a free market benefits both customers and suppliers, and ultimately the economy as a whole. A reduction in U.S. ability to compete in the commercial launch market would have consequences for satellite manufacturers as well as for launch service operators, and for the customers of both. The suggested policies for survival may also be the route to achievement of those objectives of the U.S. commercial space policies, now a decade old, which are still appropriate today.

IGOR V. BARMIN: The Design Bureau of General Machinery is the leading Russian company developing launch complexes for various types of space vehicles. It was founded in 1941 by Academician Vladimir Barmin. The development of launch complexes is a creative process and involves dozens and even hundreds of different companies and agencies and efforts of highly skilled specialists: scientists, engineers, designers and workers. Our Design Bureau is the leading company which brings together theses efforts in Russia.

Working in cooperation with our partners, we have developed the following launch complexes:

1957 - The Vostok-Soyuz complex in Baikonur. Successfully used for launching the world's first intercontinental ballistic missile and the first Earth, moon, and sun satellites. All Manned spacecraft of the Soviet Union and Russia as well as a great number of different purpose satellites have been launched from this complex.

1958 - 1960 - Similar launch complex was built in Baikonur and 4 more in Plesetzk.

1965 - The launch complex for the Proton vehicle used for launching heavy payloads, such as Salut-Mir orbital stations, Mars-Venera interplanet spacecraft and various earth satellites.

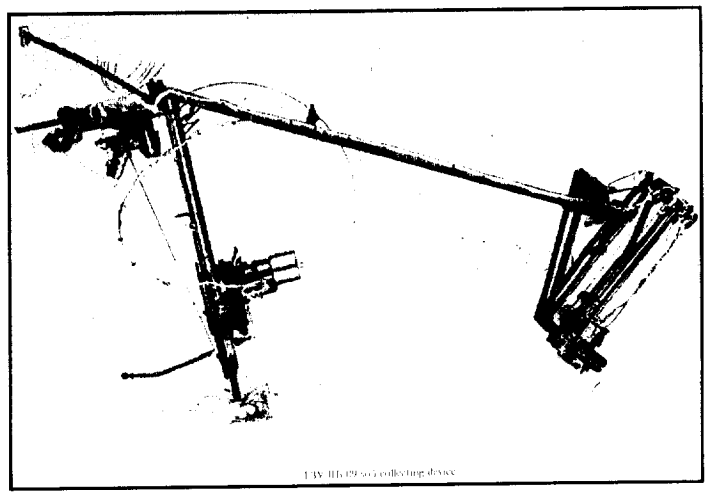
1968 - Launch complex for the vehicle intended for a manned mission to the Moon.

1985 - Multi-purpose complex named "Stand-Start" for ground testing and launching Energiya-Bureau reusable space transportation system.

In the history of our Design Bureau, there has never been any single case when a planned launch was canceled or even delayed through our fault.

Another field of our activity is the development of instruments to study the moon and other solar systems planets. In 1976 our Design Bureau of General Machinery made a lunar soil collecting device which drilled lunar ground to the depth of more than 2 meters, collected a soil sample and placed it into the re-entry vehicle.

In 1982 we made another soil collecting device, this time for Venus surface sampling. (Fig. CL-6) This device picked up a sample of Venus ground, placed it into the Venus landing vehicle for chemical analysis. From 1982-1985, our Venus soil collecting devices were successfully used on the Venus surface as part of landing vehicles: Venera 13, Venera 14, and the Vepa 2 Station.



CL-6

Between 1969 and 1981, we were making design studies for a long term lunar base. I hope the results can be used in the 21st Century, in the creation of manned lunar bases, as well as for thermonuclear power plants using Helium 3.

Part of our Design Bureau of General Machinery is the SPLAV Technical Center. This center develops on-board technical equipment for producing non-organic and biologically active materials under micro-gravity conditions.

The overarching U.S. space goal for the next two decades is to see the Earth's near space opened up to the general public and free enterprise.

Beginning in 1978, the SPLAV Technical Center specialists, in cooperation with scientists of many research institutes of Russia as well as Germany, France Czechoslovakia, Hungary, Poland, Bulgaria, and other countries have conducted hundreds of experiments on producing semi-conductor, metal, optical, and biologically active materials, using various technologies, such as Directional Crystallization Method, bulk solidification, Floating Zone Method, Traveling Heater Method, growth from a vapor phase, growth from a solution, zone electrophoresis and isoelectrical focusing.

The highly skilled specialists, unique on-board technological equipment created in the SPLAV Technical Center in ground test cells—all of that can be made available for you, and will allow you to prepare and carry out necessary experiments in space in a very short time. The SPLAV Technical Center offers expertise in space experiments, on-board equipment tests, and obtaining and processing telemetry data transmitted from a spacecraft during the experiment.

The Design Bureau of General Machine is open for cooperation with specialists from the United States and other countries.

TOM ROGERS: I hold some strong personal views about the space area. I am the President of the Space Transportation Association. All of its members might not either agree with me altogether or express themselves the same way that I do.

Discussions of space transportation should take place in a broad context today. The most important elements should be:

- The Federal civil space program is in decline and bordering on disarray because it has lost most of its constituency.
- The Gulf War demonstrated that the military use of space is solidly founded, but, as our warriors adjust to geopolitical changes and a sharp decrease in appropriations, they cannot be expected to develop new, very costly, space capabilities.
- Thus, the primary focus of United States space activities now must be economic, not cultural or military—if they are successful, cultural activities can again expect to be supported and the military can look to obtaining new capabilities.
- There are potentially large space-related economic opportunities, but they cannot be grasped because of the enormous unit cost of basic space infrastructure, especially surface-LEO transportation.
- We need truly fresh thinking about space and a willingness to change our present public-private space institutional arrangements.
- The private sector now must take the lead in advancing our space prospects, and the primary role of our government is to support our business community; and
- Finally, those of our civil space leadership that expected trillion dollar Moon-Mars programs, 10%/year real growth in public funding, and science to be the major focus of a $15 billion/year public expenditure, now should give careful thought before making further suggestions.

In this context, it is vital that we articulate, and strive to attain, our primary national civil space goal:

> The overarching U.S. space goal for the next two decades is to see the Earth's near space opened up to the general public and free enterprise.

To attain this goal:

> For the next decade the highest national space priority, *by far,* is to increase the safety, reliability and convenience of basic space infrastructure, especially surface-LEO transportation, by two orders of magnitude and, in large scale use, to reduce its unit cost by two orders of magnitude.

Make no mistake about it. Outside of the information area, America's future in space depends directly upon our getting the unit cost of basic space infrastructure down, sharply and soon.

In order to reach this objective we must: (a) undertake new technological and operational approaches by a

cost-and profit-conscious private sector; (b) develop space markets larger than today's by orders of magnitude; (c) create new and imaginative public-private arrangements to finance large-scale asset acquisitions; and (d) begin to think really *big* about space, not just *costly* about space; very low unit costs are inextricably intertwined with serving very large markets.

We must all appreciate that all "Space Transportation Modernization Studies" to date have been flawed in two fundamental respects:

1. They offer no solution to the problem of how to pay for acquiring a new vehicle-fleet when there will be essentially no public money made available to do so (by the way Congress should have made this clear) and

2. They give no useful attention to the vital transportation matter of "induced traffic", i.e., to the increase in transportation use whenever a transportation service is markedly improved and/or its price markedly reduced. For instance, one could never imagine being able to pay for a costly Chesapeake Bay Bridge & Tunnel with the revenue provided by the handful of ferries that it would replace. But it was built, it carries very large north-south traffic streams, and is a financial success.

And, of course, very few accept *any* government estimation of the time and public funding required to acquire a next generation vehicle-fleet.

Therefore, the rest of my talk will be concerned with finance and market, not technology and operations, but *finance* and *market.*

The primary market opportunity to be addressed is a new, national and international, commercial one. This market of enormous potential size, is tourism — it must be created and demonstrated during the interval required to modernize our "backbone" vehicle-fleet. I will speak more about tourism later.

Therefore, a truly modern "backbone" transportation service must carry both people and cargo to and from LEO; it must have a total capacity orders of magnitude greater than our "backbone" Shuttle and ELV capabilities; and fleet operations must replicate commercial airline-like operations.

The service must include launch/recovery sites, appropriately located, to allow profit potentials in raw land, its development, and related hotels, theme parks, etc. And it must include a large volume of appropriate living and working accommodations in LEO of great safety and low unit cost.

Of course, for national security, especially economic reasons, these infrastructure elements must become available to the United States well ahead of those of any other country.

The acquisition and operating costs of a new vehicle-fleet must be privately financed. This near-revolutionary idea has gained considerable credibility in the past year. Recently, the assistant to the NASA Administrator for access to space, testified that "...we would have considerable interest in private financing [of a new vehicle]...a lot of people are showing interest in this today."

The primary market opportunity to be addressed is a new, national and international, commercial one. This market of enormous potential size, is tourism.

In the early days of commercial aviation the Federal government was very helpful, not with the provision of large amounts of R&D money, but by means of the Kelly bill that allowed the government to help pay for the rapid long-distance delivery of a large and continuing government pay-load: the mail.

Private financing could become available under the following conditions:

- The service would be designed to meet the "backbone" government military and civil needs, and projected national and international commercial markets;
- The Federal government would agree to purchase a large fraction of its anticipated service needs, say, 200,000 pounds/year for, say, upwards of a decade;
- It would do so from the organization that, in a competitive process, would be judged to offer the best "deal" insofar as meeting the government's needs at the earliest time and the eventual lowest unit cost, and that exhibited the best plan for developing other, much larger, markets;
- The government would agree to pay a price that, initially, should be somewhat lower, but certainly not higher, than it pays today. The difference between the government's payment and the organization's low cost would be used to pay down the latter's initial financing;
- With such an agreement in hand, the organization would obtain its required financing in private capital markets;
- As the organization's paydown of its vehicle-fleet acquisition cost progresses, and its commercial sales and profits increase, the price of the service provided to the government would continue to be renegotiated downward; and
- With its acquisition and initial operating costs paid

for by the government service purchase, differential pricing by the organization would prompt an explosive expansion in service use.

Of course this concept could be used to improve today's ELV performance and cost as well. The Hercules Aerospace Co. has just suggested doing so to allow private financing for its development of a family of solid rocket ELVs. This new capability would be offered at a unit price of 1/2 or less than today's ELVs. Hercules would ask the Federal government to agree to purchase a number of launches for prices that are no higher than today's.

Tourism is the largest business in the world, 1994 should see revenues of nearly $2 trillion. It accounts for over 10% of the world's gross domestic product. It continues to grow rapidly; and increase to $4.5 trillion is forecast by 2005, an average growth of some 8% per year.

With this agreement, Hercules would raise its required capital—some $1/2 billion—in the private financial marketplace. The difference between the government price and the Hercules low cost would allow paydown of the initial acquisition cost. Subsequently, Hercules launches would cost the government much less.

Whether the government could be depended upon to aggregate its space transportation needs appropriately, or shelter a new organization, perhaps organized along the original COMSAT Corp. lines, now should be debated.

So, attitudes about private financing of space transportation are changing and, clearly, there are ways of bringing it about. We must be just as imaginative in the development of our space industry—Federal government institutional arrangements as we are about the development of technology.

Tourism is the largest business in the world, 1994 should see revenues of nearly $2 trillion. (That's right: $2 trillion!) It accounts for over 10% of the world's gross domestic product. It continues to grow rapidly; and increase to $4.5 trillion is forecast by 2005, an average growth of some 8% per year.

People as payload is potentially available in enormous magnitude; it is available now—no R&D on people is required; and, unlike astronauts as payload, the general public is prepared to pay, not to be paid, to take space trips.

Perhaps the first professional paper on space tourism was written by Kraffte A. Ehricke in 1967. The 1984 OTA space station report observed that, ". . . we could have space "Lodge/Habitats" established in low-Earth-orbit, with the Shuttle being used to see [large numbers] of persons per year [particularly from] the general public . . . being transported there to spend a short time in space . . . Only when a large number of our citizens, representative of a broad cross-section of our society, begin to experience the "space adventure" will the space domain and space activities . . . begin to move into the mainstream of our national interests . . ."

Three space-related U.S. polls and one U.K. poll were conducted in the 1980"s that, in effect, asked the general public what it wished to see done in space. All of these polls found that roughly one-half of the adult population wished to take a trip to space. For the U.S. the number indicated was some 80 million Americans.

The National Science Foundation expected nearly 10,000 tourists to visit Antarctica in 1993 at a price of $10,000 - $20,000 each. In fundamental ways a trip to Antarctica is analogous to a space trip. If as many people were to visit LEO, we would have a payload market 5X that of our total annual payload today.

The Commercial Space Transportation Study just completed by the six-U.S. space company CSTS Alliance (Boeing, General Dynamics, Lockheed, Martin Marietta, McDonnell Douglas and Rockwell) concluded that, at a price of $10,000 per seat, the space tourism market would probably be at least hundreds of thousands of people per year, i.e., a revenue stream of $2 billion/year.

The idea of space tourism is very popular in Japan. A detailed 1993 poll there of over 3,000 persons suggests that, when the price of a surface-LEO trip becomes available at less than some $15,000 per passenger, global tourism traffic could reach millions of passengers per year.

Space tourism is now being taken quite seriously in Japan. Last year the Japanese Rocket Society formed a continuing Space Tourism working group with four sub-

Only when a large number of our citizens, representative of a broad cross-section of our society, begin to experience the "space adventure" will the space domain and space activities . . . begin to move into the mainstream of our national interests . . ."

groups: Space Medicine, Finance, Transportation, and Passenger Services. The Society has just published a special Space Tourism issue—with an all English edition that has just become available.

The working group has laid out an initial goal of providing a short space trip service for 2 million people/year at a price of some $10,000 each. For the provision of such a service they are considering, as a first service model, a vehicle-fleet sizing of 100 vehicles, each able to carry 50 persons, each making a trip a day. This suggests an annual payload three orders of magnitude greater than that of the U.S. total today and revenues of $20 billion/year.

Nothing like the sweep of this space vision holds in the United States today. Nothing.

For every American who takes a space trip today, 10 million take a trip on a commercial airline. The United States should strive to see that, a decade or so from now, one travels to space for every 10,000 that take to commercial air.

A final observation about space: the hero astronauts of a quarter century ago have given way to the Shuttle scientists and technicians of today. This is in the nature of things, since what goes on in LEO is scientific and technical work.

But from the perspective of the general public it is simply dull, dull, dull. As my grandchildren say: *boring!* Have you ever seen anyone sweat in space? Shout out in sheer joy in space?

We simply must return some of the excitement and vitality of those early days. We should use the Shuttle fleet to again carry private individuals to/from space:

- to obtain information and experience for our future tourism business;
- to begin to market and merchandise this business; and
- to regain the space flavor of three decades ago when the public sensed that it was part of the space adventure and could dream of visiting space.

And why don't we have our young Army, Navy, and Air Force astronauts engage in sports in space when their trip "mission" work is at an end? Why can't we have our service Academies fashion a few basic athletic contests, and challenge each other? [I know what my favorite contest would be.] And, later, challenge Russian and the astronaut/cosmonaut/sportsmen and women of other nations?

It would cost a near-trivial sum to do so; need not be paid for by our government; would capture the attention and enthusiasm of the world; and create, overnight, a new space sports-communications business of potentially large economic dimensions.

In conclusion: "As industries around the world adjust to the new post-cold-war era, the space industry is facing the need to restructure radically. In particular it needs new markets." Space tourism offers the clearest promise of becoming such a market as soon as the space transportation problem, now finally beginning to be usefully faced, is solved.

For every American who takes a space trip today, 10 million take a trip on a commercial airline. The United States should strive to see that, a decade or so from now, one travels to space for every 10,000 that take to commercial air.

It can be solved by fundamentally new, cost-reducing, technology, and imaginative and responsible public-private risk-reducing arrangement, and leadership taken up by a competitive private sector looking to large profits, drawing upon private capital, and creating new space markets.

As it becomes a reality, and as the unit cost of other elements of space infrastructure also drop sharply, and as many, many more people become directly acquainted with space, free enterprise and business imagination will be reflected in people doing things in space that few can even imagine today. And the constituency for an imaginative Federal space program will begin to be restored and the tax base for so doing is enlarged.

Supporting Life on Planet Earth

Lionel (Skip) Johns
Associate Director of Technology
White House Office of Science & Technology Policy

Dr. Arturo Silvestrini
President & CEO
EOSAT

Dr. Harrison (Jack) Schmitt
Consultant
University of Wisconsin
Former U.S. Senator and Astronaut

Marc Stanley
Associate Director
Advanced Technology Program
National Institute of Standards & Technology

Linda H. Strine
Deputy Associate Director for Program Affairs
Office of Commercial Space Transportation
Department of Transportation

Steven D. Dorfman
President
Telecommunications & Space Sector
GM Hughes Electronics

LIONEL (SKIP) JOHNS: Technology is the engine of economic growth — creating jobs, building new industries, and improving our standard of living. In the U.S., technological advances have been responsible for most of the productivity growth since the depression. Breakthroughs such as transistors, computers, recombinant DNA and synthetic materials, have created entire new industries and millions of high-paying jobs. I believe that investing in technology is investing in America's future.

A growing economy with more high-skilled jobs — high-wage jobs for American workers; a cleaner environment where energy and materials efficiencies increase profits and reduce pollution; a stronger more competitive private sector able to maintain U.S. leadership in critical world markets; an educational system where every student is challenged; and an inspired scientific and technological research community focusing on securing not just our national but our economic security and quality of life — these are the things we are striving for.

Leadership and the use of commercialization of technology provides the foundation for America's status as an economic and military super power. As most of you know, this Administration is placing an extremely high priority on technology because of its direct linkage to economic growth, good job opportunities, quality of life, and the environment in which we live. One of the innovations of our new technology policy is that it explicitly recognizes the crucial role that the Federal government plays in working with the private sector to develop and transition innovative ideas and technologies to the commercial marketplace and for government use.

For too long, government and its work in science and technology have been isolated from the private sector. We believe that a more proactive partnership with the private sector is needed. Partnerships, that is, alignments of public and private interests, are now growing in number and variety of consortia, joint ventures, and cooperative work. The boundary that has existed between a mission focus and the relevancy of the work to civilian sector opportunities should largely

Leadership and the use of commercialization of technology provides the foundation for America's status as an economic and military super power.

disappear and Federal labs will be spending more time developing and understanding the relevancy of their work to the needs and opportunities in the civil sector. One of the most important measures of success should be the ability to make a difference in the lives of American people.

The Federal R&D enterprise is a multi-agency enterprise at the Federal level, investing nearly $72 billion a year in areas ranging from fundamental science to national security and space, to health and the environment. This R&D enterprise involves more that 700 Federal labs, most major universities, and a broad cross-section of U.S. industry.

Today, the nation is faced with a severely constrained fiscal environment with the compelling national

PRECEDING PAGE BLANK NOT FILMED

need to bring our deficit under control; R&D, despite its priority, will likely be a zero sum gain for the foreseeable future. So, it is clear that we cannot continue everything we were once doing and adopt a new, more relevant agenda. This means we must continually look at existing investments in R&D and make the necessary tough choices to redirect them for greater payoff and relevance to this nation's future, not its past.

Last year, we began a process designed to improve the way the President's priorities are reflected in Federal R&D expenditures, concentrating on critical national priorities. When the President established the National Science & Technology Council in November, he created an important new tool for enabling this work to be done. Strategic interagency budget planning is essential in R&D since many critical projects require cooperative work of several departments and agencies. The initial task of this Council and its nine committees will be to define strategic goals and objectives for Federal R&D and to establish investment priorities based on real contributions to job creation, economic growth, quality of life, and the environment. This process will have a major impact on the formulation of the fiscal '96 budget for R&D, rebalancing both in and among the nine major R&D categories.

What this means for NASA: the new NASA is rapidly becoming an agency of global community partnerships between nations seeking understanding and solutions to global environmental problems; the Mission to Planet Earth program, seeking cooperation in manned space flight; and understanding the complex problems of human physiology. It is involved in the mysteries and benefits of microgravity, the international space station, and cooperation in exploring our planetary universe and beyond in such programs as Cassini and Hubble.

It is these continuing investments that can create whole new industries, such as the satellite and space launch industries. The global positioning system put in space for DOD is creating many land-based opportunities and manufacturing navigation services in other areas. Soon, a satellite-based global cellular phone industry will create many more good jobs in the U.S. The importance of NASA in its new roles is far more important to sustaining global cooperation and exploration and new technology creation than its old role of the past. I am confident that Congress and the American people will recognize the importance of its contribution and support the new NASA as it serves this nation. In response to the strong cross-currents of change, NASA, under the leadership of Dan Goldin, has initiated a broad effort focusing on reinventing the agency, attempting to improve a government agency that has been a hallmark not only with its technological leadership and management innovation. The efforts in this area are being undertaken as part of a broader effort being lead by the President and Vice President who are determined to help the Federal government reinvent itself as a more streamlined, customer-oriented, and effective organization. There are encouraging signs that a new NASA is emerging. Space Station is a centerpiece arising from the original Freedom project which was too costly and plagued with overruns, not all of which were NASA's fault. It was clear to this Administration that the nation could not afford a space station with a price tag of as much as $3.2 billion a year. So President Clinton asked NASA to redesign the Space Station last year. He said: spend less money, get it done sooner, and make sure there is a payoff to the American public. That is exactly what NASA is doing. On December 6, the initial Space Station partners — U.S., Canada, Japan and the European nations — formally invited Russia to join in the Space Station project. Under U.S. leadership, these nations will join us in pursuing the largest peacetime technological project ever attempted. Our partnership with the 15 nations involved will give us a safer and more robust system. We will have access by more than one launch system. We will be able to start assembling in a few years instead of waiting until the end of the century.

The importance of NASA in its new roles is far more important to sustaining global cooperation and exploration and new technology creation than its old role of the past.

I would like to give you a report card based on the comments of the head of an external management review team, a former member of the Vest Commission. That person had commented shortly after the Vest Commission meeting last summer that there was no way that the Station could ever be built under the current management structure. These are the comments of that same individual as a result of our review at the end of last week down in Houston.

- A quality, single prime contractor has been engaged and is firmly in place.
- The NASA center directors have been moved from the direct line of management control for the Space Station project.

- Significant levels of management have been removed.
- The science team leader has been integrated into the management system in an appropriate way.
- There has been a large reduction in NASA and contractor staff support.
- The integrated product team concept has been implemented and seems to have removed the bureaucratic oversight functions which previously frustrated decision-making and responsible authority chains.
- Safety and audit functions are now a part of a team approach that the audit integration teams established as integral parts of the management structure and safety personnel assigned to each of the ITPs.
- Training issues have been faced head on and are a priority for the management team.
- The international partners have become much more integrated into the management and operational structure.
- The quality of the management personnel, especially at the prime contractor seems outstanding.
- The experience level is completely appropriate to the tasks.
- Relationships with the subcontractors appear to be appropriate and effective.

This was the observation of Dr. Mary Goode, and as many of you know, know this is one tough lady. I was down there during this team review and we were extremely impressed, in fact shocked, by the degree of progress that NASA has made. This is a station that looks like it is going to be built robustly. It is going to be a useful international laboratory and it is going to be done on budget and within schedule.

I would like to just mention a few more elements of NASA's new agenda, such as the new technology investment programs, the advanced small satellite, smaller and more frequent science space missions, a re-dedicated aeronautics program, and assistance on the clean air initiative of this Administration. NASA has much to bring to that party in terms of materials, simulation, virtual design, environment, and so on. However, much more needs to be done. In this changing environment, NASA is one of the civilians' largest R&D agencies. It is being challenged by this Administration to significantly increase its contribution to U.S. economic security. The country needs and expects relevance and value from its investments in NASA. I believe that this is one of the next frontiers for NASA, as it continues the process of renewing and redefining its relevance to the national needs. To do this, NASA needs to invest, not just spend, its resources. Spending provides no leverage for longterm job or wealth creation. When you spend $14 billion, you employ people and provide the often one-of-a-kind goods and services necessary to execute the space mission. But these jobs last only as long as resources continue to be committed. If you develop technology with an investment culture and the knowledge of market needs, you can create economic benefits that live beyond the Federal money spent. To do this, the agency must look not so much at what they do, but *how* they do it. Commercial technology cannot be an afterthought to a mission. Rather than relying on serendipity to insert technologies developed specifically for NASA missions into the private sector, activities should also focus on providing useful technology to industry as it focuses on accomplishing the primary missions of NASA. This doesn't diminish the importance of the space mission, but enhances it. NASA will continue to accomplish its fundamental mission and at the same time seek commercial benefits from all of its programs. It must be viewed from everyone's job from top management down to the bench researcher. It is the key way to keep the American taxpayer willing to continue NASA's support.

If you develop technology with an investment culture and the knowledge of market needs, you can create economic benefits that live beyond the Federal money spent.

In summary, NASA is reinventing itself, driven by a new vision emphasizing commercial technology. It is not a temporary trend or fad, but a major sea change in America. The Administration, Congress, and the general public expect and deserve real value from the investment in NASA. Just as the seafarers of the 16th, 17th, and 18th centuries helped to fuel the engine of economic and technological progress, you, the spacefarers of the 20th and 21st centuries, must fuel this economy. My hope is to see a NASA that will enter the 21st century as an organization recognized for excellence in all it does and the way it does it. A NASA that will be recognized as an organization that thrives on technological challenge with the full support and accountability to the taxpayer. NASA needs your help in reinventing itself. As Americans, we all have a stake in the outcome.

DR. ARTURO SILVESTRINI: Last year, here, there was a roundtable led by Mr. Goldin. I remember one of the major concerns of everybody was "What can we do to get Congress to back and support space? We asked the gentleman from Pennsylvania, Representative Bob Walker, who was very fast in answering our questions. He said, "We will do what everyone of our constituents ask us to do. Get them interested in space again, and you get the money." Well, it is true. We keep asking the Congressmen, the Senators . . . we have to ask the people. What does space have for the people? It did have a lot before — it has glory, defense, too. They are gone as attractions for the people. I am not saying gone, but that is the feeling. Communication is a good thing, everybody understands it. Everybody can relate to TV, PC's and things like that. What is the other new attraction? Earth sensing. Why? Because it helps people, not just makes money. That is why I am back from retirement. Earth sensing is the future of space. Why is it not so successful like communications yet?

A few months ago, six very important companies in earth sensing, present and future, wrote a letter to OSTP. ... "Please don't try to do our job, let us do the job for you."

Let's see...I came here with the intention of giving a message to the government of the U.S., as well as informing the people who care about something that is happening in the private sector.

One application (communications) already had the users in place. In earth sensing, we had to train the users to use what NASA was offering. That was our mission at EOSAT, and we did it. The other reason is that for some reason the government doesn't want to let earth sensing go like they did with communications. A few months ago, six very important companies in earth sensing, present and future, wrote a letter to OSTP. They were Lockheed, Loral, EOSAT, WorldView, CTA and Orbital Sciences. The message was very clear, "Please don't try to do our job, let us do the job for you." I don't know where the letter is, nobody asked us what we meant, but on the other hand the government came up just recently with the decision to license companies to do things that the government was doing before. That is very positive, but at the same time other things happened. It is like the message is not clear within the government itself. There are other organizations, international organizations, where the U.S. is represented very strongly by NASA and the Department of Commerce. I was told by people who were at meetings that when other countries suggested that private industry should participate in deciding the future of earth sensing, the American delegation was the most opposed to it. That is not good. So, the message is that we private industry in earth sensing would like to ask the government if there is a partnership, or there isn't any yet.

We are going ahead anyway. EOSAT took the initiative of suggesting to private sector users that they form a group. I'm talking about the real users, the commercial users and distributors of the data. The response has been extremely good. We have already had two meetings in Europe attended by the major companies that provide and use data. One in Australia, another one in Europe attended mostly by Americans, and there will be two major meetings in the Americas, North and South. The two people who are sponsoring this thing, one is myself and the other one, who is supposed to be my enemy, is Gerard Brachet of SPOT Image. We have also asked one of the most significant members of the public life in space to join us to lead this group and he has accepted. He is Roy Gibson, former Director of ESA. So, we are going ahead. What do we want? We want the users and the providers of the private sector represented as well as governments in the international forum. So that the users of the private sectors, which is more than 50%, can tell the governments and the others what they need in earth sensing. Earth sensing is expensive and is extremely useful. I think the partnership between government and industry — especially when it is international — is the only way to go. The market will grow, private dollars will be fed in the programs that are now supported only by governments. In addition, these programs will be taken away from the fluctuations of the budgets. Here is the message. Commercialization is not bad for earth sensing. What is bad is the way commercialization was envisioned by the government ten years ago. The commercialization that we look at now is not bad. EOSAT has been operating the landsat satellites at no expense to the tax payers since Octo-

"What can we do to get Congress to back and support space? ... We will do what everyone of our constituents ask us to do. Get them interested in space again, and you get the money."

ber 1992. SPOT's Gerard Brachet is starting now to be independent from CNES at least for the data processing. Industry can participate. This is one of the best activities to support life on planet Earth.

DR. HARRISON (JACK) SCHMITT: The real issue before us, I think as we look at the next 50-100 years, relates to this equation: the world energy demand is the product of two simple numbers at any given time, our population, times the use of energy by each person. The growth of that energy use is fairly easily projected. This

... just to stay even by about 2050, we must have the equivalent of doubling the availability of energy particularly energy for the production of electrical power over what we have today ...

I believe is derived from some DOE projection some time ago. Basically it said, just to stay even by about 2050, we must have the equivalent of doubling the availability of energy particularly energy for the production of electrical power over what we have today, up to about fifteen barrels of oil equivalent per capita per year. A consequence of that of course is a steadily rising introduction of CO_2 and other energy related contaminants into our earth's atmosphere and what the consequences of this introduction are, we really don't know. We aren't sure what the consequences are, but being as unsure as we are, it probably isn't prudent to persist much longer than we absolutely have to.

There are some alternatives to fossil fuels of our future, and a very important one which we should be exercising now and will continue to search for ways to exercise is conservation, increased efficiency in the use of energy that we currently have available to us. We also know that there are some very interesting — potentially very exciting — concepts for the use of space to provide concentrated solar energy for use here on earth, but the scheme that may be most important to us in that future in my estimation is fusion. Importantly, is the steady progress in spite of everything that you may have read towards understanding fusion technologies of a variety, particularly those technologies related to magnetic confinement fusion, mainly the Tokamak system and just recently at Princeton, you all should have become aware of an important milestone. I am not sure if I would refer to it as a breakthrough, but certainly a milestone in this progress towards harnessing fusion energy for use as electrical power in our future.

The introduction of fusion beginning about the year 2015 could result in the capture of about 50% of the U.S. electrical generation or market by about the year 2050 and that is based on some fairly conservative analysis of how other nuclear systems have been introduced into the world economy. The verse of the cycles are probably of the greatest interest. DT is the current main state program of research. D-helium^3 has some significant interests to us primarily because of the reduction in the production of neutrons and if the physics and technology permit the helium^3 fusion becomes even more exciting because ***there is absolutely no residual radio activity*** produced as a consequence of neutron production. The use of the helium^3 cycles — not only D helium^3, but also helium^3 — has been held back because of the need for much more stringent physics and technological demonstrations. And up until 1985, helium^3 fuel was not known to be present in reserves sufficient to fuel an energy economy.

In 1985, the folks at the University of Wisconsin suddenly realized that those of us who had sampled the moon beginning in 1969 had demonstrated that there was a significant resource base of helium^3 in the soils of the moon. Something on the order of a million metric tons. As a whole, this is actually low as we are just beginning to understand recently that in the sampling process and in the analysis process a significant amount of solar wind volatiles may have been lost before we had a chance to make the measurements upon which these figures are based. They are concentrated primarily in the old marea soils that were sampled by most of the missions.

Some perspective on the significance of lunar helium^3: one ton of helium^3 can produce 10,000 megawatt years in electrical energy, 25 tons, schematically the payload of a space shuttle return mission, would provide for the entire U.S. electricity consumption in 1992. We are talking about relatively small quantities of helium^3, but an awful lot of energy that is contained in them and if you look at the economics nobody quite knows where the price of a barrel of oil is going to end up over time, but if it were $7 per barrel the equivalent of helium^3

The introduction of fusion beginning about the year 2015 could result in the capture of about 50% of the U.S. electrical generation or market by about the year 2050.

would be a billion dollars a ton. Today, price for oil is about $14, so it would be twice that.

The new thing from last year when we talked about this subject in great detail is the work that we headed at relative to inertial electrostatic confinement has progressed with some bench level experimentation and the University of Wisconsin experimenters are now routinely confining plasmas to inside of a grid system and confining them continuously. They could run these plasmas for as long as any particular set of experimental set of measurements need to be conducted and we are talking about hours or days as the case may be. A fusion research program leading towards commercialization is still compatible as we thought it was a year ago. That really hasn't changed. What has changed is the potential for near term spin off from a device, an electro-static device that is not even producing commercial power. What it becomes, depending on what you introduce, is a source of neutrons or protons. Many of you are aware that there are many applications for relatively low cost sources of neutrons and protons.

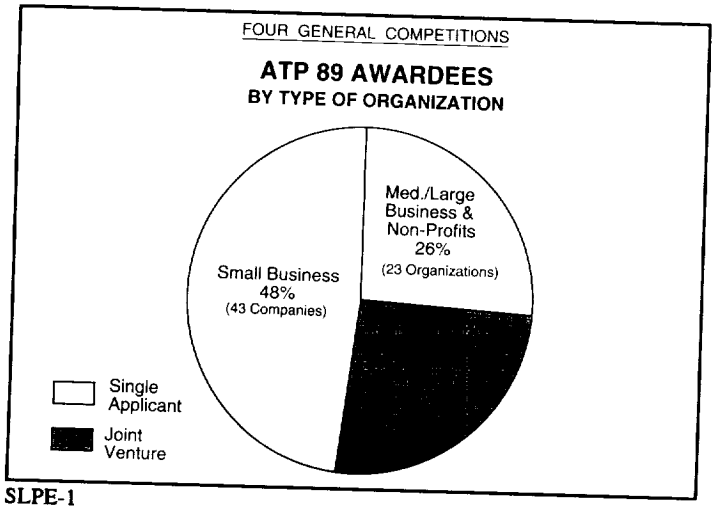
Critical to this is the potential private financing of course of these kinds of efforts is that we can find some near term payoff for the investment of capital in these kind of future technologies. Phase 1 and 2 of such a plan could depend on the existing availability of helium^3 primarily from weapons programs, U.S. and others, where helium^3 is extracted as the decay product of tritium contained in those weapon systems. There are a few other sources of helium^3, all of which would make it possible to conduct not only your research programs, growing from around the world, but also could sustain those near term benefits. There is considerable interest throughout the world in the helium^3 related technologies and in what the possibilities for resource extrication for the moon.

In conclusion, I think it is safe to say that in the not too distant future and within the lives of most people still alive, we will need a new source of safe and clean energy, certainly by the middle of the 21st century. The fusion fuel cycles containing helium^3 could provide that energy as we have talked with you before. Fusion rockets if you want to look any farther based on the helium^3 fuel cycle also appear to be reasonable and feasible for opening up the solar system to further exploration and settlement and the present world fusion program really needs to begin a more serious investigation of the electrostatic confinement as a means for advanced fusion fuel cycles.

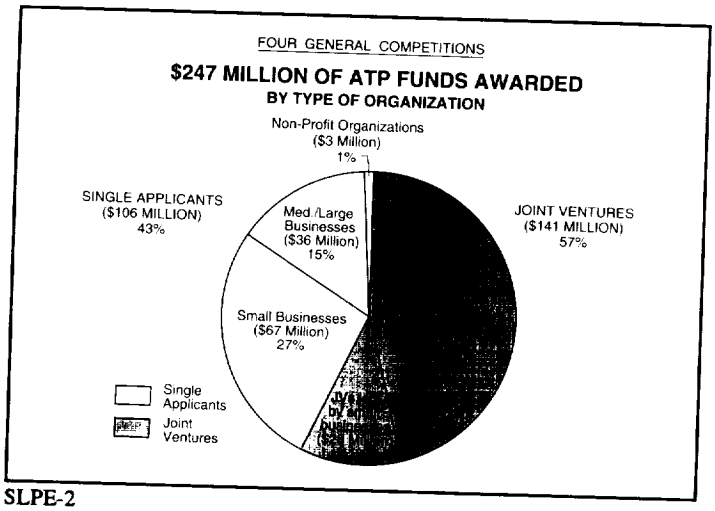
MARC STANLEY: What I am going to explain to is a new program — actually it was started back in 1988 by the Congress. The NIST Advanced Technology Program was developed as a pilot program in the previous Administration, but this wonderful new Administration headed by President Clinton has decided that this is going to be one of the models of how the Federal labs are going to help U.S. industry commercialize high tech, high risk technologies. What I would like to do is define the program for you because for some, I am sure, you have not heard about it. It is industry led. The particular goals of the program are fairly clear.

First, this is a program established for U.S. business only, Universities may participate as subcontractors, but the proposals must come from the private sector. Next, there must be a commercialization plan. This program demands of those who want to participate to present a business plan. We are not only interested in being a good partner with you, we want to make sure that should you develop these new technologies, particularly with space applications, for example, that you have some plan about how it is going to impact and enhance U.S. economic growth. We were also asked to help in assisting in manufacturing technologies and refining that art, and NIST has several programs, I will not be able to elaborate on them in detail today. One is the creation of manufacturing technology centers and one other is the MEP program and we were finally asked to cooperate with other agencies of which we were doing in a wonderful fashion, not only with NASA, but with the Department of Energy as well. We have had conversations with the Environmental Protection Administration too. You need to become very familiar with what this new Administration is doing. It is encouraging the Federal labs to work directly with you in the development of high risk technologies. The goals of the programs are very obvious. We will help you by giving you a grant, interest free, for you to patent and hopefully produce a product, but the particular technology must be innovative, must be unique, must have enabling characteristics, and of course it has to have high value. Simply put, this program is to enable our country, to become more productive and more competitive.

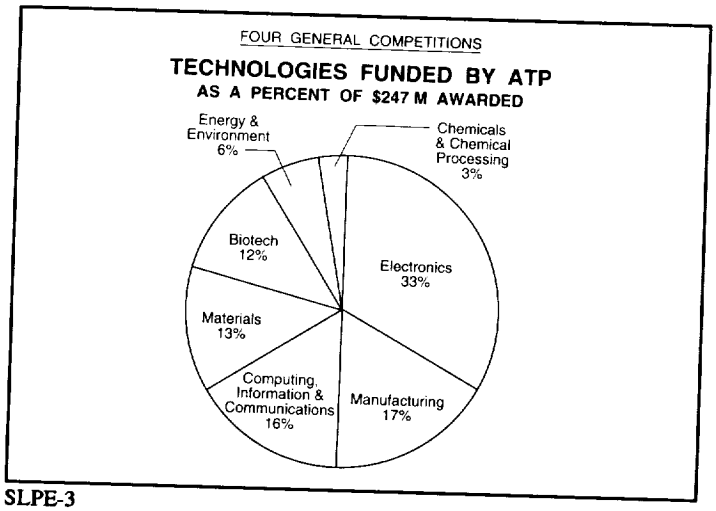
Simply, what is the bottom line? The bottom line is that you as a company may apply to the National Institute of Standards and Technology, and the current competition for the — general one just began March 21st — $25 million in the pie right now. You elect which way you would like to be receiving this grant by way of a proposal. You can apply as a single company. We will fund you up to a maximum of three years and a $2 million limit. We will pay all the direct funding includ-



SLPE-1



SLPE-2



SLPE-3

ing your new equipment which you can keep, and you must assume all indirect costs, or you may form a joint venture. You must have at least two for-profit companies in that joint venture, you can be headed up by a non-profit. In both instances, you can have universities as your subcontractors. We will fund you up to five years, we will not put a ceiling on how much money we will give you, but we will require you to match more than 50 percent. We have formed 23 joint ventures involving a 130 participating companies throughout the U.S., and we have assisted sixty-six individual companies in the advanced technology program in the past four years.

Why are we unique? I am here selling all the Federal programs. We are unique because we are broad in scope. The Department Defense has its Technology Reinvestment Program and your applications must have a military application, Department of Energy and NASA

We will fund you up to five years, we will not put a ceiling on how much money we will give you, but we will require you to match more than 50 percent.

have to have related mission programs. I can accept technologies from any area — agriculture, advanced materials, space, biotech, manufacturing processes, sensors, telecommunications — anything. I will fund only high risk technologies. The research and the development characteristics are set by you as the companies. There is a very rigorous process which involves both a scientific and technical review as well as a business review. This is peer review process. This is not the Federal government telling you where you should go.

A good analogy is that I am your catcher, you are the pitcher. We sunset the amount of time, either three or five years. We do not expect you to go to product development in that time. We are there to assist you with a grant, enabling you to use this money to develop the building blocks so that when you go back to your corporate VP for research or go to a bank, you can now explain how you have reduced the risk to develop the new technology. We have given substantial support for small business. This is a pork-free program. We have full support of the Congress, without any set asides, either geographical or for any size of the business, and yet based on the ability of the people who have submitted the proposals 48% of all of our rewards have gone to small business, purely on the strength of their submissions. We want you to keep the patents. The government retains a nonexclusive right to license, if something were to be developed which could benefit the

national public welfare of our country. All the proprietary information which you must share with us is guarded. All of us who work on this program must sign various non-disclosure documents. If we released the information, we would be in serious trouble.

In the four years that the program has been administered we have had not one problem with proprietary information being released. In addition, we received an exemption from the Freedom of Information Act from Congress, so ***no one*** can see your proposals. Suffice to say, 70% of all the criteria of how you are reviewed both scientifically and from a business point of view are based on good business reasons: what is the broad based impact of your technology to the country?, who do you have on your team?, how are you putting that together? and what is your commercialization plan?

The other program I wanted to mention to you, in addition to the general competition announced March 21st is the focused technology competition. If you call our 1-800 number, you can receive our kit and the information which appeared in the Federal Register to apply. In addition to this program, the new director, Arati Prabhakar, is starting a focused $120 million competition program. We have had extensive workshops in all areas of technology. We will continue to have those. Through those workshops, through our interaction with trade associations, with CEO's of all sizes of businesses, our program managers have presented to the director of NIST and the director of my program their best judgement of where industry wants to go in the future in a particular technology area.

Some time this month, we will be announcing four to five focused competitions. The announcement will appear in the Federal Register and you can apply to that program in the same manner as you can the general competition.

The bottom line of my program is we are here — this is sort of a new model of how the Federal government is operating with industry. We want to assist you in this time of difficulty in getting patent capital to enable you to develop those kinds of technologies on planet earth that can sustain us, enable us to go forth and be competitive in the world and give you a chance to move forward with your best ideas of which you have many, with us as a full partner. The ATP Phone number is: **1-800-ATP-FUND (287-3863)**.

AGENCY CONTACTS

Department of Energy: Thomas F. Cornwell; Deputy Director; Office of Technology Utilization; Washington, DC (202) 586-7939

NASA: Dr. Robert L. Norwood; Office of Advanced Concepts & Technology; Washington, DC; (202) 358-2320

National Technology Transfer Center: Melanie Griffith, 316 Washington Ave.; Wheeling, WV 26006; (304) 243-2130

LINDA H. STRINE: The Symposium's theme, "Windows of Opportunity" is very appropriate for the arena of space and especially for space transportation because there must always be a launch window available to launch. If we take our thinking from the rocket science aspect of space launch to thinking about the business of space launch, we are acutely aware of the fact that today that window of opportunity for space is growing and becoming world wide with space based products and services touching even the most remote corners of the globe. As it was pointed out in the Symposium's letter of invitation, "...one challenge facing the aerospace community is how to develop new markets and customers for products." This challenge must be met to keep up with the ever widening window of opportunity.

My theme this afternoon is "It's Not Just Rocket Science, It Is Also Business." I will begin by developing this theme for you, explaining how I interpret this theme for the U.S. commercial space industry. I will also talk about some of the initiatives, projects and activities that my office is involved in and which have significant impact for the industry.

When I was appointed to the position of the Director of the Office of Commercial Space Transportation by the Secretary of Transportation Fedrico Peña, I knew right away that there needed to be a shift in the traditional way of thinking about commercial space transportation. At that time, I met with Secretary Peña to talk about the goals of the Clinton Administration for the U.S. commercial space transportation industry. In line with the Administration's goals, for the development and enhancement of the nation's high tech industries, which we have just heard about so eloquently, Secretary Peña expressed his desire that the U.S. maintain a robust, viable U.S. commercial space transportation industry. He also emphasized the need for a more market based or business orientated approach in order to advance the competitiveness of the industry.

In January, the Secretary released the Department's Strategic Plan. Goal 3 of that plan calls for the creation of, and I quote, "...a new alliance between the nation's transportation and technology industries, to make them both more efficient and internationally competitive."

And one of the objectives under Goal 3 is to:

"Promote low cost access to space with technical enhancements to the current expendable launch vehicle fleet, while the next generation launch system is developed."

I know you have seen and heard those words a lot lately, and I'm sure the jury is still out on what will become of such words. I believe that in order to advance the international competitiveness of the industry, there are two major objects which we much concentrate on. They are to reduce the current ELV costs up to 25% through research and development; and have the next generation launch system operational by the year 2000.

The benefits of maintaining the international competitiveness of the U.S. commercial launch industry are increased employment in high technology industries, economic stimulation, affordable and accessible communication services, U.S. technological leadership and reduced cost of Government's access to space. The last source of inspiration for my theme came from the cooperative efforts taking place among NASA, Department of Defense, Department of Transportation and you the commercial space launch industry, which is helping to define the characteristics and requirements of a common launch system capable of launching a wide range of payloads for civil, military and commercial purposes. These efforts are important because in today's reality there are not enough resources and funds to support separate programs; they seek to benefit the civil, military and commercial space sectors, and seek to develop more cost effective ways of maintaining and enhancing the nation's space program; and last, they represent positive steps in moving towards a more business oriented approach in the area of space.

This means if we think in terms of business, and not just rocket science, it would be extremely advantageous for this country to have a new space transportation system operational by that time ...

I am encouraged by all of the factors I've mentioned above, especially the Administration's interest in the industry which you just heard. I am also encouraged by the economic indicators for the industry as the annual revenues in 1993 were $465 million, and are projected at $580 million in 1994. And finally, I am encouraged by the industry proposals that are springing up all the time to enhance the U.S. commercial space launch industry and to help make efficient, low cost access to space a near term reality instead of a long term dream.

I would like to bring to your attention some more of the initiatives and activities at the Office of Commercial Space Transportation. First of all, DoT has taken an active role in the Department of Defense Space Launch Modernization Plan led by General Moorman, which you heard earlier this afternoon. Its objective was to evaluate the space transportation requirements of DoD, NASA and the commercial industry and to determine options for recommendations to the Administration. I feel confident that this study will produce a very credible assessment of needs with strategies that can be implemented beginning with the Fiscal Year 1996 budget. The needs of the commercial space industry would be adequately addressed as well. DoT is also working to ensure a level playing field in the international commercial launch market and to ensure the international competitiveness of the U.S. industry. (This is one of the reasons that Frank Weaver is not here with us today.) Through my office, DoT chairs the Working Group for Information and supports the Office of the U.S. Trade Representative and the federal interagency community in monitoring compliance with both the US/PRC memorandum of agreement for space launch services and the US/Russia Agreement Regarding International Trade and Commercial Space Launch Services.

The prospect of a new agreement between the U.S. and the People's Republic of China, to replace the current memorandum of agreement which expires on December 31, 1994 is under consideration. As many of you probably know, on September 2, 1993, Vice President Gore and Russian Prime Minister Chernomyrdin signed the US/Russia Agreement Regarding International Trade and Commercial Space Launch Services which allows the Russian Federation an opportunity to enter the international launch market as it makes the transition from a nonmarket economy to one based on market principles. A Federal Register Notice was published on March 10th of this year, outlining the provisions of this Agreement and describing the U.S. government's implementation, monitoring and enforcement of this agreement.

As I mentioned earlier, we must concentrate on having the next generation launch system operational by the year 2000. This is because the US/Russia Agreement will be in effect until December 31st of the year 2000 and if a replacement agreement is entered into between the U.S. and the People's Republic of China, we would hope to synchronize its expiration in the year 2000. This means if we think in terms of business, and

not just rocket science, it would be extremely advantageous for this country to have a new space transportation system operational by that time by the year 2000.

DoT is also an active participant in the various interagency working groups led by the Office of Science & Technology Policy including the Working Group on Excess Ballistic Missiles. In this working group, we are examining the potential effects on the U.S. industry if these assets, both U.S. and foreign, are used for commercial launch purposes. Will the use of excess missiles represent an impediment to the growth of the commercial launch industry or will it represent a means of low cost access to space contributing to the economic enhancement of the industry? This working group will be examining this question very carefully over the next few months.

There are many challenges facing the U.S. commercial space launch industry, but I think if we really think in terms of business and window of opportunity in space and for space, these challenges can be met very successfully. One hope that I have as a decision maker for Federal space policy is that the government and industry partnerships that we heard echoed this afternoon will continue and flourish. With this type of business and cooperative spirit and support of this Administration, we can work together in an era of constrained resources to bring about low cost, efficient access to space for government, military and commercial purposes. Thank you.

This loss of traffic to fiber optics has been more than compensated for by new applications of satellite communications, particularly direct broadcast television, private networks, and mobile wireless telephony.

STEVEN DORFMAN: I am going to talk about the state of satellite communications, which I believe is one of the most outstanding fruits of the U.S. space program.

In 1987, there were 74 communication satellites in orbit, and *Time* magazine published an article in which they said fiber optics was the new technology and satellite communication was about to become passe.

Today, there are 123 communication satellites in orbit, and there are more than 100 on order. Hughes alone will be launching 25 satellites within the next two years. That is about a satellite a month, so we will have the opportunity to continue to prove how good we are in our quality.

It is true, as was predicted then, that fiber optics have taken over most of the trunking traffic between major cities, say New York to Los Angeles, and even across the ocean between cities like London and New York. This loss of traffic to fiber optics has been more than compensated for by new applications of satellite communications, particularly direct broadcast television, private networks, and mobile wireless telephony.

We are now in the era of privately owned satellite receivers. There are probably more than 10 million privately owned satellite receivers in the world, and that number is growing very rapidly.

This explosive growth in satellite communications has been made possible by the development of three new interrelated technologies. The first of these is more powerful and efficient satellites. In the past decade, major improvements have been made in satellite technology. Spacecraft antennas shape the beams more precisely and at lower mass. Receivers are more sensitive and lighter, using microwave integrated circuits.

Travelling wave tubes and solid state power amplifiers have substantially increased their efficiency, perhaps by a factor of two in some cases. And the power systems that supply those power amplifiers-batteries and solar panels-have mostly become lighter and more efficient. We now also have extensive use of microprocessors to control the satellites and simplify their operations.

Onboard propulsion has become more efficient. Next year, Hughes will launch the first commercial satellite to use electrically accelerated ion propulsion, which will reduce the mass of the satellite by 800 pounds and reduce the equivalent launch cost by over $10 million.

Meanwhile, the cost of these more powerful and efficient satellites is being driven down by keen competitions. There are at least a dozen companies capable of building communication satellites now, even though only two to four companies compete for each program. Customers demand and deserve high quality, good schedules, technical excellence, and competitive prices.

