



The Director's Report

David R. Criswell [ISSO]

THIS REPORT SUMMARIZES RESEARCH ACTIVITIES SUPPORTED by ISSO at UH and UHCL through the winter of 2003 and follow-up reports on ISSO projects funded between 1999 and 2002. The report previews new seed-grants and UH/UHCL-JSC Post-Doctoral Aerospace Fellowship projects awarded in March, 2004. These new research projects are described. Joint activities with the Texas Space Grant Consortium (TSGC), including awards received at UH and a letter by the Board of Directors to the President's Space Commission, are highlighted. The Texas Legislature authorized a new program that will eventually fund several hundred scholarships and fellowships to TSGC member universities. That program is described below.

2003 Seed Grant Projects and Post-Doctoral Aerospace Fellowships

During 2003, the last four of the second set of UH/UHCL-JSC Post-Doctoral Aerospace Fellowship projects were completed. One fellow joined NASA-JSC, one joined the faculty of Houston Baptist University, and one remained with the University of Houston in research positions. During this reporting period ISSO supported 26 faculty members at UH and UHCL as principal investigators on the four fellowship projects and 21 seed-grant and special projects with \$357,000 of funding. Fifteen other UH and 11 other UHCL faculty participated in the research along with four faculty from UH-Downtown. Seven NASA investigators, five industry researchers, and ten researchers from other organizations participated. These organizations included:

The Mars Society
Integrated Microsystems, Inc.
University of Montreal
SEMATECH
Clear Creek High School
Boeing Company
Houston Baptist University
University of Texas Medical Branch
Baylor College of Medicine,
Jet Propulsion Laboratory, and
Texas Space Grant Consortium

VX-10 EXPERIMENT—Dr. David R. Criswell, ISSO Director (l.), meets with Dr. John V. Shebalin, plasma physicist (r.), at the NASA-JSC Sonny Carter Training Facility north of NASA-JSC. Dr. David Garrison (UHCL) and Dr. Edgar Bering (UH), not shown, are Principal Investigators in the development of the VASIMIR. The research team solicits ISSO Post-Doctoral Fellows interested in the research and capable of bringing unique experience to projects in advanced space propulsion.

Two UH graduate students completed their Ph.D. studies and two others pursued this degree on ISSO research projects. Twenty-six other students pursued MS degrees on ISSO topics at UH and UHCL. Faculty delivered 58 presentations and published and/or submitted 35 technical papers for publication. The work of the ISSO director was reported by 18 Web sites, magazine articles, and book reviews. Faculty submitted 22 proposals that requested \$11,800,000 in external funded and reported being awarded \$2,960,000 in external funding during the period.

ISSO worked at UH with the Colleges of Engineering, Natural Sciences, and Education and the Texas Center for Superconductivity and Advanced Materials. ISSO sincerely thanks Dean John L. Bear (Natural Science & Mathematics), Dean Raymond W. Flumerfelt (Engineering), Dean Robert K. Wimpelberg (Education) with Associate Dean Amaury Nora (Education), and Dr. Alex Ignatiev, Director (TCSAM), for their support in the joint research projects. At UHCL, ISSO worked primarily with the School of Science and Computer Engineering. Thanks are sincerely extended to Dean Charles W. McKay (SCE).

New Instrumentation

Prof. Abdelhak Bensaoula and Dr. David Starikov (UH-TCSAM) and Dr. Chris Boney (ISSO Fellow) are investigating the development of new optical sensors to detect contamination in air and water. They are concentrating on compounds of *GaN*, *AlN*, *InN*, and their alloys. Prototype sensors grown at the Texas Center for Superconductivity and Advanced Materials (TCSAM) have been integrated into a working biomedical instrument in collaboration with Integrated Micro Systems Inc. It was demonstrated at the Mars Analog Research Station in the Southwestern U.S. Under an ISSO seed grant, the team and three graduate students completed the fabrication of a miniature chemical sensor. They are collaborating with the Bio-Processing Laboratory at the University of Quebec at Montreal.