There is tremendous pressure on satellite manufacturers to improve productivity and reduce cycle time. I am proud of the fact that Hughes has been able to improve its productivity at the rate of about 10 percent per year over the last years, enabling us to capture a 45% market share in recent times — all the while maintaining our quality, which is so important.

As a result of these technology and productivity improvements, I would estimate that our current generation of satellites, the HS601, is about eight times more

cost-efficient than its predecessor of about a decade ago, Incidentally, we are using in our government programs some of the same management approaches and technologies that we developed for our commercial satellite programs, and our government customers like it.

The second important technology that has led to the proliferation of satellite communications is more efficient, low cost satellite earth terminals. In the 1977 World Administrative Radio Conference, it was anticipated that 60 dBW satellite power — that is the equivalent of a million watts of effective isotropic radiated power — would be required to transmit TV to one-meter dishes.

That was 17 years ago. That is what the best estimates were then. Since then, there have been substantial improvements in antenna efficiency, receiver sensitivity, and signal processing. So today, only 50 dBW-equivalent to 100,000 watts of EIRP, or ten times less than the 1977 figure-is required to transmit TV to dishes that are less than one-half meter in diameter.

At the same time, in terms of cost, about ten years ago we saw the first TV receive-only antennas intended for consumers coming on the market. They were advertised in the Neiman-Marcus catalog, in that section aimed only at the really wealthy, for $30,000. Today, you can buy a TVRO for less than $700 at mass consumer electronics stores.

The third interrelated technology is digital communications. Continuing improvements in compression technology, combined with low-cost chipsets to restore compressed signals, have made satellite communications more exploitable and cost-efficient than over before. As a result, we now have a proliferation of new applications here in the U.S. and worldwide.

One of these is private networking, where major companies like General Motors or Chrysler or Wal-Mart, or retailers in general, are using two-way systems that incorporate digital signal processing for transmission of voice and data. Each transceiver site costs them between $5,000 and $10,000, and they are using these networks to make their businesses stronger. There are probably 200 private networks in this country.

Another new application is mobile telephony. Next year, American Mobile Satellite and Tolesat Mobile will go into service with the first land mobile satellite system and will put a total of 4,000 circuits in orbit that can be received with a $1,500 car phone system. People will be able to communicate through satellites with digital compression techniques that enable good quality voice at five kilobits per second.

I think many of you are aware of the fact that within the next month or so, we will go into commercial service with our DirecTv system, and we expect millions of DBS dishes to come online in a very short period of time.

These types of utilizations will be worldwide. In fact, the growth of satellite communications is occurring not only because of new applications, but also because of a proliferation of new users throughout the world. As emerging countries start developing their infrastructures to participate in the global economy, major investments are being made in telecommunications infrastructure.

In many instances, wireless communications and satellite communications are the most efficient ways to develop this infrastructure. So countries such as Thailand, Argentina, and Malaysia- countries with relatively small economies -are developing their satellite systems for the applications I mentioned earlier.

As a consequence of all this, I see continued growth in the demand for satellite communications in the future. In fact, my major worry concerns launching these satellites, which was the subject of an earlier session. For example, there is inadequate capacity to launch our HS601 satellites for the next three years unless we launch them from Russia or China, which is what our customers are doing. With the proposed new systems, such as Iridium, Globalstar, P21, and perhaps Teledesic - the most recent proposal - this situation could continue or worsen. Launch failures, such as have occurred recently on Ariane and Atlas, cause severe problems. We do not have a robust launch infrastructure for the commercial programs.

... the growth of satellite communications is occurring not only because of new applications, but also because of a proliferation of new users throughout the world.

And yet, at the same time, some have proposed quotas and price-fixing on Chinese and Russian launch vehicles, to inhibit their use and protect the U.S. expendable launch vehicle industry, whose worldwide commercial market share has dropped to 30 percent.

I am concerned that such protectionism could damage the U.S. satellite industry, which must compete not only with foreign satellite competitors but also with terrestrial communications as well.

I am a strong advocate of developing a new generation of efficient launch vehicles, which will reduce the cost of launching government spacecraft make the U.S.

more competitive in the international launch vehicle marketplace, and provide a more robust launch infrastructure for a $30 billion a year space industry.

It is important to our country because communication satellites have become a key element of the global information infrastructure, and as this infrastructure grows, satellites will become even more important.

U.S. suppliers of satellites and related services generated sales of $4.8 billion in 1993, as well as hundreds of thousands of jobs in this country. In 1994, it is estimated that sales will reach $5.8 billion. I think it is safe to say that communication satellites have been one of the outstanding results of the United States space program.

Q&A Session

QUESTION: Why is the U.S. opposed to commercial remote sensing?

SILVESTRINI: I don't know why, and I am not sure that this is as a matter of fact. The fact is that the attitude of sections of the government and the Administration is inconsistent. There are times, for instance when the new license for higher resolution has been granted, where clearly it is a partnership demonstration. There are other times, where definitely the government could use money, people and knowledge from industry to support programs that would otherwise either die or come up half way, and the government doesn't do it. Now, the only thing that I can think of is that in one case it is a group of people and in another case it is another group of people because otherwise this doesn't make sense.

Commercialization for earth sensing is considered dead by many people and I am the first to admit that the way it was conceived ten or twelve years ago, yes that one is dead: but the fact is that from a wrong experiment it came out that, to some extent, if we change the formula then commercialization can survive. The two experiments are EOSAT and Spot-Image. We are alive and I know exactly how alive Gerard Brachet is. I guarantee it — the last time I saw him, he is very well alive.

I keep hearing that EOSAT is dying. Ladies and gentlemen, we are paying for the operation of two satellites with the revenue of our data. Our data, is four or five times cheaper than the French data. We have only one satellite a little old, the French have two, and we are alive and doing well. We are just now finalizing a deal with Telespazio of Italy to build portable ground stations. The government is not paying for that, we are. In India, it is the government that supports the programs and they decided to go commercial. Only the U.S. doesn't do that. The question was why? I don't know why.

QUESTION: Does it appear that the Congress believes NASA has truly reformed?

JOHNS: Religious conversion does not necessarily occur overnight, but we are hopeful that missionary work is going to bring a solid and reliable constituency in the Congress because of the viability of the program and the important contributions that it makes in a variety of different ways — from foreign relations to science to support of our aerospace industry to continuation of our manned space program and to contributions to Mission to Planet Earth. I believe we have a station now that they don't have to worry about it being an embarrassment to their constituents in being out of control with regard to price and uncertain with what it is going to do. I am very optimistic that the consensus will be built. We could certainly use the help of everybody in this room in selling that effort.

QUESTION: What success stories can the ATP program produce up to date?

STANLEY: I can tell you, I had a meeting with someone from NASA Life Sciences a couple of days ago. One of our successful award winners is in Salt Lake City, Utah called Arianne and they are working on synthesizing the chrysanthemum flower to produce by extraction of DNA this particular chemical that is a biodegradable insecticide. They are very close to being able to identify what part of the DNA that is. Now, they are working to see how they can trigger that mechanism. Out of the 89 awards to date in the first four years, everyone is accomplishing their milestones and we expect several to announce going to product very shortly. I should add that the woman I spoke with talked about a particular program in NASA dealing with looking at plants and the way in which they can be utilized to produce CO_2 in space, and maybe partial applications for transportation uses in our domestic airplanes. We are going to carry on some conversations with them and see where that may go. I also failed to mention that NASA is creating its own ATP type program for those of you who are directly involved with NASA. Let me just give you one name, Dr. Robert Norwood, Office of Advanced Concepts and Technology, NASA, Washington, DC 20546. He is putting that program together with our assistance, and you might want to give him a buzz. His telephone

number is (202) 358-2320.

QUESTION: Did you heard Dr. Middleton's proposal in the earlier panel, to get back into the commercial launch competition via buying into the Zenit and as I recall, a near equatorial launch facility which probably recommended as being an Australian. I thought this sounded like a very cost effective straight forward option, have you looked at it, and do you have any comments?

STRINE: Unfortunately, I didn't hear Dr. Middleton's proposal; however, the OCST is familiar with his Cape York proposal of several years ago. I would prefer not to give any comments to a proposal that OCST has not seen and is not aware of the details.

DORFMAN: Space port, which uses one of the launch vehicles you would ordinarily launch out of Florida or elsewhere, doesn't make any sense because you need to add in amortization of the cost of the investment. However it could make sense, and KPR launch in Australia if the Zenit was extraordinarily inexpensive, which I think the Russians are promising. It would be a way to capitalize on a very low cost of the Russian launch vehicle. You could still bear the amortization of the space port and perhaps at a competitive price. The thing that makes it work is if the Zenit is extraordinarily low cost which I understand it might be.

QUESTION: Are there any Administration plans to move forward on the development of a cost-effective launch vehicle before the turn of the century or sooner, if possible?

JOHNS: We are working on a national launch policy in the White House and in interagency groups now and working with General Moorman's efforts as well. It is our hope that we will have something to present to the Congress very soon. I would not say that we have backed off from new launch options at this stage.

SCHMITT: Do those options (studies, etc,) include an effort to have a purely commercial initiative with the government maybe being an initial anchor customer, rather than government-funded research and development?

JOHNS: That hasn't been ruled out at this time. Our problem, as most everybody in this room knows, is that we have a partnership on the Hill as well and we have this compelling budget problem, so what we are going to push for as much as possible, has to be politically possible in addition to being technically and commercially desirable. So, I would be deluding you if I did not say we had some work ahead of us at building a consensus. We intend to be aggressive in doing that, rather than seeing a bunch of reports going back on the shelf and putting launch policy off to another year.

STRINE: As I stated earlier this afternoon, in line with the Administration's goals for the development and enhancement of the nation's high-tech industries, Secretary of Transportation Federico Peña expressed his desire that the United States maintain a robust, viable U.S. commercial space transportation industry. To do so, the Secretary calls for the creation of a "new alliance between the nation's transportation and technology industries to make them both more efficient and internationally competitive." In an effort to meet that objective one of the options could include a purely commercial initiative with the government acting as the initial anchor tenant. Between the work being conducted by General Moorman's Panel and the on-going process led by the Office of Science and Technology Policy, options such as the anchor-tenant initiative could become a recommendation As one of the decision makers for federal space policy, I sure hope that the government/industry partnerships will continue and flourish.

QUESTION: Reading your NASA proposal to sell EOS-DIS data at processing cost, considering that information value is age sensitive, wouldn't differential pricing make more sense economically? Relatively cheap but older data could stimulate small business which provide value added services.

SILVESTRINI: I don't think we should focus on the U.S. or any other data, data in general coming down from satellites for earth observation, in respect to the value added companies that do the improvement of the data or analyze the data to come up with information needed for the users. We have surveyed our clients like we do fairly often to find out how are our services, what they want and things like that. One of the things that becomes clear from the surveys all the time, is that the commercial client really does not mind how much he pays if he has a good service, which is typical of every client in any world. I think that the answer is more political than business. Given the fact that the client wants good stuff, can the government always provide good stuff? Is the government equipped to provide good

stuff to everybody the way that they want it? The government was distributing earth sensing data before we did it. Were they doing a good job? Yes, excellent. Were the data distributed on time? Not necessarily. How much did they cost? Same as we charge now. That answered the question already. Why did I say political? It sounds very good, politically speaking, to say we will distribute data at the cost of reproduction to everybody. Who is paying for it? I pay for it, you pay for it, the taxpayer pays for it. Does it pay the same way? No, because if the government does it, the cost to produce is three times as much as if a company does it. That is my experience, and I have been on both sides.

QUESTION: What are some of the near term paybacks that might encourage investing in the D-helium^3 research?

SCHMITT: Interestingly enough, some of them do relate to the topic of this panel. One that does indirectly, is a relatively cheap source of neutron provides us with an opportunity to create at a lower cost and on site positron emitters for medical applications. Also, a relatively cheap source of protons provides some interesting possibilities for the reprocessing of spent fuel lines, in converting long life isotopes to short life or stable isotopes. Those are probably two of the more interesting short term. The longer term potentials or midterm potential even including taking a new look at nuclear powered aircraft relative to the fuel loading casing in a KC-135. With some preliminary engineering estimates, it looks like about half that weight you can have an electric power source using the electrostatic confinement technology as a base for power production. There are some very interesting midterm things. These will hopefully be outlined in the next year in somewhat greater detail.

QUESTION: Mr. Johns, could you share with us some of the strategies that the Administration has for convincing Congress that they should support the Space Station this year?

JOHNS: I think that is probably fairly hard to share at the moment. We are going to use every legal method that we have at our command. It is obvious that there are serious players and then there are the outside voters, and we are working all of those avenues. We intend a strategy which is going to involve everybody who has a stake in participating, and you will be hearing a lot more about that starting next week. But I don't think it will help the cause if I were to elaborate at this point.

SCHMITT: Is it safe to say that the Administration is interested in that goal?

JOHNS: Let me say that it will start with involving the President and the Vice President and others at the White House, OMB, NASA and the contractors, and the supporting state legislators and state delegations. The Space Station is something we don't want to lose. So, everybody is going to be involved.

SCHMITT: Marc, back to your ATP program. Was it my understanding that you don't draw any boundaries in terms of the technology applications in that program? It is as wide open as a technology program can be?

STANLEY: It is absolutely wide open. The thing that I failed to mention specifically are the areas that we will fund so that you understand the parameters. We would fund only between basic research and prototype. We do not fund product development, but it is any technology that you are interested in. You apply to us through a formal process. If you get the kit by calling the 1-800 number, everything that I tried to explain to you, but it takes a little bit more than ten minutes and I apologize for that. It is explained beautifully in that kit and it is every area that you could be interested in.

JOHNS: I am not sure it was clear why this isn't the government picking winners. Could you clarify that for me.

STANLEY: This program was established with a lot of consultation with industry. In addition, to a full scientific and technical panel review, we bring in business consultants, retired CEO's, joint venture capitalists, people who have a very strong background in technology, and after signing these nondisclosure statements review each individual proposal at a minimum of at least three reviews before it is presented to the source evaluation board. It really is a peer review program. The proposals come from industry and we go through these five criteria that we have established to resolve which of those proposals closely meets those criteria. It is not us sitting back and us deciding on our own where we want to go. It is an industry led program.

QUESTION: Linda, has your organization been looking at the reengineering of existing rocket launch systems as well as looking at what new launch systems might consist of?

STRINE: As suggested by the Secretary of Transportation's Commercial Space Transportation Advisory Committee (COMSTAC) and included in Secretary Peña's DoT Strategic Plan, improvements in launch system technologies and launch infrastructure are needed to gain lower cost, reliable access to space and to maintain the competitiveness of the U.S. commercial space transportation industry. Some strategic focus areas for new expendable or reusable launch vehicles could include the examination of Russian engine technology' use of advanced composites; the integration of new components or systems; vehicle health management systems, and navigation systems utilizing the Global Positioning System. Possible focus areas for launch infrastructure include telecommunications and/or information technologies (such as wireless communications and heterogeneous databases) for application to advanced launch control centers and more efficient launch operations.

The need for sometimes expensive launch range support such as tracking might be reduced by the use of GPS-based navigational systems. As a major user, the government benefits from both the lower costs that accompany improved competitiveness and from increased reliability and performance.

QUESTION: As it has been stated many times during the Symposium, there is a lack of public and consumer advocacy for space programs. Please comment on the irony that while increased satellite telecommunications is good for industry, it is making the public complacent, lazy and taking space for granted.

JOHNS: In public service, one comes to believe the public isn't complacent or lazy. They are busy living their lives and tribulations. If they are not aware and supportive of the importance of space to their lives it is almost certainly because we are not making it more important and not communicating that importance well enough. That means NASA, the Government, Industry, and yes, the U.S. Space Foundation.

QUESTION: In 1976, Robert Pusard was considered somewhat of a rogue in the nuclear industry for advocating small scale, low cost fusion reactors. He believed that the large scale approach of the fission industry and the then current fusion research was slowing the development of perfecting fusion industry. In the past eighteen years has the industry shifted some energy towards small scale, low cost reactor development?

SCHMITT: I guess the simple answer is no, but the better answer is that I think Bob Pusard's research is now recognized as much more of a profit than it was in those days. Indeed, the basis for the inertial electrostatic confinement work at Wisconsin is his patented polywell concept which — as some of you may not be aware — was also funded for several years by DARPA. Wisconsin became the inheritor of the equipment built by Darpa. Experiments have been run based on Pusard's polywell concept. Bob has still, at least within the helium^3 community, continued to be held in very high regard and is an active player in that arena.

QUESTION: What is your opinion of the proposed Teledesic projects suggested by McCaw and Gates?

JOHNS: I like the filing that McCaw and Gates recently submitted to the FCC for several reasons. One is, I believe that satellites are a very important part of the national and the global information infrastructure. I frankly think that it has not been properly emphasized by the current Administration because of the emphasis on the terrestrial part, and all the people in this room have a vested interest in seeing that this an important part of the information infrastructure. A couple of people who really aren't part of the satellite industry — Craig McCaw and Bill Gates — are putting in this bold application at this point in time. I think it has done more than anything else to create the positive publicity about the satellite contribution, not only to the national information infrastructure, but also for the global information infrastructure.

DORFMAN: I think that part is good. It is an extraordinarily bold venture in suggesting $9 billion. I have looked at it enough to know that it will need technological breakthroughs and reductions in the cost of building satellites and launching them probably by a factor of 20, but if McCaw and Gates who have been very successful in getting financing in previous ventures gets say $4 and a half billion from building satellites, I will be delighted to build those satellites for them. It will keep us in business for quite a long time. Furthermore, if you look at the details it will require a launch capability that is roughly equivalent to an atlas or an Arianne or proton launching these satellites at the rate at about one per week for about two years and then maybe we will get on with developing our new launch vehicle. So, I like this proposition even though I must admit, it is quite ambitious and might be accomplished more efficiently with an alternate approach.

National Security Space Issues

General James E. Hill, USAF (Ret.)
Chairman of the Board
U.S. Space Foundation

General Charles Horner, USAF
CINCNORAD/CINCSPACE
Commander, Air Force Space Command

Admiral William Studeman
Deputy Director
Central Intelligence

Rear Admiral Lyle G. Bien
Commander
Naval Space Command

L/General Donald Lionetti, USA
Commanding General
US Army Space Command & Strategic Defense Command

M/General Robert W. Parker, USAF
Director of Operations
USAF Space Command

L/General (Sel) Richard Scofield, USAF
Special Assistant to SAF/AQS

B/General (Sel) James R. Beale, USAF
Director of Intelligence
HQ NORAD/USSPACECOM

GENERAL HILL: Good morning Ladies and Gentlemen. As we go to Symposia and various seminars all of us have heard athe introducer say "this speaker needs no introduction." That certainly is true of the speaker that I am about to introduce; however, because I have such high regard and personal, professional respect for this man, and because of his great contributions to our nation, I'm going to say a couple of things about him. He's a fighter pilot. He flew 111 missions in North Vietnam, and he certainly has earned his decorations and credits for having done that. I believe that the credit for the swift success in Desert Shield and Desert Storm belongs to this man. I think he did more than any other single person to bring that successful campaign to a close. He is the Commander in Chief of the North American Aerospace Command, the Commander in Chief of the U.S. Space Command and the Commander of Air Force Space Command. And he is truly one of the great heroes of our time: General Chuck Horner.

GENERAL HORNER: I'm going to open with a series of questions that will frame remarks for our following speakers who are the real experts, and give a brief discussion of issues that I think are so important; they must be addressed in the coming years with regard to military space and our national security.

From a national security standpoint, we in space must come to grips with our reason for existence. Space by itself attracts people who are interested in technology and science — the dynamics of exploring this great new frontier. Unfortunately, that attraction can deter us from what our roles should be. I know in the case of Air Force Space Command, so much of our effort was designed toward being involved in the launch of satellites, the control of satellites and stating the requirements for military satellites. We lost sight that our real job is to provide space and its products to people — people who pull triggers, the warriors in the foxholes, on ships and in airplanes. If we fail to do that, then we fail to service the people who are depending upon us. That dependence is growing by leaps and bounds. Space is fundamental to military operations. There is no turning back.

There are some significant issues in terms of national defense needs, and ballistic missile defense has to top the list. This is because of the proliferation of weapons of mass destruction, and the means to deliver them, not only by space means like ballistic missiles, but also cruise missiles, terrorism and conventional aircraft.

From a national security standpoint, we in space must come to grips with our reason for existence. ... We lost sight that our real job is to provide space and its products to people — people who pull triggers, the warriors in the foxholes, on ships and in airplanes. ... Space is fundamental to military operations. There is no turning back.

PRECEDING PAGE BLANK NOT FILMED

We must first and foremost develop adequate warning — that's fundamental and all things grow from there. As the range of missiles increases, that warning needs to include space-based elements such as Brilliant Eyes. Without a space-based tracker, your land and sea based defenses lack range and lack opportunities for engagement.

In terms of space-based defenses, there are those who make a philosophical argument that these are weapons in space — I reject that. The weapon in space is the ballistic missile, not the space-based defense. The space-based defense will not engender an arms race and, in fact, is probably one of the few ways we have of deterring the proliferation of ballistic missiles and weapons of mass destruction. Proliferation *is* the new war, the war that is replacing the Cold War. So I see ballistic missile defense as not only important in defending our people abroad, but also in defending our people in this theater of operations.

Proliferation *is* the new war, the war that is replacing the Cold War. So I see ballistic missile defense as not only important in defending our people abroad, but also in defending our people in this theater of operations.

The intelligence roles in space have been fundamental and are growing. We've had difficulty in the past because of walls erected through organization or classification from concerns about protecting secrecy. That is changing — I applaud those changes.

We also need to look at our ability to task the timeliness of the information, and its dissemination. War is now fought in minutes and seconds, not days and months. The flow of information — the acquiring of information, the decision processes and the execution processes involved with that information — is going to be fundamental to the success on the battlefield, particularly if you consider other constraints that have been imposed on warfare such as the adverse impact of casualties. Desert Storm provides us glimpses of how important it is, not only to not incur friendly casualties, but also not to inflict casualties on the enemy if at all possible. It's a very difficult balancing act, but something that is very important — and it all starts and ends with intelligence. We ignore that in peace time and have to become deeply involved in war time. It's a question of education, a question of exercising, and a question of goodwill on the part of the operations and intelligence communities.

We must come to grips with the concept of controlling space. We fully understand freedom and navigation of the seas in peace time, and the laws of war and how to conduct operations. We hesitate to talk about policy with space control. And yet, as space has become so fundamental to modern warfare, we must protect our assets in space, our access to space, the information coming from space, and we must deny those same opportunities to any enemy. We fought space control in Desert Storm. We attacked Saddam Hussein's ground terminal sites. We used diplomacy to deny him Spot Image imagery and Russian imagery.

People do not want to discuss control of space because there is a desire to have the world as people would have it — not as the world is. They want to create the idea that space is pristine — that we don't want the military in space. While I might be able to sign to that philosophically, there are, unfortunately, cases that space is filled with military. In fact, the military was first in space. So I think the space control issue is how we support the regional CINCs as they plan an intelligent, effective space campaign and how we can implement policies and laws for the continued development of the systems needed to accomplish that mission.

And yet, as space has become so fundamental to modern warfare, we must protect our assets in space, our access to space, the information coming from space, and we must deny those same opportunities to any enemy.

In peace time, the single most important issue the military faces is really not a military aspect — it affects all aspects of space. That's the efficiency of our space operations. This is an issue at the forefront of debate because of the declining dollars, and no one knows that better than the people in this room. But the reason I'm most concerned about that, setting aside just a natural Iowa farmer's desire to do things efficiently, is that it means limited availability to space and limited space assets to support the war fighter.

So first, we must address the cost of access to space in terms of dollars and in terms of time. Our lack of responsiveness means vital capabilities are sitting on the pad 2-1/2 years after they were supposed to be

launched. That should be unacceptable. We need to look closely at how we do space lift, and Tom Moorman has conducted an extensive study. (He did an interesting thing with his study this time — he put it on floppy disk so when they decide to do the next study they won't have to lay out millions of dollars — they can just take those disks and put them in the computers and do their study again.)

Modern roles for space make for strange bedfellows sometimes.

We need to look at how we do payload integration and operations on the pad. We need to look at our range operations, to get the cost of space down in every aspect. Space has grown up as a brand new frontier. No longer a new frontier, space is a known quantity — a known operation. We will continue to make advances in technology but, as in the case of flight, it is something we must get down to a business-like fashion. It makes sense.

We have to look at our costs of operations. Right now, we have stove pipe controls for satellite flying. That's inappropriate. Satellites operate on signals, and each one is different. But you build a software system that addresses the difference and one individual can fly five, six, or seven different kinds of satellites. There's no reason we shouldn't be doing that. It's just a question of attitude.

We have more than one satellite control network. That may be appropriate for redundancy purposes, but we need to examine the protocols associated with satellite control network, we need to examine duplication, and we need to get out of that business where possible. We need to make it efficient, but not only in terms of military operations. There's no reason we couldn't share with regard to commercial and civil activities.

Cost of operations also extends to what we do with military space. We're involved deeply in things like convergence with NOAA on weather satellites. That is inappropriate duplication. NOAA has that job — let them do it. We provide them our unique requirements for military operations, they satisfy those requirements and we're making good progress.

One of the areas we need to examine most is communications. The military has long sought to have it's own unique military communications satellite. We found in the Gulf War we relied more and more on civilian communications because we always underestimate our need for communications. As a result, during the Gulf War, our land line communications went through Kuwait City which was occupied by the enemy. I don't know whether they ever exploited it or not. If they did, they certainly didn't do it very well. And Saddam Hussein and the United States used the same satellite for communications. Modern roles for space make for strange bedfellows sometimes.

We need to take a look at what we really need for military space communications. Things like EHF may not be appropriate for commercial use, but may be necessary for the Army to maneuver on the battlefield or for the Navy to have help for low-probability of intercepts for their submarines. We will fill those needs, but we should come to rely on the commercial sector.

Also, we see a whole fundamental shift in communications with regard to military operations. In the past we used the satellite communications to go from the United States to the theater. I think we will find an increasing use of fiber optic cable to go from the United States to the theater and use the satellite communications within the theater. Because modern warfare requires high mobility, it requires fluid operations and immediate command and control. All those advantages come from space-based communications.

There is no doubt about it, the global positioning system has revolutionized military operations and will continue to be operated by the military. But as we operate the GPS, we are finding millions of uses for it in the commercial and civil sectors. And that raises questions — what will follow GPS? I think we may well find that what follows GPS will probably be commercial systems the military used rather than the huge up-front investment we did in the case of GPS.

We found in the Gulf War we relied more and more on civilian communications because we always underestimate our need for communications.

The last thing in terms of efficiency is one that I hope to hear from — and Dick Scofield's here with us today — the cost and time of acquisitions of new systems. If you look at the MILSTAR program, it is an ideal example. MILSTAR is a brilliant system whose requirements were defined in the Cold War. The Cold War may be over, but you'll have trouble convincing the people who pay the bills that it's not over. MILSTAR is very expensive because of its unique Cold

War requirements. The EHF system associated with MILSTAR will become fundamental to modern military operations. So the question is, how did we get in this fix where we have a very expensive satellite to do a vital job that could be done in a more efficient way if we had known that the world was going to change?

The answer is, we've got to get out of the 10-year acquisition cycles. We need to get our acquisition cycles down to one or two years. The world is changing so rapidly, technology is changing so rapidly, that we in space can no longer afford long times in terms of acquisition. Dr. Perry has made acquisition reform one of his top priorities. I don't know if he'll succeed, but the time in acquisition must be changed and the cost of acquisition must also be changed if we're going to have on orbit the things we need to fight in the future.

The world is changing so rapidly, technology is changing so rapidly, that we in space can no longer afford long times in terms of acquisition.

There are issues that go into the technology side. We need to look at payload design. We need to look at the size of our satellites. We need to look at the function and how it relates to other systems. We've been reluctant to do that. Often we look at systems in terms of a unique system — a stove pipe. For example, we often look at space intelligence in isolation when in reality we ought to look at how it compliments or how it is complimented by air breathing systems or land based systems. Until we start looking at these things in terms of systems within a function, we're going to have either unnecessary duplication or gaps. And that's going to take serious cooperation among a large number of agencies.

In the terms of space lift — there's no doubt about it, we need national leadership. The Department of Defense can no longer embark on a bold program to develop a new space lifter. The money is not there. People are fighting for their lives. When the Navy talks about going from 12 to 10 carriers unilaterally, you know there are serious problems in the defense budget.

I think we need to look at the role of the military with regard to all the agencies in Washington. In the case of the areas where I have influence, Unified Space Command is very pleased with what's happened over the past year. General Vern Conner has led an effort to get the space operator to become the servant of the regional CINCs in areas such as Communications and Intelligence, areas we have avoided in the past because they belong to the communicator or the J-2s of the world, and finding that we're suddenly forcing a marriage between Operations and Intelligence that was not always there, but is fundamental.

I think we need to work on teams. Certainly what we do in regard to Unified Space Command, sending teams out to places like Korea, Europe, Bosnia, or with CENTCOM, have proved to be very important because, in the past, the war fighter has been ignorant of space and what it can do for him. And quite frankly, when you're ignorant, you're indifferent. Now, that might be okay if you were in business. But the trouble with the business we're in, is the price of failure equates to American lives. So the Unified Command's three components, Air Force Space, Army Space and Navy Space, have become very aggressive in their outreach programs to the components and the Unified Commanders in each of the regions. That's paying off.

Their job is to provide space requirements to the acquisition community so we can get things that truly meet the needs of the war fighter. We've had a gap in the far past, it has been closed rapidly. Most people now understand that the customer is not the payload — the customer is the soldier, sailor, marine and the airman. We need to continue that. We must bring space to the war fighter. The war fighter does not appreciate what space can do and needs to be educated, exercised and trained. We're doing that. We've been involved in a number of extensive theater training exercises and the beauty of it is not that we do any great wonderful thing, not that any great horizons are broken, but that we are developing what I call "CINC-pull." We're developing a requirement now being supported by the regional war fighter, where in the past they have not had the knowledge nor the interest to do so. And that's going to be fundamental if we're going to develop and defend vital programs in intelligence, communications or support functions that space can provide.

Most people now understand that the customer is not the payload — the customer is the soldier, sailor, marine and the airman. We need to continue that. We must bring space to the war fighter.

Finally, we see that we're having war fighting centers. The Navy has done this for years, and done it

well. The Army has done it. Certainly the folks here in Colorado Springs have brought space to the Army. And we've stood up out at the National Test Facility the Air Force Space Warfare Center. There are those who are concerned about whether Air Force, Army or Navy has space. I think those are foolish concerns. It's important that all people know, understand and have a voice in space; that all the military feels the need for it and has the knowledge of how to use it.

I think the bottom line of military space issues is this: space has never been so important to war fighting as it is today. People say Desert Storm was the first space war. I don't know whether that's true or not, but I can tell you that it is fundamental to modern war fighting. We ignore it at our own peril and we ignore it at the cost of American lives. We need to understand how to apply it, and we need to educate the people who need to use it. And that's not the space people — it's the people who pull triggers. They are the customer and we must never forget that. They are the most important person.

Not very long ago, the idea of speaking before such a broad public audience on intelligence and national security aspects of space would have been all but unthinkable.

I'd like to now introduce the next speaker. This one gives me great pleasure. I've known of Bill Studeman for a long time. He doesn't know Chuck Horner from a hill of beans. But, I'll tell you, when you're hanging out there in the tactics and concepts business like I was in the Pentagon, back when I was a Major, I knew of Bill Studeman. And then when you're in Desert Storm and you see people in the intelligence community who are willing to take risks, who are willing to be selfless in their support of the war fighter can do for you, you become an ardent fan. And I'm an ardent fan of Bill Studeman. In fact, I was intrigued when Bobby Inman was going to become the Secretary of Defense. You look at that, there's no powerful transference that would exist in Washington than the Mike McConnell-Bill Studeman-Bobby Inman trio and I thought, we're going to really see some things happen. But unfortunately one of the trio dropped out, so we have the duo up there blazing trails.

So, Bill, I think we're all honored that you're here, we're interested in what you have to say, but most of all, I can tell you personally I deeply appreciate the attitude you've had over the years and the support you've given the war fighters of all the services. Thank you so much.

ADMIRAL STUDEMAN: Thank you. It's an honor to be speaking here at the National Space Symposium, but it's something of an unaccustomed honor. Not very long ago, the idea of speaking before such a broad public audience on intelligence and national security aspects of space would have been all but unthinkable. That I do so today is evidence of just how much has changed in our view of the world since the Berlin Wall came down. I have a lot to cover today, so I will be moving quickly.

There's no question this is an extremely challenging time to be part of the national security establishment in general and the Intelligence Community in particular. The pressures to generate and accommodate change are enormous — pressures evidenced by changing world threats, declining national defense and intelligence budgets, personnel reductions, heightened debates over the merits of various intelligence systems, and a host of other developments — all of which include extremely complex and difficult issues and decisions.

Challenging as it is, it is also an exciting time to be involved with planning the future of space reconnaissance systems — not the least because the doors for commercialization and internationalization of reconnaissance are beginning to open wide, certainly much wider than most of us would have predicted just a few years ago. The next five years promise to be revolutionary and not for the faint-hearted, if you are wed to the ways things were done in the old days of the Cold War. This is because there are complex equity issues. Much is at stake, much is unknown and much is still to come. In many cases, we will find ourselves in uncharted territory, making the rules up as we go along, and worrying about the consequences of a misstep. The world, after all, may have changed its political contours, but it remains a dangerous place, increasingly so as we approach the end of this century and begin a new century.

Space, as we know, offers enormous potential benefits. But space, as we also know, can be used against us by nations hostile to our interests. This is the equity issue for national defense and intelligence. It is imperative that whatever decisions we make in the coming years, we get them at least approximately right from the start. We have to make sure that all constituents of the space community become sensitive to the needs and the implications of space commercialization and security — and that we find ways to deal with the inevitable tensions and issues that will also arise. We also have to

make sure that we focus our efforts on the areas of greatest need and priority. What I intend to do today is talk about some of these issues and areas and outline what I see to be their principle impact.

I want to begin with some thoughts on context. Remote sensing from space provides a wide range of potential users with the capacity to gather data for a variety of useful purposes, including military uses. The U.S. Government operates very high resolution space-based reconnaissance systems for intelligence and military purposes. These systems are amongst the most valuable U.S. national security assets because of their ability to collect high quality data in short order over a wide range of ground — in essence because they give us an ability to monitor events around the world on a near real time basis. Indeed, more nations have discovered the advantages of such satellites and are developing indigenous capabilities or seeking the purchase of data or systems — I'll say more about that later.

National economic imperatives have been added to the traditional national security mix of diplomacy, defense and intelligence. Space programs — civil and military — find their costs and benefits weighed in terms of a broader national agenda.

Our understanding of the definitions and dimensions of national security are in flux. No longer is there a singularly monolithic, powerful and hostile opponent to be used as a benchmark for the direction, priority, and urgency of national security programs. National economic imperatives have been added to the traditional national security mix of diplomacy, defense and intelligence. Space programs — civil and military — find their costs and benefits weighed in terms of a broader national agenda. Moreover, the advance of technology, together with the end of the Cold War, has allowed and encouraged the globalization in the defense industry, including firms that develop and operate space systems. Applications, even in the intelligence, reconnaissance, and surveillance areas are increasingly internationalized as we support UN, Allied partnership and coalition activities around the world with our sensitive reconnaissance means.

There has been a general blurring of the distinctions among the agendas and overlapping arenas of security, commerce and science. Programs to advance national security, economic competitiveness and scientific achievement are no longer sharply distinguishable and the process by which public policy is shaped in these areas are spilling over one into the other.

One important aspect of these developments is the on-going reassessment of the interests and needs of national security — and their accompanying implications for US space policy and the Intelligence Community. The outcome will be affected by a number of factors, including the intensification of the competitive environment, including the reality of foreign availability (to use an export control term), the realization of the advantages of commercial practices, and the growing uncertainty of the industrial base that supports production of space hardware. One issue, though, is not in doubt — the role of space systems in modern warfare.

I don't think that anyone has seriously disputed the notion that the denial of space use to our adversary was significantly demonstrated by our experience in the Persian Gulf War. The unprecedented degree of space-based support justifies the description of Desert Storm as "the World's first satellite war." Space reconnaissance assets were brought to bear in a sustained and large scale regional conflict that tested their ability to contribute to critical decisions. The Gulf War clearly served as a rite of passage for space systems and expanded their place in the operational doctrine and support plans for the Unified Command.

This is the point I wish to emphasize: *support to military operations continues to be the first, last and always top priority mission for the Intelligence Community.*

It is also true that the space assets available to military customers during the war were built and flown, at least in part, for other reasons. The performance of the space systems in the war owes much to their flexibility and to the experience of the dedicated individuals who operated them and interpreted that data that they acquired. As some of you know, we are now in the midst of the decisions that will shape the evolution of the existing space architecture. As we make these decisions, the central focus will be support for military operations. This is the point I wish to emphasize: ***support to military operations continues to be the first, last and always top priority mission for the Intelligence Community.***

I have listened to many briefings and reviewed many

studies that describe the lessons learned from Desert Storm and explore alternative futures. While individual studies differ in the specifics, they are universally consistent in recognizing that the geography of crisis is uncertain, in assuming that resource constraints will continue to color debate, and in recognizing that, whatever the conflict, timeliness, accuracy, completeness, and relevancy disseminated at the lowest possible classification level will continue to be critical performance criteria for space reconnaissance systems.

The space inventory in orbit today is generally less capable than the inventory on orbit during Desert Storm. The effectiveness of the systems we have in place will continue to diminish.

Desert Storm did reveal some key shortfalls, the most important of which can be tied to an inability to move data with absolute efficiency and to provide the necessary total coverage of the battlefield. The major one, of course, is our ability to consistently dwell or to acquire synoptic imagery in sufficient quantities to meet the intensive tactical demands. Similarly, because of bandwidth demands of other architecture issues, we were plagued by problems with the dissemination of imagery.

As we look to the future we have kept these shortfalls in mind and we have strategies that will hopefully overcome these problems. A main issue, though, is cost. We are carefully weighing the tradeoffs that will allow us to provide — in a resource-constrained environment — collection assets that most effectively address these shortfalls and the other needs of military commanders and national policy makers.

To ensure that funding is available to continue a meaningful program while seeking modest system improvements in the future, we have sacrificed near term capacity while living off the resources of the past. The space inventory in orbit today is generally less capable than the inventory on orbit during Desert Storm. The effectiveness of the systems we have in place will continue to diminish. We have the technology to evolve a substantially more powerful satellite future, but we are likely to be resource constrained and forced to stretch our current and future systems. As I noted, the Intelligence Community in conjunction with intelligence consumers and the Congress, are in the midst of determining the phasing of a viable, future satellite mix. In this case, commercialization and internationalization of space reconnaissance has the benefit of being adjunctive or complimentary to our needs.

I spend a great deal of time trying to convince people that they need to look beyond the lens of the camera. Largely because of its cost, the collection apparatus — its physical attributes, orbit, bells and whistles — get the majority of our attention. Components like ground processing, data portability and intelligence product refinements generally get far less attention and are usually the first to get cut when budget reductions are necessary. Yet these components in the end are at least equally as critical as the collection hardware. I don't want to overstate this, but I think Dr. Lan, an early reconnaissance technology pioneer and founder of Polaroid, had it right with his principle that it's NOT the camera, but the ability to deliver the information direct to the user in the most timely manner that is important.

But of course we're not the only ones who are acting on lessons learned from Desert Storm. The good news is that we were able to use reconnaissance satellites effectively as a force multiplier; the bad news is that everyone else, including potential adversaries, recognize it as well.

Total air superiority denied Saddam the ability to conduct theater reconnaissance, allowing coalition forces to execute the virtually undetected mass movement of troops in the now famous Hail Mary maneuver. At the same time, even with our shortcomings, our own reconnaissance capabilities gave us an impressibly detailed understanding of the battlefield when compared to earlier wars. The success was a demonstration to the rest of the world of the advantages of intelligence assets such as satellites and create a double-edge sword for U.S. and allied military commanders. Widespread proliferation of global reconnaissance means creates significant vulnerabilities for the movement and maneuver of large military formations which will increasingly be available to virtually any threat country (and possibly even routinely available to the media). Similarly, highly proliferated space reconnaissance means will likely further dramatize and sensitize threat elements to their own vulnerability to satellites, driving them to satellite avoidance measures which diminish the longer term all round productivity of expensive space reconnaissance means.

Particularly as a consequence of our success, demands for broader access to satellite reconnaissance technology are growing. An understanding of the value of space systems is spreading rapidly. Russia is currently marketing two-meter resolution imagery and plans to market a .75 meter resolution imagery sometime in the near future. Russian industrial representatives have also

offered turn-key remote sensing satellites and/or technology and know-how to foreign entities. The French are developing HELIOS. The technology from this system is expected to be offered for commercial development by the end of the decade.

An important fact to bear in mind is that foreign capabilities need not equal ours in order to offer a product that meets many customer needs and also has significant national security impacts. Russian, French and potentially other country or consortia initiatives to commercialize the product of some reconnaissance systems make it likely that significant amounts of military useful products will be widely available and the proliferation of remote sensing technology will continue to influence military doctrine. U.S. Commanders will have to coordinate the tempo of battlefield preparation with hostile force opportunities for collection; conversely, they will also need to phase U.S. collection operations to support OOB determination, situational assessment, targeting and battle damage assessment.

I'm sure that many of you are interested in the intelligence view on the recent policy decisions on foreign satellite sales. It is clear that the United States remains far and away the preeminent player in the space reconnaissance business, and we are moving to take advantage of this enormous competitive advantage in ways that protect the legitimate concerns of the nation. We now have a set of implementation guidelines that address the process for selling reconnaissance satellite technology. This is a very complex issue that involves a number of competing interests.

A fundamental goal of our policy is to support and to enhance U.S. industrial competitiveness in the field of remote sensing space capabilities while at the same time protecting U.S. national security and foreign policy interests. Success will contribute to maintaining our critical industrial base, advancing U.S. technology, creating economic opportunities, strengthening the U.S. economy and promoting regional stability. The size of the future commercial marketplace is uncertain and possibly overstated.

The new executive branch policy now in place covers foreign access to remote sensing space systems, technology, products and data for scientific, industrial, civil, government, military and individual users. With respect to commercial licenses, this could include operating licenses granted under the Remote Sensing Act of 1992 and export licenses for certain items controlled on the U.S. Munitions List (USML). A key objective of the Remote Sensing Act of 1992 was to create an environment in which U.S. industry could provide remote sensing imagery to a potential market of domestic and international customers. While the executive branch policy will define certain restrictions for export of items on the USML, export of items on the list or the Commerce Control List would continue to be licensed in accordance with existing laws and regulations.

A fundamental goal of our policy is to support and to enhance U.S. industrial competitiveness in the field of remote sensing space capabilities while at the same time protecting U.S. national security and foreign policy interests.

License requests by U.S. firms to operate private remote sensing space systems will be reviewed on a case by case basis in accordance with the Lan Remote Sensing Act of 1992. There are as well a set of restrictions that I would call the "conditions of citizenship" for all those who want to reap rewards from participating in the remote sensing market place. I'd like to outline a few of these conditions: *An important caveat to keep in mind is that all requests will be evaluated on a case by case basis.*

With respect to licensing and operations of private remote sensing systems

- the government will have insight into all satellite tasking;
- the license is not transferable nor subject to foreign ownership above a specified threshold without the explicit permission of the Secretary of Commerce;
- all encryption devices will be approved by the U.S. Government;
- as new foreign customers are brought on board, the U.S. Government will be notified;
- the data downlink format will be accessible to the U.S. Government when needed;
- and most importantly in my mind, during periods when national security or international obligations may be compromised, the U.S. Government (after cabinet level approval and consultation at the highest levels) can place restrictions on collection and/or dissemination.

With respect to the transfer of advance remote sensing capabilities:

- there is no resolution cutoff;
- as a general guide, the imagery quality characteristics being provided should be those that are available or are planned for availability in the world

marketplace

- any system made available to a foreign government or other foreign entity may be subject to a formal government-to-government agreement;
- proposals for government-to-government intelligence or defense partnerships with foreign countries (regarding remote sensing) that would raise questions about U.S. Government competition with the private sector shall be submitted for interagency review at the policy level;
- approval of requests for export of systems would also require certain diplomatic considerations such as informing other close friends in the region of the request.

Regarding the transfer of sensitive technology:

- the United States will consider applications to export sensitive components, subsystems and information concerning remote sensing space capabilities on a restricted basis. Such sensitive technology shall be made available to foreign entities only through a government-to-government agreement with assurances to protect U.S. technology.

In a recent speech to the Intelligence Community, Vice President Gore highlighted the escalating security dimensions of environmental degradation. In making the link between the environment and national security he said, "since we collect so much more information in the 'black' than in the open, it's of critical importance to translate and apply this information to the broader and more varied dimensions of national security." The Vice President's speech on the environment is a good example of an issue that has not been within the province of the Intelligence Community but in which the Community can make contributions as a consequence of the capabilities it possess for its main missions.

Consistent with the spirit of that approach, as well as with initiatives to foster greater openness within government and with the American people, the Intelligence Community assumed a very active role in the Environmental Task Force (ETF), which assessed the potential Community contributions to environmental issues. Over 100 classified briefings and full access were given to the ETF for a technical assessment to determine the environmental utility of classified data from unique sources. With the completion of the ETF's work, a follow-on group known as MEDEA has just been set in place. MEDEA is a group of distinguished scientists who have been given access to classified programs. Our involvement in this important area signifies a commitment to maximize the use of intelligence information, maximize the use of historical intelligence archives, and gain additional value out of forty plus years of intelligence expertise.

In many ways, the MEDEA group is reviewing what mich be termed "archeological data" on the Earth's natural environment. World scientists will then gain a much better understanding of a whole range of environmental topics, including global climate change and related issues such as decertification, deforestation, and the human impact on nature in general. The next phase — which is about to begin — will be a determination of how we can establish a process that will institutionalize support to environmental science through disclosure of data that has been collected over the years.

The environment is not the only non-traditional area that has engaged our space assets. Last summer, with due care for legal constraints, we supported the Federal Emergency Management Agency with data on the floods that devastated the Mid-West. Again, we were able to do this as a by product of our main missions.

Closing Thoughts:

I expect that we will see more and more requests for non-traditional support, and I expect us to honor them where we can. Additionally, the Intelligence Community will be offering some more forthcoming initiatives on space reconnaissance openness to the National Policy Community, which I am not at liberty to detail here today. All this notwithstanding, we cannot lose sight of the main business we are in, which is to use space systems for intelligence purposes, which we hope to keep at the leading edge of technology.

Let me close here and thank you for your time and interest. I have talked at some length this morning of changes that are affecting us and that will continue to change the way we do business. Commercialization and internationalization are likely to have a particularly strong influence in this regard. But — as I hope was evident in my remarks on the military uses of space — I fully expect space to remain a strategic national security and intelligence enterprise. In that context, I am sure that many of you in the audience will have continuing important roles to play. Thank you for your attention.

GENERAL HORNER: This looks like the Navy hour — me with my Naval suit on, Studeman and our next speaker. When I was in Rhyiad, in order to do the air component job of course you had to have vital support from all the nations and all the coalitions and all the services of the United States. Heading up the Navy contingent, showed up at my headquarters, was this

unassuming, often in-articulate, non inspiring individual and everyone called him Ho-Chi-Min. His name is Lyle Bien, and he became professionally known as Ho-Chi-Min Bien. If there's one thing that I think we respect more than anything else in a military individual, it's selflessness. The calling in and of itself requires selflessness even to the giving of one's life. I have never met a more capable, more inspiring, more selfless leader than our next speaker. When I was told that Lyle Bien was being promoted to Admiral, I was ecstatic. When I was also told that he would come and head up Naval Space Command, I was filled with joy from the bottom of my heart. Our next speaker, Lyle Bien ... oh, by the way, let me get out the Jim Hartinger stool for him.

REAR ADMIRAL BIEN: It is a special honor to be here today representing the Naval Space Command. We believe the Navy and Marine Corps story in space is one very much worth telling. We also believe that our history of concentration on tactical support to our warfighters offers a baseline methodology for the future. And we're proud of the relationships we've developed in the space industry as represented by folks like you.

In this room are many of the great minds in the American space community. It should be our collective goal to harness that national brainpower to better serve our customers — customers defined simply as that diminishing corps of intrepid young men and women who man the front lines in defense of our nation's liberties. All that we do here should be with their needs as warfighters uppermost.

All of the services, and most especially the naval services, have become deeply and irreversibly space dependent. There are those who bemoan that. If the Gulf War is a fair test, then I think its more a cause for celebration. But before we celebrate, I should briefly introduce the Naval Space Command.

More than a few of the people I meet seem surprised to learn that there is a Naval Space Command, leaving us with a continuing burden of always having to introduce ourselves. We are located in Dahlgren, VA, an hour by car from Washington, DC. It is an idyllic place, so remote it still has its own on-base school system. It is an ideal shore duty home for our sailors and their families, and a source of civilian labor known for their permanence and dedication.

From Dahlgren we operate our one-of-a-kind Space Surveillance electronic fence that runs from San Diego to the Georgia Coast. From that fence we maintain an exacting catalog of over 7000 objects in space with special emphasis on the 500 currently active payloads. We are also the Alternate Space Surveillance Center and Alternate Space Defense Operations Center for the centers in Cheyenne Mountain. We perform those duties in our role as the naval component to General Horner's US Space Command.

It is also from Dahlgren that we dispatch our Navy and Marine Space Support Teams. These teams represent the best and the brightest of the Navy's small but vibrant space culture. Their credibility is derived from the limited but broad involvement across the entire space horizon. These teams of 1 to 5 people take tailored training to the Fleet and Fleet Marine Forces. For most of our lives space products were the sole domain of the intelligence specialist. What got into the hands of the operator was a sanitized product which sometimes met, but often did not satisfy his needs. Since the Gulf War, we've come to realize that infinitely more timely and complete space-derived products must be provided to our warfighters. Our Space Support Teams are masters at training our sailors and Marines on what is available, how to get it, and how to exploit it. As a side benefit, these teams then become an avenue by which the Fleet can transmit their needs and concerns for advocacy in the space requirements process. If we hear and act properly on those needs, our future deployed forces should have the right product, in the right place, at the right time. We also have a very active Plans and Policy Division that gives real Fleet definition to the Navy's position on everything from Military Satellite Communications to the all important roles and missions debate.

Our only two outlying commands are the ROTHR site in Chesapeake, Virginia, and our Navy Satellite Operations Center in Point Mugu, California. It is from Point Mugu that we fly the TRANSIT navigation satellite constellation and the EHF packages on FLEETSAT and our newest bird, the UHF Follow On, or UFO.

It is often said that the Navy is the biggest military user of space. That may be true, but what I believe is intended is that the Navy and Marines are actually the most dependent users of space. Nearly everything we do today in the command and control of our ever diminishing, but increasingly lethal forces, has to do with bandwidth. For most folks, including many military forces, that may simply mean another T-1 or even T-3 line. For the Navy it represents a painful dilemma of finding enough satellite capacity, enough antenna real estate, and enough terminals to support our troops. And we never have enough. To illustrate the point, the typical U.S. military installation ashore has 100 times the bandwidth available on our major combatants. Further, while most major installations now have video teleconferenc-

ing, we're still struggling to make it possible for sailors to call home or to watch the Super Bowl — live. Not surprising then, it is that dependency on satellites for tactical communications that made us early developers of UHF satellites (and not coincidentally, why we are a bit single-minded about MILSTAR).

Likewise, it was the uncharted vastness of the world's oceans that led us to develop the Transit Navigation satellite, which became the desert super star — GPS. It was our forward deployed operations that led us to develop (along with the Army) the JTAGS and TACDAR, where we strip raw IR data from DSP and pump it directly to the Fleet. None of this is intended to boast, but it is intended to portray some of the Navy's long history of space pioneering and dedication to the tactical warfighter — and to suggest a model for future space acquisition. We believe this tactical focus combined with the current trend toward commercial technologies is on the mark both fiscally and operationally. An example of that marriage can be found in the Navy's UFO program. It embodies very straightforward functional specifications, is built with almost totally commercial technologies and commercial specs, and employs a simple build and launch contract. For less than $200 million per satellite, the nation will get nine satellites on orbit, and the contractor has a commercial bus that is rapidly becoming the world standard for communications satellites. The point of this one program is that there is a great deal more common ground between the military and commercial user than we have generally exploited. If military satellites are to be affordable, I believe this model must become commonplace.

Speaking more immediately to the Fleet, it is a fact that of all the DOD systems on orbit today, many may have Navy roots, but few are acquired by or flown by sailors. We are not any longer small players on the space field — we are downright tiny. I'm not here to bemoan our status. In stating our warfighting needs, we will hold fast to our belief that it takes a sailor to articulate the needs of another sailor, or as my deputy says, "The man in the crow's nest must understand the sea." The Air Force is on record as wanting to become the sole agent for the U.S. military in space. We remain opposed to that notion — not on parochial grounds, but of the belief that life and war at sea are too foreign to be fully appreciated except by those who go there. We insist that to cede our core mission of training the Fleet and being their spokesman is to put at some risk the Fleet's ability to wage war as well as peace, with ultimate efficiency. Accordingly, when we argue for DDL on ALARM, its because the Fleet has told us they need the data direct to the shooter. When we argue for Polar EHF, it is because we have forces in the polar regions that are dangerously comm-deficient without it. When we build GFO, it is not so we can be a one satellite Navy, it is because our vast ocean topography needs are not being otherwise satisfied. When we stand up for MILSTAR, it is because we don't have the terrestrial options available to garrisoned forces.

Well, I've talked long enough. Let me wrap up here with a reminder of what it is that we are about. In the Navy's policy white paper "From the Sea," the Navy and Marine Corps have joined hands as the enabling forces that will kick open the door and form the beachhead permitting the entry and support of follow-on forces ashore. We think of this as operational maneuver warfare from the sea — in keeping with the practices of victorious navies over centuries. To succeed in that duty, we must have highly skilled and intensely motivated sailors and Marines deployed to far-flung regions on the sea. For them to fight and win, they must enjoy abundant, tactically relevant, and timely space support. To send them in harm's way with less is not only an abrogation of our responsibilities to those brave young men and women, it is to put at risk the principles they defend. I speak for my entire command when I say that we look forward to working with you to ensure we never fall short of fulfilling our sacred obligations. God bless you and thank you for having me.

The Air Force is on record as wanting to become the sole agent for the U.S. military in space. We remain opposed to that notion — not on parochial grounds, but of the belief that life and war at sea are too foreign to be fully appreciated except by those who go there.

GENERAL HORNER: Our next speaker will claim that the Army is the biggest user of space. I first met Don Lionetti when he was the Commander of the Army Space Command. Previous to that he'd had an important role in the acquisition of the Ballistic Missile Defense System, and it was a natural merge to bring the Army Space Command under his purview. I think it sends the right signal that the Army is deeply interested in space and it's support of the soldier, but more than that it brought a man of tremendous intellect and tremendous

courage to our business. I welcomed him because he's truly at heart a war fighter, but more than that he's a thoughtful and a spirited leader. I must say, just before he comes up here, that I find a personal appreciation for having Don Lionetti — his height and his obviously overblown figure make me fondly remember Schwartzkopf. Don Lionetti...

We all breathed a great sigh of relief when the Cold War ended and we experienced a short period of euphoria followed by the realization that, with the demise of our former antagonist, we still faced the threat of conflict on a number of smaller fronts.

L/GENERAL LIONETTI: I'm really delighted, sir, to be back a year later to speak at the National Space Symposium. As you may recall, last year my remarks focused upon some of the points made by the CINC, the essentiality of the delivery of tailored, smart space applications to support war fighters. Today I have chosen to limit my subject much more narrowly and speak about missile defense . . . to take you a bit afield from where we've been thus far during the preceding presentations.

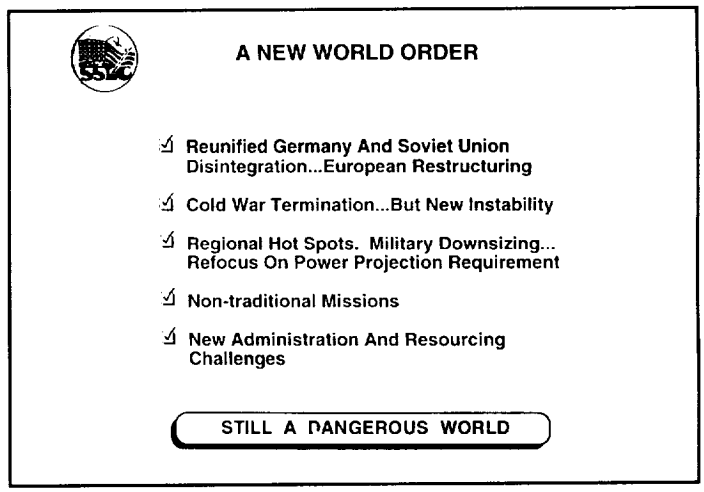
Let me start with a slide that just about everybody has seen in one form or another since the end of the Cold War (Fig. MIL-1). Sure the world has changed. It remains in a state of flux, this has both good and bad sides to it. We all breathed a great sigh of relief when the Cold War ended and we experienced a short period of euphoria followed by the realization that, with the demise of our former antagonist, we still faced the threat of conflict on a number of smaller fronts. Regional hot spots have blazed since 1989 — Iraq, Somalia, Bosnia, North Korea — all of them have flared up and have presented unique and sometimes unconventional situations for our armed forces.

We can no longer count on a narrow range of uses for the military option. As an arm of national policy, our military will continue to be called upon to overcome the challenges of conventional, unconventional and even undreamed of situations in the future. When you add all this activity to the current resourcing environment that we find ourselves in, we come face to face with the challenge: how do we do more with less and do it better, and do it consistently. Of course the United States soldier, sailor, airman and marine certainly is where our greatest investment goes and must go, but advances in technology will give solutions to age-old problems that we continue to encounter on the battlefield.

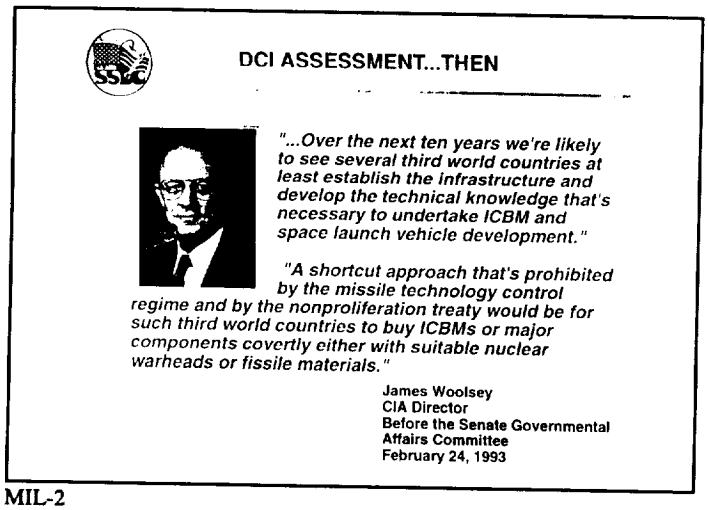
No matter what we do, there are still going to be grave dangers out there. Maybe they're less concentrated than during the Cold War period, less powerful than our former enemy the Soviet Union, but these forces (in the Third World particularly) could soon possess weaponry to demand an equal seat at the table with the rest of the nations included in the nuclear club.

The former Secretary of Defense, I think, did a good job of defining principle dangers for us and our current leader in the Department of Defense expressed very well during his confirmation hearings last February, in the fact that both old and new threats pose dangers to peace and security. As a soldier, perhaps I can determine the immediate threat on the battlefield, but for a more complex look at the world and a prediction for where we go in the future, you really have to look for broader intelligence means. So I turn to Admiral Studeman's boss and take a look at what the DCI said during his confirmation hearings about the threat to both the United States and to forces deployed abroad. This particular quote (Fig. MIL-2) really talks about the threat to the U.S. and the fact that over a recognizable period of time we're going to see the Third World develop the capability to deliver a weapon of mass destruction into the United States. It could perhaps even come sooner if the missile technology regime were avoided and weapons were sold directly to those nations.

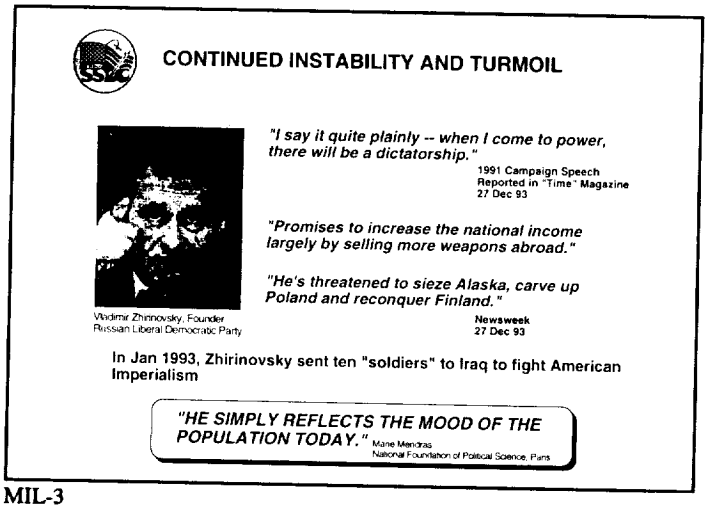
Since that time, and as recently as March of this year, the Director's estimate sharpened around the edges a bit and he warned of the combination of declining morale in the Russian military and increased organized crime efforts by states such as Iran to purchase nuclear material or the brain power to build their own. He specifically warned of North Korean threats. And, of



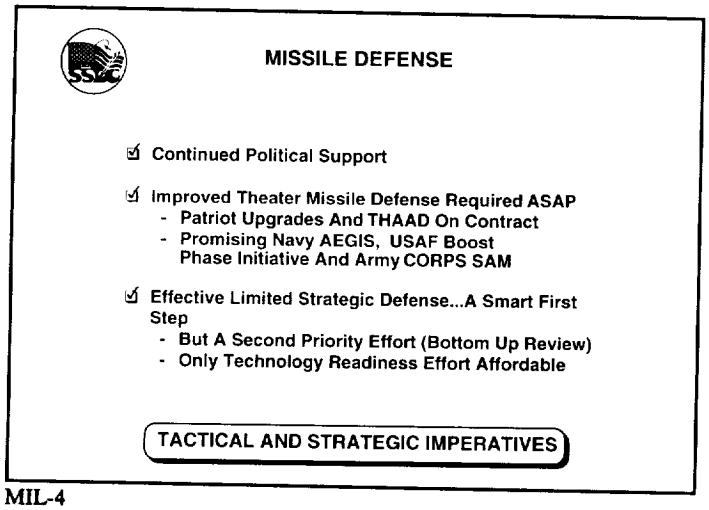
MIL-1



MIL-2



MIL-3



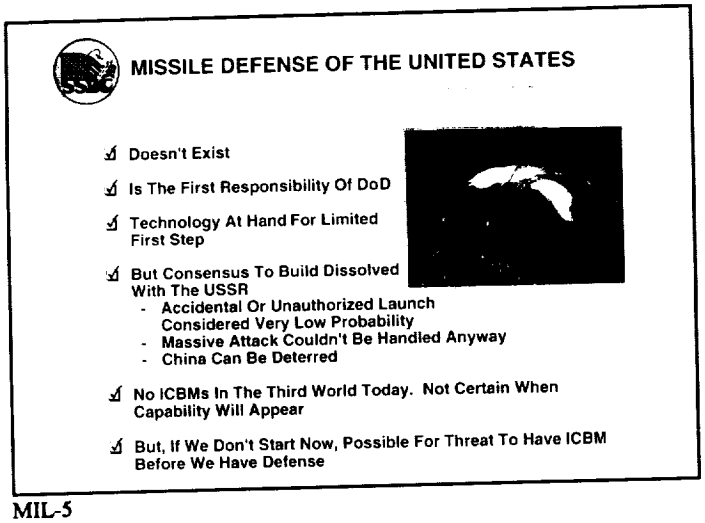
MIL-4

course, very recently he announced the North Koreans have developed a missile capability capable of delivering weapons at more than 1,000 kilometers range. If these should be sold to their traditional customers in the Middle East — Israel, Turkey, Saudi Arabia — all could be threatened.

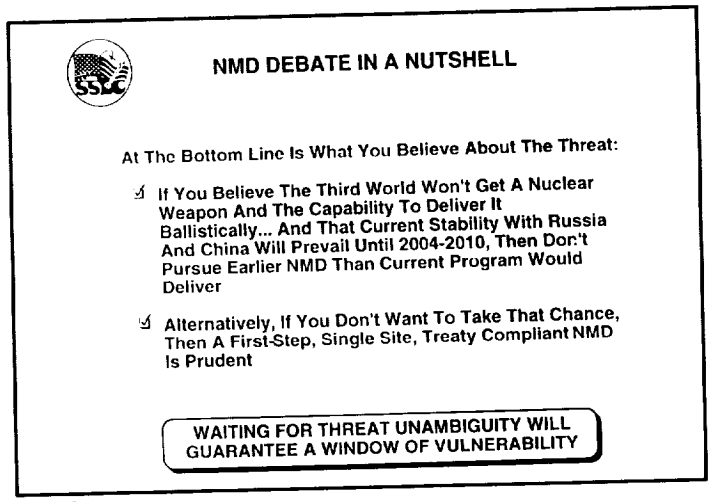
In Russia as well we see continuing instability and turmoil characterized by the sentiments and the actions of one of my real heroes, Vladimir Zhirinovsky (Fig. MIL-3). He has become the Rush Limbaugh of Russia, but at least Rush only has a radio talk show. This character is the leader of his party. I think he's not very misinterpretable in terms of what he says. It reminds me of the story of supersex, where you really have to listen very carefully or you're going to miss the point. The story goes that two brothers decided that their 75 year old father needed to be perked up a bit; after all, mom's been gone for five years now. So for his birthday, they decided to get some female companionship and hired a professional lady to provide supersex. A gorgeous 30-year old blond knocked at the 75 year old's door on his birthday and when he opened it she said, "Hi. I'm here to provide you supersex." The man thought about that and said, "I think I'll take the soup."

In the missile defense world we're doing reasonably well, particularly in the theater missile defense arena. This slide summarizes missile defense for you (Fig. MIL-4). Theater missile defenses are our first priority as established by the Bottom Up Review and by Secretaries Aspin and Perry. These defenses enjoy first position. We have upgrades coming called Patriot PAC Three; we just selected the missile that will support that built by Loral called ERINT. Theater high altitude area defense is on contract. Navy Lower Tier is going gangbusters. And then there is an amorphous, but large, food fight out there for the rest of the pieces of theater missile defense involving boost phase intercept, CORSAM and Navy Upper Tier. That is being dialogued even as one speaks in the halls of the Pentagon these days. But at least there's emphasis there, there's focus, there are people working it. It's happening and we're going to get some solutions and we're going to deliver them to soldiers in pretty reasonable time.

I am not so sanguine that in the strategic sense, in that other theater called the United States if you will, that we're doing as well. I have been an advocate for effective limited strategic defense as a smart first step, and now we're pursuing that in a second priority system off the Bottom Up Review in what's called a technology readiness program. This is a little worrisome, so let me spend a few minutes talking to you about national missile defense, defense of the United States, and summarize it for you on the slide on the right screen (Fig. MIL-5). First, it isn't there — it doesn't exist. General Horner has stated many times in the past that, of all



MIL-5



MIL-6

those tourists who come through Cheyenne Mountain and are impressed with our wonderful ability to detect launches from anywhere in the world, 70% are flabbergasted to learn that we have absolutely nothing we can do about it once those missiles are launched other than to warn people to duck. I don't think this story is well understood throughout the United States, and I think it should be because it represents, in my judgment, a critical need. Especially when one considers the threat that we just talked about, the uncertainty of it, the lack of knowledge when Country X will get capability Y and the fact that you don't just develop national missile defenses overnight. It's the principle responsibility of the Department of Defense, certainly, to defend the nation. And technology is there to be able to take that smart step. But we lost consensus to build, (we had it for awhile with the Missile Defense Act of 1992), when the Soviet Union disintegrated. Some didn't believe it was really credible that there could be an accidental launch out of the former Soviet Union, many believe that China is deterable; and the Third World doesn't have the capability anyway so why do you have to hurry.

As the threat has developed in that manner, the decision makers really have a dilemma, and that is, do I put money on that in the near years or do I recognize that this permits me to delay the investment in the near years, take some amount of risk, and hopefully get to it later on. That's really where we are as a result of the decisions taken. Because we see no ICBMs in the Third World, we have decided instead to have a technology readiness program. My concern, my worry, is the last point on that slide. It says "but if we don't start now, it's possible for a threat to have an ICBM capability to threaten the United States before we have an ability to put forth a defense." The debate is shown in a nut shell in this slide (Fig. MIL-6).

It really depends on what you wish to believe about the Third World. Notwithstanding the Soviet Union and that something could happen there, but just looking at the Third World in and of itself, if you don't think they'll get a capability until the mid to far term then there's no need to rush. If you don't want to take that chance, I suggest that a first step, a single site treaty compliant system is prudent because, if you wait for threat unambiguity, I believe you're going to guarantee for yourself a window of vulnerability.

The consequence of making the wrong choice here, I suggest, is intolerable because if it ever came to pass that an irrational Third World leader had the means to launch a weapon of mass destruction into this nation, not only are we back into a nuclear blackmail kind of environment, not only must we be careful about what we would do preemptively, would we have the national will to preemptively take it out. Look at the debate raging right now about North Korea . . . and that does not include weapons that can reach the United States. Should we or shouldn't we? It would be very difficult to make a commitment to do some kind of preemptive

... of all those tourists who come through Cheyenne Mountain and are impressed with our wonderful ability to detect launches from anywhere in the world, 70% are flabbergasted to learn that we have absolutely nothing we can do about it once those missiles are launched other than to warn people to duck.

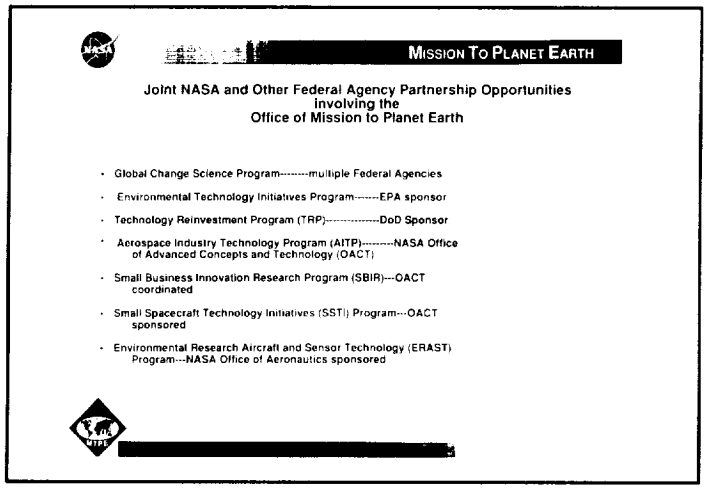
take-out ... and even if you did, one would have to be very careful not to miss.

Finally, and this last point is probably the most important one I will make today and that is that if we let ourselves get into that situation, our national strategy, one of holding military forces back into the continental United States and deploying them where necessary regionally to exert our national will or within our national interests, I believe we would be intimidated from such a deployment ... from extending ourselves in such a military strategy ... if the region to which we were deploying was covered by a Third World crazy who had the means of putting one into the United States and who was not able to be deterred conventionally. Intolerable.

Having said that, what are we doing about national missile defense? Here's a summary of the program strategy out of the BMDO. We're to build a program that's responsive to an evolving threat but it's not an acquisition commitment. And it needs to be responsive to Congressional guidance. We've got all those ticks up there on Congressional guidance: operationally effective, put priority money on the technical challenges, keep the option to deploy, reduce lead times, and do not develop, test or deploy a system in violation of the ABM Treaty. Notwithstanding what my boss said, because I agree with him 100%, I'm talking pragmatically that whether you like it or you don't, the Treaty is there. This Administration has stated a commitment to abide by the Treaty so it seems to me we need to do what we can do, do what is permitted within the construct of our Congressional guidance, or we might end up getting nothing and the nation will continue for another 10-20-30 years without any effective defense against ballistic missiles.

I believe we would be intimidated from such a deployment ... from extending ourselves in such a military strategy ... if the region to which we were deploying was covered by a Third World crazy who had the means of putting one into the United States and who was not able to be deterred conventionally.

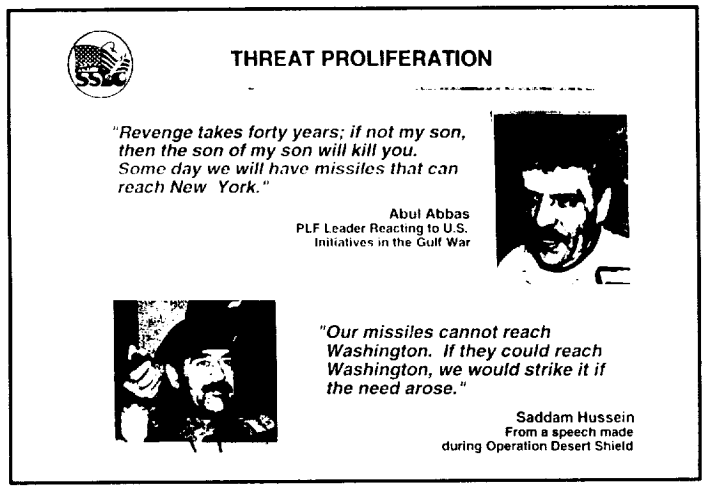
Technology is very important. A technology readiness program, in my words, is shown on this slide (Fig. MIL-7). It just says that if we ever do anything, the first effort really is going to be very modest. It probably means sending brass board equipment and maybe even some contractor support out with it. The BMC³ associated with it is probably going to be the command and control, the computers and the intelligence systems that would be used for the technical demonstration. Therefore, I say that whatever you're going to do in demonstration must be designed at the outset to be used for operational purposes and that whenever you do a demo, you ought to make it as realistic as possible, perhaps even using the ARSPACE tactical operations center to launch the missile from Kwajalein Atoll. Could that be done? Of course. We do off-set shooting all the time. I'm talking about off-set of a hemisphere . . . but it certainly could be done. Such training, such an operational development, where the user community would be embedded and closely wedded to the developer community, would perhaps be able to cut time line down and produce for us at least the first step NMD system as soon as it is possible to do.



MIL-7

In this era of budget constraint, it's very easy to rip apart the technology base. This is the only commercial I'll put up (Fig. MIL-8). It just says you need to be very careful about taking money away from our investments and technology for the future. It was these investments that got us what we have today. If we're not careful in this budget environment, we'll find ourselves eating seed corn that will therefore not be available to us in the future. And while seed corn is nutritious and tastes good, it can only be eaten once. I'm not saying that you want to have rampant technology. I am saying that the technology must be focused on what our mainline programs ought to be in this tight resource environment, but, nevertheless, we do need to maintain interest in and funding for a technology base that makes sense to support missile defense in the future that surely we will need.

MIL-8



MIL-9

As I close, I'll leave you with some final threat thoughts that reiterate what I've been saying all along. That is, in my judgment, the most worrisome part of the ballistic missile threat yet to emerge but inevitable, is that threat which will put the means to deliver ballistic missiles in the hands of Third World crazies such as the ones you see here (Fig. MIL-9). You can find scores of quotations for guys like that, and what, of course, we have to prevent at all costs is that lighting up of the sky over Pittsburgh or Chicago or New York or some other city in the United States.

That is my missile defense story for you today. Thank you very much for inviting me.

GENERAL HORNER: That was a powerful presentation Don, as always. The next speaker was presented to me when I was looking for an operator for Air Force Space Command. Billy Bowles, in his inevitable way of selling, said "We have this wonderful individual." I said, "What's his background?" And they said, "he's an arms control expert." And I said, "That's interesting. Who else do you have?" He kept coming back to this individual, not because of his previous assignment with ACTA where he lived in Russia and counted warheads, but because of his tremendous potential to serve the Air Force and the nation.

Bob Parker came out to Colorado Springs. I didn't know him from Adam's house cat. Believe me, he received extreme scrutiny. He has passed every test with more than flying colors. In fact, I find myself scrambling to keep up with him. One of the most important tasks he took on, in addition as the DO for Air Force Space Command, was as the interim commander for the Air Force Space Warfare Center where he gave them guidance and impetuousness. If you haven't visited the Space Warfare Center, if at all possible you should do so either while you're here on this trip or some other trip. What they are doing out there is truly marvelous.

So I can tell you that Bob Parker's future in the Air Force is brighter than ever. He has the diplomacy, he has the intellect to serve at the highest councils of our government, but more than that, he has the drive and the savvy to be a great leader at the operational level. Bob, here's your chance.

M/GENERAL PARKER: Good morning, I appreciate that introduction. As General Horner mentioned, when I arrived here he gave me a challenge — I'm not sure if I ever fulfilled it. He said, "I want you to set up a think tank on space warfare and we're going to man it with fighter pilots." Now there's a challenge.

Space Warfare Center: I was the interim commander for a few months, and I have to admit this is probably the single biggest initiative Air Force Space Command is going to take on for this decade. There's a lot of need to get space out of space and apply it to war fighting. I think that's probably where the Command was remiss for several years. We're very good at launching and controlling satellites, but not good at the integration of what satellites did or could do for the war fighter. So we set up the Space Warfare Center.

As you know, in all good briefings, I have to tell you what I'm going to tell you, tell you, then I'll recap and tell you what I just told you. So these are things that I'm going to cover quickly, and if you notice that all things coming from the satellite come to the user whether it's the guy in the foxhole, seamen or the guy in the cockpit.

Probably two things really created the Space Warfare Center. One was the lessons learned, and we heard

about the first space war and Desert Storm, etc. As the war started generating, we realized our dependency on space. Do we have adequate communications to talk to people half-way around the world. We were limited on warning for scud attacks. We had limited capabilities in some areas, we had excellent capabilities in others. For example, GPS may have come into its own during Desert Storm because we knew exactly where in the desert soldiers and jeeps were. I was in the cockpit with outstanding navigation. The weather was an absolutely essential factor, as were the weather satellites. The Hail Mary as mentioned earlier, might not have come off as well if we hadn't had good weather forecasts, not only for the target areas but also for the soil composition and moisture. Desert Storm was probably the driving force for setting up the Air Force Space Warfare Center, followed by the Blue Ribbon Committee headed by General Moorman. The committee came up with a very obvious solution. We were very good at the acquisition and the operating of our satellites, but we weren't doing an adequate job of protecting and supporting the war fighter. And that's really why we created the Warfare Center.

With that capability, we don't actually go out and deploy forces to fight, but we have to make sure that our capabilities are there when the war fighter wants them. So it's a combat operation to exploit and control space. The Warfare Center wants to work at not only controlling space, but exploiting the capabilities we have there now, and just as important, exploiting the future capabilities.

What do we do at the Space Warfare Center? There are four major functions. Space applications: what we want to do is exploit the capabilities we have, whether it's in warning or navigation communications, and get that capability to the guy in the cockpit or someone on the ground, whoever needs it communications wise, so the war fighter can execute his war plans. We want to support space in the war fighter's operational plans. You send teams out to the theaters, to the component commands, we send out Air Force teams in conjunction with Unified Command, to make sure they have the expertise in theater. It's an educational process, which is our third goal. We want to educate through our PME programs to make sure that the young officer and airman understand and can use space as a normal process when he's planning operations. And finally, because we're out at the National Test Facility, we have an outstanding capability to do war planning, operations analysis and modeling simulation.

We're very good at launching and controlling satellites, but not good at the integration of what satellites did or could do for the war fighter. So we set up the Space Warfare Center.

We're not a large organization. Manning is going to be about 150 people and we're at almost 100 right now. It isn't just fighter pilots. We have communications, a large intelligence staff, space people who are experts in the operations of satellites, electronic warfare officers — we tried to meld a cross section of the people and the expertise we have. They're familiar with operations in the theater, they're familiar with space operations and intelligence. Together we come up with a team that will exploit our space in the future. Very modest budget, a little over $30M; but this has been a rather large growth, if you look at the history of the programs from a few million dollars just a couple years ago and probably 20 people to $30M and 150 people.

By being co-located out at Falcon at the National Test Facility, we can take advantage of the inherent connectivity that the National Test Facility has. We have with the national communities, the other services, an extensive architect with the academic communities both in communications and sources that we can use the building, the computers and the modeling capability that's already there. So that was a very logical place to put the war fighting exploitation we wanted to create at the Warfare Center.

The heart and soul of the Warfare Center is our TENCAP program, our exploitation of national capabilities if you would. We look at commands and the shooters — how do you get real time intelligence into the cockpit? How do you get warning to the people in the theater? We look, and this is something we were careful of from the start, at requirements that a component has come up with, whether it's for communications, warning or navigation, and we come up with a prototype and we try to accelerate, or compress, the acquisition cycle. We develop prototypes, we demonstrate them; if they're successful to the users (and we're not the users, we just come up with the ideas), we turn it over to the acquisition cycle and it's deployed as a weapons system.

Two of the success stories, and I'll just quickly go over them (I have a short tape on a couple of others). One is our TALON SHIELD, which takes the current capability of our DSP system, which was designed basically for North American attack, and we structure it through communications nodes and relays to look at a

theater-type response. TALON SHIELD is being prototyped and it is actually being tested as I speak right now, but it is an interim device or system to provide theater warning for scud-type attacks until we come up with a follow-on system that will give us the reliable system we want for the theater commanders. So if there is an attack, we have the near real time warning for the theaters. TALON SHIELD has been exercised several times, continues with prototype testing. We will have it available over the next several months. What we're doing is actually working world-wide global coverage from Falcon Air Force Base until the system comes operational.

TALON HOOK is probably one of our earliest success stories. What we took is basically the GPS satellite, and an air crew member rescue radio and put a very small GPS adapter on it. What we wanted to do was avoid what happened in Viet Nam by the hundreds, and even by the tens that happened in Desert Storm, where an air crew member is shot down and he's not sure exactly where he is and of course, the search and rescue teams can't go over to find him. By using his crew radio, instead of transmitting by UHF voice (which we normally did), we send a microburst to the satellite. The satellite will tell the crew member exactly his location within a few meters. It will also have the capability of using communications relays to go back to a rescue center and tell them exactly where the airman is. Over time, we hope to have two-way comm so if he's in a bad location and can't be picked up, we'll tell the crew member where to go.

The accuracy has been tested, and again this is a prototype, to within actually the diameter of the rotary blades of the helicopter that went into the jungle and picked up two of our guys in the test we ran. As General Horner likes to say, we're taking the "search" out of search and rescue by exploiting space capability to a real time requirement.

Would you please run the short tape now? What you're going to see is a short demonstration of TALON HOOK and also TALON SWORD, which again takes national capabilities and actually puts this intelligence into the cockpit where the pilot can actually see the release of weapons.

TAPE: "This small device, a little bigger than a child's walkie-talkie can bring rescuers to within a few yards of the flyer. This kind of accuracy means searchers don't have to loiter over hostile territory and can get the pilot to safety much sooner. The unit is a normal emergency radio married to a global positioning system transmitter. It sends a coded signal of the location by satellite to the Joint Recovery Coordination Center in-theater, or to airborne warning and control aircraft. Air Force Space Command is developing the GPS 112 radio, known as TALON HOOK, and says it could be ready to use as early as June. Air Combat Command and Air Mobility Command could both put TALON HOOK to good use. "I would suspect ACC is now looking to an interim solution to the CSEL program (combat survival evader locator). Until CSEL comes on line, they may use something like this. AMC will probably get something similar to this to do their tracking of some of their aircraft." Field tests indicate that TALON HOOK works as planned, and that aviators are excited about it. Just a short time ago, finding and rescuing a downed crew member was sort of a crap shoot. Now, with a small radio like this, the odds are in favor of the air crew. (MSgt Phil Woodney, Air Force News).

The TALON SWORD BRAVO demonstrations focus in on the process by which information is transmitted to the war fighter. It's objective: to demonstrate enhanced combat capability by delivering multi-source tactical information over an advanced communications architecture. In 1994, a series of demonstrations will showcase emerging technologies which will be at the center of tomorrow's battlefield. This will include Joint STARS, the joint surveillance target attack radar system. A valuable asset during Desert Storm, Joint STARS passed important tactical data to the command element in Rhyiad. The BRAVO demonstrations will use Joint STARS to disseminate tactical information directly to the war fighter. An emerging communications technology will be used to achieve this. Asynchronous transfer mode, or ATM, is a commercially driven effort frequently referred to as the backbone of the communications super highway. A vision for ATM links independent defense force elements in a global grid of strategic and tactical networks, providing multipoint connectivity in a timely manner regardless of data type.

In preparation of the BRAVO activity scheduled this year, a rehearsal of the system architecture was held in December of 1993. The directive of this rehearsal was to pass military operational information in the ATM format from a national intelligence source to operational users at two geographically separated locations. Target descriptive data and imagery were transmitted via satellite from the Naval Research Laboratory in Washington, DC, to the Grumman Advanced Laboratory in Melbourne, Florida, and to the Advanced Flight Technology Integrated (or AFTI) F-16 flying over Edwards Air Force Base, California.

The rehearsal was a complete success. Imagery and data were passed from a national intelligence source to

military users in a process that took only seconds to complete. ATM proves to be a scalable and effective format to transfer operational information. Other tests in 1994 will provide a dynamic environment for the TALON SWORD team to test the BRAVO architecture. The entire TALON SWORD team is dedicated to aggressively improving the process by which information is transmitted to the war fighter, making these concepts into reality and guaranteeing our fighting edge." (End of tape.)

M/GENERAL PARKER: The TALON SWORD demonstration, the F-16 punched off a harm long before the radar hidden behind a hill ever saw the aircraft and long before the aircraft acquired the radar. The actual shot, the first one, the harm entry, came right across the antenna. The second was actually a little too accurate, it hit the antenna van. So it's again, a prototype and if you notice that we developed it for the user, in this case Air Combat Command, but there are many other users including the Navy and the Army.

The objectives of the Space Warfare Center are very modest. We wanted to stand it up, we wanted to have some programs that were fruitful, we wanted to demonstrate the capability. In the long range, we want to start working closer with the other services under TENCAP programs, developed with the National Test Facility, the modeling simulation analysis capability, and influence new space systems with the goal of supporting the war fighter.

... we've only begun to scratch the surface at how we can best take space assets and transform them into a true operational capability that supports the war fighter directly.

As you saw from the TALON SWORD model, the Warfare Center is very simple. They really believe, even though they're not the war fighters, they're there to support them. Thank you very much.

GENERAL HORNER: Dick Scofield has been one of the heroes of the acquisition world. He's been successful where others have failed, he's been tough, but he's been right minded. He's been nominated to go out to the Space & Missile Center in Los Angeles, which is the key acquisition arm for the Air Force space programs. I applaud that. His predecessor, Ed Berry, was a hero in my estimation. He was doing so much as we separate the responsibilities of acquisition and the operator in space. This is a new and important role, that we define these responsibilities. In the past, by our very youth and our very nature, they've been blurred. I can tell you that his successes in acquisition are unique because, being in the acquisition business is being in the business of failure or criticism. Dick, you honor us by being here. We're looking to you to revolutionize our acquisition business — I know you can do it. Thank you.

L/GENERAL (SEL.) SCOFIELD: Thank you very much General Horner. It's indeed a pleasure and honor to be here at the National Space Symposium, though I have to admit it's a bit of a daunting task to come in as kind of a new guy on the block. Some of you are probably wondering, "who is this guy and where did he come from?" I've been working aircraft acquisition for the last 20 years, and I'm looking forward now to my career broadening opportunity in the space world. You shouldn't, however, put too much significance in my last three jobs — the F-117 program director, the B-2 program director and the PEO. The fact that I ended up setting new records in short production runs in the fighter and bomber class aircraft shouldn't bother you. Or the fact that I was able to take eight programs down to four as a PEO in two short years shouldn't unsettle you at all either. The good news is, I have some experience in downsizing and consolidation. If you have an on-going program, however, you may not want to stand too close to me at the break.

I appreciate the invitation, although I can't say I can speak with any authority on national space security issues at this point in time. I truly don't know enough about the business at this juncture. I've had about four months to introduce myself to the space community and for you to introduce yourselves to me. I've been around to see some of you and I've spent some time with a good part of the blue suit community in trying to find out what their thoughts are and what the business is all about.

I have to tell you up front that I do see an awful lot of similarities to the aircraft acquisition business, and I guess I'd like to offer you some initial impressions based on what I have seen so far.

It seems to me our responsibility as an acquisition and a sustainer, our greatest challenge at this point in time, is to put together some sound acquisition strategies

that will put more responsive support out into the war fighter's hands through Space Command and the other support commands that provide that capability. This has only come about in the last few years, and we've only begun to scratch the surface at how we can best take space assets and transform them into a true operational capability that supports the war fighter directly. And the more directly, the better, as you've heard many times this morning.

I think unfortunately, you within the space community have been saddled with having to live with an evolutionary approach to providing new capabilities or stretch the performance of existing capabilities to carry bigger, heavier and certainly more capable payloads. However, when the evolutionary process is stretched to the fullest as it has been in the space business, it doesn't end up with a very efficient or effective way of providing the operational capability, nor is it a very efficient or effective way of conducting our business. So I think our challenge is, how do we go about changing that model?

I wouldn't want to say it's been a lose-lose situation. There have been a number of significant accomplishments by you, the space community, over the last 20-30 years. We can't overlook those, but I don't think any of us would say it's been a win-win situation up to this point in time.

There have been some significant strides made in the Air Force over the last few years. You saw one of them in General Parker's briefing with the establishment of the Space Warfare Center. A great stride in terms of putting some discipline into the process on how we define requirements, how we shake out the early technology issues, how we prototype and establish the mechanisms and the tactics in the way in which the systems will be used. All of this goes to making for a much sounder design approach and a shortening of the time lines in being able to field the capability.

Another area is mission area plans, which General Parker's group is working very hard in trying to establish road maps for the various areas in missile defense and space operations. We've had fighter road maps in the Air Force for numbers of years, and they've helped us to be able to phase in capabilities as the technology matures and allows.

Down at SMC, working with Space Command, we've created a Space Applications Project Office where the activity that comes out of the Space Warfare Center can now start to transition the technology, with the laboratories and the acquisition community so we can work simultaneously with the users in wringing out the early problems of the various systems. Within AFMC we have structured Technical Plan Integrated Project Teams and have established a technical planning process whereby we can start to think about how do we best focus and start to manage our technology efforts so they truly are aimed at payoffs in operational systems. There are very few in this room that don't realize that a lot of our past technology work has been done for technology sake. We cannot afford that anymore. We must aim our technology efforts at operational applications. And through that process, working with Space Command, Phillips Lab, the SPO's and the XR at SMC, I think we have a good start in bringing formality to that process.

The result will be a much more structured approach to technology initiatives, phasing into high leverage operational capability. I offer you a brief comparison: on the F-117 program we were less than three years from start of program to first flight, 27 months from first flight to IOC. When you take a hard look at the F-117, the only real technology in that was the fuselage. There was very much outside of the fuselage that was not new technology, but it was a good use of taking proven technology and incorporating it into a new advanced capability.

On the other hand, the first 31 months of the B-2 program was risk reduction in the areas where we did not have full understanding of all the things that would have to come to pass if we were going to make the B-2 truly effective. As it turned out, what we learned in those first 31 months caused us to essentially redesign the airplane. That set us back a series of years and look what happened: the Cold War passed us by and there we were with only 20 airplanes and no way to justify more. So we need that up front planning, that up front requirements definition, technology maturity and then move on into the programs themselves.

Now we intend to share our technology process with you, the contractor community. We want your inputs. We want to be able to do the technology initiatives in our lab where we have capability, but we also want you to spend your money wisely in technology areas, either through your IR&D or through direct application within your companies. We need to lash up pretty tightly between the Air Force, services, and the contractor community to make sure we're spending all of our limited research dollars on the high leverage items as best we can.

Don't take any of this to mean that this is specific only to the space community. Because of the budget pressures and downsizing, we've done much of these same activities within the aircraft and the electronics side of the acquisition process. We now must take a much harder look at what I see as the tougher side of the equation, and that is the mindset that exists within

the space business.

I think that mindset exists, because of the evolutionary approach you folks have had to deal with, is, in my opinion, the major hurdle we'll have to overcome if we're going to transition into a truly operational concept in working with Space Command and providing the capabilities. We've all grown up in the R&D test environment. It's a nice, comfortable environment if you want to get things done at your schedule and make sure there are zero failures.

I'm not saying that in the negative sense. I recognize that you all were asked to push the envelope on the margin. That's a very difficult thing to do. You need to be careful when you do that, particularly when it involves the size of the dollars involved in each of our launches and the capabilities we stick on the top of the launch systems we use. It probably was the right approach for the time, but I think the time has come where we need to proactively start to work on changing the mindset of how we go about doing our business. We really need to step back, because we can't afford not to, and look at a new way of doing business.

National security considerations dictate that our systems are, in fact, responsive to the war fighter's need, and that responsiveness can best be stated in the form of availability which then translates into reliability.

I truly believe that we within the space business are at a juncture providing a window of opportunity, especially when you look at all the interrelated factors, with all the balls that seem to be up in the air at the same time today in the space world.

There is no doubt that the trends on satellite life are in the right direction, but the dilemma then becomes, what is our replenishment strategy and how do we go about establishing that strategy. Given the fact that lead time on orbit is still a fairly long period of time, I'm not sure we can afford or have the wherewithal to reduce that significantly in order to be truly responsive.

This then drives us to think about a new architecture, one where we have overlapping and perhaps even some backup capabilities within the total systems architecture to begin to provide the support the user can depend on day in and day out. There has already been some very credible work done in this area and the folks at SMC are working very hard with Space Command to try to define the best architecture and the most cost effective way.

I must say it's a little troublesome that this architecture is beginning to take on the title of "the system of systems." When you start defining things in terms of systems of systems, it starts to take on a very large shape and starts to become the wherewithal to satisfy everybody all the time. I think we need to transition in incremental steps, and we need to make everybody's expectations fit the realities of what we think we can produce. The key to success in this area will be the elimination of stove pipes, stove pipes that have been inherent because of the evolutionary past.

This integrated architecture certainly has the potential to meet our war fighter's needs, but it will demand a new level of cooperation and team work between the services and the contractor community. Based on our past practices and because of the amount of involvement by the contractor teams in the various launch and satellite operations across the services, you are a much closer partner in the day to day operations than we would see in the aircraft business. You are a part of the operational team, whether you know it or not. Circumstances would indicate today that this model probably will have to continue. That means that you, the contractor teams, will now have to start to think like operators and think more operationally.

It would seem to fall that these process improvements will effectively increase the efficiency in supporting the defense programs and, by virtue of being able to do that, have the potential to improve commercial operations as well. This then can only lead us down the path to better international competitive positions. If we become more efficient in the way we use our launch capacity and capability at both the Cape and at Vandenberg, there's no reason that this collective ability would then allow us to schedule and make commitments for commercial launches long lead time away. This potential synergy is so great that we should want to go back and critically examine the assumptions and the planning factors we have used in the way we have structured the business in the past, some of which was done for logical reasons but some of which may not be so logical.

I found out when I got here the other day that the theme for this session was "Windows of Opportunity." I truly believe that we within the space business are at a juncture providing a window of opportunity, especially when you look at all the interrelated factors, with all the balls that seem to be up in the air at the same time today in the space world. We now have a group of people who understand the value of space-based capability to the success of military operations. At the same

time, within the services we understand the value of a strong requirements process, road maps, focus technology applications and integrated strategies. There are influential people on the Hill who appear to be ready to commit to a longterm strategy; provided we can show them a good game plan that does, in fact, achieve a cost effective approach to the issues.

There are also a number of new programs, or capabilities within new programs, that are about to be kicked off, either with the releases of RFPs and/or contract awards over the next two or three years: ALARM, Brilliant Eyes, GPS IIF, DMSP, and several communications programs. It seems we have now an opportunity to start to build an integrated strategy across all these systems where we can structure ground based systems that would apply to all applications and start to evolve into a structured architecture that will allow us to take benefits across the programs. That's going to require us to break down those programmatic stove pipes, however, and to establish new working relationships across the whole contractor-service team.

All of these programs have launches scheduled about the same time between 2002 and 2006.

There is a projected growth in commercial applications which, in my mind, could do two things for us. Provide some additional base and rate, all of which could help to drive down the cost of both the military and commercial systems and at the same time provide some flexibility in the event that everything does not to come to maturity at the same time.

With the integrated strategy and a better definition of requirements comes the basis for making sound consolidation decisions in dealing with existing overcapacity. It's interesting that these new programs will come along at about the time we get the backlog out of the way in the '96 time frame. So there's an opportunity for some further synergy across the business.

I don't think anything I've said today is necessarily peculiar to the space community. We've done it, we've been through it on the aircraft acquisition side before. In some respects it's deja vu all over again, as Yogi would say. I'd point out that we only got the bomber road map two years ago, in spite of having had fighter road maps for many years. We had a thing in the aircraft business called a 1760 interface which was supposed to make everything standard between aircraft and weapons. It's only been in the last five or so years that we've been able to truly effect that in a design of weapons and aircraft and to make them synergistic. We have strengthened the requirements, technology, operational chain in the aircraft side over the last three or four years with the establishment of some of the processes to really nail down the true hard requirements and not to operate out on the corner of the envelope continuously.

The capacity within the aircraft industry has been addressed through shared programs and a consolidation within the aircraft industry itself. It didn't come quickly and it didn't come easily. It did, in fact, take a mindset change. It wasn't four or five years ago within the aircraft side of the house that we still had people who wanted to have 100% of the requirements met all the time. It took leadership on the part of General Welch and General McPeak to change that format. We can't afford every weapons system having it's own mission planning capability, it's own support system. We need to critically and quickly assess where we want to be ten years from now and start developing the integrated strategies that will get us there.

Thanks again for the opportunity to participate this morning. And I *really* am looking forward to getting out to Los Angeles and being able to work these issues with you and the rest of the space team. Thanks very much.

GENERAL HORNER: The U.S. Space Command job requires a general officer in the J2 position, the intelligence position, because of the importance of space in the area of intelligence and because of the service we provide all the regional warfighters around the world. It's one of the few general officer intelligence positions. When Owen Lenz retired, I was offered a series of people and I was very, very critical of them. Many of them had established reputations, were promoted to general, were available and, quite frankly, would have done a superb job. But, I felt it was important we truly get the right individual for this job. We needed someone who was balanced, who understood the needs of the warfighter, but more importantly also understood what goes on inside the beltway in Washington D.C. Because, obviously, one of the biggest problems we've had in our intelligence operations is breaking down that immense wall that's created by the beltway. I was blessed. There was a young man named Jim Beale available; he was not a general officer. I said, "What are his opportunities of getting promoted?" They said, "Well, the trouble is it's a very tight race this year. We have three individuals who are being nominated who'll be in the pack. Jim Beale is one of them. But, quite frankly, we're not sure he's going to get the nod and we only have one slot. So we can't guarantee anything." It's one of those risks you take in life is when you hire people you have to go with your gut instinct and I went with my gut instinct on Jim Beale. I can tell you he has per-

formed miracles. He first of all creates a favorable image of Space Command with the National Space Committee that maybe Chuck Horner doesn't always project, so if nothing else he sweeps up the broken glass that I create. But more importantly, he is thoughtful; he has insights that very few people in the Intelligence business have both in terms of their own discipline and the discipline of the warfighter. And, more than that, he's a wonderful, wonderful gentleman. I'm happy to note that despite severe lobbying by many Air Force four stars against Jim Beale in favor of their own candidates, the Board did it exactly right and he was selected for Brigadier General this last year. So Jim, come up here with your message.

B/GEN (SEL.) BEALE: I don't know exactly how to follow an introduction like that. Let me say, as I was sitting down there and General Scofield was speaking I was debating whether it was going to be better for me to come up after he finished, that would be the seventh speaker in a row and I think that's a little worse than right after lunch. The alternative was that everybody would go outside, they'd think about all the information they'd received from six other speakers and they'd be filled with questions ready to come back and go to panel discussion and say, "Why do I need to hear from someone else?" So with that challenge what I'll try to do is keep it short, touch on a few issues that I think are challenges for space intelligence and then we can move on to the questions and answers. But before I start I would like to say that it's a real pleasure for me to be here at this particular symposium put on by the U.S. Space Foundation because I've been familiar with the Space Foundation for some time. I first became associated with it when I was back in Washington working on the Space Council and working on issues like Space Station, Space Launch, LandSat, you know, some of the tough civil issues and our problem was: how do you explain to the American people that these programs are important? And the U.S. Space Foundation was right there to help. I particularly remember some radio and television spots that they put together that talked about *Space: What's in it for You?* Where they brought out to the American people that things like the moon boot is the origin of the tennis shoe that everybody wears nowadays. And all of the various small benefits that have filtered through our society as a result of space programs. So it's a particular pleasure for me to have the opportunity to publicly recognize Gen. Jim Hill, Dick MacLeod and all the folks who put on this Symposium because I think they've done a great job and it's just a continuing good organization.

Well, let me say that I appreciate Gen. Horner's introduction and probably the best thing that he did for me was drag me out of Washington and bring me out here to Colorado because I was driving over this morning and I was looking up at the mountains, snow, hot air balloon and I was thinking about the traffic jams in Washington and the frustrations of working issues that go on year after year. You go away for a decade and come back and work the same issue. So it's just a thrill to be out here. But when I think about the issues that you're working in Space Intelligence and the issues that you worked in particularly the civil space program, you know, there's really not that much difference in the budget pressures that Adm. Studeman talked about. It's sort of like a story I was told a couple days ago. It was about a lady in a poor country and she went into a store and she looked around and she wanted to buy groceries. And she said, "I see you have no vegetables." And the proprietor of the store looked at her and said, "Not true. This is a bread store; we have no bread. The store with no vegetables is across the street." So it's a little bit the same problem with the budget and I've got to tell you that having the intelligence job in 1993 and 1994 is different than it would have been in 1989. In 1989 it was simple — we had a Soviet Union. Today we have a number of Russian people in the audience here. Last night I wandered through the reception; I met with some of the Russians and they took me aside and they said, "Colonel I've got to show you this." And they showed me a videotape of the SU27 fighter and the new engine that it's got and how it performed in different climates. And I thought to myself, this is incredible. I'm an intelligence officer; here I am standing here in a Space Foundation meeting with the Russians and they're telling me, maybe trying to sell me a new generation, top of the line Russian fighter. I mean, this doesn't make very much sense. And I'd also like to reinforce what Admiral Studeman said. Five years ago it probably would have been incredible to think that two professional intelligence officers would get up and give talks to an audience like this in a totally unclassified forum. I mean, we just didn't do things like that in those days. But there's a lot of other things that have changed too.

And let me talk a little bit more substantively. I think five years ago the real warfighters didn't know much about space; they didn't care very much about space; it didn't really mean anything to them. As Gen. Horner said, they were sort of indifferent. Saddam Hussein probably did an even better job than the Space Foundation in educating at least one element of our society as

to their importance to space. You know we really learned it from the Desert Storm experience. Today the challenge is to two MRCs. How do we structure the military to respond to two MRCs and I think Space Command is right in the middle of that because Space Command has been transformed by Gen. Horner from being largely a missile warning command into being a command that's focused on supporting others, being a supporting command to the warfighter. So we've tried to focus that within intelligence; we've also been forced to deal with an issue that is very difficult. And that is the U.S. in the future is going to fight as part of alliances. And if we're fighting as part of alliances it means we've got to be able to share the information not only with our forces but the forces that are on our right flank or our left flank. So we've got security constraint issues that we've need to work ourselves through. And then the budget pressures have been really tough. Within Intelligence and I'd like to commend L/Gen Jim Clapper who's our Director of DIA and Director of the Military Intelligence because he's done a remarkable job in restructuring national intelligence within the budget pressures. So we've now consolidated almost all military intelligence into nine joint intelligence centers. And from a Space Command point of view and from a Colorado Springs point of view, that's been a positive step because we now are one of those nine centers. So we have very distinct responsibilities here that support not just us, not just Gen. Horner, but we have responsibility at the national community; we have a responsibility to all the other users of intelligence about space, missiles and certain kinds of warning information. A few years ago there would be three or four organizations working any important issue. It was the view that if a CINC needed information, he ought to turn to his intelligence staff. So if he was CINC Europe, and he wanted information about space, he turns to his intelligence staff and the intelligence staff tries to develop space information. And you end up with a lot of relatively thin depth of expertise across a lot of different subjects. We can't afford that anymore. Today we don't have three or four organizations looking at every important issue. Some say that we lost a lot by doing that because we don't have competitive analysis anymore, but we can't afford it. Competitive analysis is history. Nowadays, we have to rely on empowering one center, one place and say, "You're the expert on this; you go do the study on this. You produce the reports on this and then you support all of the others." And for Space Command, that means we have to support not only the CINC but all the other intelligence organizations in our areas of assigned responsibility.

Now, they said the world's changed and there isn't a Soviet Union and we're friends with the Russians and they're here today and, in fact, we're partners with them in space station and many other ways. We do still keep an eye on Russia. I'd be stretching the truth if I said we didn't, and I'm sure they do the same with us. After all they're probably the only nation in the world that can truly threaten our national survival and so we have to be a little wary. But as Former President Reagan said, "Trust, but verify." And I think we do that. But what I'd like to emphasize is that our focus is really changed. Today we have interdisciplinary teams that are looking across our analytic areas: things like missiles, space, command and control, other kinds of intelligence that we produce here. And we're packaging those products in ways that are focused on individual regional areas so we have a team of people that are worrying about the problems in CENTCOM. And we have a team of people that are worrying about what are the problems in Korea. And they're looking at all the kinds of intelligence that we produce, talking to all of different analysts to make sure that as we generate information we're generating in a form or format that's useful to CENTCOM or useful to Korea. CENTCOM needs to know how Iraq would use space, General Luck absolutely needs to know the same thing about North Korea.

We do still keep an eye on Russia. ... and I'm sure they do the same with us. After all they're probably the only nation in the world that can truly threaten our national survival and so we have to be a little wary.

Now, neither of those countries have indigenous space capabilities, but they do have access to a variety of commercial COMSATs, to a variety of sources of remote sensing data and so forth. Now, what we're trying to do is look at the "so what?" of that so it's not just a matter of saying yes they have access to something. What we're going to try to do is look at how they integrate that into their planning so that General Luck can really understand the threat that he's facing. They have other ways of communicating. They have other ways of gathering information. So the question really is: how does space fit it? And we're trying to help answer those kind of questions. We're trying to be proactive in tailoring and disseminating intelligence products. We produce hard copy reports in various forms: everything

from messages to glossy multi-page books with pictures in them and things like that. We produce videos; we make VCR tapes and send them out. We have video links that we can use. The Intelligence Community as it's consolidated has invested in better communications so we can actually interact, talk to the analysts. Or even give an on-line briefing to the operators in different regions to bring our special expertise to them. We put together outreach teams as part of the overall unified command outreach program so that we have at least one space intelligence officer who's dedicated to every major region. And these officers actually go out there. They go out time and again so they get to be known by those regional intelligence staffs.

They work to insure two things: one is to insure that the regional commanders and their staffs understand what products are available, and insure our own analysts know what the real needs for the people out in those regions. And they bring the information back so that we can provide the right information in the right format to the right people on time. And as space capabilities proliferate and missiles as well, I think the potential adversaries are going to adopt the strategies and doctrines to take better advantage of space. I think that's just going to increase the challenges for space intelligence here. So I think space intelligence is alive and well in Colorado Springs.

You know it's an interesting fact; I was looking at some statistics yesterday. Five years ago the former Soviet Union had about twice as many satellites on orbit as all the rest of the nations combined excluding the United States. Today if I use Russia for comparison, Russia and the rest of the world have about the same number of satellites on orbit. And if we look ahead to the year 2000 projections are always difficult, but our expectation is that we going to see substantially more rest of the world satellites, commercial satellites than we see Russian satellites in the future. Now the reason for that isn't because Russia or the U.S. are necessary doing less and maintaining few satellites on orbit. There's a little bit of that. But a lot of it that the rest of the world is getting into the space business. And so we're going to see space more and more common as the future comes.

But producing useful intelligence, which is what we're about, isn't the only challenge. As General Horner said, a key source of information essential to warfighters is really produced by intelligence satellites. So that's a challenge that we're trying to face as well. Years ago military field commanders had organic systems that they used to collect information and process information under their own control. And they understood those systems, they used them everyday. They felt responsible for them. At the same time, in the early days many of our overhead systems were aimed primarily at supporting national consumers — people that were involved in things from arms control to longer term planning. Today, many of the organic systems are gone; we're combining systems and trying to serve more people with what we have. The warfighters, therefore, become more reliant on national systems and that's an important element of where they're going in the future. So to take full advantage of these systems the warfighters really have to understand them; they need to understand them just as well as they understand an organic resource. And that's a challenge. And they've also got to have a significant voice in investment decisions so that the warfighter's really assured, that as we bring our new systems, the systems are truly responsive to their needs, their warfighting needs. Now, you know, everybody has good intentions in this and there's great progress being made. I came, as I mentioned, from the Space Council and I worked on a number of civil space programs. And it sort of reminds me of the international space station and the problems that we've have making an international Space Station really be international from the perspective of all the participants. And it's a challenge, it's a cultural challenge — something that we're all working on and I think we're making great progress. But it's something we need to kind of keep an eye on. I do think that there's progress being made and I think it's a team effort. I think that the Intelligence Community is doing a great job helping with that. I think that the regional CINCs are deeply involved. Certainly space command is involved, both from our intelligence side and from our operations side. And I think that we're contributing to this. I think our outreach teams are helping in the education process for the regional CINCs and their staff and that's facilitating their training. We've got people out there that are providing intelligence that are also then knowledgeable, known to the local staffs and they're able to help. Another thing that we've done in intelligence is supported General Vern Connor who I think has done a great job in trying to pull together integrated priority lists to reflect what the warfighters longterm needs are. Our first IPL which was coordinated with all the other CINCs was presented to the vice chairman and to the OSD staff in January. I think it reflects, from my perspective, really for the first time, a single set of priorities for space-based intelligence. It's tied exclusively to the warfighters' needs. We've always tried to integrate warfighters' needs into our priorities, but this time at least there's one set that you can got to and say, "If I

were only doing this for the warfighters what would I do?" And I think that that's a positive step forward. So I do think we're making progress.

I said I'd keep it short — I'll try. In closing let me just reference, I had the opportunity to take a trip with General Horner and we were down in Australia a couple of weeks ago and we heard a speech by Air Marshall Gration whose the Commander of the Royal Australian Air Force. It was interesting to me that much of what he said about the changed world and the effect the changed world has on air power and the problems facing the world and future, much of that could have been said right here by an American. It could have been said, it's just so universal now, these problems. But one of the things he talked about that was sort of new is he talked about the importance of knowledge. He talked about knowledge being the key to modern warfare. And he talked about knowledge warfare. We've talked about information warfare and all kinds of things, but I thought knowledge really captured it for me in a way that I hadn't heard before. And I think he's right on — I think knowledge warfare's the future. So I think the U.S. forces are relying on knowledge and we're becoming more reliant as we draw down our force structure we're more reliant still. I think potential adversaries are more reliant on knowledge and I think space is integral to knowledge. And so, from my perspective, what that means is I have plenty of work to do in the future! So, thank you, very much and I look forward to participating in answering questions.

Q&A Session

QUESTION: Our first question is addressed to Admiral Studeman. Rather than dwelling on lessons learned from a war fought three years ago, what are the Intelligence Community's goals and specific courses of action to provide timely intelligence to multiple CINCs with simultaneous conflicts taking place within their respective areas, especially if our capability is less today than it was during Desert Shield.

STUDEMAN: There are a lot of subquestions involved in this. Obviously the Intelligence Community is participating in its own version of the two military regional contingency studies, and in fact, we're going through an audit right now about what our ability really is, given the same assumptions that were done in the Bottom's Up Review. I think the Defense Intelligence Community is trying to come to some kind of determination about what the specific requirements are to support two MRCs, which is the baseline study for resource generation. Clearly we are trying to simultaneously create an environment in which we understand our individual theater requirements.

I just returned from an effort to try to understand what the intelligence support requirements are for the Korean theater should war fighting break out there and we try to do these kind of assessments on a continual basis. That said, one of the things that's obvious is in this resource constrained environment in which we live, there are insufficient resources to allow intelligence to be optimized for every war fighting circumstance globally. So we speak today about a flexible, adaptable intelligence system that has as its major features economy and efficiency. That speaks to the reality of the world, I think.

These are not just phrases we use that have no meaning. We cannot be optimized to fight the all-up conflict in virtually every theater simultaneously. It's going to be difficult, out of this two MRC study, to even provide the kinds of support for two simultaneous or near simultaneous regional contingencies. We're going to have to recognize this as a condition that's not only with us now but that, in my view, will be with us for the next four or five or six years and possibly far beyond that, given the Administration's requirement of the country's need to balance out its national security agenda with its national economic agenda.

Therefore, in the concept of flexibility and adaptability, you have to identify where a likely crisis is going to be coming from a military support point of view and you have to strive early on to achieve optimization. We were lucky in Desert Shield/Desert Storm because we had essentially a five month run-up to achieve optimization, and even as the conflict was ensuing, we were still enhancing intelligence methodologies during the war. That's going to be a feature of combat support in the future for intelligence.

Intelligence is in a position now, of course, where we're having to divide our effort, whether it's collection, processing, analysis or reporting, between the classic support to military operations accounts and the accounts associated with global access. Global access are these new areas of increased requirements. One obviously deals with economic competitiveness; the other area is that whole host of what I call transnational issues, narcotics, terrorism, proliferation (shared somewhat obviously with the military), illicit tech transfer, international organized crime, illegal mass migration, illegal pollution going on around. This is an interesting world because the intelligence world has suddenly now drawn itself very closely into collusion with the law

enforcement community, so this is a new area of cultural interaction for the future for us.

So I would say that the number of resources available for support to military operations in the classic sense in coming out of the Cold War is actually declining, and therefore, we have to put a big premium of short notice optimization.

QUESTION: What steps are being taken to increase the security of South Korea in light of threats while preventing undue provocation to the north? Why don't we have the three components answer that. Parker, you can represent Horner; Lionetti, you can start off; and Lyle, you get to bring up the end.

LIONETTI: In my field, the means by which we are assisting General Luck in dealing with the threats faced by that theater today fall into two categories. One is missile defense and the other is missile warning.

In missile defense, as has been announced publicly, a battalion of Patriot PAC Two out of Fort Bliss is in the process of deploying to Korea. It's the latest version, latest upgrade, and the 500-600 soldiers who man that equipment will be going along with it. I won't comment on where it's going to be or what specifically it's mission will be. But I would tell you that that system has capability against the scud-C class missiles that Koreans are known to possess. In addition, a joint Army Navy project called J-TAGs (Joint Tactical Air Ground Station) has been also considered part of that same package. It's a means by which we can, in theater, directly downlink DSP warning information, process it stereoscopically and without having to rely upon fragile, global comm links provide missile warning directly in theater to include Patriot users and shooters who might be able to provide counterforce against reasonably precise launch point locations that could be reported off that system.

Those are the areas that Army Space Command is involved in supporting what's going on in Korea today.

PARKER: There are two areas that Air Force Space Command is directly involved with. One is ballistic missile defense in the area of warning. Similar to the Army/Navy J-TAGS, the program I talked about — the TALON SHIELD — is going through an operational test right now which would actually provide theater warning from a global capability, here at Falcon Air Force Base as a matter of fact. So even though we're going through an operational test, it has a real world capability.

In addition to that, we are preparing to forward deploy our space support teams through our component 14th Air Force. If needed in theater, these would be the space intelligence experts who provide the expertise to the component commander for his battle operations and planning.

BIEN: We participate with the Army of course, with the J-TAGs. Beyond that, Naval Space Command and Navy Space in general are not doing anything overt that I'm personally aware of. I would remind you that the Navy has a substantial presence in that area in the form of carrier battle groups, currently, the Independence which is home ported in Japan. The Marines are heavily deployed in and around Iwakuni, Japan and then, of course, the carrier, Carl Vinson is deployed to the western Pacific as we speak. There's a total of about 30 ships and about 35,000 sailors and marines in that AOR. If called, they are ready.

HORNER: Let me help you out. One thing I can tell you is that every sailor that goes to sea is eminently well trained and prepared because of the efforts of Naval Space Command and their work up team. So you're there, and you're doing your job.

QUESTION: The next one is for Dick Scofield. Many of the speakers indicated the desire to consider commercial or economic impact of future space acquisition programs or national security requirements such as launch, satellite communications, remote sensing. How will DoD, in particular Space Command, ensure the commercial initiative receives sufficient attention when pitted against additional acquisition processes. While they address Space Command, I think they mean the Acquisition arm, which is Air Force Materiel Command.

SCOFIELD: It seems to me that the environment in which we put our space assets is pretty much the same whether it's commercial or military application. It would seem then, that as we start to look at new iterations of design, there would have to be an analysis, a trade-off between the commercial application or the use of commercial products and the applications visa-vis the military, as well as, what are the requirements that are driving the application of the military standard.

From an outsiders' perspective, I would have a hard time telling you that we *had* to use military hardware at this particular point in time, not knowing specifically what are the requirements that drive the performance,

the hardware, that we now intend to use.

What are we going to do to make sure that happens? I guess I would commit to you that within the design process and within the design trade-off process that will take place between SMC and Space Command here, there will be the on-going analysis and trades that will be done to weigh the value of each of those.

It's hard for me, as the new guy on the block, to imagine how the environment is different. I can understand how the environment is different between tactical fighters and bombers, but I have a hard time understanding how the environment is different from a satellite perspective.

HORNER: I think, Dick, you'd agree that certain areas such as communications, computers and software, the commercial civilian industry has outstripped military capacities and wherever possible we should take advantage of modifying our requirements to meet the speed of acquisition and the low cost directives.

QUESTION: In view of the cancellation of FEWS, why do you believe ALARM can survive the scrutiny of requirements, affordability and military utility in a resource constraint, the Air Force and a skeptical Congress.

HORNER: First of all, you should understand, I supported Dr. Deutch's decision to cancel FEWS. He did not cancel the requirements, he canceled the program. The program involved money in the near term which is not available, and the fact we have a large stable of the Cold War systems, the Defense Support Program satellites which have a capability to fully meet the requirements for our strategic needs first and foremost, and also with programs such as TALON SHIELD and J-TAGS can be made usable for the theater war fighter. Unfortunately the FEWS program was really kind of two programs. It was a Cold War FEWS program designed to replace DSP, and also a post Cold War FEWS program. Often the debates on cost, time and technology failed to recognize that. We have clarified the issue by whittling down the requirements to the things that are absolutely essential to meet the theater war fighter requirements. That's sensitivity, the ability to find the launch point, and also allowed the program to have trade-offs in areas where we can get the costs down and meet the essential basic requirements.

There's no doubt that these systems will grow as time goes, we see that in every program we have. The DSP satellite that will be launched next will be far different from the original DSP satellites. So this is not incongruous with the way we do business.

Will we get an ALARM program? The answer is obviously we will. The need is there and we have sundown on the Defense Support Program satellites, so it's a question of timing, affordability and need. The need is there — the satellite will fly after the turn of the century.

QUESTION: What is the U.S. position on hostile acts against U.S. commercial space assets during war time? It says here, military use of commercial space assets. Why don't you bet your career on this one?

PARKER: You don't have a more difficult question, do you? You want to know what our policy is?

HORNER: Yes, or what should it be? Maybe you can advise the President from this Forum.

PARKER: I'm sure glad I was in the disarmament aspect of policy. Actually, I guess any act of aggression against the U.S., whether it's military or commercial, would have to be looked at in that context. It would depend on whether it's of national vital means or concern to us. I'm not sure what the response would be. There's a lot of uncertainty about what happenes to the satellites, but I think the bottom line would be that, as you can tell from our interests in satellites by just our country now, our policy, our economy, we'd have to consider it as probably an attack against our country. Space Control is an issue which needs to be addressed in context of our National Security Policy.

HORNER: I think what the General tried to say is that space control policy is evolving in our nation, and it's a fundamental issue that we must come to grips with because, while the models are there, and there's plenty of them and the law of armed conflict is well understood by all participants, we have yet to agree or even debate the issues of space control. I can say that these policies are being developed now very aggressively in the Department of Defense and I applaud that effort.

QUESTION: This is to all panelists. Please comment on the military future need of multispectral satellite imagery in light of DoD's withdrawal from the LandSat 7 program. Will DoD buy commercial imagery or develop a new sensor system.

Let's have Army, Navy, Air Force positions, then Jim Beale, you can recap from the Unified side.

LIONETTI: I think we had a great void appear in our LandSat constellation with the loss of 6 and now the cancellation of 7 to the point where our reliance on old technology and having to go off shore to buy remote sensing puts us in a deplorable situation in the United States. I detest it, I think we need to do something about it soon. I don't have an answer for it, but I believe that's something we'll all have to contribute to.

PARKER: The Air Force answer is "yes." Again, it's going to be another trade-off between requirements and resources. It's another tough decision, but the requirement is still there.

BIEN: I don't know what I can add to that. If the question is, are we inclined to use commercial assets to provide the needs, the answer to that is clearly yes because we're doing that routinely every day. What is significant is the number of people who see tactical application of MSI beyond what most of us imagined when we first encountered the phenomenon. It really is dramatic how dependent the Fleet marine force and the Army and indeed all the services have become on MSI. I'm a little less concerned than has been suggested here about reliance on commercial so long as it's not total. As long as we can get the products and at an affordable price, I don't have as big a problem with that.

BEALE: I think from a Unified perspective, clearly the answer is yes, we have requirements, we need it. We have tried to integrate that into our overall priorities because it's one thing to say "yes, I need it" and it's another thing to say "so what do you give up for it." What we've said is that it's very high priority for us, and I think our priorities reflect all the Unified commands. Not only for LandSat but for improvements to LandSat along the lines of the arms essential that were previously discussed. I think all of those are real priorities. The problem, of course, is money and new starts in a very austere environment. I know that NASA is going to be investing in LandSat follow-on kinds of systems and there's a number of commercial concepts out there that will provide substantial capability. We'll certainly be looking at all of those to see if we can meet our requirements there.

QUESTION: This next question I'll address to Bill Studeman, but Dick, I'll ask you to talk about the industrial based considerations in acquisition. Bill, does the Intelligence Community need to take any special steps to protect the U.S. satellite industrial base as spending on intelligence satellites is cut?

STUDEMAN: Special steps is kind of a focus question, but let me say at the outset we are clearly very concerned about what will happen to U.S. industry as we buy fewer satellites, as we stretch out satellite buys, as we tend to converge some of our technologies together so we have common buses with perhaps more flexible functionality at the front end of that bus, and that has a tendency to define winners and losers.

The concept of just going to fall back on teaming and things like that in this much reduced procurement environment where essentially launches are also stretched out will have a negative effect on the U.S. intelligence satellite support industry which we are very concerned about.

Our concern is shared by John Deutch and others as he speaks to the whole issue of procurement future for the Department of Defense and how all that's going to be done. That's one of the reasons, I think, that we were interested in playing a central role in the concept of how the commercialization of intelligence to a degree and remote sensing came about. I think there have been some articles in the paper that somehow or another intelligence was a neanderthal and the advancing of the concept of this recent policy framework that has come about. I think Intelligence's role was quite the reverse. I think we played several different roles. Number one: as a result of our concern for the industry, we clearly tried to explain to the various interests, whether it was the competitiveness interests that grew out of the National Economic Council or the Department of Commerce or NOAA or the Congressional lobbyists who were after certain aspects of commercialization on one of the spectrum and our interests on the other of preserving what I discussed in my brief. So we provided a framework for at least an interim which, I think, will ultimately be an evolving policy for the commercialization of space, not only to provide something for industry to do but obviously we had selfish interests here. We would like to be able to put our scarce dollars on pushing advanced technology so that we keep the U.S. industry in the business not only over the next five or ten years but for the next ten or twenty years and continuing to push the edge of the envelope in that area. I think that these are all related factors.

SCOFIELD: Certainly the industrial based considerations are important, but at the same time I don't think we can afford, as Admiral Studeman said, to continue to support everybody at the same level we have in the past. There has to be a natural consolidating process that has

to take place. I think I worry as much if not more about the maturing of the work force that we currently have had working on a lot of our systems over the years and are we going to have growing up within our system the resident expertise, that given whatever level of workload becomes steady state over the years, we'll have the expertise to continue to develop the products that we have in the past. I went to an Engineering Awards Banquet in the San Fernando Valley about a month and a half ago, and I was encouraged that a lot of the award winners were folks without grey hair, which gave me some sense that people are coming up through the ranks. But I think we really need to work on a growth pattern within the industry to develop the capability of the future. A sorting out of who will remain and who will do the job and how that will be sorted out maybe could take place as a natural part of the economics.

HORNER: I would only add that also we must be very careful as we draw down our military forces and we, of necessity, must draw down the support to those military forces, that we do not destroy a delicate relationship between our federally funded laboratories and our industrial base. We understand the roles of each and how they complement one another as we avoid duplication as we get smaller.

QUESTION: This next question I'm going to ask Lyle Bien. What efficiencies and economies would result from assigning space to the Air Force as advocated by General McPeak. Would this enhance war fighting?

BIEN: Clearly there are opportunities for efficiencies. That's what General Moorman's launch study was all about. That's what Admiral Frost's TT&C study is all about. And the upcoming space surveillance study is intended to answer the question of specifically where can we find efficiencies. So, to suggest that there are not some eligible candidates out there for efficiency is not correct. Clearly, there are, and the intellect has been brought together to identify those. I would only suggest there is, as the CINC has so frequently said, a definite role for the components. It may not be a very big one in numbers of dollars or people, but there is a base below which you cannot go if you are going to be true to your service and their specific needs. My estimation at the Naval Space Command is that we are about at the lower limits of that threshold. So we applaud the effort to seek out additional efficiencies and indeed are more than energetic in our support of those efforts and will continue to be. We will be equally energetic, as I said earlier today in holding fast to the notion that there are some things that just cannot be sublet to the other services, most especially the training and fleet support issues. We'll continue to argue that those ought to be harbored within the respective services.

HORNER: I would only add that Unified Space Command fully supports the need to ensure that the Army, Navy and Marine Corps requirements and equities are fully represented in space — space acquisition, space lift, and space control. Where possible, we should consolidate functions for reasons of economy, and in fact a study has been sent forward from Unified Space Command that says, in essence, the Air Force should tend to acquire, launch and control the satellites. The reason it doesn't say it must be so is that you must allow the opportunity for other services to put their money where their needs are should these needs not be satisfied by the Air Force.

But I think the larger question is not one that is argued in terms of parochialism. It is not argued in terms of roles and missions. The larger issue is how do we fund space within the existing programming situation we have in the military services. Because space is obviously a very expensive proposition. We want to get out of that but we always have significant costs with space. Space is also fundamental to warfare. So what we see is, in the downsizing environment, how do you fund space? How do you take into account the needs for, say, service-specific space needs and put them in an Air Force budget which is constrained to approximately one-third the total defense budget? Right now it's about 20% of the Air Force budget. Does the Air Force have head room for existing space capabilities that benefit primarily the Army and the Navy? This is where the tensions will arise. It's not a roles and missions issue; it's a resources issue. And we will probably have to identify some way of industrial funding or forcing all the services to come to grips with the economies that are achieved by space and the costs that are a result of space.

For example, suppose we just charged industry funds to the telephone calls. Would you use MILSTAR or would you use DSCS, or would you use a commercial satellite? I think that would resolve a lot of the issues involved. I agree with Lyle, it's not a roles and missions issue.

QUESTION: I'll address this question to Don Lionetti: "when can we expect to have both, (now this is an argumentative question and I'd love to debate you Don), a clear statement of national missile defense requirements and an acquisition decision?" And then there's the

perjoritive statement you can respond to: "right now we have a fuzzy notion of the need and no confidence in any acquisition. With no change, the technology base will die."

LIONETTI: Before I get into that, I'd like to go on record as being supportive of the statements made a moment ago about the roles that the service components play in developing space requirements and space applications for their own supported forces. Consolidations are all right, but one ought not to seek consolidations for consolidations' sake because the savings associated with them may very well be cosmetic. Both Army and Naval Space Command are very modest commands in terms of their investments that give their services a point of entry that would not otherwise be there in having access to space and the fact that we are inextricably tied in our future to the use of space products.

Let me talk a little bit about NMD. You ask when we're going to have a clear statement of requirements, an acquisition decision, etc.

Perhaps never. I'm very depressed about this subject. It bothers me greatly that we're in the position that we are right now and having demoted NMD to a technology readiness program, really says that we don't have a requirement. But, you do not need a hard requirement to pursue technologies that might support an NMD kind of a decision. I believe that what will drive the requirement will be a very unambiguous statement of threat that will eventually emerge, and the issue then becomes, will there be sufficient time from receipt of that statement of threat to take that technology readiness, complete it, deploy it and be ready to deal with the threat when it arrives.

That's what my 33 years of service causes me to have this great distress. I really don't mean to be speaking out against the decisions made, but as a professional I must say that it bothers me greatly because I don't have any confidence that you can roll from technology into deployment in a short enough period of time to be able to beat the lag from observation and then getting up the capability by a potential adversary. You in defense industry know better than I that there are engineering challenges that abound, there is testing, there are integration assessments that must be done. And while we'll do the absolute best we possibly can with a technology readiness program, to do end-to-end testing, as I said in my slide, to try to involve the user to shorten those lines, it worries me. I feel the need to continue to speak out and that's why I chose this particular topic today.

QUESTION: Bill Studeman talks about a great deal of military, shared intelligence data, why it, if possible, hinges on the military's and other government agencies' ability to release currently classified collection data. What efforts are underway and what is the likelihood of having success in breaking down long held intelligence principles and that's obviously classification overhead data? A secondary question has to do with releasing it to use for legitimate environmental purposes. You talked to that. Can you expand?

STUDEMAN: No, I would say that I made reference to the fact there's some forthcoming initiatives on openness and obviously it relates to this. I'm really not in a position to outpace others who like to make these kind of statements. So I'm not going to say anything further about it.

HORNER: I can say this. During time of war, classification is not a hindrance other than in constraining the ability to disseminate the information.

STUDEMAN: And I would say that in a lot of the things I talked about, it hasn't been a hindrance. We don't actually have to have the image, even to disseminate it at the unclassified level when you turn it into some other form of product and generally find an imaginative way to get it out. Obviously the Vice President and the DCI and the entire Intelligence Community has made a significant commitment to the environmental community. We're talking here about old imagery, of course, and that old imagery openly has to be made available to make this work.

QUESTION: This one for Dick Scofield: I'll give you this question, then I'll give you the real question. This question says, how do you plan to break the lock the SPO directors have on the planning process where they're dedicated to self perpetuation? Let's change that — what advances do you see in improving our acquisition process, streamlining, where are the opportunities and what can you bring to bear as you take on your new job?

SCOFIELD: Well, any initiatives that are going to improve the streamlining of the process I think are going to have to start where we get some relief from the amount of authority and decision making that goes on inside the beltways as opposed to out in SPOs. There has been some of that in the acquisition reform package that I've seen so far, but I guess I'm not sanguine that

the system is going to let go enough to allow us to be able to do that. Certainly if we are able to build in conjunction with the user, sound strategies that allow us to get started on a program and to be able to move forward rather quickly and then have the user advocate that on a basis of his requirement, then I think that we have the wherewithal to start to do things a little bit more quickly than we have in the past. But I've seen some of the initiatives, the acquisition reform, I've haven't seen the level of coordination across the staffs that would say that that's going to happen rather quickly.

HORNER: Last question is, what is USCINCSPACE's highest priority? The highest priority is the ALARM program.

I think we all welcome the opportunity to be before you. We are dependent upon you just as we're dependent upon military space, so we thank you for the opportunity to present our views to the space community, particularly the industrial space community and we wish you well in these difficult times.

NASA in the Balance

Dr. France Anne Córdova
Chief Scientist
NASA

A recent Congressional Budget Office report poses various options for a descoped, downsized NASA, all of them resulting in a very different NASA from the one which we associate with some of our finest moments in science, technology and human exploration. I have only to cite a litany of those moments to bring back the excitement and wonder generated by NASA: the discovery of the X-ray universe; the discovery of the origin of galaxies in the minute fluctuations of the last scattering surface of the microwave background; human footprints on the moon; the first all-sky maps of the universe at infrared, X-ray, and gamma-ray wavelengths; the reservicing of the Hubble telescope and the dramatic 'before' and 'after' pictures; the discovery of dark matter hovering around a cluster of galaxies; the illumination of the mystery of gamma-ray bursts; the discovery of moon of an asteroid; finding that the depletion of the ozone layer is increasing, and is due to buildup of human-generated emission; tracking the progress of El Niño, which may contribute to the flooding in the midwest, harsh winters in the eastern U.S., rains and mudslides in California; understanding the Earth as an integrated system and how the Earth's climate is changing due to human and other factors; the disruption of ecosystems because of deforestation; and understanding the physics of protein crystal growth, phase transitions, tissue culturing, and combustion, utilizing a microgravity environment.

Even a string of accomplishments so striking as this cannot, alone, sustain NASA in the present climate of economic and personal uncertainty. This is why the Agency has directed its present efforts in science and technology, in aerospace and human space flight, towards both shorter term and longer term benefits to the nation. NASA's present program, a program finely balanced to address diverse sectors of our economy, the challenges posed by the environment, and the multiple talents and dreams of our peoples, is more streamlined, most cost-effective, more productive, and more relevant. At the same time this program still has the potential to make the illuminating scientific discoveries and technological advances that have made Americans proud that we have NASA.

The Hubble Servicing Mission is a wonderful example of what happens when scientists, engineers, astronauts, and, yes, managers join together to solve a difficult problem: the flawed primary mirror was discovered soon after Hubble's 1990 launch and a panel of scientists and engineers immediately gathered to examine dozens of possible "fixes." The resulting optical juke-

But they also want a NASA; they want to read about the great scientific discoveries that perhaps they only barely understand, but still appreciate deeply the significance of; and they want to see human beings, people like themselves, living and working in space.

box called COSTAR was devised, selected, and put on an incredibly fast development schedule of only 26 months. The final stroke of human ingenuity was the performance of the astronauts, who accomplished every one of the mission's many complex objectives, including installation of COSTAR and the new Wide Field Planetary Camera, as well as new solar panels and gyros. As a venture with the European Space Agency, the Hubble Mission embodies our cooperative spirit in an international arena. And, although Hubble is a "big" mission in cost, its users do their science in a "small" way, with individual investigators and their students. Before I came to NASA last Fall, I applied for observing time of the reserviced Hubble. My proposal was successful and last month I became of the first guest investigators to use the new Hubble; later this month I have two additional observations. My program is observing the optical and UV spectrum of X-ray-emitting pulsars, in an effort to understand the physics of the interior of neutron stars.

When I go to different places around the country and talk with just-plain-folks I hear that these people want economic and personal security and a good education for their children. But they also want a NASA; they want to read about the great scientific discoveries that perhaps they only barely understand, but still appreciate deeply the significance of; and they want to see human

beings, people like themselves, living and working in space. Indeed, in our schoolrooms, children make models of new spaceships and design habitats on distant moons.

I want to tell you now about NASA's proposed science program for the next fiscal year. Part of this program utilizes robotic missions, and part of it humans in space. It is a vibrant program that addresses fundamental questions in physics, astronomy, planetary science, the science of the human species, and the science of our planet and its global environment. It is a program that, in taking in situ measurements of the near and far-Earth environs, enables the world to address telecommunications, satellite hazards, and global change issues. It is a program that involves the educational community in its efforts to inspire all people, to create learning opportunities, and to enlighten inquisitive minds. And finally, it is a program that explores the Universe, in peace and in partnership with many other countries, stimulating our mutual intellectual development and creating new technologies and opportunities.

1994 is NASA's most ambitious year for studying the Earth: it includes the launches of four spacecraft, flight of five Shuttle missions, and conduct of three major aircraft campaigns.

I will start with space science. NASA has a program in space science that covers much of the electromagnetic spectrum and measures particles as well as photons. NASA satellites map at close range the planets and moons of our solar system. A complement of NASA and international spacecraft, called the Global Geosciences program, is strategically placed around the far and near-Earth environment to measure the effect of the solar stream of particles upon the earth's magnetosphere and ionosphere, yielding data that will add to the scientific knowledge of weather and spacecraft anomalies. NASA telescopes in space view the most distant objects known, and look back to the origin of the universe itself.

NASA's budget request for space science in FY95 is at an all-time high, 1.77 billion dollars. This is 44 million dollars higher than the 1994 level. The bulk of the budget is for 3 large missions: Cassini and the European-supplied Huygens probe (will investigate whether the icy moons of Saturn have preserved a record of the formation of the early solar system as well as determine whether the necessary building blocks of the chemical evolution of life exists beyond Earth); AXAF (will study the composition and nature of galaxies, stellar objects and interstellar phenomena); and HST (reservicing mission will introduce a wholly new near-IR super telescope). But the budget also sustains 18 ongoing missions and prepares for a number of smaller missions, including the Relativity Mission that will test a fundamental prediction of Einstein's General Theory of Relativity. The budget continues two Discovery missions, one that parks up close to an asteroid and one that demonstrates technology for landing small robotics on Mars.

A second component of the science program is our Earth Observing effort. 1994 is NASA's most ambitious year for studying the Earth: it includes the launches of four spacecraft, flight of five Shuttle missions, and conduct of three major aircraft campaigns. In his book "Earth in the Balance," Vice President Gore speaks eloquently on behalf of a planet whose beauty IS skin deep. He describes the devastation wrought by human carelessness. He lays out a plan for a bold rescue mission, borrowing the term "Mission to Planet Earth (MTPE)." NASA today is ramping up to build upon one aspect of Gore's vision: an ambitious program of studies of the Earth from space. These are studies that will give a holistic picture of the global environment and how it is changing. The data will give us a better understanding of natural and human-induced environmental changes. These studies are rooted in scientific research on the climate, ice, wind, oceans, land and forests.

The FY95 request for this effort is 1.45 billion dollars, a 16% increase over last year's funding level and a reflection of the high priority that this program has within NASA and the Clinton-Gore administration.

One major component of MTPE is the Earth Observing System (EOS), which is NASA's contribution to the U.S. Global Change Research Program, a federal agency-wide effort. Funded in FY95 at 0.5 billion of dollars, EOS is comprised of a suite of satellites that will be launched beginning in 1998. EOS will document global climate change and observe regional and global-scale environmental processes. This knowledge is expected to provide the underpinnings for future policy decisions and, as such, will be of direct benefit to all people.

Earth Probes, funded at 82 million dollars, is a series of small, specialized satellites and instruments requiring special orbits and capabilities. The Earth Probes program will continue to complement broad studies of EOS with narrowly focused missions to study tropical rainfall, ocean winds, and global ozone. Currently on orbit are the UARS satellite, TOMS, TOPEX, and ERBE, as well as the Airborne Science Program; these conduct a

variety of research missions such as ozone studies, oceanography, soil studies, land-surface ecology and geology.

Besides flight missions, MTPE includes an innovative data system (EOSDIS) which will process, archive, and distribute the critical measurements from EOS an other earth research to a global network of investigators and users. EOSDIS is funded at 285 million dollars in the FY 95 request.

Smaller scale activities of great significance include the enhancement of existing "pathfinder" data sets, and the application of MTPE measurement capabilities to natural disaster response and mitigations, such as floods, fires, earthquakes.

The third element of NASA's science program is the Life and Microgravity sciences and applications program. Imagine how different your activities would be if this room were to be orbiting the Earth as does the space shuttle. Imagine the behavior of the coffee in your cup, and how you would have to fight to keep hold of your eyeglasses, your shirt pocket pens, your lunch. Although all of this would be fun, you would be less pleased to know that your aging process in this microgravity environment had accelerated dramatically. A year in microgravity is equal to an entire lifetime on Earth. The brain, the immune system, the circulatory system, the heart, the lungs, and hormone secreting organs--all of these are objects of study in microgravity. Tumors and proteins grow much differently when the effects of gravity are mitigated and this difference may give us clues to their production. Targeted for study are breast and ovarian tumors and proteins important in the digestion of milk, proteins that are nutrients, and proteins for the development of antiparasitic drugs. Serum albumin, the most common protein in the blood and the one that carries toxins and food, can be much better resolved in microgravity than on Earth, making this kind of study important to drug companies.

You may be interested to know that the number of neural synapses in your brain depends on gravity. A researcher at NASA's Ames Research Center, Dr. Muriel Ross, has uncovered this effect by studying neural synapses in an Earth bound centrifuge where g can be made to be greater than unity, and in microgravity, where g is much less than unity. Her models are revealing how the brain adapts to gravity changes. Incidentally, Dr. Ross left her full professorship at Michigan to join the Ames Research Center because Ames afforded her the cross-disciplinary opportunities she needed for her research, which is to combine biology with state-of-the-art computational power. Her ground-breaking science is a splendid example of the enabling function of the NASA centers.

The Life and Microgravity Science request is almost 0.5 billion dollars in FY95. This includes 112 million dollars for Shuttle/Spacelab payload mission management and integrations and 84 million dollars for space station payload facilities, as well as almost 150 million dollars each for Life and Microgravity Sciences.

The life sciences program is designed to advance knowledge in some relevant areas in biomedicine and biology and to develop technologies that enable safe human habitation in space. The life science programs include the ongoing shuttle and spacelab flight experiment programs; the cooperative research program with Russia, including studies aboard MIR and development of flight hardware for a US/Russian Biosatellite mission; the science utilization/experiments program planned for Space Station, and general cooperative research projects, including Neurolab (SLS-4) with the National Institutes of Health.

A year in microgravity is equal to an entire lifetime on Earth. The brain, the immune system, the circulatory system, the heart, the lungs, and hormone secreting organs--all of these are objects of study in microgravity.

The Microgravity Science Research program is designed to enable us to better understand important physical, chemical, and biological processes that the effects of gravity obscure on Earth. In FY95 NASA will continue development of new equipment for the Shuttle, Spacelab, and Space Station, and complete preparations for the cooperative US/Russia Spacelab-Mir mission scheduled for initial launch in 1995.

Space Station payload facilities funding supports six facility-class payloads which are being developed for the Space Station: Human Research Facility, Gravitational Biology Facility, Habitat Holding System/Centrifuge; Fluids/Combustion Facility; Biotechnology Facility which includes protein crystal growth, and Space Station Furnace Facility.

This is a snapshot of NASA's science program. This program complements, indeed enables, the agency's overall mission, which is to explore, use, and develop space for human enterprise; to advance scientific knowledge of the Earth, the Solar System, and the Universe and use the environment of space for research; and to research, develop, verify, and transfer advanced aero-

nautics, space, and related technologies. All of these comprise NASA and the expectations of Americans for NASA.

Yet NASA is "in the balance." The agency has taken a 30% reduction from its FY93 request, and almost every program has survived, demonstrating that NASA can do business in a new way — that it has made great efficiencies in restructuring itself. It has restored Hubble's vision and given it a new camera; it has reboosted the Compton GRO to a higher orbit and given it a new tracking station, increasing the satellite lifetime and amount of data immensely. But the Agency can do no more cost cutting and still remain the NASA that has given us an inventory of some of the most profound discoveries and advances that humankind has made, the NASA that has turned adversity into success.

The nation poses other challenges for NASA science beyond the budgetary one. America wants a return on its investment. A White House sponsored forum earlier this year set the tone for a national dialogue on what constitutes relevant science. Talks by senators and congressmen to the scientists and research administrators gathered at the forum all had a similar message: basic research should foster strategic goals; the nation's science plan had to become more sensitive to pressing economic and social concerns; university researchers should ally with the private sector and focus on economic goals and the broad global market; federal research agencies should seek a new balance between science and its applications. Senator Mikulski said that the U.S. is winning the Nobel Prizes, but losing the markets. While the President's Science Advisor Jack Gibbons agreed that "a substantially altered rationale for continued federal support of science and technology is emerging," he also said that it was important to allay fears that "we may be shredding the tapestry of our nation's magnificent scientific enterprise."

But the Agency can do no more cost cutting and still remain the NASA that has given us an inventory of some of the most profound discoveries and advances that humankind has made, the NASA that has turned adversity into success.

The national dialogue has not yet settled out and, indeed, has been taken up by the President's National Science and Technology Council. One of the central goals of this Council, as articulated by its subcommittee on Fundamental Science, is world leadership in basic science, mathematics, and engineering.

All of us would agree, based on knowledge gained from our own investment portfolios, that a balanced portfolio of both short and long term investments, is wisest. Thus we could agree that world leadership in science means seeking both near and longer term benefits from the science enterprise. NASA's mixed program of physics, astronomy, microgravity, earth, and life science seeks this balance; it represents investments that may influence shorter term public policies, investments that serve the continual human need for inspiration and education, and investments that enable, in the long term, new technologies and give rise to new opportunities.

In this time of diminishing budgets for the discretionary portion of the federal investment, NASA science will be evaluated and judged by the public in the larger context of basic science across all the agencies. We have, in the past two decades, been given the license by the public to dig the holes for the "oil wells" in space. But now the public is asking about the results of that investment. NASA needs to communicate its scientific returns, the quality and amount of the "oil" it has found to the public effectively. The continuation of the public's investment in NASA's science depends on this.

I would like to close with a salute to the state that is hosting this gathering today. It is a state of many of the mountains I enjoyed climbing while coming of age in nearby New Mexico. I would especially like to salute a friend of mine who climbed these mountains and many more all over the world; a woman who understood the pioneering spirit that drives all adventurers, be they bound to the planet and its highest peaks, or unbound in exploring with telescopes the farthest reaches of the Universe. She was my friend through a time when I struggled to climb a personal mountain, the one marked "astrophysicist." And I was her friend at the time she took on the challenge of becoming the first woman to climb the face of El Capitan alone. She was part of the energy that belayed me as I wrote my thesis, and my stars were hers to gaze at during the several nights she bivouacked high over Yosemite Valley during her solo ascent of El Cap. She died last Sunday, Easter Sunday, in a helicopter crash, following a glorious ski on the new snow of a Nevada peak. Beverly Johnson went for excellence with all her heart and mind. She marveled at everything; she wanted to see it all. My remarks today about NASA's new vision for science are dedicated to her unflagging optimism about what human beings can achieve if they have the will and imagination to succeed.

Earth and Space Observations — Did We Have Cousins on Mars?

Dr. Edward Teller
Director Emeritus
Lawrence Livermore Laboratory

I am happy to be here. I have been deeply impressed by what I have heard. I agree with most of it — some things more than with others. I know we have discussed extremely important issues and I want to comment on some of them.

First, I particularly agree that the space program is in real trouble. Furthermore, I believe the space program is most important because its difficulty is not only the trouble of the space program; it is a much more general difficulty. Let me precisely describe it. I came to the United States in 1935 and I claim to have lived in the United States for a longer time than most of you. When I arrived, I found that people welcomed everything that was new. Perhaps that welcome was exaggerated, but it was stimulating and I believe this positive attitude to welcome what is new, was the basis of today's strengths in the United States. This positive attitude is an old American tradition, dating from the founding of United States. In the almost 60 years that I have lived here, this positive attitude has eroded. Today, Americans greet everything new, particularly, the things that are not sufficiently understood, with suspicion. This is the tremendous danger for America. The space program, being in the leading position of what is new, suffers severely from this recent suspicion. For this reason we must review common causes, and we must unite, not to sell the space program but to explain it, to bring it home to people, and to elicit understanding for it. I would like to contribute to this explanation, but I'm scared because the job is tremendous. If I spoke for seven hours and you extracted only the best fourteen minutes, then I might make sense. As it is, you have to take your chances.

Today, Americans greet everything new, particularly, the things that are not sufficiently understood, with suspicion. This is the tremendous danger for America.

Now, the space station's trouble also presents a wonderful opportunity. The opportunity occurs because of the collapse of the Soviet Union. Although the collapse has not eliminated the dangers, it has aroused a consciousness of many more small and still very great dangers and difficulties. But the collapse has also made possible international cooperation. It has made possible the inclusion of the work of Russia, which I welcome unambiguously. Some ask the question, "Shall we proceed with the joint work?" And I want to say, as clearly, positively and repeatedly, "Yes, yes and yes!" I want you to know why I support it.

While speaking with many of my counterparts in Russia, I heard a remarkable story from four of them that I didn't want to believe. But the story has a wide circulation in Russia, and this fact, I claim, is significant. In 1949, the Russians succeeded with their first nuclear explosion and the head of that organization, Beria — of not very agreeable fame — asked Stalin, "How shall I reward the scientists who have succeeded?" Stalin said, "Comrade Beria, you surely have a list of those people you would have shot if they had not succeeded. Well, those shall now receive the Stalin Prize."

This is the story the Russians scientists and people tell each other. They are happy to be rid of that peculiar, horrible dictatorship that was imperialist and communist and had a few other negative virtues besides. America's natural instinct is to cooperate and get the most out of it; granted, not risk-free, but worthwhile.

Now, let me address the one group of presentations that really grabbed me, perhaps for personal reasons, perhaps for objective reasons. It was the military presentations. The story about America's victory in the Persian Gulf was incredible. That this victory was obtained, to a very great extent through space is clear. Space paid big dividends. I would like to mention some of the merits of this victory. What did it achieve? That oil of the Mid-East still flows is a very important point. Even more important: to my mind, America's victory in the Persian Gulf was the main factor leading to the collapse of the Soviet Union. Some of us who have been engaged in nuclear weapons and mutual assured destruction — which was an unfortunate necessity — contributed to the collapse in a defensive sense. We helped America remain technically superior; therefore, we did not lose. Furthermore, we started to develop defensive systems that worried many Soviet generals. But the

decisive factor was that the United States — the decadent democracy — together with the United Nations — the debating society — could win the Gulf War in no time at all and with practically no casualties. How? By observation and timely strikes directed by space resources. This was impressive. For the Soviet Union to survive, it had to win or have the hope of winning. The war in the Persian Gulf knocked out the Soviet's confidence, knocked out the Soviet leadership's unanimity and caused the Soviet Union to collapse. This was worth almost any price.

Even more important: to my mind, America's victory in the Persian Gulf was the main factor leading to the collapse of the Soviet Union.

Let me talk about cost...something I don't know about and if I misstate it, forgive me. I hope I won't misstate it by more that a factor ten. How much have we spent on space? An estimate by NASA: 300 billion dollars, maybe. By our military, perhaps one quarter of that. By all other sources perhaps 2 or 3%. The military has earned at least ten fold, the money they have spent.

Let's return to the space station. In the past few days, this was discussed again and again. I like it! I like it today much more than I liked it a few days ago! One strong reason for my liking it is that the space station is based on international cooperation and that the Russians are invited. I think that's a strong reason. What about the program? I believe that the international cooperation on the space station, together with scientific research project, is a wonderful idea. The positive results from this combination could counteract the negative, suspicious attitude which I mentioned a few minutes ago. It would be wonderful if the space station succeeded, but here we have a very serious worry. What have we heard at this symposium about the scientific research program for the space station? Maybe you heard more. I had my eyes and ears open. I heard nothing. In private conversations I heard a little bit. I heard the main research program is to make careful measurements in gravity-free conditions. Free of gravity means that gravity is reduced by a factor of a thousand easily and then again maybe by another factor of a thousand, if you are very careful. What do you do with it? Many difficult chemical processes work differently without gravity to disturb them. Some suspect the difference will be particularly important in living beings.

Now, I have two opposite remarks to make to this point. One is biochemistry, the understanding of how living beings work, and what life is, I consider to be the great unsolved mystery. This is the scientific field where, in the last decades, we have made the most progress. We now know that inherited properties are contained in the vocabulary of a string of nucleic acids on the double spiral. That we know some of these mechanisms is, to my mind, an extremely important fact. Biochemistry is apt to be a most important part of science, just as relativity was important to mechanics. So, study biochemistry by all means.

But how and why should minimal gravity be particularly important for this study? I like it, but I would like to have a hundred times more explanation in terms that I can understand and even my fifteen year old granddaughter, who is interested in science, can and will understand. We must provide this very understandable explanation or the American people will never accept and support the space station. It is not enough to say, "Write to your congressman." They must understand, at least to some extent, the purpose.

My final remark about the space station is that we should not put practically everything in one basket. I was happy to hear the emphasis on connection with many other programs. Let me repeat one connection. When listening to the military presentations, I was particularly happy to hear that data obtained for CIA intelligence purposes should be gathered in such a way so that operators could also use it for meteorology purposes. Congressman Walker just stated that it is necessary to have programs pay dividends sooner than in a few decades. Meteorology is one of the dividends that I feel will make magnificent progress if we pay some reasonable attention to it. Why? Because electronic calculation methods have improved to the extent that we can calculate almost anything, provided we know the starting point, provided we have measurements on a close enough net, and provided we measure the right things. What heads the list of things that have to be measured from space — and today are not measured from space — is wind velocities at all altitudes. It stands to reason that if we know the wind pattern , we can more accurately and easily calculate the next stage of the weather. This will transform meteorology from an art into a science. And we will extend today's weather predictions from a mere five days to tomorrow's predictions of a secure two weeks. If we can achieve this, the economic value for the world in agriculture, in commerce, in the stock market and in many activities would pay the $300 billion cost and more. It would be something the voter would appreciate and something we

could accomplish on an international cooperative scale in such a way that America and Russia, Italy and Somalia — everyone will benefit. It may be a positive force that binds the world, not by dictators, not by rules and governments, but by common benefits. Incidentally, I wish everybody would contribute money and/or work because if you contribute you criticize in a much more positive manner. This is one of the projects.

But here is an immediate problem. In order to make weather predictions, the observations have to be open. Can we open the intelligence observations? Our President has already said that he wants to reduce secrecy as possible. Today, I am sure that we are over classified, and have too much secrecy. A move to open information as much as possible facilitates better weather prediction and many other things, including observations of activities in every part of the world. In this way, no one can prepare for aggression against anybody else without not just the CIA knowing it, but the world knowing about it. The evaluation of the observation may be kept secret, but I think the rough data, at least in peace time, should be available for all to see.

Now this is by no means the only thing that NASA should do in the research phase. I think space observations can do a lot to dispel all fears about the future. We are afraid of radioactivity, we are afraid of pesticides, we are afraid of global warming, and we are afraid of ozone depletion. Global warming? To what extent does carbon dioxide cause it? I don't know. We have good calculations at our laboratory in Livermore. The statement we make is that the positive temperature effects by carbon dioxide are temporarily suppressed by the scattering, directly and indirectly, caused by sulfur dioxide emissions. Not a firm statement, but a possible statement. We ought to understand that.

Some of my friends and I have given detailed thought to the question, "Can we change the high layer of the atmosphere, maybe above thirty kilometers, in order to modify solar radiation obtained, so that we could get what we want?" Terribly difficult! Possible! But even more difficult because we don't know what we want! If we begin to modify anything, then some people will like it and some people will not. The problem is not only a question of technology, the problem is indeed a question of politics. At any rate, when people talk about inevitable warming of the atmosphere, my answer is we should study it. We will probably find ways, by injecting the right substances and studying their effects. This we could accomplish from the space station and thus could control the warming.

There is another danger. People talked about another ice age just fifteen years ago. From the record of ice ages, we can say with considerable confidence that in every century there will be a 1% chance of a sudden temperature decrease to conditions that are really intolerable. To have flexible answers to this questions may give people new confidence. But this cannot be done without studying the upper portions of the atmosphere which is precisely the right problem for the space station to study.

Our whole knowledge about the history of the earth deeply depends on unsettled questions, that are connected with space. And I think clarifying such processes has general public interest.

Let me mention still another project. One that is particularly appealing to me. Once in a while meteorites hit the earth. I discussed this at the space symposium two years ago. On the year of my birth, 1908, the Tunguska meteorite exploded over Siberia with the force of twenty megatons. It killed innumerable trees but fortunately no human beings since none were present. On February 1, 1994, the Air Force observed a one megaton explosion high in the atmosphere near a Pacific island. Similar explosions not much smaller than Hiroshima, occur about once a month. What effects do they have? For instance, what effect do they have on magnetic fields when they occur at very high altitude? One can easily show that these explosions, or hits, influence magnetic fields over very big volumes. We all know that 65 million years ago, a tremendous meteorite collided with the earth at Yucatan. The collision produced enough dust to stop sunlight from reaching the earth's surface for a long period. Maybe it was the end of the dinosaurs. Semi-proven! There have been other big collisions. Some people believe all major geological changes have been due to such collisions. We know the earth's magnetic field changes sign once or twice every million years. Maybe that is due to meteorolic impacts. Our whole knowledge about the history of the earth deeply depends on unsettled questions, that are connected with space. And I think clarifying such processes has general public interest.

Now I would like to change the topic and discuss a successful ongoing experiment of NASA, called Clementine, in which the Air Force and Livermore Laboratory have participated. Clementine is a small missile that is now in orbit around the moon and takes

lots of interesting pictures. After that, it will intercept for the first time, a big one- or two-mile size meteorite called Geographos, and examine it in detail. For instance, it will look at the side illuminated by the sun, the dark side, and by studying the temperature differences near the line of division, it will determine the heat conductivity of the surface layers. It will get information from close by approach, just 100 kilometers. A quick fly-by, but a lot of information. Clementine works on budget: $75 million all total, $60 million in private investment — a lot of Money! It is managed by NASA and works very well.

If fusion works at all, it works in a plasma, contained as a very hot ionized gas, held together by a magnetic field and shaped by the magnetic field to emit a small fraction of the plasma in the form a jet. In principle, fusion is a simpler apparatus.

Now, I want to mention a special interest I have in Clementine. I hope it will find the crater of my dreams on the moon. The crater of my dreams is near a pole. There are probably some near the south pole of the moon, deep enough so that the slanting sunlight arriving at no greater angle than six degrees will ever reach the bottom of the crater. At the bottom of my ideal crater, we will find a surrounding of steady low temperatures. And why do I like it? If we establish a colony on the moon this crater, because of lack of temperature changes will be the easiest place in which to live. Since it will be near a pole, colonists can continually look at and communicate with earth. In addition, they can easily move away from the earth and, shielded from its afternoon television programs, colonists can make undisturbed space observations. Another reason to establish a colony at the bottom of my ideal crater, is that colonists will find undisturbed locations of meteorite impacts. These impacts as a rule, are numerous but the sun's rising and disappearing from the horizon, causes temperature changes, that badly disturb the material of the moon's surface. In the steady, low temperature of my ideal crater, the colonists can study the undisturbed impacts and the undisturbed moon's surface. This will enable them to discover much more about the ancient history of the moon than has ever been known.

Now the colonists can accomplish many things. They can mine the moon for materials containing hydrogen and oxygen with which they can fuel vehicles to explore the solar system.

We have heard one very interesting statement, interesting in particular for me. I was delighted to hear about an advocacy of thermonuclear reactions. I visited a place in England which is, perhaps together with Princeton, the foremost in developing big thermonuclear reactors. They showed me a tremendous segment of a big reactor of that kind and I asked, "When will it operate?" "Ah," they said, "The first experiment (not yet useable for big scale energy production) will be in 2010." I said, "That's too late. Please hurry. Make it 2008. That will be my 100th birthday and I will come." They promised me, but even if they finish, a project that takes so long to develop is apt to be very expensive.

Now I mention these thermonuclear reactors in connection with the moon because the materials with which to fuel such reactors contain helium^3, which is found on the moon, deposited there by the solar wind. This is one of the many reasons to colonize the moon. But, I am afraid the thermonuclear apparatus, at least for the present will be too expensive. However, it would be an excellent apparatus for powering long distance space vehicles. If you want to leave the solar system the expedition will last at least thirty or forty years. No human can do it. No conventional energy source can do it. You need nuclear energy and for this purpose, fusion is better than fission for a very simple reason: fission gives nothing but heat. To drive a jet, we must convert the heat into electricity and then add an accelerator to drive particles with electricity. It is difficult for me to image that this apparatus will continue to work for decades without human servicing.

If fusion works at all, it works in a plasma, contained as a very hot ionized gas, held together by a magnetic field and shaped by the magnetic field to emit a small fraction of the plasma in the form a jet. In principle, fusion is a simpler apparatus.

Now ladies and gentlemen I would like talk and talk. It is a pleasure for me to think about these possibilities, to plan them for presentation to the public, to get short term dividend like better weather predictions, to get clarification of possible dangers such as Clementine will provide when it examines the big Geographos that misses the earth by approximately ten million kilometers. We can understand its composition so we know how we can work on it, how we can deflect it, and how we can make the improbable, (a collision with a meteorite), impossible in the future.

I would like to talk about one more topic. A concrete possibility of going to Mars exists and I want to go to Mars. Not for any practical purpose. Not for anything that is assured. But for something that is possible, and

to my mind, is inspiring for all people and not only to scientists.

We heard that in our planetary systems life is found only on earth' at other places we won't find anything but rocks. I don't question this fact! I will tell you or remind you that we know life on earth is at least four billion years old. We know this by having found in close association, chemicals characteristic of living substances in layers with an age of four billion years. There are two types of some carbon compounds, the right rotating and the left rotating, in amounts that are equal. In chemicals characteristic of living substances, they are not equal, and in our bodies they are not equal. We find the same peculiarities in these four billion year old substances as we find in all living beings; humans and dogs and frogs and pine trees and amebas and viruses. We are, in the eye of the biochemist, all of us, cousins. We know that life did not succeed on Mars or on the moon; We do not know if life on Mars or the moon did not have an early start similar to the start that we've found on earth after a lot of searching. Conditions on Mars in its initial stages were not all that different from conditions on earth during its initial stages. If we don't find any trace, even of early life, that will tell us something interesting. If we find something, anything of the kind, it will be incomparably more interesting. More interesting because we will ask a question. All living beings on the earth, including a dog and down to the viruses are our cousins. Are those most primitive traces on Mars also our cousins? Are we beginning to have a general understanding of life in our solar system or is life different in each location? The similarity or the difference will determine a lot, not just about the history of the world, but about the equally important history of living beings. The origins of life have stories attached to them in every known civilization. These stories prove the interest of the common man in the question, "How did I start?"

I claim that we must provide not only a better life for the American people, but also new ideas, and new knowledge, because this is a natural part of any human activity. Let's not forget this fact. We are here to proceed in what is the most exciting and, in many ways, the most easily understood and visualized part of the great expansion of knowledge. You heard that more scientists are alive today than have ever been on the planet before. Perhaps, there are too many scientists. I hope that is not true! But people will provide work for, and will want to support us if they receive a dividend in wealth and/or ideas. We must not underestimate the value of ideas in science.

We are united in a good cause. It requires work, it requires ideas, it requires imagination and I can make only a minor contribution to it. I hope, in this particular case, to participate much more by hearing and then by speaking. Thank you.

I claim that we must provide not only a better life for the American people, but also new ideas, and new knowledge, because this is a natural part of any human activity.

Q&A Session

QUESTION: You talked about the weather as the only distinct measurement of smaller and smaller intervals of being able to predict things. Recently, advocates of the Chaos theory would say no matter how minutely related the weather, you may not be able to do this.

Dr. Teller: Chaos theory predicts that the slightest change in a complicated system, like the weather, will grow in an exponential fashion. Therefore, long term predictions are impossible. It is Chaos theory why a tight net is needed so that you can see small fluctuations. A thousand fold increase in observational data will give rise to improvement of weather prediction by not much — only from five to fourteen days. A thousand fold improvement on observation and terrific improvement in calculation and an expansion of prediction by only less than a factor of three. That is a consequence of Chaos theory. That is why I am not promising you to predict the temperature on the first of January of the year 2000. That will indeed, I think, be forever impossible. But a moderate improvement in weather prediction is already worth many millions of dollars.

NASA: A New Vision for Science

John Holliman
Washington Correspondent
CNN

Dr. Mark J. Albrecht
Senior Vice President
SAIC

Al Diaz
Deputy Associate Administrator
NASA Office of Space Science

Granville Paules
Director, Technology Innovation & Advanced Planning Office
Mission to Planet Earth, NASA

Congressman Bob Walker (R-PA)
Ranking Republican
House Science, Space & Technology Committee

DR. MARK J. ALBRECHT: Thank you, it is a pleasure to be back at the U.S. Space Foundation Symposium. I would like a moment to recognize Congressman Bob Walker. For those of you who do not already know it, Bob Walker is the Republican leader on space. He was an invaluable strategist, advisor and architect for President Bush and Vice President Quayle on defining and initiating the new NASA. And he has been the indisputable field general for the Republicans for the unblemished record of victories we have enjoyed in the House on space station. And if you will indulge me a partisan moment, I would remind all that the space station has survived only by the consistent and strong support of the Republican party, not one space station vote would have succeeded without more than 50% support of the House Republicans, indeed, most carried almost 79%. This is due in large measure to the considerable influence, vision and persuasiveness of Bob Walker, and this from a Congressman whose district, I daresay, benefits little if at all directly from this program. Sir, I salute you.

First, and foremost, the key element of a new vision of NASA is rooted in the traditions of the agency itself, namely Presidential leadership. ... The new NASA belongs to the people and takes its direction from the President.

Let me turn now to the topic at hand, "NASA: A New Vision." I must admit, I find this a somewhat intriguing topic. And I must confess I've not discussed this with the moderator or any of the other panelists.

First off, the phrase itself is devilishly ambiguous. I'm not sure whether the topic is a question, a declaration, or a plea. Not knowing what my fellow panelists make of the intent, I will take it to be a declaration, that is, that NASA has a new vision.

However, I freely admit that there is a powerful argument to consider the phrase to be a question, as in "Another vision for NASA?" And I must admit I am sorely tempted to regard the phrase as a please, as in "NASA, **please**, a new vision!"

This was not an easy call, trust me. Nevertheless, I have settled on the formulation that NASA has a new vision and will restrict my brief remarks to a discussion of this.

I will argue that while we can understand the genesis of the new vision for NASA and, in fact, can define some of the key elements of it, it remains an unfinished vision and a still fragile one.

First, and foremost, the key element of a new vision of NASA is rooted in the traditions of the agency itself, namely **Presidential leadership.** NASA, to thrive, must be a tool of Presidential policy, for it is only the President in his role as the only representative of all the people who can summon the vision for an activity that is purely optional, an expression of the people's vision, not a right, not a duty. The new NASA belongs to the people and takes its direction from the President.

Next, the new vision of NASA again draws on the traditions of the agency itself. Can do, cutting edge, risk takers, bold experimenters with impudence and impatience. Quick, nimble, resourceful and smart, the stuff that made the phrase "rocket scientist" mean something

PRECEDING PAGE BLANK NOT FILMED

PAGE 174 INTENTIONALLY BLANK

special. I call this **faster, cheaper, better.**

Third, the new vision for NASA made explicit something that has been implicit for decades, NASA IS **defense conversion**. NASA was born out of the cold war and took its first generation of technology and leadership from the military space program. And while, for decades appropriate walls and safeguards had been erected to separate these two national programs, now the time for those barriers to be breached is upon us. To be sure, there needs to be some distinctions between the two programs, but there is much to be shared in terms of technology, common infrastructure, and a shared industrial base.

For years, DoD was the big brother of this relationship, the new vision of NASA must include it taking a technology and industry leadership role.

Finally, the new vision of NASA is centered on an old mission with a vital new rationale--exploration. Not the cold war mission of exploration for dominance and superiority, but **exploration for world leadership, partnership, science, hope and opportunity.**

Cooperation, not competition, shared goals and aspirations, new technological, environmental and economic horizons to be exploited to the benefit of all mankind. And a global commitment to the future. A source of inspiration to all nations that despite the enormous challenges of the moment, there is still enough

Finally, the new vision of NASA is centered on an old mission with a vital new rationale — exploration. Not the cold war mission of exploration for dominance and superiority, but exploration for world leadership, partnership, science, hope and opportunity.

wit, and will and wallet to invest in opportunities for tomorrow, the new vision of NASA sees America and NASA right in the middle of this future.

So, where do we stand on this vision? Is it succeeding? Let's look one by one.

First, the Presidential leadership. On this the record is mixed. On the one hand, the White House has taken firm control of NASA, even in ways that would have made this old micromanager and politicizer blush. And I have no problem with this. It is right and appropriate. And the President has put his stamp on the program by a bold redesign of the space station and, even bolder, inclusion of the Russians.

As is exquisitely obvious by now, this administration is not adverse to risk. On the other hand, the White House has demonstrated what appears to be an occasional chilling indifference to space--organizationally, fiscally, even rhetorically.

Simply put, joint programs and efforts have been thwarted, and the NASA budget has not grown proportionately with DoD reductions as we had hoped.

Ultimately, the credibility of the President's commitment to his vision for NASA must be in the securing of necessary resources for a viable NASA to survive.

As to faster, cheaper, better, certainly the concept has caught on. However, it will take several more years to be able to point to concrete results, although certainly the Clementine mission must give inspiration and promise to what may be accomplished. Let me take a moment, however, to make sure that we are clear on the point of faster, cheaper, better. FCB was not designed to reduce NASA budgets or save money. In fact FCB was devised precisely when we hoped that the NASA budget would flourish and grow. While FCB held the promise to do more with less, it was not a budget inspired approach. FCB was promoted to reduce overall risk, accelerate and enhance results, and to keep management focused on the mission and building and flying space craft rather than on lobbying Congress.

In this regard, the recent CBO study fails. It is simply axiomatic that the old NASA could not accomplish the new NASA agenda. The real question is can the new NASA accomplish this agenda? Historical cost and schedule program data is unfortunately not a useful guide. Why not use the cost and schedule data from Clementine as a template, for example?

As to a more explicit relationship between NASA and national aerospace technology development, industrial base preservation, and defense conversion, the record is unfortunately weak. While DoD and NASA management have made extraordinary strides over the past four or five years to reduce barriers, enhance cooperation and facilitate the development and maintenance of common infrastructure, the Congress and to some extent this administration has not appreciated the synergism, nor facilitated its expansion. Simply put, joint programs and efforts have been thwarted, and the NASA budget has not grown proportionately with DoD

reductions as we had hoped. I believe my friend, successor and, now, colleague once again in Washington, Brian Dailey, said earlier at this symposium, the administration's attention to defense conversion is a welcome initiative, but not nearly enough to offset the damaging effects to the industrial base caused by catastrophic declines in defense spending.

In the previous administration, we had always seen additional investment in NASA as a logical, efficient and effective source of defense conversion. Unfortunately, the current environment sees NASA competing with Defense Department for the most draconian cuts.

Finally, to the matter of exploration, from competition to cooperation. This has been an exceedingly difficult transition to effect. Not only have we had difficulty in giving clear and unambiguous voice to the concept itself, we face the twin obstacles of urgency and necessity. Competition with the East, a formidable and determined foe, engendered an urgency that peaceful cooperation has difficulty summoning. Likewise, achievements by an adversary compel a necessity of response, which the seemingly optional matter of cooperation seems to lack.

The fact is that the principal difference between the space science program of the past decade and the space program of the next decade is the economy.

The question is, can NASA transcend its cold war lineage while maintaining its core mission objectives, that is to say, without becoming an entirely different agency with an entirely different focus?

Let me conclude by returning to my first point. For this new vision of NASA to succeed at this critical juncture, it will require the considerable attention and commitment of the White House and President. Only he can articulate the vision, NASA cannot, only he can influence the Congress on behalf of the people to pursue this vision with an adequate commitment of resources, and only he can provide the international leadership to cause cooperation to exist.

For decades NASA was propelled by the considerable forward motion of the cold war, now it must define itself independent of that imperative, the vision exists, now is the time for the testing of resolve and commitment. We will know by next year.

AL DIAZ: It was a little bit bothersome to me to hear that in going around the country talking about science, John Holliman of CNN, said that he got the impression that the general public didn't "get it." I am going to do something a little bit dangerous. I am going to argue with this statement. I think one of the problems has been, and one of the differences between what I think is the new space science and what was the old space science is that maybe *we* didn't "get it." I think that comes in several different ways. Today what we are seeing as an environmental condition in space science, that we didn't have before, are some new realities and some new expectations. The new realities are largely driven by the economy and the new expectations come from the taxpaying public. They have expectations of their science program that are consistent with what Dr. France Córdova observed earlier in the symposium — they are expecting to "find oil in these oil wells we have been digging" for the last decade.

We have had to do some soul searching in space science. I would like to demonstrate that we have changed our way of thinking towards a new way of doing business. The administration recognizes and has endorsed what we are doing and hopefully in the coming months, the Congress will do so as well. I feel that we are going to see more of this in the future.

I am reminded, whenever I talk about the new reality, of a comment that an undergraduate professor in Engineering Economy used to tell us all the time . . . the principal difference between science and engineering is economics. (He used that as an endorsement of his course.) The fact is that the principal difference between the space science program of the past decade and the space program of the next decade is the economy. Not only is this new reality constraining the size of our appetites, it is conditioning the expectations of our ultimate customer . . . the taxpayer.

As a direct response to this new economic reality and new expectations, the Office of Space Science has embarked upon the development of a new strategy for space science that now comes in three parts:

1. A mission/program strategy-that continues discovery, exploration, and expansion of knowledge, and provides inspiration and vision but does it with an emphasis on doing more with less and doing missions that are smaller, quicker and cheaper;

2. An integrated technology strategy-that provides for the formulation of a partnership between the Office of Space Science and Office of Advanced Concepts and Technology (OACT) in achieving national objectives for the development and transfer of technologies to indus-

try; and

3. An integrated education strategy-that provides for a partnership between the Office of Space Science and NASA s Office of Education in achieving national objectives for improving science and math literacy by taking advantage of characteristics intrinsic to the space science programs and its participants.

Our education strategy is still in its formative stages but it's already apparent that it will also articulate a new way of doing business. It will call for a partnership between OSS and NASA Office of Education in achieving NASA s objectives in support of the national education goals first articulated by the Federal Coordinating Council on Science, Engineering and Technology, or FCCSET, Committee on Education and Human Resources and now in preparation by the National Science and Technology Council (NSTC) Committee on Education and Training. It will put renewed emphasis on Kindergarten through 12th grade education and on the use of technology to broaden the impact of OSS education efforts.

We are in the process of changing the way this country conducts the enterprise of space science and I think that we do now "get it." We have seen some evidence recently that the Administration endorses the new vision for space science. Let me point to some testimony to that.

You know, after the loss of the Mars Observer in August of last year, there was an intense effort at NASA to identify an appropriate recovery mission response. There were some very strong and familiar voices in space science that spoke out in favor of a second Mars Observer, or what is sometimes referred to as MO-2, as the most cost effective way to recover all of the Mars Observer data. But many, including myself, felt that in addition to the practical issues of identifying and fixing the failure mode as well as getting the additional near term resources, MO-2 was another end which punctuated the old way of doing space science. Ultimately, NASA proposed and the Administration accepted, what I think is a new beginning ... the Mars Surveyor program.

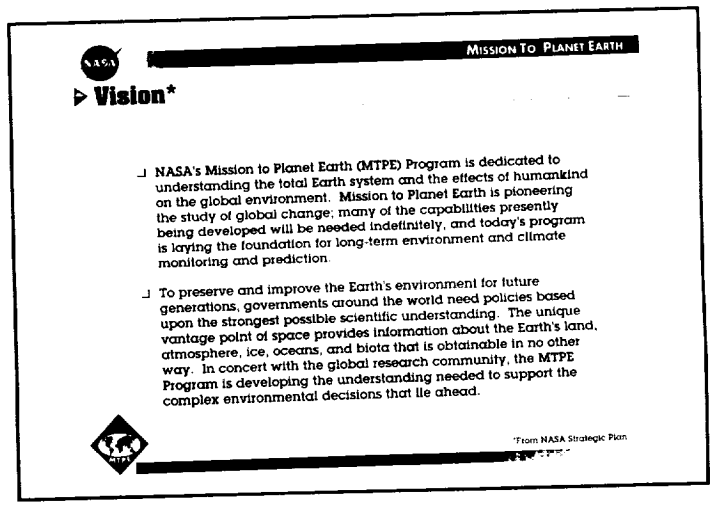
This program marries the Mars Observer science with the lander science, which was part of the planned MESUR (or Mars Environmental Survey) program, into a coherent program of Mars exploration which will continue into the next century. It could evolve into the U.S. contribution to an international Mars exploration program involving long range surface mobility, sample returns and network meteorology and seismology.

The program is built around the principal of distributed risk and frequent access. It requires a technology investment in order to achieve its low cost and scientific objectives. It will take advantage of industrial capabilities to the extent that they exist and require participation of the private sector for technology transfer and an educational initiative for each element. I believe that the inclusion of this initiative in the President's proposed FY 1995 budget is an endorsement of the new way of doing business in space science. I am convinced that if the Congress echoes that endorsement, we in NASA's Office of Space Science as well as our partners in the space science community, are committed to reshaping all of space science for the future.

GRANVILLE PAULES: This is just a vision statement from our strategic plan (Fig. NV-1). It is important for understanding the total Mission to Planet Earth program. Many people think that we are just focusing on climate change, ozone holes, that sort of thing.

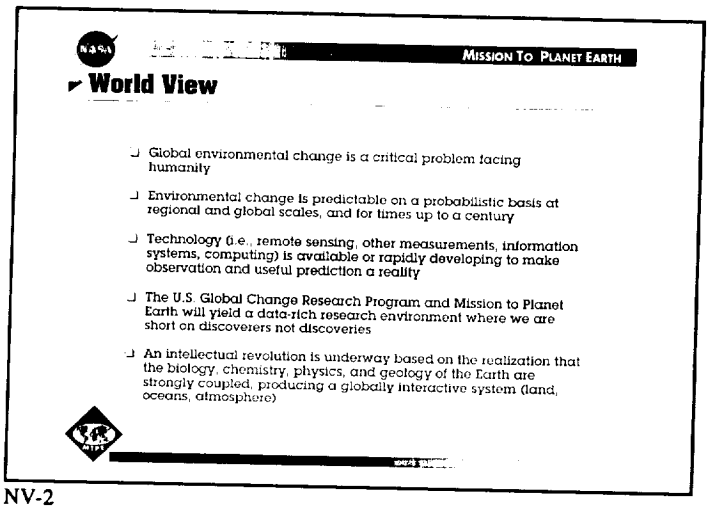
We are looking at it from a bigger perspective, considering the effects of humankind on the global environment. The key point in the mission is the issue of policies — "world need" policies — based on strong scientific understanding. The MTPE program is a science program; it provides a basis for our policy-related decision making. The program is global in scope. The scientific revolution including biology, chemistry, physics, geology are strongly coupled and a world system (Fig. NV-2).

The MTPE program covers the lands, seas and the atmosphere, and is a truly global program. We focus especially on human induced change (Fig. NV-3). We also study the natural phenomenon, like volcanism and the tectonic plate movement as they affect changes in ocean temperature and volume. When you try to understand these effects at a global level, you also get insight at a regional scale. The program is taking global infor

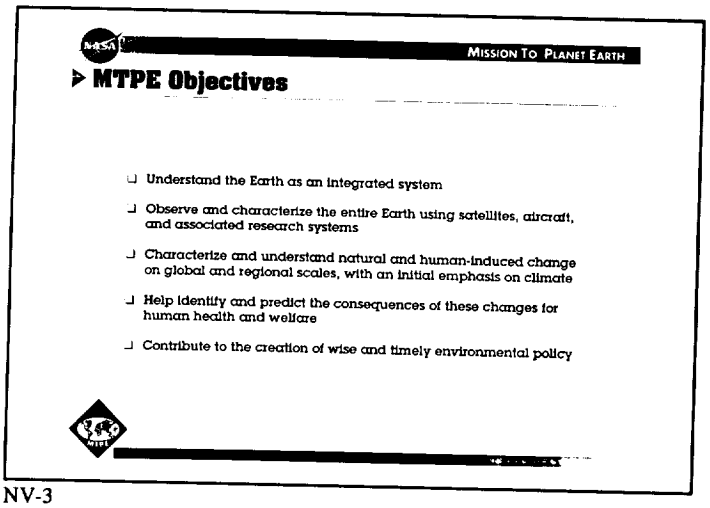


NV-1

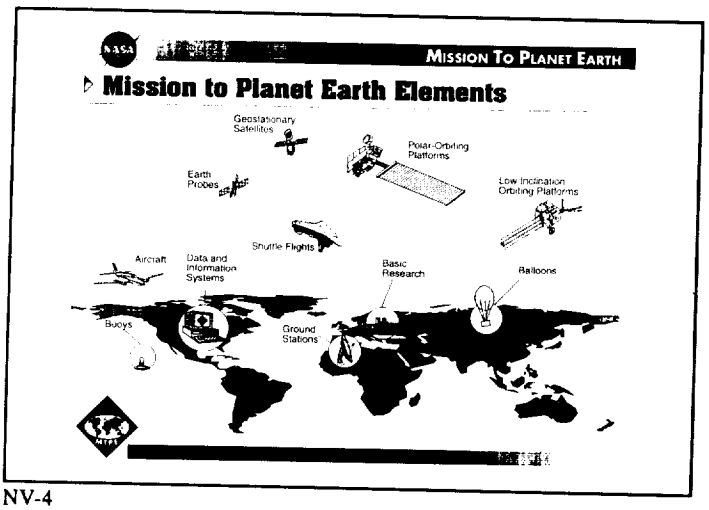
C-3



NV-2



NV-3



NV-4

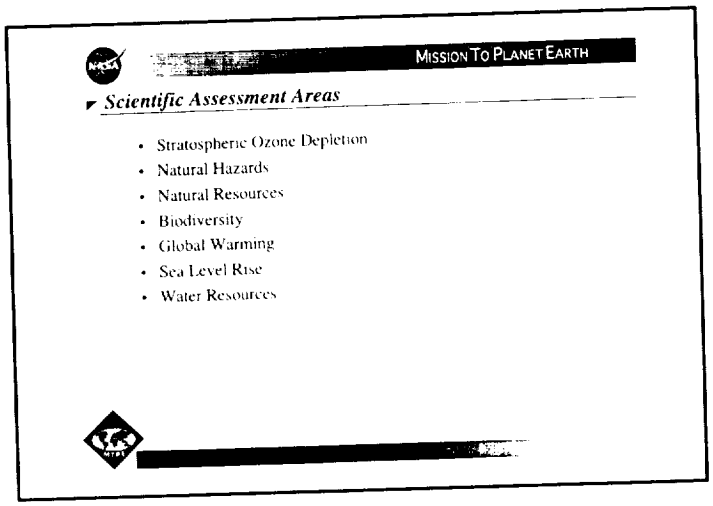
mation and making it available at a regional level for even more near term analysis.

The program includes spacecraft, balloons, aircraft and ground activity (Fig. NV-4). The aircraft provides a transition for the more sophisticated instruments moving from a prototype on to a qualified space instrument. Much of our work is done on the ground on basic scientific research. We use the instruments to collect the data — the scientific research turns the data into useful information (Fig. NV-5).

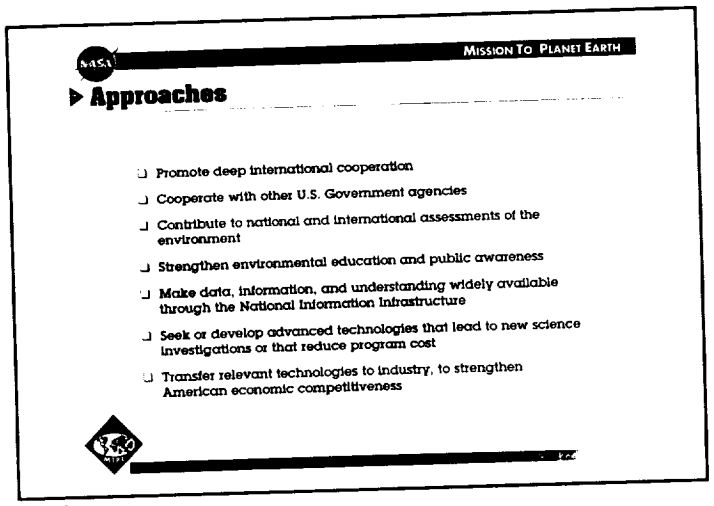
One of the major scientific assessment areas is ozone depletion. However, I won't spend time on this because most people in this room understand it. Other areas are of high interest and less well understood, especially natural hazards: earthquakes, volcanos and large scale flooding issues. Also, concerns for natural resources — deforestation is an example. Biodiversity, impacts resulting from land cover changes, habitat changes as a result of floral-fauna changes, and regional climate changes. Another emphasis is on global warming, including identification of sinks of greenhouse gases. Sea level rise is another interesting problem requiring understanding of how the sheet ice moves, ebbs, grows, and changes with climate. Finally we seek understanding of the water cycle from underwater aquifers to rain cloud making.

What is important for you to understand, is that this is a very large international program (Fig. NV-6). It has been one from the beginning and it grows each year. The global change research program is an international program. Also, Global Change has 11 major U.S. government agencies involved in research. We have a number of internal activities that I will talk about for just a second. In terms of what is new, our internal cooperation within NASA as Al Diaz pointed out is one of our major differences in the way we do new business. In the past, programs were very insular, very focused within NASA. But we found that there is good reason to cross fertilize the work we do. Also the National Information Infrastructure provides a major opportunity that we don't want to miss. We are seeking and developing advanced technologies. Seek is a big word — we think there are opportunities with the existing technologies available through defense conversion. Relevant technologies — we really just transfer relevant technologies in from industry. This dual use concept is being stressed these days and we will exploit it as fully as we can in these tough budget times.

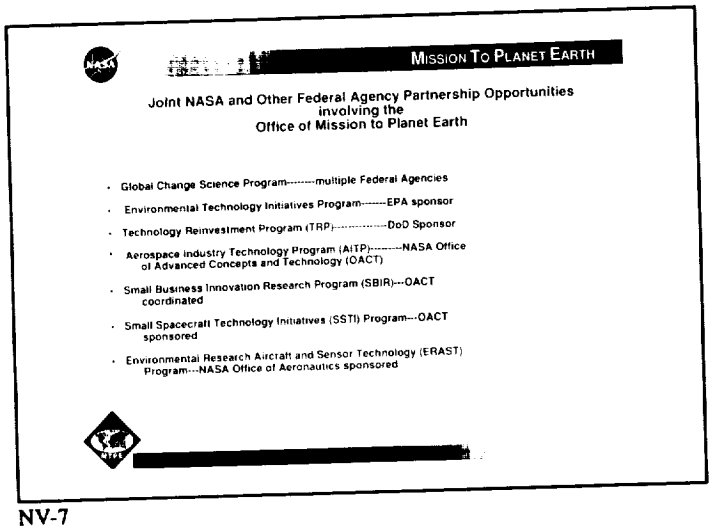
Just quickly, I wanted to summarize the scope of the way that we are working together with other programs (Fig. NV-7). I mentioned global change as a multi-federal agency effort. EPA has a major initiative that you may or may not know about. It is an important one to understand because we are working with EPA to develop joint ventures. They can be multi agency and combined with industry, with emphasis especially on



NV-5



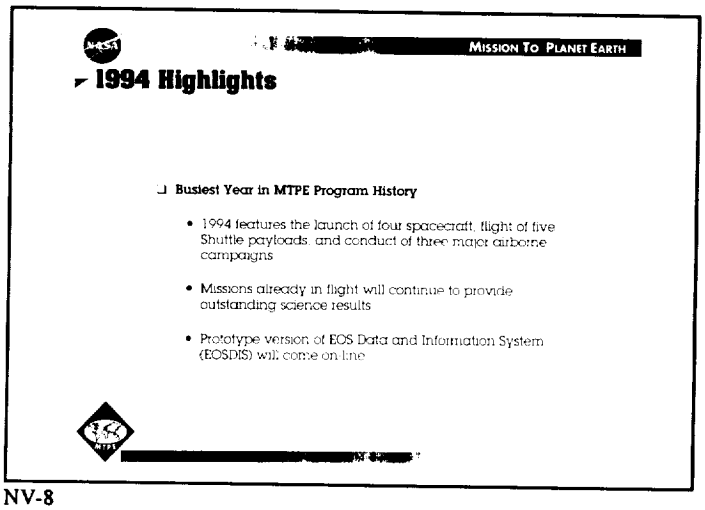
NV-6



NV-7

industry-focused ventures. The TRP program most of you know about, we are playing in that arena. The AITP, we are working closely with NIST to put that program together. Mission to Planet Earth is involved in that. We are very interested in taking advantage of this heavy push to do joint ventures. SBIR, most of you know about. It is not new, but it is being given a very heavy commercial flavor with industry partnershiping. In the SSTI — Sam Venerri's program — we are contributing and helping them select and evaluate the science that is viewed as a part of the mission objective. The NASA aeronautics has a new initiative program on unmanned aerospace vehicles. They will fly instruments that help determine aviation measurements for the hypersonic aircraft engines. The push is to reduce high level pollutants by aircraft engines. The upper atmosphere effects are of interest to us and we are working with them on initiatives to get good instruments selected as part of the overall program. Also, as another initiative, there is a proposal conference today that is pushing off on new ways to develop advanced information systems, use of AI expert systems, and so on to deal with very, very large and distributed databases. We have ongoing Shuttle activities, two kinds of ELV missions, some basic R&D, some operational NOAA and foreign space probe missions, and aircraft missions. We are working on the Landsat program transition from DoD to NASA. NASA will have responsibility for launching the Landsat and will work jointly with NOAA on its operation.

The Mission to Planet Earth program is going through change, it has been through a fairly traumatic time over the last couple of years because it was big — it is as visible as the space station (Fig. NV-8). We are making many changes internally to be efficient. For example, two of our activities were two of the "reinvention" labs within the agency — one dealing with access to science data and the other one dealing with management of institutional resources. We are fully pushing on the industry partnership idea within NASA and with other federal agencies. There is funding and opportunity for those here to apply for. Along the line of new initiatives, Dr. Kennel, our Associate Administrator, is interested in applying efforts of this program to much more near terms problems. He is stressing the near term environmental payoff of using this kind of technology. He has made it a major goal of the program to take advantage of our efforts. At the bottom line, we are not going to try improve on what Mother Nature does best, but we will try to understand her approach and attempt to deal with her vagaries and tantrums. Thank you.



NV-8

CONGRESSMAN BOB WALKER: I just want to talk a few minutes about a couple of things that I think need to be focused in on as we talk about vision because if we talk about vision being purely internal to NASA, I don't think at that point we get it. We are going to have to have a vision that looks and thinks beyond NASA if we are going to get a lot of things done that have been described. You have technical experts here that know a lot more about these programs than I ever will. Mark has worked with the breadth of these programs across the entire government and knows that far better than I do. But the one thing that I can talk about, is the political point of which we are working. I have to tell you that if we don't think beyond a narrow focus on NASA, we are in real trouble.

Let me talk about a few things I think it is possible to do and maybe will give you a sense of where we can go. There really is some potential being developed technologically, for new generations of new cheaper, reusable vehicles. It is extremely important that we latch into those kinds of technologies and develop them not just because they are the right things to do for the future of the space program, but also develop them for the reason that they also extend our ability to do a lot of other things. If you can in fact get cheaper vehicles, all of these things that we want to do in Mission to Planet Earth and any number of other technologies become far more possible within the budget constraints of Congress. So, latching on to those are important, but let me tell you, you are not going to be able to sell new generations of vehicles as a program that Congress has to fund in order to get there. What you are going to have to do is end up with partnerships, where NASA in fact is leveraging investment dollars in the private sector for this new generation of vehicles. I sure was excited the other day, and I don't want to brag on one company, because there are many of them doing exciting things right now, but the other day, Orbital Sciences Corporation came into see me to talk to me about their new generation of vehicles that they want to fly. They want to talk not about NASA coming up with all the money for them, they want to talk about their private investors coming up with the money and NASA being a partner in all of this. The problem for Congress is that NASA wouldn't necessarily direct a program like that and so you run into the political problem in Congress that says how do we keep control of all of this if actually the company is doing it and we are just a partner with the company.

... if we talk about vision being purely internal to NASA, I don't think at that point we "get it." ... I have to tell you that if we don't think beyond a narrow focus on NASA, we are in real trouble.

I have to tell you, if you are not willing to do some of those things you can't leverage any investments dollars out there. Leveraging those investment dollars I think is absolutely instrumental to moving us forward. We also have to be willing then to look at what investment dollars may follow. My guess is that those pictures that John talked about a few minutes ago would be a very valuable commodity in his industry and they would be willing to pay a lot for those kinds of pictures on a fairly regular basis, but one of the most intense fights that we have on Capitol Hill is not to get that kind of high resolution technology available. Heck, we can't even get people to sign off on the licenses for the low resolution technology. We have been in a life and death struggle over some of those kinds of things.

If you are going to leverage money in the economy as a whole, we have to look beyond where we have been in order to find places where people are interested in utilizing space technology for the benefit of us all. I think NASA has to get in the business of flying a lot of skunk work projects. I have also come to the conclusion that the political institution is not willing to sit still for long term programs. You simply cannot expect Congress to sit still while we plan for four years and then we try to bend metal for another four years and then maybe at the end of a decade, we actually have something that will fly. I tell you somewhere in the course of

that 10 years the patience runs out, the funding runs out, the political will runs out and you end up having to spend billions of dollars or at least hundreds of millions of dollars and get nothing for it. What we have got to do is come up with programs where you decide you can get something that flies, that at least gives a proof of concept, so that Congress has something to grab on to. I have been trying to encourage NASA with everything I can to come up with those sorts of projects so that you get the smaller, cheaper kind of philosophy into much of what we do in our programs.

I will also tell you that I believe it is time to begin utilizing a lot of the things that we develop as a part of the defense programs and a lot of other programs around the country. When you take a look at Mission to Planet Earth and a lot of things that we have done, I have been out and seen some of the miraculous things that have been done for the SDI program by Dr. Teller and some of his colleagues out at Lawrence Livermore. We ought to be taking a lot of that technology right now and figuring out a way to be using it in civilian programs. It is a damn shame that we would spend billions of dollars developing some technology and maybe never fly the SDI mission. We ought to take what we learned about computers that are microminiaturized and all kinds of things and adapt them to what we can do in civilian space. It is about time that we find ways of utilizing what we have developed over a broad scope in programs that are more narrowly focused.

I think also that the new vision has to include the kind of international content that you talked about. There is no way that you are going to do any big programs in the future that are not international in nature. If you depend upon being strictly a national program again, the problem is the big programs, the national will runs out and you cannot move them forward. As long as you have international content in those programs, what happens is that we can sell them on Capitol Hill in part because we have international commitments. And those international commitments are going to be instrumental it seems to me in any kind of NASA program that has legs for a long duration. Mark mentioned in his remarks, and I thought is was an extremely important point about the need for Presidential leadership as we try to move a new vision forward for space science and for space as a whole. Let me tell you the impression that I have, and it is based upon some meetings that I have had with President Clinton and it is somewhat different from where some of the public perception is and some of the perceptions within this community are. I think this President left to his own council would be extremely aggressive in the space arena. I say that because I sat in on some private meetings and heard him articulate a vision for space that is some of the most magnificent kind of wording that I have ever heard of why we ought to move forward.

The problem is that we are not necessarily hearing that as a matter of a policy statement from the Administration and Jack Gibbons' testimony on Capitol Hill the other day was a disaster where he suggested that you can cut the NASA budget in order to get more money for NSF. You can't have that kind of mixed signal coming to Capitol Hill, because I assure you that you will get exactly what they ask for. What you have to have is some understanding of what is really happening there, the Congressional Budget Office (CBO) study that was done, was a set up to assure that there are a variety of options available to the appropriations subcommittee when they begin to look at this dire circumstance that they are in this year. What that means is, you now have some people on Capitol Hill who have looked at that CBO study or at least the newspaper articles about it and said, oh, you mean we can have a space program for $8 billion. Yes, you could have one; it certainly won't be anything that shares any vision of anyone in this room, but you can have one. CBO has now given a roadmap for that kind of an effort and you can bet that you will hear it over and over again as part of the debate.

If some of that discourages you, at least understand that there are also a lot of things happening that I think are somewhat positive. I thought one of the more positive that happened the other day was we had gone through a whole exercise in our committee of implementing some of the things that the new Administration wants to do in terms of new kinds of economic policies that related to science. One of the things that they had in there that they wanted to implement, was the new Science and Technology Council at the White House which we approved and said that is something that we want to move ahead with. However, one of the items that was in there was to abolish even the authorization for the National Space Council. Our Committee took a look at that and decided you know at some point in the future we may want to come back to that; at the very least what we ought to do is leave the authorization in place. We understand that this Administration is going to go forward on its own, but let's leave the authorization in place and so George Brown offered the amendment the other day in committee that kept the authorization for the National Space Council in place. The reason that I say that is because it sends a positive signal. I think that we need to have some things out there that we are assured if we in fact can implement a mission that

some of the ways of coordinating that can in fact be put back together at the time that they are needed. I think our Committee has recognized that and made a commitment in that direction, I hope we can hold to it.

Q&A Session

QUESTION: Congressman Walker, what do you want to see in terms of successes from NASA to gain Congressional support or more funding.

WALKER: I think that NASA has to do a number of things. First of all, it has to show that what it says it will do on these programs can be done and can be done within budget. The days of being able to come up to Capitol Hill, describe a program, and then hope that some how the funding will follow despite the fact that cost overruns begin to pile up are over. Any kind of program like that brought to Capitol Hill any longer is dead before it hits the desk. If there is any suspicion that the funding levels are phonies, it is gone. So NASA has to be extremely effective in managing its program, and it has to present us with programs that are real from the outset. Secondly, I think that you have to fly hardware. That speaks to the need for faster programs. We can't spend years building big platforms, we are better off getting what data we can off small platforms and at least flying something. We are better off when we do aeronautical programs to be up flying things. If you are going to talk about hypersonic research, don't give Congress a bunch of drawings and a bunch of models, those will only last for so long. Ultimately, you are going to have to go out and fly some X-type airplanes, so that Congress can key in on what is real and so the public can key in on it. Part of this is establishing public support and a lot of those programs are where you build the base of public support that then feeds back into the Congress. I think that it is extremely important for NASA to develop programs that are capable of being flown in the near term.

QUESTION: Mark Albrecht, what are the areas of NASA and DoD cooperation that ought to occur right now?

ALBRECHT: I think the most obvious case for cooperation and most pressing issue is launch. We have tried, we have tried, we have tried. We have tried upgrades to current system. We have tried pushing the state of the current art for low cost, joint launch systems. We have pushed for exotic launch systems like National Aerospace Plane (NASP) and Single Stage To Orbit (SSTO). We have pushed for things like the Delta Clipper. We have tried everything. Improved launch capability is clearly the most urgent national requirement. It is a logical, natural thing for DoD and NASA to go in and, with all due respect to my friend Congressman Walker, the Congress, I don't know whether it is just jurisdictional, whether it is inherent, but there is an aversion in Congress for doing joint projects and taking advantage of obvious synergisms between departments. I think that launch is one, I think data processing, I think in the area of Mission to Planet Earth, is another one. DoD and the intelligence community have been dealing with enormous real time, near real time databases and data management, and dissemination for a considerable period of time. That technology is as Congressman Walker suggested, directly applicable to trying to move terabits of data around to support environmental research. Clearly, these two are first and foremost things that can be done jointly right away, should be done right away. I am embarrassed to admit, however, that they are not being done.

WALKER: I agree with Mark, but the only way that you are going to solve that problem is to ensure that members of Congress have something real to latch on to. I think part of the problem with this is we have talked about space transportation, but we have ended up giving Congress a series of drawings rather than as we were doing in the late 40s and early 50s out actually flying aircraft. I think you have to do that. If you can put an Apollo program together from scratch in a matter of a few years, the fact is that what you can do is fly a few programs that allow us to develop the base technologies for an Apollo-type effort at some point in the future. I just think with a host of new materials that we have learned about because of NASP some of the ideas for new engines are now coming on, some of the concepts that have been developed as a part of the SSTO concept. I think there are real potentials there to give us a real flyable vehicle, and that is extremely important in changing the mood in Congress.

JOHN HOLLIMAN: We may be outsmarting ourselves. One of the reasons that we are not flying those prototypes is we are substituting the cost advantages and schedules of simulations, enormous computer simulations. The good news is it moves the advancement of the technology along faster. The bad news is it leaves out a critical elements which is to be able to see it, smell it, touch it and watch it go do things. These pro-

grams go through generations all inside the computer which is technically efficient, cost efficient, but you leave out the intermediary steps of showing the customer, in this case the taxpayers, that the program is actually moving along.

WALKER: The reason we do that, in large part is to eliminate risk and we have become basically risk adverse in virtually everything we have done in the space effort and I am one who tends to believe that there is no way that you are going to have an aggressive space program if you are totally risk adverse. Somewhere along the line, you've got to decide to take a risk and that also goes back to some of the skunk work kinds of things.

QUESTION: Mr. Paules, is Sage II to go on the international space station? If yes, what happens to the EOS Arrow as a separate spacecraft system?

PAULES: The Sage instruments that we are going to fly on the space station are the next development cycle of the Sage instruments. A similar capability will be flown on EOS because the instruments, as I said earlier, assure consistency and comparability of data where the subtle differences are really important. A Sage type capability will be required. However, we need it earlier and we are going to fly it on our Shuttle.

QUESTION: Mr. Diaz, where should NASA direct its efforts for the next decade?

DIAZ: I think one of the places, is one that Mark has mentioned. I really believe we need to get on with the business of the next generation of space transportation. The notion that somehow when the mission is identified, the need will be there and we will develop the capability is naive. The fact s there will never be a mission requirement generated for a mission that requires a launch vehicle that doesn't exist. As a consequence, we all recognize that we need a new generation of launch capability and we ought to get on with it. In addition, as France talked about, we need to move into an era where we have a lot more short term demonstrations of progress as opposed to requiring long term commitments by the taxpayer of major investments of digging holes in the ground hoping "we are going to find oil." That is probably consistent with what Mr. Walker was talking about and I am familiar with what Mark has been talking about for years, this quicker, better, cheaper approach. We have been looking at what Strategic Defense Initiative Organization (SDIO) has done. I must tell you in the wake of the Mars Observer failure, the National Research Lab (NRL) and the SDIO have grown much closer to the Office of Space Science in terms of communications than we ever have been before. It is terrific in a lot more subtle ways than you think. Within about one-half mile from my house in Alexandria, Virginia is a space flight operations control center. I am embarrassed to tell you, being in the planetary program, that it wasn't until after the failure of the Mars Observer that I realized the Clementine operations is in downtown Alexandria. I went over there and was very surprised to find the high level of capability that was being produced by small companies. In fact, an "8A" minority owned company, out of Herdon, Virginia, is doing its image processing and doing a world class job. They are doing things, that frankly for years I had felt was a capability of only a very few large institutions. We are learning a lot from them and this is a good thing.

QUESTION: Congressman Walker, if NASA gets into the skunk work business as you suggest should the skunk works be located in somebodies factory in Alexandria, Virginia or in a NASA center some place.

WALKER: I think what NASA should do is allocate some money to some of the real pros in the field in hopes that they will also put some of their own investment dollars in these. I would like to see a skunk works project where NASA is leveraging some money from within the private sector and that would indicate it probably has to go beyond the NASA centers and is something that will principally be out there within the aerospace industry.

QUESTION: Mr. Paules, explain the National Information Structure from NASA's point of view.

PAULES: The Information Infrastructure is an emphasis that you heard yesterday on a global basis. At Mission to Planet Earth we are looking at whole new ways of moving data and information around. We are distributing data to science focused centers where it will be located. It can be accessed through Internet and Internet-like capabilities by any scientist and by any other user that wants to take advantage of it. For instance, many commercial applications in remote sensing tend to require higher resolution than much of the science data requires. The data we collect can, however, be used to extend small area, hight resolution data to a regional context. We anticipate lots of uses of data and the Na-

tional Information Infrastructure is a concept that allows a very transparent access to and use of the data.

QUESTION: Congressman Walker, you talked about the need for internationalism in big space projects. How about this reusable launch vehicle you are talking about, could that be done by an international consortium?

WALKER: Sure, it could be. It happens to be an area where we are probably further along than anyone else in the world. There may be some hypersonic engine technology that the Russians have been working on and some others have been looking at that we can find in an international program. This is one where we appear to have some leadership on it. If we can find some outside people who are willing to put some investment money in, that may be a way of helping to move along the technology. If we are not capable of funding it with public and private sources here, it does make some sense to look to see whether or not the Europeans, the Japanese and some others might want to also go with us towards building the new generation of launch technology.

QUESTION: Is NASA going to Mars in 1995 or 1996? If not then, when?

DIAZ: Absolutely, 1996. Two launches in 1996, one to the surface and one to orbit the planet. This is due to the fact that some of the vision outside of the Agency, the vision of Congress in retaining the funds to get this program started as quickly as 1994, vision of the Administration to make a commitment to do something that others would have hesitated in deciding that they had the will to return to Mars. I am absolutely convinced that we can do it and we are looking forward to it.

WALKER: The one thing that we have to realize, is that there is no way we are going to do any of those programs if the NASA budget takes a hit in the appropriations process. This idea that some how you are going to cut back some on space station, you are going to find some money in the Shuttle program and you are going to move money around and you can do it all and cut another $500 million out of the NASA budget beyond the cuts already been taken, it is just not possible to do. We are down to the point right now where we are going to have to scrub programs if the Appropriations Committee begins to cut into funding.

JOHN HOLLIMAN: Congressman lay odds on what is going to happen.

WALKER: I am not real optimistic; I've got to tell you. I hate to be a downer on this, but the real problem in that subcommittee is the fact that they not only took a hit on the NASA money, they also took a hit on the housing money. Money for elderly housing was cut, money for community development block grants was cut. Those are very popular political programs and they need to find a way to fund those in addition to funding veterans money in that committee. That is the reason the other day that the testimony indicating that the National Science Foundation was the foremost priority was a very disturbing piece of testimony because those guys are looking for ways to allocate money and move it around to do a number of things. That subcommittee, regardless of their intent, is going to have a very difficult job and I am fearful of what we may end up with.

QUESTION: Given a less than up beat forecast for at least the near term, and the next 5 to 10 years in aerospace employment, doesn't it seem obvious to you if and when the industry is revitalized, highly educated scientists and engineers may not be available? In the light of downsizing, some NASA codes are trying to work internally rather than support industry. This makes NASA a competitor of industry. How could this effect be mitigated or eliminated?

DIAZ: Let me answer the last one. the fact of the matter is that our Administrator is committed to that not happening. I think he is committed to NASA not being a competitor with industry. One of the ways he is making sure that happens, is by downsizing NASA in the process of downsizing the whole aerospace industry.

There is no place that this issue of excess talent currently and a future deficiency of talent, is more pressing than in the scientific fields. Let me tell you where we stand today. David Goodstein at Cal Tech did an article for a policy journal in which he indicated that we have more scientists alive today than have existed in the history of mankind. That statement has always been true. The number of scientists in this country is growing exponentially. The budget is not growing at all, so somehow we have to convince these scientists that the government is not the only source of compensation and there are other noble objectives that they can spend their lives on, like helping with the issues of education, and competitiveness. That is what we are going to have to do in the scientific fields to divert some of that talent

into other productive areas. With respect to the aerospace community, I think that in fact, some of the same thinking needs to take place. The military has done that to some degree in terms of the conversion of aerospace people in the military and retraining them for teaching.

ALBRECHT: I don't disagree with anything Al said, but I must say that I found what he said, even though I agree with it, absolutely chilling for a country that over the last 50 years has left the world economy behind largely on the basis of our technology advancements. It is absolutely chilling to me to consider a future for the U.S. in the golobal economy in 10 or 15 years if those trends go on. I would only take one small issue with what Al said, and that is, I believe the federal government is right in the center of developing that technology. That industry because of economies of scale, will never be able to develop the cutting edge technology that the federal government has created. We have enjoyed 50 years of Cold War imperatives that have allowed us to develop this enormous technology advantage. The question is, and this is a political question, how without that can we transition and maintain the fly wheel of technology for American economic growth? Our view was that a growing civil space program could take part of that weight. The Congress has to agree, but this Administration and its resource allocation has clearly not agreed. I think it sends a chilling signal of the economic prospects of the U.S.

WALKER: The problem is a political one because what you need is government/private partnerships at the present time. Government has resources that ought to be used in the private sector, the private sector has resources that are needed for government priorities. The problem is that the way you would get this done, is to have industry led partnerships utilizing government resources. There are all kinds of things that NASA has, that ought to used as part of an industry-led partnership in a whole variety of areas that you can come up with. The national labs are certainly places that could be utilized. The problem is, that the political establishment does not want industry led partnerships, what we are getting is government partnerships. We are bringing people in, we are putting together these consortiums at NIST and at other places. The problem is they are government-led consortia, and out of that, we are not getting advanced. What we are getting is a freezing in of the status quo because government is by nature reactionary. It is always behind the curve. The fact is that we ought to be letting the people out who are on the leading edge of these technologies lead the partnerships, and government provide the fill-in, but the political establishment won't allow that to happen.

Space Technology Hall of Fame Dinner

Norman R. Augustine
Chairman & CEO
Martin Marietta

It was suggested this evening that I focus my remarks on the policy of acquiring space systems. Now, as a late after dinner speech, I realize that stirs up about as much excitement that places it slightly ahead of reading the Congressional Record, but well behind the Federal Register. So, I am going to depart a bit from that topic and I thought I would rely on my book of laws a bit to talk about the space program. Those of you who have a copy of my book of laws, I would like to congratulate you on being a member of a very select, small group. Actually, one of the most-sought after collectors items today are unsigned copies of my book. I destroyed the value of several earlier this evening. One of the great things about writing books of laws is that the other people who write them, participate in a kind of a network of communication. I got a marvelous letter from Laurence Peter when my first book came out. This is true. He had written to me — I treasure this letter — he said that I had undermined his entire life's work. He said that I had risen not one, but two levels above my level of competence. The book has gotten me in a good deal of trouble, which I hope it won't this evening. For example, General Vuono some years ago, when he was Chief of Staff of the Army, before a large audience like this, said he didn't think much of my book because he said he didn't like my law that says "Rank times IQ is a constant." That does not apply to the corporate world, incidentally. I move now into a broader field of law writing: My most recent law — which I have very good empirical evidence in support of — states that tornadoes are caused by trailer parks.

"Here is Edward Bear coming downstairs now bump, bump, bump on the back of his head. It is as far as he know, the only way of coming downstairs, but some how he feels there really is another way, if he could only stop bumping for a moment and think of it."

Now as we meet here this evening, America's space program is suffering if not from tornadoes, certainly from heavy winds. It is has been heavily buffeted with many troubles, budget cuts, replanning of programs, starting and stopping, flight failures. Yet, it would seem that everyone in the program is working as hard as they ever have in their lives. It raises the question: What to do? I have been amazed how one finds the best advice in the most unexpected places.

Many years ago, when my children were very small, we seemed to be living through a period in the space program much like that I have just characterized. I was reading to my children the book *Winnie the Pooh,* and the opening lines of *Winnie the Pooh* tell about Edward Bear being dragged down the stairs by his feet, as he always was. The book starts out as follows, and it struck me that it applies so well to the space program then and now: "Here is Edward Bear coming downstairs now bump, bump, bump on the back of his head. It is as far as he know, the only way of coming downstairs, but some how he feels there really is another way, if he could only stop bumping for a moment and think of it." Well, tonight, my hope is that we can stop bumping for a few moments, and I would like to offer a few lessons taken from children's stories as they apply to the space program. And they turn out to be actually very, very profound.

Having given this world "Augustine's Laws," this evening in this very room, I am going to offer "Augustine's Space-age Fables," with apologizes to Aesop. For those of you from Brooklyn, I said Augustine's "fables" not "foibles." I am going to offer one fable for each day of the week, seven in all. Alright, fable number one, I have borrowed from *The Tortoise and the Hare.* You remember the story — how the tortoise and the hare had to race, and the hare would make a great sprint and then stop and rest for awhile, and the tortoise kept plowing ahead. At the end of the race, of course, the hare was resting sound asleep and the tortoise had won. Unfortunately, that characterizes much of the U.S. space program, I am afraid. For example, take the civil space program's funding. When the Committee on the Future of the U.S. Space Program met three years ago, almost everybody involved with the space program thought that a real growth of 5% to 10% per year for the foreseeable future was very realistic. But what we have seen instead

is each year a further decline in space funding, such that today, the space program is actually seeing a negative real growth. America, which placed the first humans on the Moon and dominated the free world launch market, today has people involved in the program who have

... almost everybody involved with the space program thought that a real growth of 5% to 10% per year for the foreseeable future was very realistic. But what we have seen instead is each year a further decline in space funding, such that today, the space program is actually seeing a negative real growth.

spent fully a quarter of their careers redesigning space stations. Meanwhile, Japan has developed its own launch vehicles, France dominates the commercial launch market, China builds increasingly robust space systems, and Russia has piled up a prodigious number of astronaut hours. So the tortoise somehow moves ahead, as the hare rests. Each new year there seems to be a new budget cycle, and each new year seems to bring a new space program. We are trying to do twelve-year projects, with four-year administrations, two-year Congresses, one-year budgets and daily newspapers. It is a very volatile mixture. Now let me put that fable in modern context, and to do that I am going to describe where I used to live near Fort Worth, Texas, where they said it was so barren there that a cow had to graze at sixty miles an hour just to stay alive. That is the modern fable of the space program.

That brings us to fable number two, the story of *The Dog and the Shadow,* which some of you may have read to your children or grandchildren. You remember: It is the dog that has the big juicy bone in his mouth, it's crossing a bridge and looks down into the water and sees its reflection. It looked like the dog in the water had a bigger bone than he did, so he dropped his bone and tried to grab the one from the reflection — and wound up with no bone, of course. I just stated otherwise, rather than always trying to leap-frog, maybe we should just keep the first frog. In both the civil and military programs, I am afraid we suffer from trying to do too much for the money. Our platter is too full. When we try to do so much, somehow we keep starting new programs, new undertakings, while we underfund the ones that are already underway. Needless to say, I would like a bigger space budget. But given that we do not have any great likelihood of a larger space budget in either the civil or military sphere, it would be my belief that we be well advised not to start a lot of new programs, rather finish the ones we have, fund them fully, and try to have our record be one of not how many programs we can start but how many we can complete. Putting that fable in the modern-day Aesop's format, my modern-day Aesop is my favorite philosopher Yogi Berra. I would like to quote him about what he has to say about this business of continuing to start new programs, continuing old programs — all at the same time without adequate budget. He addressed the subject of making choices and his quote was as follows, "When you come to a fork in the road, take it." Very good advice.

That brings us to fable number three, which is the famous one about *the goose that laid the golden eggs* which you remember so well. The person that owned the goose decided to cut the goose open to see if they couldn't get more of the eggs quicker — and the goose died. Our space program has had a lot of geese that laid golden eggs. One of them is the military space program about which, unfortunately, not a great deal can be said. Probably one of the brightest spots in technology in America. The SDI program, also a military space program, one about which we can talk a little bit more, is

We are trying to do twelve-year projects, with four-year administrations, two-year Congresses, one-year budgets and daily newspapers. It is a very volatile mixture.

in great danger of becoming an example of the goose that laid the golden eggs. It has produced very important technology. There are many who credit the decision in the Soviet Union to reassess the practicality of continuing the arms race to the progress that was made in the SDI program. Today, we have this cutting-edge program that is very much in danger of producing few, if any more golden eggs, because it has been cut back so heavily. In fact, one of Augustine's laws of SDI programs is that our goal is to win a program in SDI where our manpower peaks at sometime other than at the proposal phase. My colleagues told me not to say that.

Another example of the "goose that laid the golden egg" problem would be the manned space program. We started out with the Apollo program and all its great

accomplishments, technological and philosophical as well. Then, the shuttle in which took such enormous pride in its accomplishments. The next logical step in that sequence, in my judgement, is clearly the Space Station, but there are many, even in the space community, who oppose the Space Station. There are many reasons. Some say the reason is that if the Space Station were to be gone, there would be more money available for other space pursuits. It is my belief that we deceive ourselves if we believe that. The fact is that the Space Station is the linchpin in the civil space program. If we have no space-based station, we probably don't need a shuttle. If we don't have a space shuttle or a space station, we don't have a human in space program in America. It is my belief, if we have no human in space program, which is the main focal point for the public's interest in the program, we will see the interest in *all* space activities diminish markedly, whether they are scientific programs, earth observation programs, or what have you. So, the modern day version of Aesop's fables relating to the Space Station and programs like that is taken from the view of the opponents to those programs, one of whom went to work one day and the boss came in. It was a boss that nobody particularly cared for. This boss happened to weigh about 240 pounds, and the boss announced that he was going to go on a diet and was going to be losing five pounds a week. Everybody was ecstatic, because they figured they would be rid of him altogether in just 12 months. Well, that could happen to our Space Station if we are not careful. In other words, we better help Goldin save "Goldin's Golden Egg."

Turning to fable number four, that is the story of *The Ant and the Grasshopper*. You remember the ant worked all summer long. He put food down in his ant hill. The grasshopper spent the whole summer jumping around, hopping around, having a grand time, singing all evening. When winter came, of course, the grasshopper froze to death and died from lack of food. The tech-base that underpins the space program has a lot in common with the ant and the grasshopper story. The tech-base that produces the building blocks for future major programs has declined in funding almost every year since the Apollo program. It has now been 22 years since America has developed a new main rocket engine, which is, of course, the heart of the space program. We can no longer continue to live off the efforts of the past.

We can no longer continue to live off the efforts of the past. The tech-base is not glamorous; it is just important.

The fact is that the Space Station is the linchpin in the civil space program. If we have no space-based station, we probably don't need a shuttle. If we don't have a space shuttle or a space station, we don't have a human in space program in America.

The tech-base is not glamorous; it is just important. We have tended to keep putting it off, assuming that if we put it off long enough, it will all become clearer and the problem will resolve itself. But I think we fool ourselves to think that. The modern version of that fable would be taken from John Lowenstein of the Baltimore Orioles. He was asked one time, "What would you do to improve the game of baseball?" His answer was: "Move first base back a step to cut out all the close plays." That is what we are doing to the tech-base I am afraid.

So we move on to fable number five, which has to do with *The Milkmaid and the Eggs*. You remember that the milkmaid had a bucket of milk and was walking to the market. On the way, she became enthralled with prospects for the future — she thought she could sell the milk for a bucket of eggs, take the eggs home, hatch them into chickens, chickens would grow up and she could trade them for a pig, and then the pig would grow up and she could trade it for a cow. She walked to the market thinking all of these wonderful thoughts. Looking off into the sky, she tripped and fell and spilled the bucket of milk, and that was the end of the whole thing. There are certain parallels there to the space program. Certainly, we can have all kinds of dreams of great things in space, but we will fall to Earth if we don't pay attention to the most down-to-earth ingredient of all, that ingredient that makes the whole space program possible, mainly a viable space launch capability, space transportation. In this case, America's progress the last few years is not an Aesop's fable, it is a "Grimm's fairy tale." The Committee on the Future of the U.S. Space Program recommended getting on with a new launch vehicle, and I strongly endorsed that at the time we

made the recommendation. About the only thing that I would change in what that committee said, with three years' hindsight, is in the area of launch vehicles. I have become convinced pragmatically that America probably cannot afford to develop a new launch vehicle in the foreseeable future. Given that, what then should be our policy with regard to launch vehicles? Let me suggest to you the policy I have been proposing for a year or so. The first of which, is that any new launch vehicle will have to be a joint effort of NASA and the Air Force. The second is that we should upgrade the current fleet of launch vehicles principally to improve their reliability, partly to reduce their cost, but there is great leverage to doing that. We should invest in breakthrough technology for a new generation of launch vehicles to be developed in such time that we could afford to do it and that we have the technology in place. I think we should use the Shuttle only for missions where there is a payoff from having humans in space for in situ missions. We should buy no new shuttles, no new orbiters. We should spend the money on upgrading systems we have, including the Shuttle. I believe in the case of commercial payloads, whoever pays for the payload, whoever buys the end-objective, should be able to choose on what vehicle they want to launch it. I think that in the case of U.S. government launches, it is probably in the best interest of U.S. government to try to preserve a viable U.S. industry and U.S. launch capability by using U.S. launch vehicles. I would exclude the case, of course, where allies working on joint programs offer free launch capabilities as part of their contribution to a project.

We should invest in breakthrough technology for a new generation of launch vehicles to be developed in such time that we could afford to do it and that we have the technology in place.

That's the rudiments of what I would propose for a space-launch capability that might help us not have the problem of the milkmaid and the eggs, of looking too much to the sky and neglecting what is right in front of us on the ground.

The modern-day version of the milkmaid and the eggs fable is one that I borrowed from Bud Wilkinson's son. Wilkinson, as you all know was the great coach of Oklahoma for many years. His son some years ago was running for Congress, and he had a well financed campaign. He ran television spots for months before the election, flooding the air waves. The basic spot he used was one that showed him walking across a beautiful Oklahoma field, looking up into the sky, very contemplative. Meanwhile, in the background, the announcer droned on about how if you voted for Wilkinson, he would bring you to this great future that you could look to in the sky. His opponent was a "good old boy" from Oklahoma who not that many people knew. He didn't have enough money for a campaign; he hardly campaigned at all, in fact. About two days before the election, he started his own series of spots; they were 15-second TV spots, very inexpensive. They consisted of a close-up of his face — not all that attractive. Anyway, there was a close-up of him and he was talking. He was saying, obviously alluding to his opponent, he said, "Well, my father wasn't a famous football coach, my wife wasn't Miss Oklahoma, I didn't go to Harvard, I don't have a million dollars, but I do know that when you're walking through a cow pasture, you don't look up into the sky." Needless to say, he won by a mile. All of which suggests to me, as we walk through this cow pasture, that we keep our eyes not only on the sky but also how we get there and be sure that we don't lose our launch capability along the way.

In the case of the space program, there *are* wolves out there. You can't avoid them, you have to live with *risk* if you want to have a space program. It's not possible to learn to swim by walking around the swimming pool.

That brings me to fable number six, the story of *The Three Little Pigs*. You remember they built the house out of straw, brick and so on, and the wolf got the ones who didn't build the houses well enough. In the case of the space program, there *are* wolves out there. You can't avoid them, you have to live with *risk* if you want to have a space program. It's not possible to learn to swim by walking around the swimming pool. You can minimize risk, for example, by having financial reserves, schedule reserves, always having two flight articles, not one. That comes under the category, "If it is worth doing at all, it's worth doing well," and certainly by supporting the investments in the tech-base. Still, even with all of these ameliorating effects, it is

necessary to take risks. I am not proposing irrational risks, I am proposing prudent risk-taking. Columbus would never have discovered America had he been afraid to leave the harbor. America never would have gone to the moon if we had been afraid to leave the launch pad at Cape Kennedy. The modern-day version of *The Three Little Pigs* on risk-taking, is a true story from a course my wife and I took called "Pace." It was

I would ask the question, and ask yourself honestly: Do you think we could do the Apollo program today in 10 years? Remember in the Apollo program, that of the first 11 probes that we launched to find a landing spot on the moon, 10 of them failed.

a little three-day program on decision making and managing your life. The speaker got up, he was trying to make the same point I was just making about prudent risk-taking, and he picked a volunteer from the audience. This fellow stood up — as I said this is a true story — and the speaker said, "Supposing I have a huge I-beam that is laid across the stage here in front of me, and I said to you if you'll walk across that I-beam I will give you $20. Would you do that?" The fellow in the audience said, "Sure." The speaker said, "Okay, suppose I take the same identical I-beam and I suspended it between two 40-story buildings across a highway and I say to you if you'll walk across the I-beam, I will give you the sam $20. Would you do it?" The fellow in the audience said no, he wouldn't do it. The speaker had made his point and should have stopped, but he plowed ahead. He said, "Supposing this same I-beam is between these two 40-story buildings and you are on that building over there and I am on that building over here and I am holding one of your kids out over the edge of the building. I say to you if you don't walk across that I-beam, I am going to drop your kid. Now would you walk across the I-beam?" The fellow in the audience said, "Which kid do you have?" So clearly, we should give careful thought to what program we have, what objective we have before we take risk, but I worry that America has become very risk-averse.

That brings us to fable number seven, the last one which is about *The Boy Who Cried Wolf.* You remember that story well, but in the modern case the problem is not one of paying too little attention to those who cry wolf. In our case, I think it is one of applying too *much* attention to those who *pretend* to cry wolf. I suppose you could use "Chicken Little" as an example of this point incidentally as well! "The sky is falling down." In this regard, I speak of some of those in the media who would describe our space program, some of those who are investigators, some who are auditors, some who are watchers, some of those who are checkers. Not long ago, the GAO discovered a roof at NASA that leaked. That turned out to be front-page news around the nation, because NASA had roofs that leaked. The slightest problem in checking out a shuttle produces a horde of reports of problems in the shuttle program. The *Washington Post* discovered not many years ago a toilet seat on an airplane that they thought cost a lot of money, and that toilet seat became kind of the symbol of the then-Secretary of Defense, one of whose other accomplishments was to help bring about the SDI program that has had such a major positive effect. But the impact of that was somewhat lost by the image that they always painted of him with a toilet seat around his neck. Every problem somehow seems to become a catastrophic world-threatening event. I would ask the question, and ask yourself honestly: Do you think we could do the Apollo program today in 10 years? Remember in the Apollo program, that of the first 11 probes that we launched to find a landing spot on the moon, 10 of them failed. We lost three astronauts in a fire. There was a major war that broke out and conducted in the middle of the Apollo program. The President who started the program was assassinated. Obviously I am not arguing for covering up programs or problems or minimizing problems, but I am arguing that we need to put our problems in perspective. Today, the headlines about the Superbowl say that the Buffalo Bills lost four Superbowls; they don't say that they went to four consecutive Superbowls. The newspapers today, if they were to report on Babe Ruth's life, undoubtedly would say that he struck out over 1300 times. They would very likely point out that in the basketball tournament just completed, that 63 of the 64 teams lost. Or as a tennis coach once told me — and it never really occurred to me — the first thing he told me in giving a tennis lesson was that half the people who play tennis lose — a dreadful thought.

Actually there is precedence for all this, because when Dr. Robert Goddard flew his first liquid rocket in the cabbage patch up in Massachusetts, you recall that the *New York Times* report dismissed that magnificent achievement by saying his rocket had fallen 234,000

miles short of the moon. They went on to explain that he should have known better because as everyone knows a rocket won't work in a vacuum because there is nothing to push on. Well, the modern version of this fable is taken from the great hockey goal tender Jacques Plante and his quote is as follows, "Goal tending is a normal job. Sure! How would you like it if in your job every time you made a small mistake, a red light went on over your desk, and 15,000 people stood up and yelled at you?" He is well qualified to become "CINC-Space" or the head of NASA.

"Americans will always do the right things — after having exhausted all other alternatives."

In conclusion, those are the seven lessons that I think we can all learn from our children and grandchildren, that if we applied them to America's space program — military, civil and commercial — we would be far better served. It's been just 25 years ago that we went to the moon, and we got there because we apply the lessons of the tortoise and the dog and the goose and the ant and the milkmaid and the boy and the three little pigs. But we must never fall into the position that is taken by some who would dismiss our space program, those who would say, "The grapes were probably sour anyway." I, for one, believe that we can take great pride in what has been accomplished. I believe that what has been accomplished is barely a beginning. I am very proud to be associated with the people that are helping us take this next great step for mankind, and I take encouragement from Winston Churchill's words to the effect that, and I quote, "Americans will always do the right things—after having exhausted all other alternatives."

****

1994 SPACE TECHNOLOGY HALL OF FAME INDUCTEES

Space spinoffs—materials and products originally developed for applications in space programs which have made significant contributions to benefit all people— are nominated for induction each year into the Space Technology Hall of Fame.

Sponsored by NASA since 1988, the Hall of Fame honors individuals and companies responsible for these remarkable products. While there can only be a limited number of "inductees," every product nominated is truly a winner. Each is an innovation, extraordinary in its valuable, practical applications for the benefit of human kind.

Digital Imaging was developed in the mid-1960s to explore the surface of the Earth's moon. Conventional camera equipment mounted in the unmanned Ranger spacecraft returned distorted, lopsided images from the moon. Digital Imaging—a process that turns analog signals into digital signals which are, in turn, fed into a computer for enhancement—returned sharp, accurate images of the lunar surface. Today, Digital Imaging is used in familiar medical applications such as CAT-Scans, Ultra-sound images and advanced X-ray technology. It is also used for surgical monitoring and brain or cardiac angiography.

Digital Imaging was developed through the cooperative efforts of: NASA Jet Propulsion Laboratory, NASA Lyndon B. Johnson Space Center, NASA John F. Kennedy Space Center, NASA John C. Stennis Space Center, NASA Goddard Space Flight Center, Perceptive Scientific Instruments, Inc., Mallinckrodt Institute of Radiology at the Washington University School of Medicine, Robert Nathan, Ph.D., Robert Selzer, Kenneth R. Castleman, Ph.D., Don G. Winkler, Michael W. Vannier, M.D., Robert L. Butterfield, Doug Rickman, Ph.D., Douglas M. Jordan, Ph.D., Arlene G. Kerber, and Janette C. Gervin, Ph.D.

Excimer Laser Angioplasty System, a laser system initially developed for satellite-based atmospheric studies, is now a powerful instrument for treating heart disease. Laser angioplasty is a procedure where a thin fiver-optic catheter is inserted into an artery in the leg and threaded to a blockage in a coronary artery. A tiny optical assembly diffuses the laser strand into a small cone-shaped laser beam as it is emitted from the catheter. The nonthermal laser vaporizes blockages in the artery without damaging delicate tissue. The procedure can be performed in a non-surgical setting using a local anesthetic. The hospital stay is minimal, and there is less post-operative pain, discomfort and risk to the patient.

Excimer Laser Angioplasty System was developed through the cooperative efforts of NASA Jet Propulsion Laboratory, Cedars-Sinai Medical Center, Advanced Interventional Systems, Inc., Spectranetics Corporation, James B. Laudenslager, Ph.D., Tsvi Goldenberg, Ph.D., Thomas J. Pacala, Ph.D., Warren S. Grundfest, M.D., Frank Litvack, M.D., and James S. Forrester, M.D.

Featured Speakers

Norman R. Augustine

Dr. France Córdova

Dr. Roland Doré

Norman R. Augustine

Norman Augustine has been chairman and CEO of Martin Marietta Corporation since 1988 and 1987, respectively, having previously served as president and chief operating officer. Prior to his move to Martin Marietta, he served as undersecretary and assistant secretary of the Army; vice president, Advanced Programs and Marketing for LTV Missiles and Space Company; assistant director of Defense Research and Engineering in the Office of the Secretary of Defense in the Pentagon; and program manager/chief engineer for Douglas Aircraft Company. Augustine has served as chairman and president of numerous governing boards of directors to include the Defense Policy Advisory Committee on Trade; the American Institute of Aeronautics and Astronautics; the Defense Science Board; the Aeronautics Panel of the Air Force Scientific Advisory Board; the NASA/White House Committee on the U.S. Space Program; and the NASA Space Systems and Technology Committee. He has also served on advisory boards to the White House, U.S. Senate, NASA, FAA, and the Departments of Defense, Army, Navy, Air Force, Energy and Transportation, The General Accounting Office, and NATO. Augustine is the current chairman of the Board of Governors of the American Red Cross and executive vice president of the Boy Scouts of America. He has four times been awarded the Department of Defense's highest civilian decoration, the Distinguished Service Medal, and has received the Defense Meritorious Service Medal, the Army Distinguished Service Medal, the Air Force Exceptional Service Medal, and the Department of the Treasury Medal of Merit and Gold medal of Merit. Augustine is co-author of The Defense Revolution and author of Augustine's Laws. Augustine attended Princeton University where he was awarded a BSE in Aeronautical Engineering magna cum laude, and MSE and was elected to Phi Beta Kappa, Tau Beta Pi and Sigma Xi.

Dr. France Córdova

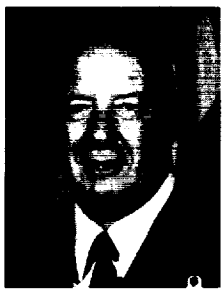
Dr. France Córdova was appointed chief scientist of NASA in 1993. She serves on NASA's Inventions and Contributions Board and the Presidential National Medal of Science Committee. Prior to joining NASA,Córdova was department head of Astronomy & Astrophysics at Pennsylvania State University. Previously she served as deputy group leader, Space Astronomy & Astrophysics Group and staff scientist, Earth and Space Science Division at Los Alamos National Laboratory. She has been active in many scientific societies and organizations including vice president of the American Astronomy Society, Advisory Committee for Astronomical Sciences at the National Science Foundation, Committee on Space Astronomy & Astrophysics of the Space Science Board of the National Research Council, and Board of Directors of the Association of Universities for Research in Astronomy.Córdova is recognized in many publications including Who's Who in America, Who's Who in Frontier Science and Technology, and The World Who's Who of Women. She has authored 90 scientific papers and reports.Córdova received a B.A. with Distinction in English from Stanford University and a Ph.D. in Physics from California Institute of Technology. She is a member of the International Astronomical Union, American Astronomical Society, Sigma Xi and the Los Alamos Mountaineers.

Dr. Roland Doré

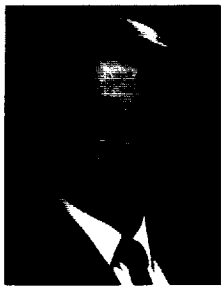
Dr. Roland Doré was appointed president of the Canadian Space Agency in 1992. He oversees the implementation of the agency's mandate to promote the peaceful use and development of space, to advance the knowledge of space through science and to ensure that space science and technology provide social and economic benefits for Canadians. Previously he was vice president of the Natural Sciences and Engineering Research Council. Doré was appointed Dean of Research, then Dean and Director, and finally Principal and Chairman of the Board of the Ecole Polytechnique at the Université de Montréal. His energy and commitment earned him the presidency in many of Canada's leading academic and professional organization including the Advisory Committee of Industrial Materials Research Institute of the national Research Council of Canada as well as the national Committee of Deans of Engineering and Applied Sciences of Canada. Doré has authored or co-authored more than 70 scientific papers and lectured extensively at international conferences. He has made important contributions to major projects in applied engineering research and design for MLW-Worthington, Canadian Vickers, Babcock and Wilcox, and Dominion Bridge. Doré is a member of the Canadian Society for Mechanical Engineering, Engineering Institute of Canada, the Canadian Academy of Engineering, Sigma Xi, and the Ordre des Ingénieurs du Québec. The Engineering Institute of Canada awarded him the Julian C. Smith Medal; the Canadian Royal Military College of St-Jean and McGill University an honorary degree, and the Centre Jaques Cartier, the Centre's medal. The Ordre des Ingénieurs du Québec awarded Doré the Grand prix de l'Excellence. In recognition of his significant contribution to Canada, he became an Officer of the Order of Canada in 1992 and received the Confederation 125th Birthday Commemorative Medal. Doré holds an engineering degree from the Ecole Polytechnique of the Université de Montréal and an M.S. and Ph.D. in Mechanical Engineering from Stanford University.

Featured Speakers

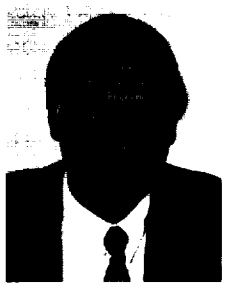
Daniel S. Goldin



Gen. Charles A. Horner



Jean-Marie Luton



Dr. Jan-Baldem Mennicken

Daniel S. Goldin

Daniel S. Goldin became NASA's ninth administrator in April 1992. He began his career with NASA in 1962 at the Lewis Research Center in Cleveland, where he worked on electric propulsion systems for human interplanetary travel. He rejoined the agency last year after serving as vice president and general manager of the TRW Space & Technology Group in Redondo Beach, Calif. In that position, he managed the development and production of 13 advanced spacecraft, technologies and space science instruments. Under his leadership, the Space & Technology Group won the 1990 Goddard Award for Quality and Productivity. It was a finalist in 1991 for the George M. Low Trophy - NASA's highest quality award for contractors. In 1992, working with NASA, the TRW group received the National Space Club's Nelson P. Jackson Aerospace Award for work on the Compton Gamma Ray Observatory. A native of New York City, Goldin earned an undergraduate degree in mechanical engineering from the City College of New York.

Gen. Charles A. Horner

Gen. Charles A. Horner is commander in chief, North American Aerospace Defense Command and the unified U.S. Space Command, and commander of Air Force Space Command at Peterson Air Force Base, Colo. Horner entered the Air Force in 1958 through the Air Force Reserve Officer Training Corps upon graduation from the University of Iowa. He earned his pilot wings in 1959 and began his flying career in the F-100. His military career has included assignments to England, North Carolina, Thailand, Virginia, Washington, D.C., Florida, Nevada, Arizona and New Mexico. During two tours in Thailand, Horner flew 111 combat missions over North Vietnam in the F-105. He also served as commander of the 23rd North American Aerospace Defense Command Region and Tactical Air Command Air Division at Tyndall Air Force Base, Fla. In August 1990, he deployed to Saudi Arabia as the forward commander for U.S. Central Command as well as the commander of U.S. Central Command Air Forces. There he assumed command of all U.S. and Allied air assets for the duration of Operations Desert Shield and Desert Storm. Horner has been in his current position since June 1992. He has been decorated with Canada's Meritorious Service Cross and honored by France, Pakistan and the sovereign states of Bahrain, Kuwait, Saudi Arabia and the United Arab Emirates.

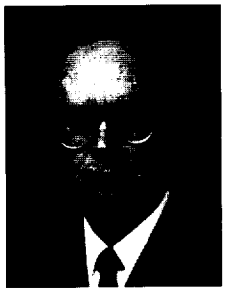
Jean-Marie Luton

Jean-Marie Luton has been the director general of the European Space Agency since 1990. Prior to his move to ESA, Luton served as director general of CNES, the French Space Agency, and as director for space programs within the Strategic and Space Systems Division of AEROSPATIALE Company. Luton has also served as ChargÇ de Recherches at CNES and as ChargÇ de Mission at the Service des Programs des Organismes de Recherche within the Ministry for Industrial and Scientific Development. In the latter capacity, Luton was involved in drawing up the French position on space policy and in the European negotiations which led to the creation of the European Space Agency and the adoption of the Agency's programs. In 1974, he joined CNES where he served as head of the Research Programs and of the Planning and Projections divisions. In 1978 he was appointed director of programs and planning, a post he held until 1984, when he became deputy director general. Luton is Officer de l'Ordre National de Merite, a member of the International Academy of Astronautic, and in 1985, was awarded the Astronautics Prize of the French Association for Aeronautics and Astronautics.

Dr. Jan-Baldem Mennicken

Dr. Jan-Baldem Mennicken is director general of the German Space Agency (DARA). He is also the head of the German Delegation to the European Space Agency and chairman of the European IGA Coordinating Committee and spokesman for the European delegation. Prior to joining the German Space Agency, Mennicken held many leadership positions with the Federal Ministry for Research and Technology where he served as deputy section head for International Research Organizations, head of the directorate for Administration, Finances, Research and Technology Policy and head of the directorate for Environmental, Marine and Polar Research, Geosciences, Aerospace and Transportation. He has also served in the Foreign Office on assignment to the Permanent Delegation of the Federal Republic of Germany to the EC in Brussels as head of the division for Research, ERATOM, Science, Environment and Education. Mennicken completed studies in law and political science at the Universities of Bonn and Cologne and received a Doctorate in Law (Dr. jur.) from Cologne University.

Featured Speakers



Admiral William O. Studeman

Dr. Edward Teller

Rep. Robert S. Walker

Masato Yamano

Admiral William O. Studeman

Adm. William Studeman was sworn in as deputy director of Central Intelligence on 9 April 1992. As the principal deputy to the Director of Central Intelligence, he has responsibilities in the Intelligence Community and for the direction of the Central Intelligence Agency. He has served as the air intelligence officer, Air Anti-Submarine Warfare Squadron 23 where he made several deployments to the western Pacific aboard USS YORKTOWN; as a member of Staff Amphibious Group One, which was twice deployed as the staff of the Seventh Fleet Amphibious Force Commander; in Naples with Commander, Fleet Air Mediterranean/Commander, Anti-Submarine Warfare Force, U.S. Sixth Fleet; Washington duty in the Naval Intelligence Command, including an extended period of time attached for duty to Defense Intelligence Agency for duty in Iran, and CNO Staff as Executive Assistant to the Director of Naval Intelligence; assignment as OIC, Fleet Ocean Surveillance Information Facility, Norfolk, while assigned to the staff of Commander in Chief, U.S. Atlantic Command/U.S. Atlantic Fleet, and ACOS Intelligence on Commander, U.S. Sixth Fleet staff in Gaeta, Italy. In 1980, Studeman served as Executive Assistant to the Vice Chief of Naval Operations, and as Commanding Officer of the Navy Operational Intelligence Center. His first flag assignment was as the Director of Long Range Planning Group and Executive Director of the Advanced Technology Panel of the CNO Executive Board. Studeman became the 53rd Director of Naval Intelligence in September 1985. Selected for promotion to Vice Admiral, he became the 12th Director of the National Security Agency on 1 August 1988. He holds a B.A. in history from the University of the South, is a distinguished graduate of both the Naval War College and the National War College and has an M.A. in Public and International Affairs from George Washington University.

Dr. Edward Teller

Dr. Edward Teller, director emeritus at the Lawrence Livermore National Laboratory, is best noted for his work on the development of nuclear explosives and for his advocacy of a strong defense for America. He is also noted for his more than 100 technical publications, books, and patents. He received his Ph.D. in physics at the University of Leipzig in 1930. With the rise of Nazi Germany, Teller left Hungary to work in London and Copenhagen, becoming a U.S. citizen in 1941. The possibilities of fission, together with the menace of the Nazi's led to Teller's work on the Manhattan Project. Teller has held positions which include senior research fellow at the Hoover Institute and associate director emeritus at Lawrence Livermore Institute. In 1982, he was appointed a member of the White House Science Council. Recipient of many honors and medals for his work and contribution to scientific developments and to the defense of western democracy, these include the Albert Einstein Award and National Medal of Science.

Rep. Robert S. Walker

Rep. Bob Walker has served Pennsylvania's 16th district since 1977. He presides as Republican chairman of the U.S. House of Representatives' Science, Space and Technology Committee. Walker supports the nation's space program and is an advocate of a diversified U.S. Space program featuring the space shuttle, heavy launch vehicles, unmanned deep-space probes, and the space station. He also supports development of the National Aero-Space Plane and co-sponsored legislation calling for a flight-ready prototype by 1995. He ardently believes the private sector should be involved in building a space infrastructure and is the author of the 1985 book Space, Our Next Frontier. Before entering the House, he taught high school for three years and served for 10 years as a congressional aide. He earned a Bachelor of Science degree from Millersville University and a Master's Degree in Political Science from the University of Delaware.

Masato Yamano

Masato Yamano became the fifth president of the National Space Development Agency of Japan (NASDA) in 1989. He previously served as president of AST Development, Inc. and chairman of AST, Inc. Prior to that, Yamano was vice minister for Science and Technology. He has also served as director general of the Atomic Energy Bureau, STA; administrative counsellor for Space Activities, Research and Coordination Bureau, STA; and first secretary in the Embassy of Japan in the Phillipines. Yamano graduated for the Imperial University of Tokyo, Department of Aeronautics.

Space Commerce Participants

Ronald J. Birk

Dr. Brian Dailey

Frank DiBello

Donald E. Fink, Jr.

Ronald J. Birk, a physicist with Sverdrup Technology at Stennis Space Center, has been engaged in remote sensing activities since 1986. He is manager for Commercial Remote Sensing Program group providing technical services support for NASA's Office of Advanced Concepts and Technology Level II office at Stennis. He is responsible for developing commercial applications of remote sensing and geographic information systems technologies through NASA's Earth Observation/ Commercial Applications Program, Visiting Investigator Program, and the Space Act Applications Program. Birk is leading the integration of an Airborne Instrument Test System with the capability to provide comprehensive high resolution remote sensing data acquisition for product development, and the efforts associated with encouraging development of a commercial remote sensing small satellite system. He has supervised an Advanced Sensor Development Laboratory developing airborne sensing multispectral scanning systems. He received a B.S. in Physics from the University of Notre Dame and is pursuing an M.S. in Physics at the University of New Orleans. Birk is president of the Mid-South Region of the American Society of Photogrammetry and Remote Sensing.

Dr. Brian Dailey is vice president of Washington Operations for Lockheed Missiles & Space Systems Group, Washington, DC. Previously, he held the position of vice president of Lockheed Commercial Space Company within Lockheed Missiles & Space Company, Sunnyvale, CA. He came to Lockheed from the White House where he was executive secretary of the National Space Council. In that capacity, he was responsible for formulating and coordinating U.S. civil, commercial and national security space policy. Prior to his appointment to this position by President Bush, he served as senior professional staff member at the Senate Armed Services Committee. He was responsible for all military space and intelligence programs for the Strategic Forces and Nuclear Deterrence Subcommittee. He has served in various capacities in the Department of Defense and research institutes including a professorship at the U.S. Naval Postgraduate School where he taught courses on intelligence programs, space policy, arms control and nuclear targeting. Dailey is a graduate of the University of Southern California where he earned his Ph.D. in International Relations.

Frank DiBello is vice chairman of SpaceVest. He previously was a senior partner with KPMG Peat Marwick in Washington, D.C. DiBello has participated in many market assessments supporting aerospace and high technology companies. The studies included a review for the Department of Commerce of the remote sensing market, commercial client studies for launch vehicles, natural gas and other air products, protein crystallography, telecommunications and data services, and a variety of aerospace systems, products and services. He received a B.S. in Mathematics from Villanova University.

Donald E. Fink, Jr. is editorial director of the Aviation Week Group and editor-in-chief of *Aviation Week and Space Technology*. In his 32 year career with Aviation Week, he has served as engineering editor, space technology editor, and Paris bureau chief. Fink also has served in the U.S. Air Force stationed in Paris and Strasbourg, France and has been a police reporter and aviation writer at *Cedar Rapids Gazette*, Cedar Rapids, IA. Fink received his B.S. degree in Technical Journalism from the University of Minnesota. He also received educational honors as a commercial pilot with multi-engine, instrument and rotary wing ratings.

Theresa M. Foley, the founding editor of *Space News*, now resides in Santa Fe, New Mexico, where she continues to report and write about the space industry focusing on issues that are affecting the space industry, and military and civilian space programs. She has reported on space issues for 12 years, and has authored numerous stories about the space station, space shuttle, communications satellites, and commercial and military space programs. Before joining the Army Times Publishing Co., Foley worked for three years as a space technology editor at *Aviation Week and Space Technology*. Previously she also held reporting positions at *Satellite Week*, *Space Commerce Bulletin* and *Aerospace Daily*. She has written for national and international publications on a freelance basis, including, *Final Frontier*, *Aerospace America*, *Ad Astra*, the *International Times-Herald*, *Newsweek International* and *New Scientist*. She has won reporting awards from the Washington Space Business Roundtable and *Aviation Week*. She holds a bachelors degree in Journalism from the University of South Florida and completed an intern program in the public affairs office of Kennedy Space Center in 1981.

Space Commerce Participants

Frederick H. Hauck

Rep. Joel Hefley

Salvatore J. Grisaffe serves as director of aerospace technology at the National Aeronautics and Space Administration's Lewis Research Center. His career at Lewis and as a U.S. Air Force officer spans 36 years. His responsibilities are to lead Lewis' efforts in aeropropulsion materials and structures research; space power; propulsion; communications and advanced electronics technologies; energy technology; and microgravity materials science as well as the transfer of this technology to U.S. industry. Grisaffe's earlier career was devoted to research in high temperature coatings, ceramics and power system/aerospace propulsion system materials. He also previously served as chief of the materials division. He was awarded the NASA Outstanding Leadership Medal in 1993, the United States Government's Meritorious Executive Rank in the Senior Executive Service in 1987, the NASA Exceptional Service Medal in 1986, and was the recipient of two NASA Group Achievement Awards. He is the author of over 70 technical papers on ceramics, coatings, environmental attack and materials for advanced power systems. He has received six U.S. patents. Grisaffe earned his B.S. degree in metallurgical engineering from the University of Illinois and a M.S. degree from Case Institute of Technology (now Case Western Reserve University). He also completed the Harvard Graduate School of Business Administration's Program for Management Development under a NASA fellowship.

Dr. Bert Hansen III is the technologist and strategic planner for the Microgravity Science and Applications Division in the Office of Life and Microgravity Sciences and Applications at NASA Headquarters in Washington, D.C. He is also a member of the NASA-wide strategic management planning team and was leader of the Aeronautics and Space Technology Enterprise, which was one of four mission- oriented teams at NASA Headquarters initially developing the agency-wide strategic plan. He is an employee of the Jet Propulsion Laboratory, a division of the California Institute of Technology, and has been detailed to NASA Headquarters since October 1991. Hansen's professional experience includes ten years conducting research at the University of New Mexico and University of California (Berkeley & San Francisco Medical Center) in molecular, solar, and biophysics. He has spent 14 years in various technology development and management positions at JPL with an emphasis on technology development and transfer to non-NASA customers and also was a technologist at the RAND Corporation for two years. Hansen has received several NASA group and individual achievement awards and has taught business consulting, project management, and technology transfer short courses and seminars for nine years.

Frederick H. Hauck is president and chief executive officer of International Technology Underwriters, Inc. (INTEC), Bethesda, Maryland. INTEC is a leading underwriter of space insurance, providing coverage for both commercial and government space projects worldwide. Hauck came to INTEC in 1990 after completing a twenty-eight year Navy career as a combat pilot, test pilot and astronaut. His last assignment was director of Navy Space Systems in the Pentagon. During his 11 years as a NASA astronaut, he was co-pilot of a 1983 CHALLENGER mission, commander of the first space salvage mission in history aboard DISCOVERY in 1984, and commander of DISCOVERY for the first space shuttle mission after the CHALLENGER tragedy. In 1986 he was associate administrator of NASA for External Relations, the policy advisor to the Administrator for Congressional, international and public affairs. Hauck graduated from St. Albans School in Washington, received a B.S. in Physics from Tufts University and an M.S. in Nuclear Engineering from M.I.T. He studied scientific Russian at the Defense Language Institute. He is a member of the governing boards of St. Albans and Tufts as well as the Association of Space Explorers. He is a Fellow of the Society of Experimental Test Pilots and an Associate Fellow of the American Institute for Aeronautics and Astronautics. Hauck is the recipient of many honors and awards from the Department of Defense, NASA and the aerospace industry.

Rep. Joel Hefley serves in the U.S. House of Representatives from the Fifth Congressional District, Colorado He has served in the Colorado State Senate and the Colorado House of Representatives. Congressman Hefley's Congressional committee assignments include House Armed Service Committee, House Natural Resources Committee and House Small Business Committee. Hefley also holds several leadership positions including assistant minority whip, 1989-present and president of the class, 1987- present.

Space Commerce Participants

Randy D. Hoffman

Randy D. Hoffman is president and chief executive officer of Magellan Systems Corporation, a pioneer in Global Positioning System technology and one of the world's largest manufacturers of positioning and navigation products using the United States governments's Global Positioning System (GPS). Since joining Magellan in 1987, Hoffman has presided over the development of the world's first hand-held, low-cost GPS receiver, and the expansion of its technology into products for marine, recreation, survey, mapping, military, aviation and vehicle navigation markets. The company shipped its first GPS receiver in 1989 and now reports annual sales in excess of $30 million. Previously, Hoffman served as president of the Bushnell Division of Bausch & Lomb, the nation's largest sports optics equipment manufacturer. Prior to his association with Bushnell, he worked with the management consulting firm of Booz, Allen & Hamilton, specializing in strategy and marketing consultation. Hoffman is a summa cum laude graduate of the University of Southern California with a B.S. in business administration. He also earned an M.B.A. from Harvard University. In addition to his duties with Magellan Systems, Hoffman is a founding member and current Chairman of the United States GPS Industry Council (USGIC). Founded in 1991, the USGIC represents manufacturers of GPS receivers and satellites, systems integrators and major users of GPS technology.

Dr. Robert L. Norwood currently serves as director for program planning and integration and the director for advanced concepts in the Office of Advanced Concepts and Technology (OACT) at NASA. These positions are responsible respectively for overall strategic planning and integration of NASA's advanced technology program, and the preparation of advanced concepts which rely on or incorporate emerging technology into NASA missions. Norwood has served as deputy director for space technology in the Office of Aeronautics and Space Technology. In this position, he assisted the Director in the overall direction, advocacy, and budget allocation of the Space Research and Technology Program. Norwood came to NASA from the Department of Defense where he held the position of director for space and strategic systems in the Office of the Assistant Secretary of the Army (Research, Development, and Acquisition). Prior to that, Norwood respectively held operations research and engineering positions with the Center for Naval Analyses and McDonnell-Douglas Astronautics Corporation. He received a B.S. in Mechanical Engineering from the University of Illinois, a M.S. in Mechanical Engineering from the University of Southern California and a Ph.D. in Theoretical and Applied Mechanics from the University of Illinois. His professional activities span several organizations including the American Institute of Aeronautics and Astronautics, the American Society of Mechanical Engineers, the National Space Club, and the Board of Technical Advisers for the National Technical Association.

Gregory M. Reck is acting NASA associate administrator for Advanced Concepts and Technology. He is responsible for the overall NASA program to identify and develop innovative concepts and advanced technologies to enable new mission capabilities, to advocate commercial applications of NASA developed space technology and to encourage the development of market-driven space products and services. Reck began his career at NASA's Lewis Research Center as a student trainee. After college he was assigned to Lewis' Combustion Branch as a research engineer. He then joined NASA Headquarters as assistant to the Acting Chief of the Noise and Pollution Reduction Branch and later returned to Lewis as a project engineer on the Global Atmospheric Sampling Program. Reck has held a number of management positions with NASA: program manager of the Stratospheric Cruise Emission Reduction Program; head of Lewis' Fuels Research Section; chief of the Chemical Propulsion Branch; deputy chief of the Propulsion Systems Division; and manager of the National Aero-Space Plane Office at NASA's Langley Research Center. Reck came to NASA Headquarters to serve as director of the Propulsion, Power and Energy Division in the Office of Aeronautics and Space Technology (OAST) and prior to his current appointment, served as director for Space Technology in OAST. He received a bachelor's degree from the University of Cincinnati and attended the Harvard Business School Program for Management Development. He is a member of Phi Eta Sigma and Sigma Gamma Tau. He has received NASA's Exceptional Service Medal, and in 1991 received the Presidential Rank Award of Meritorious Executive. He has authored or co-authored 15 technical reports on combustion systems, fuels, and atmospheric composition.

Space Commerce Participants

Robert W. Schick

William B. Scott

Dr. Tom Velez

Robert W. Schick is a senior manager and director of KPMG Peat Marwick's Space/High Technology Group. He currently leads a team of 11 professionals who provide strategic business support in the areas of program planning, market research, finance and economic analysis associated with commercialization of advanced technology. His domestic and international clients include NASA, DOT, DOD, General Dynamics, FMC, Orbital Sciences Corporation, Lockheed and other private and government clients. Schick has led various study teams assessing several topics effecting the aerospace industry. Schick is program manager for the market requirements research currently being conducted in support of the Defense Landsat Program Office's Advanced Land Remote Sensing System. In addition, he is past Chairman of the Washington Space Business Roundtable. He is also active in the National Security Industrial Association, the American Institute of Aeronautics and Astronautics, the International Small Satellite Organization, the U.S. Space Foundation, and other professional organizations. Before joining KPMG Peat Marwick, Schick was an officer in the United States Marine Corps where he served as a tactical aviator and flight instructor. He was awarded a B.A. in geology from Colgate University and a M.S. in Management from the University of Southern California.

William B. Scott is senior national editor for *Aviation Week & Space Technology*, assigned to the Washington, DC bureau. In nine years with *Aviation Week*, he also has served as an avionics and senior engineering editor, covering the western U.S. and Pacific regions from the Los Angeles bureau. He focuses primarily on advanced aerospace technology and business, flight testing and military operations. He has written more than 1,500 stories for the magazine and has received six editorial awards. He co-authored one book, *Inside the Stealth Bomber: The B-2 Story*, with Col. Rick Couch. Throughout 1993, Scott was assigned to a special corporate project, developing a potential new business area related to technology transfer. Scott is a flight test engineer (FTE) graduate of the U.S. Air Force Test Pilot School. During a nine-year Air Force career, Scott served as aircrew on nuclear sampling missions; an electronics engineering officer at the National Security Agency; and an instrumentation and flight test engineer at three USAF bases. He also worked for General Dynamics, Falcon Jet Corp. and Tracor Flight Systems Inc. He received a B.S.degree in Electrical Engineering from California State University - Sacramento and an Associate of Applied Science in Electronics from the University of Southern Colorado. He is a member of the Society of Flight Test Engineers, the Aircraft Owners and Pilots Association, and the National Press Club.

Dr. Syed Z. Shariq is director of the office of commercial technology at NASA Ames Research Center. He is responsible for overall leadership and management of Ames' commercial technology programs, including innovative programs that bring together NASA, universities and industry to leverage federal resources through public-private collaboration and dual use joint R&D ventures for transfer and commercialization of technology. On a recent assignment from NASA, he successfully launched American Technology Initiative, a nonprofit corporation dedicated to the facilitation and implementation of dual use joint R&D ventures between the public and private sectors, and served as it first CEO for four years. Prior to joining NASA, Shariq was a senior associate with Montgomery Securities. Before joining Montgomery, he was associate director of research and development and senior management consultant with SRI International. Shariq has consulted and advised corporation and government agencies on a wide range of business and policy decisions and their implementation. He has also served on the faculties of several universities, including Duke and Johns Hopkins, and has been a visiting faculty fellow at Stanford University. He has authored over 20 reports and publications. He holds a Ph.D. in Operations Research from Virginia Polytechnic Institute and State University, M.S. degrees in Applied and Mathematical Statistics and Industrial Engineering from Rutgers University and a B.A. (with honors) in Mechanical Engineering from the University of Jabalpur, India.

Dr. Tom Velez, the founder, president and CEO of CTA, Inc. provides overall technical and management leadership and directs contract and in-house research in software and systems engineering for the company. CTA has won several awards reflecting the success of the company including the Group Achievement Award, the National Space Club Award to the Solar Maximum Repair Mission team and the Small Business Administration Innovation Award. Velez has more than 25 years experience in the design and development of major aerospace systems and research in computer system engineering and celestial mechanics. Previously, he was director of Software Engineering Research and Development at Martin Marietta Aerospace and chief of the Systems Development and Analysis Branch, NASA Goddard Space Flight Center. Velez received a B.S. in Mathematics from Iona College, a M.S. in Mathematics from Adelphi University, a Ph.D. in Applied Mathematics from Georgetown University, and a J.D. degree, Magna Cum Laude, from the University of Baltimore. He has published more than 25 technical articles and received honors from NASA and the academic community.

Symposium Participants

Dr. Mark J. Albrecht

Edward C. "Pete" Aldridge, Jr.

Colonel James R. Beale, USAF

Rear Admiral Lyle G. Bien, USN

Dr. Mark J. Albrecht is the senior vice president of Science Applications International Corporation located in McLean, Va. He served three years after his appointment by President Bush to be the executive secretary of the White House National Space Council. Prior to that, Albrecht served six years as the legislative assistant for National Security Affairs to Sen. Pete Wilson of California. He was a senior research analyst for the Intelligence Community Staff in Washington, D.C., and the Rand Corp., in Santa Monica, Calif. He had previously been a member of the SAIC research staff. Albrecht graduated Phi Beta Kappa from UCLA with a degree in History and holds a Ph.D. in Public Policy Analysis from the Rand Graduate School. He has been awarded the Department of Defense Distinguished Civil Service Medal and the NASA Distinguished Service Medal.

Edward C. "Pete" Aldridge, Jr. is president and chief executive officer of the Aerospace Corporation, a nonprofit organization dedicated to the objective application of science and technology toward the solution of critical national problems. Previously, Aldridge served as president of McDonnell Douglas Electronic Systems Co. He has also served in numerous government positions including Secretary of the Air Force. Among his numerous military decorations and awards are Secretary of Defense Meritorious Civilian Service Award; Department of Defense Distinguished Civilian Service Award, Department of Defense Distinguished Public Service Award, National Space Club Robert H. Goddard Memorial Trophy, Air Force Association Jimmy Doolittle Fellow, Ira Eaker Fellow, and the Brazilian Air Force "Merito Aeronautico" (Legion of Merit). He holds a B.S. in Aeronautical Engineering from Texas A&M University and an M.S. in Aeronautical Engineering from Georgia Tech.

Colonel James R. Beale, USAF is director of intelligence for North American Aerospace Defense Command and United States Space Command at Peterson Air Force Base, Colorado. He was commissioned through the Air Force Reserve Officer Training Corps program in 1969 at the University of Washington. He has served in the military space community for more than 16 years, including duties as deputy chief of staff for Space of the Electronic Security Command, director of the HQ USAF Office of Space Policy, and acting military assistant for Space to the Secretary of the Air Force. He was one of the first staff members selected by former Vice President Dan Quayle for duty on the National Space Council where he served as director for Space Infrastructure and Launch Policy. In this capacity, he was the White House staff focal point for all matters relating to space launch, satellite command and control, surveillance, reconnaissance, and earth observing space programs. Among his major awards and decorations are: Defense Superior Service Medal; Bronze Star Medal; Defense Meritorious Service Medal; Meritorious Service Medal with one oak leaf cluster; and Joint Service Commendation Medal. He holds a B.A. in history from the University of Washington and an M.B.A from Central Michigan University.

Rear Admiral Lyle G. Bien, USN, after selection as Naval Flight Officer and training in the F-4 replacement squadron at NAS Miramar, completed two combat deployments to Southeast Asia aboard the USS RANGER. His assignments include instructor for the initial F-14 cadre; F-14 deployments with VF-2 aboard USS ENTERPRISE; instructor at the Navy Fighter Weapons School (TOPGUN); officer in charge of TOPSCOPE, maintenance officer with the USS KITTYHAWK, fighter readiness officer at Commander Fighter Airborne Early Warning Wing Pacific, commanding officer for the "Fighting Aardvarks" of VF-114; became the deputy CAG in CVW-15; and first senior CAG aboard USS CARL VINSON. After attending the post command course at the Naval War College, he assumed command of Air Wing 15. Following a WESTPAC deployment aboard USS CARL VINSON, he was assigned to the Naval Central Command Riyadh, Saudi Arabia, staff as the senior Navy strike planner for Operations Desert Shield and Desert Storm. Bien attended the National War College, reported to the Joint Staff, and this year joined the Naval Space Command. He has logged 5.500 flight hours in fighter aircraft including 2,900 hours in the F-14; 1,300 carrier landings; and 225 combat missions. Bien's awards include the Defense Superior Service Medal, Legion of Merit (2), Meritorious Service Medal, and the Vietnamese Cross of Gallantry. He holds a B.A. in biology from Augustana College.

Al Diaz is NASA's deputy associate administrator for Space Science. In this position he is responsible for the management direction and oversight of NASA's space science flight programs, launch vehicle requirements, technology infusion requirements, and mission study reviews and assessments. He will also serve as the chief engineer for NASA's newly-organized Office of Space Science. Previously, Diaz served as the deputy associate administrator for the former Office of Space Science and Applications (OSSA), where he played a similar role in the management of OSSA's flight programs. Just prior, he was division vice president, Space and Aeronautics Services for General Electric's Government Services Division. In this capacity he was responsible for management of NASA-related services. He joined NASA as a co-op student at the Langley research Center and was actively involved in the Viking Project. He has served NASA in a variety of position including International Solar-Polar Mission program manager, the Galileo program manager, manger of Planetary Advanced Programs, deputy director of the Solar System Exploration Division and assistant associate administrator for Space Station within OSSA. Diaz received a B.S. degree in Physics from St. Joseph University and a M.S. in Physics from Old Dominion University. In addition, he attended Massachusetts Institute of Technology Sloan School of Management as a NASA Sloan Fellow, where he received a M.S. degree in Management. He is an associate fellow of the American Institute of Aeronautics and Astronautics and received a NASA Medal for Outstanding Scientific Achievement.

Symposium Participants

Steven D. Dorfman

Lt. Col. Charles D. (Sam) Gemar

Lionel Skipwith ("Skip") Johns

Steven D. Dorfman is a senior vice president of GM Hughes Electronics Corporation and its subsidiary, Hughes Aircraft Company, and president of the Hughes Telecommunications and Space Sector. He is a member of the GMHE Office of the Chairman and policy board. Dorfman was named to his present position in October 1993 after serving for more than two years as president of Hughes Space and Communications Company. Prior to that he served for five years as the number two executive in the Space and Communications Group, which was renamed the Hughes Space and Communications Company. Dorfman helped develop and implement the strategies that led to the doubling of the organization's sales during this time period. Dorfman joined Hughes in 1957 and, in subsequent years, held positions of increasing responsibility in management, systems engineering and electro-optics. Dorfman is a member of the National Academy of Engineering. He also has served on advisory committees for the U.S. Information Agency, the Department of Transportation and NASA. He is a member of the National Research Council's Aeronautics and Space Engineering Board and the Air Force Studies Board. He shares in two patents, has written a number of technical papers and received the Distinguished Public Service Medal, NASA's highest award, for his work on Pioneer Venus. Dorfman received his bachelor's degree in Electrical Engineering from the University of Florida and his masters's degree in the same field from the University of Southern California.

Lt. Col. Charles D. (Sam) Gemar was selected as an astronaut in 1985. After graduating from West Point, attended the Infantry Officers Training Course, Initial Entry Rotary Wing Aviation Course and the Fixed Multi- Wing Aviator's Course at Ft. Rucker, Ala. In 1980, he began assignment at Stewart/Hunter Army Airfield as an assistant flight operations officer and flight platoon leader. He also completed the Army Parachutist Course, Ranger School and the Aviation Officers Advanced Course. Gemar's first Shuttle flight was as a mission specialist on STS-38, a Department of Defense mission aboard Atlantis in November 1990. He next flew as a mission specialist on STS-48 aboard Discovery that deployed the Upper Atmosphere Research Satellite in September 1991. He most recently served as a mission specialist on the crew of STS-62, a 14-day extended duration Orbiter mission from March 4 through March 18. Experiments on STS-62 included growing crystals of experiments allowed the scientific and commercial communities to test space-based processes for beneficial applications here on Earth. Gemar has logged more than 581 hours in space. He received a bachelor's in Engineering from the U.S. Military Academy in 1979.

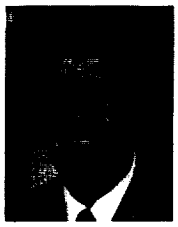
Lionel Skipwith ("Skip") Johns is the associate director for Technology in the Office of Science and Technology (OSTP) within the Executive Office of the President. He reports to Dr. John Gibbons, Director of OSTP and assistant president for Science and Technology. At OSTP, Johns is responsible for technology R&D policy coordination between Federal agencies. These activities, coordinated through the National Science and Technology council (NSTC), include space and aeronautics, industrial R&D, defense conversion, information and communications (including "the information superhighway") and education and training technologies. He serves as White House Co-Chair of three NSTC committees: Information and Communication R&D, Civilian Industrial Technology R&D, and Transportation R&D. Prior to joining OSTP, Johns served as Assistant Director of the Office of Technology Assessment (OTA), which was created in the Legislative Branch to provide the U.S. Congress with objective non-partisan analysis of major public issues related to the development and use of technology. Johns' Division at OTA was responsible for the analysis of industrial competitiveness, quality of the work force, energy, materials, national security, space, and international technology transfer and trade. Immediately upon earning his B.S. degree from the University of Virginia, he served as an officer in the United States Navy as a carrier-based naval aviator. He has participated in numerous international meetings in Asia, Europe, and Africa on arms control, energy, trade, and third world development. Johns is a member of the Council on Foreign Relations and serves on the Critical Technologies Subcouncil of the Competitiveness Policy Council. He was elected Fellow of the American Association for the Advancement of Science. Johns has 16 years of experience in management in high technology industries. He gained them at Ocean Science and Engineering, Inc., Hazeltine Corporation, the Magnavox Company, and General Instrument Corporation. He worked on projects involving the design, development, and production of radars, communications, sonar, and command and control systems. Marine experience includes management and sales of ship design, ship operations, mineral exploration, and ocean engineering systems. Johns also spent several years in corporate finance at Alex Brown & Sons.

Symposium Participants

Nicholas L. Johnson

L/Gen. Donald M. Lionetti

Dr. Bruce S. Middleton



Lt. Gen. Thomas S. Moorman, Jr.

Hon. Bill Nelson

Nicholas L. Johnson, Senior Scientist at Kaman Sciences Corporation in Colorado Springs, is recognized internationally as an authority on foreign space systems and the near-Earth space environment. He is the author of 15 books and more than 100 articles and reports on these and related space topics and has appeared as an expert before Congressional hearings, US government panels, and at the United Nations. At Kaman Sciences Corporation, Johnson is responsible for providing technical expertise to numerous space-related US Government projects, including those sponsored by NASA, the Jet Propulsion Laboratory, the Defense Nuclear Agency, the US Air Force, the Ballistic Missile Defense Organization, Naval Space Command, and the Department of Transportation. He has led efforts for NORAD, USAF Space Command, the US Space Command involving space threat assessments, space defense and space control operations, and functions of the US Space Surveillance Network. He is currently engaged in studies evaluating the potential of international space surveillance and is a member of the US National Academy of Sciences' Space Environmental and Orbital Debris Resource Center. Johnson is a veteran of both the US Air Force and the US Navy and is a Distinguished Alumnus of Memphis State University.

L/Gen. Donald M. Lionetti is commanding general of the U.S. Army Space and Strategic Defense Command headquartered in Arlington, Va. The command serves concurrently as the Army component of U.S. Space Command, manages the Army's strategic defense research and development activities for the Ballistic Missle Defense Organization from facilities in Huntsville, Ala., and operates the U.S. Army Kwajalein Atoll as a National Missile Range. Before assuming his present duties, Lionetti was deputy commanding general and chief of staff at the U.S. Army Training and Doctrine Command, Ft. Monroe, Va. Following graduation from the U.S. Military Academy, he was assigned to site duty with the Nike Hercules strategic air defense system. Subsequent assignments included duty in the NORAD Command Center; warhead support for a German armored division and battery command in Vietnam. He also was an assistant professor in the Department of Earth, Space and Graphic Sciences at West Point. His overseas assignments included Vilseck, Germany and Ramstein Air Base, Germany. Lionetti also served as director for Plans, U.S. Space Command, Peterson Air Force Base, Colo., and commanding general of the U.S. Army Air Defense Artillery Center and commandant of the U.S. Army Air Defense Artillery School at Ft. Bliss, Texas. He also served at the Pentagon and Ft. Lewis, Wash.

Dr. Bruce S. Middleton served for six years as the inaugural executive director of the Australian Space Office, a term which he completed in 1993. He was concurrently executive member of the Australian Space board and then of its successor, the Australian Space Council. Australia's space policy emphasizes the development of space industry, and substantial industrial growth was achieved during the period of his leadership. Middleton was directly involved in business strategy formulation and international negotiations for business development. He visited manufacturing plants, research laboratories and other space facilities in most countries which have an active space program. He also lead delegations, comprising mainly businessmen, to the Soviet Union, Russia and Ukraine, and participated in industry missions to the USA and France. Middleton was involved in studies into the prospects for establishing commercial space launching activities in Australia, and was an official guest at the world's five largest active space launch sites (Baikonur, Cape Canaveral, Kourou, Tanegashima and Xichang), as well as the Woomera and Cape York regions in Australia. On two occasions he was involved in successful negotiations with the US Government for approval under the US Arms Export Control Act for American companies to participate in these studies. Middleton previously served ten years with the staff of the Australian Science and Technology Council (roughly equivalent to the OSTP), five as head of staff. He holds a PhD in chemistry, and his early career was in industrial research and development and in pollution control for a government agency. He is currently on secondment to the Australian Government research agency CSIRO, as a consultant.

Lt. Gen. Thomas S. Moorman, Jr. is Vice Commander of Air Force Space Command. In almost 29 years of Air Force service, he has held many national security space-related positions including Deputy Military Assistant to two Secretaries of the Air Force. He came to Air Force Space Command in 1981 as the Director of Space Operations in Cheyenne Mountain and later became the Deputy Director, Space Defense, NORAD. He served as the Director of the Commander's Staff Group and later the Vice Commander of the 1st Space Wing. At the Pentagon, he was selected to be the Director of Space Systems within the Office of The Secretary of the Air Force, and Director of Space and SDI programs in the office of the Assistant Secretary of the Air Force for Acquisition. The general's military decorations and awards include (each with one oak leaf cluster) the Defense Superior Service Medal, Legion of Merit, Meritorious Service Medal and Air Force Commendation Medal. He also wears the Master Space Badge. Moorman received the 1991 National Geographic Society's Thomas D. White U.S. Air Force Space Trophy. He earned his B.A. degree in History and Political Science from Dartmouth College, a M.B.A. from Western New England College, and a M.A. in Political Science from Auburn.

Hon. Bill Nelson is a former Congressman from Florida and currently serves as legal counsel with the law firm of Maguire, Voorhis & Wells, PA. He was elected to congress in 1978 and served on the Budget Committee during his first three terms. He also served as chairman of the space subcommittee and became the first member of the U.S. House of Representatives to fly aboard the space shuttle when he trained and flew as a member of the crew of the spaceship Columbia. Nelson graduated from Yale University in 1965, and from the College of Law at the University of Virginia in 1968. Following graduation he served a tour of duty in the U.S. Army, earning the rank of captain.

Symposium Participants

Maj. Gen. Robert W. Parker

Granville E. Paules III

Mr. Thomas F. Rogers

Dr. Harrison H. "Jack" Schmitt

Maj. Gen. Robert W. Parker is director of operations, Headquarters Air Force Space Command, Peterson Air Force Base, Colo. As such, he is responsible for overseeing and developing policy and guidance to conduct the command's space and Intercontinental Ballistic Missile operational missions. He entered the Air Force through the Air Force Reserve Officer Training Corps in July 1963. He has served in various capacities, including combat missile and airborne launch control system crew member, instructor and nuclear weapon plans officer. He has commanded a strategic missile wing, served as senior military advisor to the U.S. Arms Control and Disarmament Agency, and directed the U.S. Government On-Site Inspection agency. During his early career he had the distinction to be certified combat ready on the first airborne launch control system missile crew. He has nearly eight years of missile combat crew experience and more than 800 flying hours as a missile crew member- airborne. General Parker's military awards and decorations include the Distinguished Service Medal with oak leaf cluster, Legion of Merit, Airman's Medal, Meritorious Service Medal with oak leaf cluster and Air Force Commendation with oak leaf cluster. He earned a B.B.A. from St. Michael's College, Vermont, in 1963, a M.B.A. from Ohio State University, attended Kellogg School of Executive Business Management, Northwestern University, and Harvard University's John F. Kennedy School of Govt., National Security Program.

Granville E. Paules III is the director of Technology Innovation and Advanced Planning Office, Office of Mission to Planet Earth (OMPTE), NASA. As the chief technologist for the OMPTE he formulated and coordinates implementation of the policies and plans that lead to the identification, development and infusion of new technologies in established missions. A significant role is that of ombudsman and broker of joint ventures and partnerships within and outside NASA which better leverage the various program investments in new technology development and application. Paules represents NASA on the White House Office of Science and Technology Policy activities related to environmental technology initiatives. Prior to his current position, he served as director, Operations Division, Space Station Freedom Program Office. Previously he was a senior engineer, R&D office director and systems engineer for the U.S. Department of Transportation and an Apollo Mission flight control guidance officer at Johnson Space Center. Paules is a member of the American Institute of Aeronautics and Astronautics and the International Astronautical Federation. He holds a B.S. in Electrical Engineering from the University of Texas and a M.B.A. from the University of Maryland.

Mr. Thomas F. Rogers is a physicist, a communications engineer, a private investor, and the president of his family's private operating foundation, the Sophron Foundation. His past experience is extensive and has included serving as deputy director of Defense Research and Engineering in the Office of the Secretary of Defense where he was responsible for research and development supporting the command and control of our nuclear strike forces. Rogers did research and development work during WW II at the Radio Research Laboratory of Harvard University and, later, at the Bell and Howell Company and the Air Force Cambridge Research Center. He has held senior federal government positions, and professional positions with university, industrial, and non-profit organizations. Rogers holds a B.Sc. from Providence College and M.A. degrees in physics from Boston University.

Dr. Harrison H. "Jack" Schmitt has the varied experience of a geologist, pilot, astronaut, administrator, businessman, writer and United States Senator. He studied at Caltech, as a Fulbright Scholar at Oslo, and at Harvard receiving his Ph.D. in 1964. He received Air Force jet pilot wings in 1965 and Navy helicopter wings in 1967. Selected for the Apollo Scientist-Astronaut program in 1965, Schmitt served as lunar module pilot for Apollo 17. His studies of the Valley of Taurus-Littrow on the Moon in 1972 made Schmitt one of the leading experts on the history of the terrestrial planets. As the only scientist to go to the Moon, he was the last of twelve men to step on the Moon. In 1976, Schmitt was elected to the U.S. Senate, and served as chairman of the Senate Subcommittee on Science, Technology, and Space. He also served on the Senate Commerce, Banking, Appropriations, Intelligence, and Ethics committees, the President's Foreign Intelligence Advisory Board, the Army Science Board, Interior's National Strategic Materials Advisory Committee, several NASA advisory committees, the President's Commission on Ethics Law Reform, the Vice-President's Blue Ribbon Discussion Group on space policy, and the U.S. delegation to the World Administrative Radio Conference. Schmitt's numerous honors include the 1973 Arthur S. Fleming Award, 1973 Caltech Sherman Fairchild Distinguished Scholar, NASA Distinguished Service Award, Fellow of the AIAA, 1989 Lovelace Award (space biomedicine), 1989 G.K. Gilbert Award (planetology) and Honorary Fellow of the Geological Society of America, the American Institute of Mining, and the Geological Society of London. Honorary Doctorate Degrees have been awarded to Schmitt by the Colorado School of Mines, Franklin and Marshall College, Rensselear Polytechnic Institute, and Salem College.

Symposium Participants

Maj. Gen. Richard M. Scofield

Robert W. "Bill" Schick

Dr. Ronald M. Sega

Maj. Gen. Richard M. Scofield is program executive officer for bombers, missiles and trainers, the Pentagon, Washington, D.C. In June 1964 General Scofield was assigned to Da Nang Air Base, South Vietnam, flying C-123s. He transferred to the 6594th Test Group, Hickam Air Force Base, Hawaii, in June 1965 as a C-130 aerial recovery pilot and became part of a select group of pilots involved in the aerial recovery of satellites. After graduating from the University of Oklahoma in June 1970, he was assigned to the Air Force Satellite Control Facility, Space and Missile Systems Organization, Edwards Air Force Base, Calif. While there, he served as chief of the Aerial Recovery Section and was responsible for the development and testing of equipment and procedures used by the 6594th Test Group. The general is a command pilot with more than 5,500 flying hours. His military awards and decorations include the Legion of Merit, Distinguished Flying Cross, Meritorious Service Medal, Air Medal with 10 oak leaf clusters, Air Force Commendation Medal, Air Force Outstanding Unit Award with "V" device and six oak leaf clusters, Air Force Organizational Excellence Award with oak leaf cluster, and Armed Forces Expeditionary Medal. He is a member of the Order of Daedalians and the Beta Gamma Sigma National Scholastic Honor Society. He earned a B.B.A. from the University of Massachusetts, a M.B.A. from the University of Oklahoma and a M.S. in Systems Management from the University of Southern California. He completed Squadron Officer School in 1965, Armed Forces College, and the National Security Management course and Defense Systems Management College.

Robert W. "Bill" Schick is a senior manager and director of KPMG Peat Marwick's Space/High Technology Group. He currently leads a team of 11 professionals who provide strategic business support in the areas of program planning, market research, finance and economic analysis associated with commercialization of advanced technology. His domestic and international clients include NASA, DOT, DOD, General Dynamics, FMC, Orbital Sciences Corporation, Lockheed and other private and government clients. Schick has led various study teams assessing several topics effecting the aerospace industry. Some of his most recent projects include: an extensive market survey of potential commercial opportunities for the satellite remote sensing market, culminating in a national conference and publication of "Market Requirements for Spatial Observation Systems;" conducting a survey of the financial community to examine motivation and concerns regarding space industry investment; surveying and publishing an annual report of the industry in conjunction with Space News entitled, "1992-1993 Space Business Review;" supporting a business assessment of the viability of commercial launch facilities in Manitoba; and currently supporting a discussion on the financing options of the National Wind Tunnel Complex. Schick is program manager for the market requirements research currently being conducted in support of the Defense Landsat Program Office's Advanced Land Remote Sensing System. In addition, he is past Chairman of the Washington Space Business Roundtable, a nationally recognized space industry group that focuses on the business and economic issues surrounding the space industry. He is also active in the National Security Industrial Association, the American Institute of Aeronautics and Astronautics, the International Small Satellite Organization, the U.S. Space Foundation, and other professional organizations. Before joining KPMG Peat Marwick, Schick was an officer in the United States Marine Corps where he served as a tactical aviator and flight instructor. He was awarded a B.A. in geology from Colgate University and a M.S. in Management from the University of Southern California.

Dr. Ronald M. Sega was selected as an astronaut in 1991. Sega completed Air Force pilot training in 1974 and served as an instructor pilot in the Air Force from 1976-1979. From 1979-1982, he was on the faculty of the Air Force Academy's Dept. of Physics, and, from 1982 through 1990 was on the faculty of the University of Colorado in Colorado Springs. While on leave from the University of Colorado, Sega served as research associate professor of physics at the University of Houston and was a co-principal investigator of the Wake Shield Facility. Recently, Sega was a mission specialist on STS- 60, the first joint U.S./Russian Space Shuttle Mission. Launched on February 3, 1994, STS-60 was the second flight of the Space Habitation Module-2 (Spacehab-2), and the first flight of the Wake Shield Facility (WSF-1). During the 8-day flight, the crew of Discovery conducted a wide variety of biological materials sciences, Earth observation, and life science experiments. He was the "flight engineer: for ascent and entry on this mission, performed several experiments on orbit, and operated the robotic arm, berthing the Wake Shield onto its payload bay carrier on four separate occasions. Following 130 orbits of the Earth in 3,439,705 miles, STS-60 landed at Kennedy Space Center, Florida, on February 11, 1994. With the completion of his first space flight, Sega has logged 199 hours in space. Sega received a bachelor's degree in Mathematics and Physics from the Air Force Academy in 1974; a master's in Physics from Ohio State University; and a doctorate in Electrical Engineering from the University of Colorado in 1982.

Symposium Participants

Dr. Arturo Silvestrini

Marc G. Stanley

Dr. Arturo Silvestrini is the President and CEO of Earth Observation Satellite Co. He has more than 20 years of professional experience in aerospace-related industries. Prior to joining EOSAT in November 1991, Silvestrini served as Senior Vice President at Computer Sciences Corporation for its augmented European operations. Although most of Silvestrini's career has involved managing large business operations, the span of his technical contributions includes such diverse projects as scientific satellite mission planning and ground facilities development, communications and weather satellite analysis and design, the application of space technology to earth sciences and resources, data acquisition and process control system design, ground instrumentation for military and sounding rockets, range tracking instrumentation, analysis and design of guidance and control systems for missile applications, and air traffic control instrumentation and systems. Silvestrini joined Computer Sciences Corporation in 1965 to support a joint NASA/DOD spacecraft project and was later appointed by the U.S. Government as investigation coordinator for the entire mission. Subsequently, he managed a new acquisition of CSC and, later, two Centers of CSC's Systems Division, the precursor to CSC Systems Group. In 1973, Silvestrini was selected to form a new CSC division which consolidated the company's aerospace technology and scientific disciplines for expansion, and transfer to defense and civilian applications. Under his 15-year leadership, the Systems Sciences Division grew from a $10 million annual revenue to a 1000-employee organization recognized as a major supplier of computer-based aerospace systems for a variety of federal agencies, state agencies and major industrial clients. He elected early retirement from CSC and joined EOSAT in 1991. Silvestrini received his doctorate degree in Electrical Engineering from the University of Rome in 1954. He has authored textbooks and numerous technical and scientific publications. He is an Associate Fellow of the American Institute of Aeronautics and Astronautics and a Fellow of the American Astronautical Society. He serves on the Board of Directors of CTA, Inc., an advanced technology company headquartered in Rockville, Md.

Marc G. Stanley is the associate director for Technology and Business Assessment, Advanced Technology Program (ATP), in the Office of the Director, National Institute of Standards and Technology (NIST). Stanley is the primary policy advisor to the ATP Director with regard to technology and business assessment issues related to the ATP and general policy issues of importance to NIST. Previously, Stanley was Associate Deputy Secretary of the U.S. Department of Commerce by Presidential appointment. He has served as a senior policy advisor to the NIST Directors, as a consultant to the Department of Commerce's Technology Administration, and as Assistant Secretary for Congressional and Intergovernmental Affairs at the Department of Commerce. Stanley earned a B.A. from George Washington University and a bachelor of law degree from the University of Baltimore.

Space Technology Hall of Fame

Space spinoffs—materials and products originally developed for applications in space programs but which have made significant contributions to benefit all people—are nominated for induction each year into the Space Technology Hall of Fame. Sponsored by NASA since 1988, the Hall of Fame honors individuals and companies responsible for these remarkable products. While there can only be a limited number of "inductees," every product nominated is truly a winner. Each is an innovation extraordinary in its valuable, practical applications for the benefit of humankind.

Digital Imaging was developed in the mid-1960's to explore the surface of the Earth's moon. Conventional camera equipment mounted in the unmanned Ranger spacecraft returned distorted, lopsided images from the moon. Digital Imaging—a process that turns analog signals into digital signals which are, in turn, fed into a computer for enhancement—returned sharp, accurate images of the lunar surface. Today, Digital Imaging is used in familiar medical applications such as CAT-Scans, Ultrasound images and advanced X-ray technology. It is also used for surgical monitoring and brain or cardiac angiography.

This amazing technology was developed through the cooperative efforts of:

Organizations

NASA Jet Propulsion Laboratory
NASA Lyndon B. Johnson Space Center
NASA John F. Kennedy Space Center
NASA John C. Stennis Space Center
NASA Goddard Space Flight Center
Perceptive Scientific Instruments, Inc.
Mallinckrodt Institute of Radiology,
Washington University School of Medicine

Individuals

Dr. Robert Nathan
Robert Selzer
Dr. Kenneth R. Castleman
Don G. Winkler
Dr. Michael W. Vannier
Robert L. Butterfield
Dr. Doug Rickman
Dr. Douglas M. Jordan
Arlene G. Kerber
Dr. Janette C. Gervin

Excimer Laser Angioplasty System, a laser system initially developed for satellite-based atmospheric studies, is now a powerful instrument for treating heart disease. Laser angioplasty is a procedure where a thin fiber-optic catheter is inserted into an artery in the leg and threaded to a blockage in a coronary artery. A tiny optical assembly diffuses the laser strand into a small cone-shaped laser beam as it is emitted from the catheter. The nonthermal laser vaporizes blockages in the artery without damaging delicate tissue. The procedure can be performed in a non-surgical setting using a local anesthetic. The hospital stay is minimal, and there is less post-operative pain, discomfort, and risk to the patient.

This fascinating technology was developed through the cooperative efforts of:

Organizations

NASA Jet Propulsion Laboratory
Cedars-Sinai Medical Center
Advanced Interventional Systems, Inc.

Individuals

Dr. James B. Laudenslager
Dr. Tsvi Goldenberg
Dr. Thomas J. Pacala
Dr. Warren S. Grundfest
Dr. Frank Litvack
Dr. James S. Forrester

The 1994 Nominees for the Space Technology Hall of Fame were:

Automated Waterjet Stripping is a high-speed waterjet cleaning system for the shuttle external tank being used for several industrial cleaning applications such as paint removal from aircraft, railroad cars, tank farms, and shipyards.

CLIPS is a software tool developed by NASA which integrates expert systems programs with conventional computer programs. Made available to and now used extensively by private sector companies.

Space Technology Hall of Fame

Electric (Ion) Beam Generators

were developed in the 1960's at NASA's Lewis Research Center.The generators were developed to power spacecraft designed for extraplanetary missions. While the engine has yet to be used, engineers are looking at possible uses in deep space missions. Industry, NASA, and research universities are looking at potential future uses of ion beam generators. One unusual use of ion generators introduced this year deposits a diamond-like film on eyewear that produces a scratch-proof coating.

Magnetic Fluids (Ferrofluids)

do not exist in nature. These fluids can be used in a variety of industrial processes, including fusion research, the development and manufacturing of analytical instrumentation, visual displays, medical equipment and automated machine tools.

Parawings or hang gliders were first developed in 1948. In 1958, NASA considered the parawing as a means of returning space payloads to Earth. While NASA decided not to pursue the parawing in its program, the military was interested in the parawing for parachuting. In the mid-1960's Pioneer Aerospace and Irvin industries, parachute manufacturers, built parawings.

Transportable Applications Environment is a productivity tool for computer software developed at NASA's Goddard Space Flight Center. TAETM is a software management system that supports greater utility of image processing and remote sensing software. An updated version, TAETM Plus, is available from NASA's Computer Software Management & Information Center and is used by Boeing, Computer Sciences Corp., EOSAT, Harris Corp., and Philip Morris.

Rapid Measurement Clinical Thermometer is a product of research involving measuring temperatures of space bodies. Most of these instruments measure emitted infrared radiation which can be translated into temperature. The Diatek Corp. has used that technology to develop thermometers that measure human temperatures in two seconds measuring infrared radiation emitted from the bottom of the ear canal.

Underwater Location Aid (Pinger)

is a system that can precisely locate submerged space objects (space payloads, spacecraft, booster, etc.) and is now used by airlines and others to assist with their location in the event of an accident.

1994 Selection Committee

Fred Abatemarco
Editor-in-Chief, *Popular Science*

Frank E. Penaranda
Deputy Assistant Administrator
Commercial Programs, NASA

Congressman George E. Brown
Chairman, House Committee on Science, Space & Technology

Sam R. Iacobellis
Executive Vice President & Deputy Chairman, Rockwell

Senator John Glenn
Senate Armed Services Committee

Dr. Harrison H. Schmitt
Consultant, university of Wisconsin
Former Astronaut & Senator

Don Fink
Editor-in-Chief
Aviation Week & Space Technology

John Hendricks
Chairman, Discovery Communications

Senator Ben Nighthorse Campbell
Senate Banking, Housing & Urban Affairs Committee

Doug Invester
President, Coca Cola Company

Max L. Ary
Director, Kansas Cosmosphere & Space Center

Bill Schnirring
Editor-in-Chief, *NASA Tech Briefs*

Congressman Joel Hefley
House Armed Services Committee

Jim Slade
Science Editor, ABC TV

Dr. Peter Clarke
Professor, University of Southern California

John Street
President, Telephone Express

1993

Liquid-Cooled Garments were developed to protect the Apollo astronauts from the high temperatures on the moon. This technology is now found in garments being used by race car drivers, fire department hazardous materials handlers, personnel working at nuclear reactors, lumber and paper mill workers and shipyard workers. The garment is also used for medical purposed for example by children born with Hypohidrotic Ectodermal Dysplasia (lack of sweat glands) to help them dissipate body heat during normal activities.

Physiological Monitoring Instrumentation was developed to transmit astronaut physiological data to ground stations for monitoring and analysis. This family of technologies opened a whole new world of remote biological monitoring on Earth. Patients in locations away from a medical facility or in transit can be monitored and assisted. For example, heart readings can be acquired by an electrode and sent by wire to a telemetry transmitter attached to the patient's body. The readings are then relayed to a display console at a central station where medical personnel can simultaneously monitor the conditions of several patients.

1992

Direct Readout Satellite Data creates images of cloud formations sent from the weather satellite direct to the user anywhere on the face of the Earth. The images are received by more than 4,000 satellite ground stations in over 120 countries. The benefits in saving life and property are difficult to measure; however, in one instance, it is estimated that 12,000 lives were saved in Bangladesh in the May 1985 cyclone.

Earth Resources Laboratory Applications Software enables meteorologists, scientists, climatologists, and others to monitor changing conditions on Earth. The data is gathered from spaceborne sensors detecting various types of radiation obtained from Earth. ELAS supports many applications to include drought condition assessments on the African continent, aquaculture site selection in Central America, and locations of drug fields in Mexico.

1991

Automatic Implantable Cardioverter Defibrillator is a life saving cardiac pacemaker device incorporating microminiature circuits that have built-in microprocessor capability and the ability to communicate. More than 12,000 patients have been implanted with this device. Survival rates for patients using the device is 92 percent at one year and 76 percent at five years.

PMR-15 Polymide Resin is a reinforced plastic highly resistant to heat and oxidation. PMR-15 Polymide Resin is used by jet engine manufacturers and significantly improves engine thrust-to-weight ratios without sacrificing structural integrity.

1990

Safety Grooving is the cutting of thick grooves across concrete, greatly reducing accidents and injuries on slick surfaces, such as the interstate highway system, airport runways and playgrounds.

Heat Pipe Systems is a passive heat transfer device that passes heat from one area to another It rapidly and effectively. Keeps the Alaskan Pipe Line from freezing and improves dehumidification performance of conventional air conditioners.

1989

Cordless Tools were developed originally to satisfy the need for a lightweight lunar drill that could operate independently and be capable of extracting core samples from as much as 10 feet below the moon's surface.

Scratch Resistant Lens Coating was developed nearly 20 years ago when scientists recognized the need to prevent scratching of astronauts' equipment in harsh environments.

Fabric Roof Structures were developed as a lightweight non- combustible fabric for space suits. Now structural materials made from glass fiber yarn are a cost-effective alternative to conventional building materials. They are used to cover shopping malls and sports centers.

1988

Improved Firefighter's Breathing Systems were first used in the portable life support system by Apollo astronauts on the moon. They now decrease inhalation injuries among firefighters.

Sewage Treatment with Water Hyacinths was a means to purify water at a fraction of the usual cost. Hyacinths thrive on sewage by absorbing and digesting nutrients and minerals from waste water. This was first developed for possible use in space colonies and on long-duration manned space flights.

Power Factor Controller is an important energy-saving mechanism which senses the balance between voltage and current in motors under load and idling conditions, automatically adjusting current to the minimum efficiency level needed.

NASTRAN Software is now an indispensable computer-aided design and analysis tool which solves structure problems in automotive, aircraft, chemical plant, and architectural design. It supplants time-consuming conventional mathematical methods.

Programmable Implantable Medication System is an adaptation of a miniaturized pump and valve system, developed for the Viking Mars Lander. Diabetics now have a valuable device for dispensing medication in controlled dosages.

1994 SYMPOSIUM VOLUNTEERS

**Committee Chair

Lisa Alberts
Karen Altom
Jason Anderson
Sandra Arbee
Nina Armagno
Daniel Arnold
Louise Atkins
Warren Atkins
Larry Bagley
Thomas Bailey
Ray Barrios
Ted Barthel
Mark Bedell**
Nicole Benton
Bill Biddlecomb
David Bishop
Mary Blodgett
Mike Bodtke
Andrew Borden
Bill Braden
Derrel Brayton
Terry Brennan
Dave Brescia**
Vicky Brocious
Gary Brovetto
Eugene Brown
Ed Browne
Susan Browning
Ed Buchanan
Donna Burk
Angela Burns
Budd Butcher
Dion Butler
John Bystroff
Keith Calloway
Len Campaigne
Wayne Cantwell
Elvira Canzanella
Jon Carden
Gary Carpenter
Stein Cass
Therese Cass
Richard Chiavetta
Carrie Clancy
Steve Clancy
Henry Clark
Randall Clark
Sally Claunch
Alison Clay
Paul Coile
Larry Cooper
Gina Corson
Betty Cox
Susan Cunniff
Sharon Czeikus
Michael d'Albertis
Robert Davila
Noel Davis
Robert DeLine
Vic DePetrillo
Pete Dettelis
Kathy Dismukes
Mary Duran
Hildred Edmonds
Mark Eger
Tracy Estes
Bob Ewell**
Marti Fallon
Dean Feller
Randy Ferrand
Helena Fierro
Chuck Finkle
Carolyn Fisher
Duncan Fisher**
Jane Flanders
James Franze
Byron Gainers
Cheryl Garza
Amando Gavino
Shirley Gesick
Craig Girard
Thelma Goforth
Marilyn Grant
Monty Greer
Mark Griffith
Sperry Griffith
Mark Grisko
Tom Groebner
Darrin Guilbeau
Marty Haase
Rich Hand
Priscilla Hanson
Andrew Hart
Angela Hawks
Les Hayden**
Mark Heinrich
Bev Heising
Jeff Hill
Tom Hill
Dennis Hilley
Trae Holcomb
Bradley Hooker
Ben Ingram
Phoebe Jackson
Ann Jacobs
Bob Jamnicki
Charles Jansen
Norma Jenkins
Mollie Jenson
Calvin Johnson
Julia Johnson
Laura Johnson
Renee Johnson
Lyndal Joplin
Dan Jordan**
Mark Jordan
Ed Keegan
Brian Kellner
Sheila Keone
Jim Kerr
Marcus Koen
Paul Kolodziejski
David Koster
Luc Lambert
Mike Landon
Tara Lane
Mellie Leaf
Steven Leaf
Joe LeBlanc
Jerry Lemberger**
Sheila Lemberger**
Kenton Loar
Aaron Logeman
Adam Longoria
Jennifer Lucero
Kay MacDonald
Donald MacLeod
Eleanor MacLeod
William MacMillan
Kevin McGinnis
Mike McKenzie
George McMullin
Lynda McPeeks
Lee Maddox
Gordon Mangente
Laurie Marzano
Tim Matthews
Laura Mender
Mike Merritt
Judy Miller
John Millsaps
John Mims**
Beverly Montera
Carlo Montera
Clem Morris
JonPaul Mozee
Kathy Nelson
John Neri
Wade Norman
Donovan Obray
Frank Ocasio**
Todd Olinger
Rebecca Oliver
Chris Olmedo
Eric Olson
Denise Ortega
Chris Palermo
Lisa Palermo
Randolph Pasko
Tony Paulhus
Joseph Pearson
Eldon Person
Chris Pindat
John Pitts
Mark Platten
Dorothy Polen
Chuck Pothier
Chris Povak
Rick Purinton
Loretta Ramirez
Chip Regan**
Kurt Reynolds
George Rice
Andrew Richardson
Randy Rickards
Jim Rix**
Michelle Roberts
Jim Rohrich
Steve Ross
Arnold Rothenberger
Maria Ryan
Pat St. John**
James Sahm
Phillip Sandlin
Brian Satre
Todd Schilb
Debbie Scott
John Scott
Sean Scott
Mark Sensano
David Shannon
Robert Sheehan
Susan Shrieves
Leigh Ann Shriver
Denette Sleeth
Martin Smith
Mike Snodgrass
Alan Sommerfeld
Stephen Sovaiko
David Spackman
Kurt Steeby
Tina Steele
Glenn Stewart
Bret Stoneking
Robert Strickland
Stacy Suhr
Tim Sutton
Frieda Tata
Randy Tedrow
William Thomas
Richard Todd
Verda Turner
Vic Villhard**
Frank Warner
Steven Webber
Robert Welch
Kevin Westburg
Stephen Wilkinson
Rick Williams
Anthony Wilson
Frank Wisneski**
Michelle Wohford

SYMPOSIUM PARTICIPANTS

Mr. John Adams
Director, Colorado Springs Ops
AlliedSignal Technical Services
1925 Aerotech Drive, Suite 200
Colorado Springs, CO 80916

Mr. Patric Albert
Martin Marietta Corporation
MS: 5030 P.O. Box 179
Denver, CO 80201

Mr. George Alcorn
Chief
NASA Goddard Space Flight Center
Office of Commercial Programs
MC: 702
Greenbelt, MD 20771

Mr. Robert Alleger
Vice President, Range Programs
Martin Marietta Services
1150 Academy Park Loop, Ste 204
Colorado Springs, CO 80910

Dr. J. Lamar Allen
President
Kaman Sciences Corporation
1500 Garden of Gods Road
P.O. Box 7463
Colorado Springs, CO 80933

Mr. Jerry Alles
Consultant
Digital Equipment Corporation
305 Rockrimmon Blvd. S
Colorado Springs, CO 80920

Ms. Shirley Alverson
Sales Manager
Digital Equipment Corporation
305 Rockrimmon Blvd., S
Colorado Springs, CO 80920

Mr. Ray Anderson
President
SEAKR Engineering, Inc.
4030 Spencer Street, Suite 108
Torrance, CA 90503

Mr. John Angell
Vice President, Operations
Ak Juit Aerospace
1525 One Lombard Place
Winnipeg, Manitoba CANADA

Mr. Michael (Mick) Anna
SIG District Office Manager
TRW, Inc.
1250 Academy Park Loop, #202
Colorado Springs, CO 80910

Mr. Brian Archimbaud
Executive Director
Spaceweek International Assoc.
1110 NASA Road One, #100
Houston, TX 77058

Mr. Robert Aronno
President and CEO
Tinsley Laboratories, Inc.
3900 Lakeside Drive
Richmond, CA 94806

Mr. John Bahnemann
Project Manager
Computing Devices International
8800 Queen Avenue-S.
Bloomington, MN 55431-1996

Ms. Susan Fields Bailey
LLV Business Development
Lockheed Missiles & Space Co.
D/8M-01, B/154 P.O. Box 3504
Sunnyvale, CA 94089

Mr. William Bailey
President
Bailey Associates International
339 Surrey Drive
Bonita, CA 91902-2352

Dr. Boyd Baldauf, Col, USAF (Ret.)
2106 Mountview Drive
Pueblo, CO 81008-1516

Mr. Neil Barberis
Vice President, National Programs
Loral Space Systems
MS: G01
3825 Fabian Way
Palo Alto, CA 94550

Mr. Brian Barnes
General Manager, SSG
Frontier Engineering
P.O. Box 1023
Stillwater, OK 74076

Mr. Glenn Barney
Manager, Business Development
Com Dev
155 Shelton Drive
Cambridge, Ontario N1R 7H6
CANADA

Ms. Deborah Barnhart
Vice President, Bus Dev
Hamilton Standard Space Systems Int'l, Inc.
One Hamilton Road
M/S 1A-2-A66
Windsor Locks, CT 06096

Mr. Jerome Barsky
AlliedSignal Technical Services
Goddard Corporate Park
7515 Mission Drive
Lanham, MD 20706

Mr. Kurt Bassett
Director, Bus. Development & Advanced Programs
Martin Marietta Astronautics
P.O. Box 179
Denver, CO 80201

Mr. Peter Beardsley
Director, Western Region
Martin Marietta Corporation
2041 Rosecrans Avenue, S. 107
El Segundo, CA 90245

Mr. Robert Bebee
Manager
Martin Marietta Astro Space
Defense Systems Business Dev.
Room M1237
P.O. Box 8555
Philadelphia, PA 19101

Dr. Neil Beer
Colorado Space Advocate
Colorado Office of Space Advocacy
1420 Austin Bluffs Parkway
Colorado Springs, CO 80933-7150

Capt John Best, USAF
Space Systems Requirements Manager
Air Mobility Command
402 Scott Drive, Unit 3A1
Belleville, IL 62225-5302

Mr. Mark Bever
Advanced System Manager
TRW, Inc.
One Space Park
Redondo Beach, CA 90278

Mr. Ron Birk
Manager, Com'l Remote Sensing Program
Sverdrup Technology
SSC Group
Building 1210
Stennis Space Center, MS 39529

Mr. Richard Blakley
Director, Titan IV Business Development
Martin Marietta Technologies, Inc.
MS: L5004; P.O. Box 179
Denver, CO 80201

Mr. Robert Bocek
Director, Space & Technology
McDonnell Douglas
1735 Jefferson Davis Hwy
Suite 1200
Arlington, VA 22202

Mr. George Boehmer
Operations Manager
TRW Systems Integration Group
Colo Springs Engineering Ops.
1555 North Newport Road
Colorado Springs, CO 80916

CDR Greg Bolan, USN
U. S. Naval War College
686 Cushing Road
Newport, RI 02841

Mr. Dwight Bone
Senior Training Developer/Writer
U.S. Army
C 306 MI BN
Ft. Huachuca, AZ 85613

CDR Robert Borries, USN
Chief, Architecture Division
NORAD/USSPACECOM J6N
250 S. Peterson Blvd., Suite 116
Colorado Springs, CO 80914

Mr. W. Leo Boudreaux
Tech Advisor
NORAD/USSPACECOM J6N
250 S. Peterson Blvd., Suite 116
Peterson AFB, CO 80914-3050

Dr. David Boyle
Deputy Director
Center for Space Power
Texas A&M University
223 Wisenbaker ERC
College Station, TX 77843-3118

Mr. William Braselton, Jr.
Vice President, Bus Dev
Harris Corporation, GASD
101/4041 MS P.O. Box 94000
Melbourne, FL 32902

Mr. Gerhard Brauer
Deputy Washington Office
DLR/DARA German Space Agency
1627 Eye Street, N.W., Ste 540
Washington, DC 20006

Dr. William Breedlove, Jr.
Executive Dir for Space Tech.
Space & Naval Warfare Systems Cmd. (SPAWAR 40A)
2451 Crystal Drive
Arlington, VA 22245-5200

Mr. Don Briggs
McDonnell Douglas
5301 Bolsa Avenue
Huntington Beach, CA 92647

Mr. Jay Brownfield
Manager, NASA Programs
AlliedSignal Aerospace
1530 Wilson Blvd., Suite 1000
Arlington, VA 22209

Mr. Philip Buckley
Vice President
Aerojet
Electronic Systems Plant
1100 West Hollyvale Street
Azusa, CA 91702

Mr. Robert Butterfield
NASA/MD-RES
Kennedy Space Center, FL 32899

Ms. Maricela Camarena
Evaluator
U.S. General Accounting Office
1244 Speer Blvd., Suite 800
Denver, CO 80226

Mr. Thomas Carroll
Vice President & General Manager
PRC, Inc.
Aeronautics & Space Tech. Div.
1500 PRC Drive
Mc Lean, VA 22102

Mr. John Carter
Professor
St. Cloud State University
Headley Hall 204
St. Cloud, MN 56301

Mr. Charles Cash
Program Manager
1080 Lockheed Way, Box 36
Onizuka AFB
Sunnyvale, CA 94089-1231

Ms Karen Cash
Systems Engineer
Scitor Corporation
256 Gibraltar Drive
Sunnyvale, CA 94089

Mr. Robert (Ted) Casner
Director, Business Development
United Technologies
Chemical Systems Division
P.O. Box 49028
San Jose, CA 95161-9028

Mr. Marlowe Cassetti
McDonnell Douglas Aerospace
1250 Academy Park Loop, #108
Colorado Springs, CO 80910

Mr. Ralph Christie
Vice President
Merrick & Company
P.O. Box 22026
Denver, CO 80222

Mr. Frank Christy
Manager, Space Programs
ASEC
21221 Western Avenue, Ste 130
Torrance, CA 90501

Mr. Bob Clark
Strategic Account Manager
Digital Equipment Corporation
305 Rockrimmon Blvd., S.
Colorado Springs, CO 80920

Mr. Derek Clark
Squadron Leader
Royal Air Force
RAF Cranwell
Sleaford
Lings N934 8HB England

Mr. Jack Clark
Manager, New Business Development
Lockheed Corporation
4450 E. Fountain Blvd., #204
Colorado Springs, CO 80916

Mr. Ronald Cloward
Space Propulsion Products Manager
Thiokol Corporation
MS: C10 P.O. Box 689
Brigham City, UT 84302-0689

Mr. David Conrad
Director. Space Automation & Robotics Center
Environmental Res. Inst. of MI
P.O. Box 134001
Ann Arbor, MI 48113-4001

Mr. David Conrad
Product Line Sales Manager
AlliedSignal Fluid Systems
1300 West Warner Road
P.O. Box 22200
Tempe, AZ 85284

Mr. Marc Constantine
VP, Launch System Program
Aerojet
Propulsion Division
P.O. Box 13222
Sacramento, CA 95813-6000

Mr. Thomas Costello
Manager, Colo Springs Office
Boeing Company
1250 Academy Park Loop
Colorado Springs, CO 80910

Mr. Robert Coté
Manager, Systems Eng. & Ops
TRW, Defense Systems Division
R5/1221
One Space Park
Redondo Beach, CA 90278

Mr. Robert Coward
Assistant Manager
Hughes Aircraft Company
Colorado Springs District Office
1250 Academy Park Loop, # 138
Colorado Springs, CO 80910

Mr. Richard Cress
Vice President
Kaman Sciences Corporation
P.O. Box 7463
Colorado Springs, CO
80933-7463

Lt Gen Donald Cromer, USAF (Ret.)
President
Hughes Space & Communications
200 N. El Segundo Blvd.
El Segundo, CA 90245

Mr. Richard Culpepper
Special Assistant to Director
National Aero-Space Plane JPO
2475 K Street, Suite 3
Wright-Patterson AFB, OH
45433-7644

Mr. Robert Cunningham
Director, Regional Operations
Dynamics Research Corporation
1250 Academy Park Loop, #235
Colorado Springs, CO 80910

Mr. John Cusick
President
Prime Star Partners
100 N. Presidential Blvd.
Bala Cynwyd, PA 19004

Mr. Peter Dachel
Vice President, Military Space
AlliedSignal
One Bendix Road
Columbia, MD 21029

Mr. Donald Dalton
S/W Regional Manager
UTC - Pratt & Whitney
Space Operations
1601 Randolph Road SE, #100S
Albuquerque, NM 87111

Mr. Thomas Damon
Professor
Pikes Peak Community College
5675 S. Academy Road
Colorado Springs, CO 80906

Mr. Donald Dandurand
Manager
Lockheed Corporation
Colorado Springs Office
4450 E. Fountain Blvd., #204
Colorado Springs, CO 80916

Mr. Thomas Daschbach
Consultant
Logistic Specialties, Inc.
655 Blackhawk Drive
Colorado Springs, CO 80919

Mr. Henry Davis
Director
NASA Johnson Space Center
Technology Transfer & Commercialization
2101 NASA Road One
Houston, TX 77058

Mr. Frederick Day
Evaluator
U.S. General Accounting Office
1244 Speer Blvd., Suite 800
Denver, CO 80204

Mr. Robert DeCort
AGE, Test & Launch Ops Mgr.
Martin Marietta
Space Systems Division
MS: 21-7040 P.O. Box 85990
San Diego, CA 92186-5990

Mr. Robert Dean
Sr. VP and Group Executive
Ball Aerospace & Communications Group
10 Longs Peak Drive
Broomfield, CO 80021

Mr. Richard Dessling
President
Lockheed Technical Operations Co., Inc.
1309 Moffett Park Drive
Sunnyvale, CA 94088-1687

Dr. Peter Diamandis
Dir, Commercial Space Prgms
CTA Incorporated
6116 Executive Blvd., Suite 800
Rockville, MD 20852

B/Gen Robert Dickman, USAF
Commander
45th Space Wing, CC
1201 Minuteman Street
Patrick AFB, FL 32925-3299

Mr. Bruce Dingman
Manager, Business Development
Babcock & Wilcox Company
1400 Old Hwy. 69 South
Mt. Vernon, IN 47620

Mr. Joseph Dodd
Principal Director
Aerospace Corporation
MS: M1-119; P.O. Box 92957
Los Angeles, CA 90009

Mr. William Dolling
Dir, ELV Product Development
Thiokol Corporation
Strategic Operations
P.O. Box 689
Brigham City, UT 84302

Mr. Thomas Doran
Martin Marietta Corporation
1250 Academy Park Loop, #104
Colorado Springs, CO 80910

Maj Gen George Douglas, USAF (Ret.)
Douglas & Associates
Consulting Services, Inc.
225 E. Cheyenne Mountain Blvd.
Colorado Springs, CO 80906

Mr. William Doyle
Product Line Manager
TRW, Inc.
MS: R2/2004
One Space Park
Redondo Beach, CA 90278

Mr. Richard Drennan
Director, Space and C4I Systems
Hughes Space & Communications Company
Bldg. S50, MS: X325
1700 E. Imperial Hwy.
El Segundo, CA 90245

Mr. Steve Ducoff
Executive Director
Colorado Springs Sports Corp.
12 E. Boulder Street
Colorado Springs, CO 80903

Mr. Bernard Elero
Manager, Civil Space Bus. Development
Martin Marietta
Astro-Space Division
MS: NP-2B
P.O. Box 800
Princeton, NJ 08543

Dr. Thomas Eller
Space Applications & Astrodynamics Manager
Kaman Sciences Corporation
4410 E. Fountain Blvd.
Colorado Springs, CO 80916

Mr. Andrew Engelhardt
Director, Program Development
Honeywell, Inc.
P.O. Box 52199
Phoenix, AZ 85072-2199

Mr. Durwood English
Martin Marietta
Space Systems Division
P.O. Box 85990
San Diego, CA 92186

Mr. Donald Ernst
DTX/Thermacore
780 Eden Road
Lancaster, PA 17601

Mr. Raymond Evans
Chief
NASA Kennedy Space Center
Future Launch Systems Office
DF-FLS
Kennedy Space Center, FL 32899

Mr. Robert Evans
Senior Vice President & Gen. Manager
PRC, Inc.
1500 PRC Drive
Mc Lean, VA 22102

Dr. Jack Ferguson
Manager, Space Programs
DoD Software Engineering Institute
11055 Burgess Lane
Colorado Springs, CO 80008

Mr. E. Stokes Fishburne
Manager, Remote Sensing Center
TRW, Inc.
R5/1261
One Space Park
Redondo Beach, CA 90278

Mr. Matthew FitzGerald
Director, Business Development
Applied Solar Corporation
15251 Don Julian Road
Hacienda Heights, CA 91745-1002

Mr. Terry Fleener
Director, Business Development
Ball Aerospace
P. O. Box 1062
Boulder, CO 80306

Dr. Joseph Fletcher
Advisor
Sievers Instruments
2500 Central Avenue
Boulder, CO 80301

Mr. Gareth Flora
VP, Business Development
Martin Marietta Launch Systems
Advanced Programs
MS: 5003
P.O. Box 179
Denver, CO 80201

Mr. Anthony Flores
Director
UNISYS Corporation
Space & Satellite Control
1150 Academy Park Loop, #240
Colorado Springs, CO 80910

Mr. Jerry Florey
Senior Specialist-Strategic Planning
McDonnell Douglas Aerospace
5301 Bolsa Avenue
Huntington Beach, CA 92647

Dr. Jamie Floyd
18290 Upper Bay Road, #86
Houston, TX 77058

Mr. Larry Flynn
Senior Rep, Business Development
Loral Federal Systems
685 Citadel Dr. E
Colorado Springs, CO 80909

Ms. Celeste Ford
Vice President
Scitor Corporation
256 Gibraltar Drive
Sunnyvale, CA 94089

Maj Gen Larry Fortner, USAF (Ret.)
Sr. Representative, Colo. Springs
TRW Space & Electronics Group
1250 Academy Park Loop, #202
Colorado Springs, CO 80910

Dr. Charles Fosha
Director
UCCS Office of Space Studies
1867 Austin Bluffs Pkwy, #202
Colorado Springs, CO 80918

COL Erling Foss, USA (Ret.)
Consultant
Institute for Defense Analyses
3845 Overlook Road
Colorado Springs, CO 80906

Mr. Chris Fox
Marketing Manager
Eagle-Picher Industries, Inc.
C and Porter Streets
Joplin, MO 64801

Mr. Jack Frohbieter
President & COO
Fairchild Space & Defense Corp.
20301 Century Blvd.
Germantown, MD 20874

VADM David Frost, USN
Deputy Commander-In-Chief
U.S. Space Command
250 S. Peterson Blvd., Suite 116
Peterson AFB, CO 80914-3010

MSgt Ed Fuller, USAF
Space Systems Staff Officer
HQ USAF/XOFS
Space and Nuclear Forces Division
1480 Air Force Pentagon
Washington, DC 20330-1480

Mr. Arthur Gallegos
Evaluator
U.S. General Accounting Office
1244 Speer Blvd., Suite 800
Denver, CO 80204

Ms. Lori Garver
Executive Director
National Space Society
922 Pennsylvania Avenue, SE
Washington, DC 20003

Mr. Robert Gastineau
Chief
NAIC/PON
National Comm. Interaction Div.
4115 Hebble Creek Road, Ste 38
Wright-Patterson AFB, OH 45433-5642

Dr. William Gaubatz
Director, Program Manager
McDonnell Douglas Aerospace
A3-L370-46S2
5301 Bolsa Avenue
Huntington Beach, CA 92647-2099

Mr. James Geros
New Initiatives Development & Strategic Manager
Boeing Missiles & Space Division
P.O. Box 3999
Seattle, WA 98124-2499

Mr. Warren Goldberg
Manager, Space Bus Dev
Loral
15378 Avenue of Science
San Diego, CA 92128-3407

Dr. Stephen Gomes
Chief Executive Officer
American Tech. Initiative, Inc.
535 Middlefield Road, Suite 180
Menlo Park, CA 94025

Mr. Richard Gordon
President
Space Age, America Inc.
9800 S. Sepulveda Blvd., Ste 818
Los Angeles, CA 90045

Mr. Jim Gorman
Satellite/Ground Systems
Engineer
13555 Pinery Drive
Colorado Springs, CO 80908

Mr. Thomas Gormley
Project Manager
Rockwell Space Systems Division
12214 S. Lakewood Blvd.
Downey, CA 90214

LTG Daniel Graham, USA (Ret.)
Director
High Frontier Foundation
2800 Shirlington Road, Ste 405A
Arlington, VA 22206

Lt Col Deborah Gregoire, USAF
250 S. Peterson Blvd.
Peterson AFB, CO 80914

Mr. James Grohowski
President
Astrotech Space Operations
12510 Prosperity Drive, Ste 100
Silver Spring, MD 20904

Mr. Stuart Grossberg
Market Manager, Hydrazin
Propellents
Olin Corporation
350 Knotter Drive
Cheshire, CT 06410

Mr. Jon Guthrie
Vice President, Bus Dev
Loral Space Information Systems
Marina Plaza, Suite 500
P.O. Box 58487
Houston, TX 77258

Mr. John Haaren
Senior Systems Engineer
ANSER Corporation
1250 Academy Park Loop, #223
Colorado Springs, CO 80910

Mr. Markham Hacke
Business Development Manager
Ketema/PCI
380 Cliffwood Park
Brea, CA 92621

Ms. Karen Haenke
Trident Data Systems
P.O. Box 5662
Vandenberg AFB, CA 93437

Mr. Ray Haley
Contract Manager
Tech/Aid Corporation
7222 Commerce Center Drive,
Suite 102
Colorado Springs, CO 80919

Mr. Gerald Hansen
VP, Strategic Planning
Applied Technology Associates,
Inc.
3601 Aviation Blvd., Suite 3800
Manhattan Beach, CA 90266

Maj Gen Donald Hard, USAF
(Ret.)
General Manager, Colorado
Division
Aerospace Corporation
1150 Academy Park Loop, #227
Colorado Springs, CO 80917

Mr. Mike Hardgrave
Director, Business Development
Rockwell
3200 E. Renner Road
Richardson, TX 75082-2402

Mr. Christopher Harlambakis
Director, Western Region
Aerojet
2250 E. Imperial Hwy., Ste 552
El Segundo, CA 90245

Mr. Carl Harrison
New Business Development
McDonnell Douglas Aerospace
1250 Academy Park Loop, #108
Colorado Springs, CO 80910

Mr. Alex Harwood
DoD Account Executive
Software AG
11130 Sunrise Valley Drive
Reston, VA 22091

Dr. Hideo Hasegawa
Director, Houston Office of
NASDA
National Space Agency of Japan
Johnson Space Center, MC: KN
Houston, TX 77058

Mr. Richard Haserot
Director, Western Region
Thiokol Corporation
215 N. Marengo Ave., 2nd Floor
Pasadena, CA 91101

Mr. Michael Hayner
Manager, Space Programs
Bechtel National, Inc.
P.O. Box 193965
San Francisco, CA 94119-3965

Ms. Maureen Heath
Product Line Manager
TRW, Inc.
02/2706
One Space Park
Redondo Beach, CA 90278

Mr. Charles Heimach
Consultant
30543 Rue De La Pierre
Rancho Palos Verde, CA 90274

Mr. John Heintz
Assistant Division Manager
Hughes Aircraft Company
Electro-Optical Systems
E1/C150
P.O. Box 902
El Segundo, CA 90245

Lt Gen Edward Heinz, USAF
(Ret.)
System Management Programs
Martin Marietta
10803 Parkridge Blvd., Suite 400
Reston, VA 22091

Maj Gen Gerry Hendricks,
USAF (Ret.)
9432 Mt. Vernon Circle
Alexandria, VA 22309

Mr. K. Michael Henshaw
Vice President, Business
Development
Martin Marietta Space Group
6801 Rockledge Drive
Bethesda, MD 20817

LTC Richard Hewitt, USA
Chief, Future Systems &
Contract Mgt.
HQ USSPACECOM/J4L
250 S. Peterson Blvd., Suite 116
Peterson AFB, CO 80914-3050

Mr. Douglas Heydon
President
Arianespace, Inc.
700 13th Street, NW, Suite 230
Washington, DC 20005

Mr. Don Hicks
President
Ball Aerospace
Systems Group
10 Longs Peak Drive
Broomfield, CO 80028-1235

Mr. Jack Hilden
Vice President, Advanced
Programs
Thiokol Corporation
Strategic Operations
P.O. Box 689
Brigham City, UT 84302-0689

Mr. Edward Hollop
Research Director
Bureau of Mines
Denver Research Center
Bldg. 20, DFC
P.O. Box 25086
Denver, CO 80225

Mr. Mark Homrig
Chief, Commercial Space Policy
SAF/SX
1640 Air Force Pentagon
Washington, DC 20330

Mr. Greg Hoover
Consultant
Digital Equipment Corporation
305 Rockrimmon Blvd., S.
Colorado Springs, CO 80920

Mr. Mark Hopkins
President
Spacecause
2439 25th Street
Santa Monica, CA 90405

Mr. Patrick Houston
Manager, Business Development
Aerojet Electronic Systems Plant
1100 W. Hollyvale St.
MS 59/1463 P.O. Box 296
Azusa, CA 91702-0296

Maj Jerry Hutcherson, USAF
Director of Operations
1st CACS
3541 Summer Breeze Drive
Colorado Springs, CO 80918

Mr. Charles Ireland
Director, Business Development
UNISYS Government Systems
1150 Academy Park Loop, #240
Colorado Springs, CO 80910

Mr. Harry Ivey
Senior Partner
Ivey Associates
480 Kakkis Drive
Long Beach, CA 90803

Ms. Tracy Jacobson
Account Representative
Digital Equipment Corporation
305 Rockrimmon Blvd., S.
Colorado Springs, CO 80920

Maj Glenn James, USAF
U.S. Air Force Academy
2354 Fairchild Dr., Suite 6D2A
USAF Academy, CO 80840-6252

Mr. Larry Janski
Partner
KPMG Peat Marwick
2001 M Street, N.W.
Washington, DC 20036

Mr. Leonard Jenkins
Manager, Business Development
Martin Marietta Astronautics
P.O. Box 179
Denver, CO 80201

Mr. George Jennings
Trident Data Systems
5933 W. Century Blvd., Ste 700
Los Angeles, CA 90045

Mr. Dar Johnson
Technical Support Manager
bd Systems, Inc.
385 Van Ness Avenue, Suite 200
Torrance, CA 90501-1483

Mr. David Johnson
Vice President
Computer Tech. Associates, Inc.
6116 Executive Blvd.
Rockville, MD 20852

Ms. E. LaVerne Johnson
President & CEO
Int'l. Institute for Learning, Inc.
110 East 59th Street, Sixth Flr.
New York, NY 10022

Mr. Phillip Johnson
Vice President & Director
AlliedSignal Technical Services
Civilian Space
7515 Mission Drive
Lanham, MD 20706

Mr. Louis Jones
Space Industries, Inc.
101 Courageous Drive
League City, TX 77573

Mr. Norman Jorstad
Director, TIAC
Institute for Defense Analyses
1801 N. Beauregard Street
Alexandria, VA 22311

Mr. John Keith
Merchandising Manager
Computer Support Corp.
15926 Midway Road
Dallas, TX 75244

Mr. Ted Kerr
Senior Manager, Business Development
AlliedSignal Technical Services
1150 Academy Park Loop, #100
Colorado Springs, CO
80910-3715

Mr. Thomas Kerr, Jr.
Director, Corporate Comm
Barba-Arkhon International Inc.
10000 Midlantic Drive, Suite 300
Mt. Laurel, NJ 08054

Mr. Jim Ketchledge
Program Manager
Aydin Computer & Monitor
Space Data Systems
700 Dresher Road
Horsham, PA 19044

Mr. Douglas King
President
Challenger Center for
Space Science Education
1055 N. Fairfax Street, #100
Alexandria, VA 22314-1541

Capt William Korber, USAF
Laramie County Commmunity College
Continuing Students
1526 Newton Drive
Cheyenne, WY 82001-1646

Ms. Maxine Krieger
Krieger Publishing Company
P.O. Box 9542
Melborne, FL 32902

Mr. Phillip LaCombe
Managing Director
Aerospace Education Foundation
1501 Lee Highway
Arlington, VA 22209

Mr. T. Cleon Lacefield
Director
Aerojet
P.O. Box 13222
Sacramento, CA 95813-6000

Ms. Rayetta Lantzy
Policy Analyst
Aerojet
1250 Academy Park Loop, #120
Colorado Springs, CO 80917

1Lt Steven Letch, USAF
Chief, Stand/Eval Branch
ICACS
1856 Brookdale Drive
Colorado Springs, CO 80918

Mr. Robert Lewis
Program Manager
Martin Marietta Astronautics
P.O. Box 179
Denver, CO 80201

Mr. W. Jay Lovelace
VP, Location Manager
Honeywell, Inc.
19019 N. 59th Avenue
Glendale, AZ 85308

Maj John MacLellan, USAF
Space Systems Staff Officer
HQ USSPACECOM/J6NI
250 S. Peterson Blvd., Suite 116
Peterson AFB, CO 80914-3050

Mr. Robert Mali
NSP Program Manager
Loral Space & Range Systems
1260 Crossman Avenue
Sunnyvale, CA 94089-1198

Mr. Scott Manatt
Manager, Space Systems
AlliedSignal Aerospace Company
2525 W. 190th Street
Torrance, CA 90504

Mr. Robert Manson
Senior Development Officer
Government of Manitoba, Canada
Dept. of Industry & Trade
430-155 Carlton Street
Winnipeg, MB R3C 3H8
CANADA

Mr. Don Markham
Business Development Manager
Hughes Electro-Optical Systems
Bldg. E1, MS C150
P.O. Box 902
El Segundo, CA 90245

Mr. James Markwith
Program Development Manager
Rockwell
12214 Lakewood Blvd.
P.O. Box 7009
Downey, CA 90241-7009

Mr. Charles Marshall
Mngr, Titan Advanced Programs
Martin Marietta
6874 S. Lewis Court
Littleton, CO 80127

Mr. Glenn Marshall
Director
Technology Associates of Colo
1420 Austin Bluffs Pkwy.
Colorado Springs, CO 80921

Mr. Paul Maye
Deputy Director, Western Ops
ITT Federal Services Corp.
Bldg. 7204A, P.O. Box 5728
Vandenberg AFB, CA 93437

Mr. Claude W. "Bud" McAnally
Deputy, Flight Systems
Martin Marietta
P.O. Box 179
Denver, CO 80201

Mr. Evan McCollum
Public Affairs Manager
Martin Marietta Astronautics
P.O. Box 179, Mail #DC1020
Denver, CO 80201

Ms. Lisa Marie McKeown
Vice President
Lincoln Public Affairs Corporation
1421 Prince Street, First Floor
Alexandria, VA 22314

Mr. John McMahon
President & CEO
Lockheed Missiles & Space Co.
P.O. Box 3504
Sunnyvale, CA 94088-3504

Mr. Raymond McMillan
COO Services/Executive Vice President
CTA Incorporated
6116 Executive Blvd., Suite 800
Rockville, MD 20852

Mr. Stephen Meyer
Senior Director
McDonnell Douglas
8201 Greensboro Drive, Ste 300
Mc Lean, VA 22102

Mr. Donald Meyers
Government Systems Mktg. Manager
Honeywell, Inc.
1250 Academy Park Loop, #102
Colorado Springs, CO 80910

Mr. Donald Midkiff
Program Manager
PRC, Inc.
985 Space Center Drive, Ste 200
Colorado Springs, CO 80915

Mr. Scotty Miller
Manager
Motorola, Inc.
Program Managrment Dept.
MS: G2228, 2501 S. Price Road
Chandler, AZ 85248

Mr. Steve Miller
Business Development Analyst
Honeywell Space Systems
MS: H15, P.O. Box 52199
Phoenix, AZ 85072-2199

Mr. Steven Miller
Business Development Manager
ETA Technologies
3650 N. Nevada Avenue
Colorado Springs, CO 80907

Mr. William Mitchell
Manager, Business Development
AlliedSignal Aerospace
Dept. 8329, F/C6
Teterboro, NJ 07608

Mr. Robert Molloy
Dir, Directed Energy Programs
Martin Marietta Corporation
MS: DC8005, P.O. Box 179
Denver, CO 80201

Mr. Barry Moss
Aerospace Corporation
2350 E. El Segundo Blvd.
El Segundo, CA 90245

COL William Mundie, USA
Chief, Programs Division
HQ USSPACECOM/J30
250 S. Peterson Blvd., Suite 116
Colorado Springs, CO 80914

Dr. Ken Munechika
Director
NASA Ames Research Center
Moffett Field, CA 94035-0001

Mr. Charles Murch
Product Line Manager
TRW, Inc.
Bldg. R5, Room 1221
One Space Park
Redondo Beach, CA 90278

Mr. Stephen Nesbitt
Chief, Public Services Branch
NASA Johnson Space Center
2101 NASA Road One
Houston, TX 77058

Mr. Anthony Noblett
Director of Marketing
Mountain Optech, Inc.
4775 Walnut Street, Suite A
Boulder, CO 80301

Mr. James Noblitt
VP & General Manager
Boeing Defense & Space Group
Missiles & Space Division
MS: JW-86; P.O. Box 240002
Huntsville, AL 35824-6402

Mr. Christopher Nolan
Manager, Business Development
Martin Marietta Corporation
M.P. 163
6801 Rockledge Drive
Bethesda, MD 20817

Mr. Douglas North
Executive VP & Gen. Manager
UTC
Chemical Systems Division
Box 49028
San Jose, CA 95161-9028

CDR John Nunley, USN
USSPACECOM/J36C
1 NORAD Road, Suite 9-101
Cheyenne Mtn. AS, CO 80914

CMD Stephen O'Brien, USNR
Naval Space Command
12205 Captains Court
Woodbridge, VA 22192-2131

Mr. Stephen O'Neill
Program Director - MSLS
Martin Marietta Tech., Inc.
MS: M-5030; P.O. Box 179
Denver, CO 80201

Dr. Willard Olson
VP & General Manager
McDonnell Douglas
Aerospace-West
Space and Defense Systems
MS: 14-3
5301 Bolsa Avenue
Huntington Beach, CA
92647-2048

Mr. Charles Ordahl
Vice President-General Manager
McDonnell Douglas Space
Systems
5301 Bolsa Avenue
Huntington Beach, CA 92647

Mr. Vito Pagano
Director, Business Development
Lockheed Technical Operations
Co., Inc.
4450 E. Fountain Blvd., Ste 200
Colorado Springs, CO 80916

Mr. Tom Palmer
Program Manager
Loral Space & Range Systems
1290 Highway A-1-A, Suite 102
Satellite Beach, FL 32937

Mr. William Paramore
Manager, Business Development
Harris Corporation
MS: 22A/4738; P.O. Box 94000
Melbourne, FL 32902

Mr. Mark Parker
Business Development
Delco
MS: 204; 6767 Hollister Avenue
Goleta, CA 93117

Mr. Thomas Parkinson
Director, Strategic Business
Development
McDonnell Douglas Aerospace
13100 Space Center Blvd.
Houston, TX 77059

Mr. John Pasalevich
Manager
Hughes Aircraft Company
Colorado Springs District Ofc.
1250 Academy Park Loop, #138
Colorado Springs, CO 80910

Mr. Dave Payne
Manager, Line of Business
TRW, Inc.
R4/2082
One Space Park
Redondo Beach, CA 90278

Mr. Pete Peekins
Senior Washington
Representative
TRW Space & Electronics Group
1001 19th Street North, Suite 800
Arlington, VA 22209

Mr. Manfred Peinemann
Marketing Manager
Rockwell
Rocketdyne Division
D/582, 055-IB07
P.O. Box 7922
Canoga Park, CA 91309-7922

Mr. Thomas Peoples
VP, Business Development
Aerojet Electronics Systems
1-3/1401; 1100 W. Hollyvale St.
Azusa, CA 91702

Col Walter Petrofski, USAF
Command Competition Advocate
AFSPACECOM/CA
Peterson AFB, CO 80914-4030

Mr. A. H. Piantes
Director, Washington Operations
Aerojet Corporation
1025 Connecticut Ave., NW
Suite 1107
Washington, DC 20036

Mr. Terry Piddington
Executive Vice President
CTA Incorporated
7150 Campus Drive, Suite 100
Colorado Springs, CO 80920

Mr. Misha Plam
President
Sievers Instruments, Inc.
2500 Central Avenue, Suite H-1
Boulder, CO 80301

Dr. Wilford Poe
VP & General Manager
Honeywell, Inc.
Space Systems Division
13350 U. S. Highway 19 North
Clearwater, FL 34624-7290

Ms. Shannon Polk
Business Development
Thiokol Corporation
P.O. Box 689
Brigham City, UT 84302-0689

Capt Deborah Pollard, USAF
U.S. Air Force Academy
2354 Fairchild Drive, Suite 646
USAF Academy, CO 80840-6258

Mr. Wayne Pritz
Director
Phillips Laboratory
Space Propulsion Division
OL-AC PL/RKC
4 Draco Drive
Edwards AFB, CA 93524-7160

Mr. David Quinlan
Director, Space & Missiles
UTC - Pratt & Whitney
Propulsion Operations
MS: 702-54
P.O. Box 109600
West Palm Beach, FL 33410

Maj Donald Ravenscroft, USAF
BMDO Liaison to
USSPACECOM
U.S. Department of Defense
250 S. Peterson Blvd., Suite 116
Peterson AFB, CO 80914

Mr. Thomas Redmond
Director
Trident Data Systems
Space & Security Operations
12701 Fair Lakes Cir, Suite 1000
Fairfax, VA 22033

Mr. Alvin Reeser
President and CEO
Spacehab, Inc.
1215 Jefferson Davis Hwy #1501
Arlington, VA 22202-4302

Mr. Mark Reiff
Student
University of Houston - Clearlake
444 E. Medical Cntr Blvd. #204
Webster, TX 77598

Mr. R. H. Reinicke
Director, New Product Development
Marotta Scientific Controls
17671 Irvine Blvd., #208
Tustin, CA 92680

Mr. Jon Reynolds
Manager, Program Development
Hughes Space & Communications
SC/S50/X325
P.O. Box 92919
Los Angeles, CA 90009

Mr. David Roalstad
Director
Ball Aerospace
Systems Group
RA-2
P.O. Box 1062
Boulder, CO 80306-1062

Mr. Ron Robert
Systems Engineer
Scitor Corporation
1250 Academy Park Loop, #208
Colorado Springs, CO 80910

CAPT T. S. Robison, USN
Dep Dir for NUICCS Policy, Arch & Integ
HQ USSPACECOM, J6N
250 S. Peterson Blvd., Suite 116
Peterson AFB, CO 80914-3050

Mr. Eugene Ross
Director, Military Space Program
Northrop Grumman Corporation
1000 Wilson Blvd., Suite 2800
Arlington, VA 22209-2280

Mr. Axel Roth
Deputy Director, Program Development
NASA Marshall Space Center
MSFC/PA01
Huntsville, AL 35812

Mr. William Ruskin
Assistant Director
City of Colorado Springs
Ofc. of Economic Development
P.O. Box 1575
Colorado Springs, CO 80901-1575

LCDR Scott Sage, USN
Asst. Branch Chief, Plans & Simulation
USSPACECOM/J6NP
250 S. Peterson Blvd., Suite 116
Colorado Springs, CO 80914

Mr. Kenichi Saito
Space Age, Japan Inc.
Operations Department
1-5-17 Shinkawa, Chuo-ku
Tokyo 104 JAPAN

Brig Gen James Savarda, USAF
Vice Director, NORAD Combat Operations
HQ NORAD/J3V
1 NORAD Road, Suite 5-304
Cheyenne Mtn AFB, CO 80914-6065

Col George Sawaya, USAF
Deputy Director for Logistics
HQ USSPACECOM/J4L
250 S. Peterson Blvd., Suite 116
Peterson AFB, CO 80914-3050

Mr. Bill Schnirring
Editor-in-Chief
NASA Tech Briefs
41 East 42nd Street, Suite 921
New York, NY 10017-5391

Mr. Garold Schultz
Account Representative
Digital Equipment Corporation
305 Rockrimmon Blvd., S.
Colorado Springs, CO 80920

Mr. Brad Schwartz
President
CTA Launch Services
1521 Westbranch Drive
Mc Lean, VA 22102

Mr. John Schwartz
Senior Systems Engineer
SCITOR Corporation
1250 Academy Park Loop, #208
Colorado Springs, CO 80919

Mr. Richard (Dick) Schwartz
President
Hercules Aerospace Company
Hercules Plaza
Wilmington, DE 19894-0001

Mr. Carrol Duane Selby
Director, Advanced Prgm Dev
Harris Corporation
MS: 22A/4730
P.O. Box 94000
Melbourne, FL 32902

Mr. Larry Sharrar
Vice President and General Counsel
Barba-Arkhon International Inc.
10000 Midlantic Drive, Suite 300
Mt. Laurel, NJ 08054

Mr. William Sheehan
Patent Attorney
NASA Kennedy Space Center
Kennedy Space Center, FL 32899

Mr. Robert Sheets
Director
Northrop Grumman Corporation
1250 Academy Park Loop, #100
Colorado Springs, CO 80910

Ms. Michelle Simms
Senior Communications Rep
Aerojet
1100 W. Hollyvale Street
P.O. Box 296
Azusa, CA 91702

Mr. James Simpson
Staff Senior Manager
McDonnell Douglas Aerospace
5301 Bolsa Avenue
Huntington Beach, CA 92683

Ms. Susan Sinclair
Manager
EOSAT
North America Distribution
1 Park Plaza, Suite 600
Irvine, CA 92714

Mr. Patrick Skinner
General Manager, Space Programs
Litton Computer Services
985 Space Center Drive, Ste 204
Colorado Springs, CO 80915

Mr. Jerry Slatter
President
Logistic Specialties, Inc.
P.O. Box 540447
North Salt Lake, UT 84054

Mr. Gary Smith
Trident Data Systems
P.O. Box 5662
Vandenberg AFB, CA 93437

Mr. Richard Smith
Vice President & Regional Manager
Geodynamics Corporation
5450 Tech Center Drive
Colorado Springs, CO 80919

Mr. Robert Smith
Wing Planning Manager
30th Space Wing
30 SW/XPR
747 Nebraska Avenue, Suite 34
Vandenberg AFB, CA 93437

Mr. Skip Smith
Associate
Sherman & Howard
90 South Cascade Ave., Ste 1500
Colorado Springs, CO 80903

Ms. Mary Snitch
Mngr, Space & Booster Programs
Lockheed Missiles & Space Co.
Crystal Square 2, Suite 300
1725 Jefferson Davis Hwy.
Arlington, VA 22202

Mr. John Spearing
President
ITT Federal Services Corp.
P.O. Box 15012
Colorado Springs, CO 80935

Mr. Larry Speight
Vice President, Bus Dev
Honeywell - Space Systems
13350 U. S. Highway 19 North
Clearwater, FL 34624-2790

Mr. William Sprow
Manager, Business Development
Aerojet Propulsion System
P.O. Box 13222
Sacramento, CA 95813

Mr. Tom Stegner
Business Development Manager
Digital Equipment Corporation
305 Rockrimmon Blvd., S.
Colorado Springs, CO 80920

Mr. G. M. (Jerry) Stenovec
Director, Business Development
Martin Marietta
MS: 32-7093
P.O. Box 85990
San Diego, CA 92186-4560

CDR George Stephenson
Commander
U.S. Space Command
The Pentagon

Mr. Ivan Stern
Vice President, Business Development
Martin Marietta Services
2131 Rt. 38
Cherry Hill, NJ 08358

Mr. Siegfried Stief
Virginia Operations Manager
Tecolote Research, Inc.
2601 Oakton Glen Drive
Vienna, VA 22181

Mr. Kevin Strack
Manager, Military Sales
Whittaker Electronic Resources
1955 N. Surveyor Avenue
Simi Valley, CA 93063

Mr. Joel Strickland
Program Director
Martin Marietta Missile Systems
MP41
P.O. Box 555837
Orlando, FL 32855-5837

Ms. Linda Strine
Dep. Asso. Dir, Public Affairs
U.S. DoT
Ofc. of Commercial Space
Transportation
400 7th Street, SW
Washington, DC 20590

Mr. Arthur Sulkin
Director, Advanced Progs &
Bus. Develop.
Rockwell
MC: R01E
600 Gemini Avenue
Houston, TX 77058

Mr. Keith Sullivan
Manager
TRW Space & Electronics Group
1250 Academy Park Loop, #202
Colorado Springs, CO 80910

Lt Col David Summers, USAF
Chief, Aerospace Medicine
6547 N. Academy Blvd., #507
Colorado Springs, CO 80918

Mr. Donald Sutula
Manager, Colorado Springs
Applied Technology Assoc.
1330 Inverness Drive, Suite 335
Colorado Springs, CO 80910

Mr. Edmund Sweeney
Director/GM
GTE/MCSD
1450 Academy Park Loop
Colorado Springs, CO 80910

Mr. Richard Swendsen
Product Line Manager
TRW, Inc.
R4/2082
One Space Park
Redondo Beach, CA 90278

Mr. Kenneth Swimm
President
Martin Marietta
Management and Data Systems
P.O. Box 8048
Philadelphia, PA 19101

Mr. Keigo Taniguchi
Manager, International Section
Space Age, Japan Inc.
1-5-17 Shinkawa, Chuo-ku,
Tokyo 104 JAPAN

Mr. Kenneth Taormina
Mngr, Intelligence/DoD Prgms
Martin Marietta Co.
Management & Data Systems
7000 Geerdes Blvd.
King of Prussia, PA 19406

Mr. Joseph Tarlton
Vice President
Bechtel National, Inc.
P.O. Box 193965
San Francisco, CA 94119-3965

Ms. Carol Tevepaugh
Manager, Space Propulsion Ops
UTC - Pratt & Whitney
188 Sparkman Drive
Huntsville, AL 35807

Mr. Jim Thilenius
Trident Data Systems
1330 Inverness Drive, Suite 310
Colorado Springs, CO 80910

Mr. Dave Thomas
Vice President, Marketing
Gulton Data Systems
6600 Gulton Court, NE
Albuquerque, NM 87109

Mr. Martin Thomas
President & CEO
U.S.A. 1st, Inc.
965 Bayfield Drive
Colorado Springs, CO 80906

Mr. W. David Thompson
President
Spectrum Astro, Inc.
1440 N. Fiesta Blvd.
Gilbert, AZ 85233

Mr. Wesley Tivel
City of Colorado Springs
Ofc. of Economic Development
P.O. Box 1575
Colorado Springs, CO 80901

Mr. John Toniolli
Director, Business Development
GTE Government Systems Corp.
1050 S. Academy Blvd.
Colorado Springs, CO 80910

Mr. Jeff Torell
Manager, Marketing
Textron Aerostructures
2 International Drive, Suite 408
Nashville, TN 37217

Mr. Robert Tribit
Manager, Business Development
Martin Marietta Services Inc.
Bldg. 202-2, 2131 Route 38
Cherry Hill, NJ 08358

Mr. Michael Tupper
CTD
2400 Central Avenue, #H
Boulder, CO 80301

Mr. Darryl Van Dorn
Dir, Air Force Delta Program
McDonnell Douglas Aerospace
MC: 12/3
5301 Bolsa Avenue
Huntington Beach, CA 92647

Mr. E. S. Van Inwegen
Director, AF/Civil Business Unit
TRW, Inc.
R2/2004
One Space Park
Redondo Beach, CA 90278

Mr. Jerry Van Loon
Marketing Director
AlliedSignal ASE
2525 W. 190th
Torrance, CA 90504

Capt Alan Van Tassel, USAF
Asso. Professor of Political
Science
U.S. Air Force Academy
HQ USAFA/DFPS
2354 Fairchild Drive, Suite 6216
USAF Academy, CO 80840-6258

Dr. Ed Vande Noord
Senior Vice President
Ball
Electro-Opics & Cryogenics
P.O. Box 1062
Boulder, CO 80306-1062

Mr. Howard Vasina
Manager
Martin Marietta Corporation
Spacelift, Missiles & Electronics
1250 Academy Park Loop, #104
Colorado Springs, CO 80910

Mr. Ed Walser
Sverdrup Technology
Bldg. 1210
Stennis Space Center, MS 39529

Mr. Michael Wash
President
Martin Marietta
Commercial Launch Services
MZ: K1-9690
P.O. Box 85911
San Diego, CA 92186-5990

Mr. Mick Webber
Manager, Advanced Program
Development
GTE Government Systems
1450 Academy Park Loop
Colorado Springs, CO 80910

Ms. Pamela Wendell
Account Manager
Digital Equipment Corporation
305 Rockrimmon Blvd., S.
Colorado Springs, CO 80920

Mr. Thomas Wergen
Product Development Manager
Universal Propulsion Co., Inc.
25401 N. Central
Phoenix, AZ 85027

Mr. Wesley West
General Manager, Bus Dev
Martin Marietta
7000 Geerdes Blvd.
King of Prusia, PA 19406

Mr. Thomas White
Manager, Space Programs
British Aerospace Inc.
1101 Wilson Blvd., Suite 1200
Arlington, VA 22209

Mr. Russ Whitfield
Director, Programs
Harris Corporation
MS: 19-4581
P.O. Box 94000
Melbourne, FL 32902

Mr. Dave Whitton
Business Development Manager
Spar Aerospace Ltd.
21025 Trans-Canada Hwy.
Ste Anne De Bellevue Quebec
H9X 3L2 CANADA

Mr. Raymond Wick
Chief Scientist/Space & Missiles
Tech.
USAF/Phillips Lab.
Kirtland AFB
Albuquerque, NM 87111

Mr. Bruce Alan Widaman
State Director
M.U.F.O.N. Missouri
3112 Mockingbird Drive
St. Charles, MO 63301

Mr. James Williams
Manager, Business Development
Lockheed Technical Operations
4450 E. Fountain Blvd., Ste 200
Colorado Springs, CO 80916

Mr. R. Gordon Williams
VP & Deputy General Manager
TRW, Inc.
Space & Electronics Group
Bldg. E1/ 5010
One Space Park
Redondo Beach, CA 90808

LCDR Andy Wilson, USN
811 10th Street
Coronado, CA 92118

Mr. Donald Wilson
Manager, Castor Bus Dev
Thiokol Corporation
Huntsville Division
P.O. Box 400006
Huntsville, AL 35815-1506

Mr. William Wilson
Manager, Space Propulsion Mktg
Hercules, Inc.
300 Corporate Pointe
Culver City, CA 90230

Mr. Joseph Wingard
Director, Business Development
UNISYS Corporation
1092 Wilshire Blvd., Suite 400
Los Angeles, CA 90024

Mr. Roger Winquist
Staff Engineer
Lockheed Missiles & Space Co.
0/69-01, B/104 - SSD
1111 Lockheed Way
Sunnyvale, CA 94088

Mr. Irving Wischmeyer
Vice President
Barthelmes Manufacturing Co.
15 Cairn Street
Rochester, NY 14611-2491

Dr. Lowell Wood
Special Studies Program Leader
Lawrence Livermore National Laboratory
P.O. Box 808, L-278
Livermore, CA 94550

Col Terrence Woodruff, USAF
Commander
Det 4, AFOTEC/CC
4146 East Bijou Street
Peterson AFB, CO 80909

Mr. Glade Woods
Acting Director, P & TA Directorate
NASA Stennis Space Center
Stennis Space Center, CO 39529

Mr. Michael Wynne
VP & General Manager
Martin Marietta
Astronautics Group
P.O. Box 85990
San Diego, CA 92138

Mr. Dennis Young
Vice President
Kaman Sciences
P.O. Box 7463
Colorado Springs, CO
80933-7463

Mr. Joseph Zimonis
Executive VP & General Manager
United Tech Corporation
Pratt & Whitney, USBI
P.O. Box 1900
Huntsville, AL 3580

Mark Your Calendars Now!

The 11th National Space Symposium

April 4-7, 1995

Broadmoor Hotel

Colorado Springs, CO

ABBREVIATIONS & ACRONYMS GLOSSARY

ACRV	Aerospace Crew Rescue Vehicle
AEGIS	Airborne Early Warning Ground Integration System
AFSOC	Armed Forces Special Ops Command
AFSPACECOM	Air Force Space Command
ALS	Advanced Launch System
AMB	Airway Modernization Board
AOR	Area of Responsibility
APM	Antenna Positioner Mechanism/-Attached Pressurized Module
ARSPACE	US Army Space Command
ASAT	Anti-Satellite Weapon
ASPO	Army Space Program Office
ASTRO	Army Space Technology & Research Office
ATO	Abort to Orbit Air Tasking Order
ATP	Advanced Technology Program
BDA	Battle Damage Assessment
BLADES	Military accounting systems being replaced by JONAS
BMC3	Battle Management Command, Control, and Communication
BMDO	Ballistic Missile Defense Organization
BOE	Barrels of oil equivalent
C3	Command, Control, and Communication
CBO	Congressional Budget Office
CENTCOM	US Central Command
CEO	Chief Executive Officer
CINC	Commander in Chief
CINCSAC	Commander in Chief Strategic Air Command
CINCSPACE	Commander in Chief US Space Command
CNES	Centre National Détudes Spactiales (The French space agency)
CNO	Chief of Naval Operations
COMM	Communications
COMSAT	Communications Satellite
COMSTAC	Commercial Space Transportation Advisory Committee
CRS	Congressional Research Service
CTAPS	Contingency Tactical Air Control Planning System
DARPA	Deutsche Agentur Für Raumfahr-tangelegen-Heiten (the German Space Agency)
DARPA	Defense Advanced Research Project Agency
DMA	Defense Mapping Agency
DMSP	Defense Meteorological Satellite Program
DoD	Department of Defense
DoE	Department of Energy
DoT	Department of Transportation
DSP	Defense Support Program
EHF	Extremely High Frequency
EIS	Environmental Impact Statement
EIRP	Electronic Integrated Receiver Programming
ELV	Expendable Launch Vehicle
EOS	Earth Observing Satellite System
EOSDIS	Earth Observing Satellite Interactive Data System
ERS	Earth Resource Satellite
ESA	European Space Agency
ETF	Environmental Task Force
EUCOM	US European Command
EVA	Extra-Vehicular Activity
FCB	Faster, cheaper, better
FCC	Federal Communications Commission
FCCSET	Federal Coordinating Council on Science, Engineering & Technology
FEWS	Follow-on Early Warning System
FLTSAT	Fleet Satellite
FTS	Flight Telerobotic System
FYDP	Five Year Defense Plan
GEOSAT	US Navy Ocean Survey Satellite
GLPS	Gun Laying Positioning System
GPALS	Global Protection Against Limited Strike
GPS	Global Positioning Satellite
HHS	Health and Human Services
HUD	Housing and Urban Development
HYFLITE	Hypersonic Flight Test Experiment
ICBM	Inter Continental Ballistic Missile
ILC	Initial Launch Capability
INMARSAT	International Maritime Satellite Organization
INTEL	Intelligence Service
INTELSAT	International Telecommunications Satellite Organization
IOC	Initial Operating Capability
IRBM	Intermediate Range Ballistic Missile
ITER	International Thermonuclear Experimental Reactor
JCS	Joint Chiefs of Staff

JDISS	Joint Deployable Intelligence Support System
JONAS	Job Order Number Accounting System
KeV	Kilo-volt
KWAJ	Kwajalein Atoll
Marine HELOS	helicopters
MeV	Mega-volt
MILSATCOM	Military Satellite Communications
MILSTAR	Military Communications Satellite
Mir	Russian Space Station ("Mir" means "peace")
MIRV	Multiple Independently Targetable Re-entry Vehicle
MOL	Manned Orbiting Laboratory
MSI	Multispectral Scan Imagery
MSS	Mission planning system of a tactical Air Force
MTPE	Mission to Planet Earth
MWe-yr	Mega-watt year
MW_{th} -	Megawatts
NASA	National Aeronautics and Space Administration
NASP	National Aero-Space Plane
NERVA	Nuclear Engine for Rocket Vehicle Application
NIST	National Institute of Standards & Technology
NLS	National Launch Vehicle
NMD	National Missile Defense
NOAA	National Oceanic & Atmospheric Administration
NORAD	North American Aerospace Defense Command
NSC	National Security Council
NSTC	National Science & Technology Council
OACT	Office of Advanced Concepts & Technology, NASA
OCST	Office of Commercial Science & Technology
OMB	Office of Management and Budget
OSD	Office of the Secretary of Defense
OSI	Office of Special Investigations
	Office of Space Industry (Hawaii)
OSS	Office of Space Science
OSTP	Office of Science Technology Policy
PAC-2	Patriot missile upgrade
PADS	Position Azimuth Determination System
PDDs	Presidential Decision Directives
ppb	Parts per billion
ROI	Return on Investment
RPV	Remotely Piloted Vehicle
SATCOM	Satellite Communications
SAWC	Space Applications & Warfare Center
SBIR	Space-Based Infra Red Radar
SBIR	Small Business Innovations Research
SCUD	Mid-range battlefield missile
SDI	Strategic Defense Initiative
SDIO	Strategic Defense Initiative Organization
SEI	Space Exploration Initiative
SETI	Search for Extraterrestrial Intelligence
SHF	Super High Frequency
SLBM	Submarine-launched ballistic missile
SOUTHCOM	US Southern Command
SSDC	Army Space & Strategic Defense Command
SSRT	Single Stage Rocket Technology
SSTO	Single-Stage-to-Orbit
TAC 3	Navy's new tactical computer
TAF	Tactical Air Force
TAU	Thousand Astronomic Unit
TENCAP	Tactical Exploitation of National Capabilities
TESS-3	Tactical Environment Support System
TISS	Tactical Information Supply System
TMD	Tactical Missile Defense
TRACC 3	Tracking, Command, Control & Communications System
TRE	Tactical Receiver Equipment
TVRO	TV-receive only
TW/AA	Tactical Warning/Attack Assessment
TXP	Toroidal Plasma Experiment
UHF	Ultra High Frequency
UFO	Unidentified Flying Object
UN	United Nations
UOES	User Operational Evaluation System
GSFC	Goddard Space Flight Center
USSPACECOM	US Space Command
VORTAC	Very High Frequency, Omnidirectional (Radio) Range Tactical Air Control

United States Space Foundation
2860 S. Circle Drive, Suite 2301
Colorado Springs, CO 80906-4184
Phone: (719) 576-8000 FAX: (719) 576-8801

10TH NATIONAL SPACE SYMPOSIUM
PROCEEDINGS REPORT ORDER FORM

Please send me ____ copy(s) at the price of $50.00 each.

NAME_____

COMPANY_____

ADDRESS_____

CITY/STATE_____

ZIP CODE_____

METHOD OF PAYMENT

____ Check (enclosed) ____ Visa/Mastercard

Card number_____

Expiration date_____

Signature_____

____ Please send me information on the United States Space Foundation.

****

JOIN THE UNTED STATES SPACE FOUNDATION AND STRENGTHEN AMERICA'S LEADERSHIP IN SPACE!

MEMBERSHIP APPLICATION FORM
Memberships & Contributions are Tax Deductible

Membership Level and Annual Fees:

__ Life Member $1,000

__ Space Professional/Benefactor $75

__ Individual $35

__ Add $9 per year of Memberships outside of the Continental United States. (U.S. currency only)

__ I want to help! Here is my contribution of _____

Detach and mail this form to:

United States Space Foundation
2860 South Circle Drive, Suite 2301
Colorado Springs, CO 80906-4184

Name_____

Title_____

Company_____

Address_____

City_____

State_____ Zip Code____

Phone_____

FAX_____

___Visa____ MC Expriation date_____

Card #_____

Signature_____

Date_____

PRECEDING PAGE BLANK NOT FILMED