Dr. Abdelhak Bensaoula, Dr. David Starikov, and Dr. Chris Boney are also working with graduate students N.-E. Medelci-Djezzar, Clement Joseph, Zoulikha Mouffak, and Rajeev Rajan Pillai to miniaturize fluorescence sensors on silicon substrates. These small sensors will enable practical monitoring of contaminants in air, water, and other fluids.

Professors Thomas L. Harman (UHCL, Computer Engineering) and Frank K. Tittel (Rice University, Electrical and Computer Engineering), Dr. John C. Graf (JSC), and Dr. Yury Bakhirkin (Fellow, UHCL & Rice University) are developing biosensors based on quantum-cascade lasers. They report the second year of a joint UHCL-Rice-JSC fellowship project. The sensors are expected to find use in the detection of very low levels of nitric oxide within spacecraft or in the gases expelled by human patients.

Computer Science

Dr. Gary D. Boetticher and Ms. Kimberly Kaminsky (UHCL, Computer Science) are developing a new type of software, the Genetically Engineerable Evolvable Program (GEEP), that attempts to incorporate explicit knowledge into genetic programming. Under a separate ISSO seed grant, Dr. Gary Boetticher, Professor Hisham Al-Mubaid (UHCL, Computer Science), and Professor Karen F. Frasier-Scott (UHCL, Biology) are applying learning software (Support Vector Machine) to the recognition of patterns of proteins separated by gel electrophoresis.

Professor Kwok-Bun Yue (UHCL, Computer Science) is developing educational software that enables students to take university courses via the World Wide Web. He is enhancing existing software to enable richer collaborations between students and teachers.

Systems and Devices

Professor Karolos M. Grigoriadis (UH, Mechanical Engineering), Dr. Ian J. Fialho (The Boeing Company), and doctoral student Feng Zhang are developing systems to isolate experiments on-board spacecraft from microgravity vibrations. This seed grant research focuses on anti-windup effects resulting from slow but long-term displacements of an experiment container.

Professors James B. Dabney (UHCL, Systems Engineering) and Thomas L. Harman (UHCL, Computer Science) worked with graduate student Chakkungal Joseph Joseph under a second year of seed-grant funding to measure the dynamic response of a piezoelectric ultrasonic motor to inertial loads. This type of simple and low-mass motor will find use in the precise control of robot motion in space.

The radiating efficiency of a metallic antenna decreases as the operating frequency increases above 30 GHz (1 GHz = 1×10^9 cycles/second). Electrically insulating dielectric-based antennas can be efficient radiators and achieve high bandwidth at these high frequencies. However, different design-rules than those used for metallic antennas must be developed. Professor Stuart A. Long (UH, Electrical and Computer Engineering) received an ISSO seed grant in 1999 to initiate work on dielectric resonator antennas. In a continuation of that original project, Professor Long is working with two master's students, Mr. Chris DeYoung and Mr. Andrew Walsh. They are developing new design rules for "stacked" dielectric resonator antennas.

There is growing national interest in the use of hydrogen fuel cells as engines for transportation and local power. Professor John H. Miller, Jr. (UH, Physics & TCSAM) and Dr. James R. Claycomb (Houston Baptist University, Physics) report new publications on this topic resulting from a 2002 ISSO seed grant.

Life Sciences

Professor George E. Fox (UH, Biology and Biochemistry) and NASA-JSC researchers Drs. Duane L. Pierson, Mark Ott, and Don L. Tucker (former UH PDAF) are demonstrating that bacteria retain their virulence under weightless conditions. *Salmonella* virulence appears to increase when it is grown

under simulated, microgravity (i.e., low-shear modeled). They are identifying genes that are regulated by decreasing gravity.

Living cells are complex electrical machines. Professors John H. Miller, Jr. (UH, Physics) and Dr. James R. Claycomb (Houston Baptist University, former UH PDAF) can now measure the changes in dielectric properties of proteins as they undergo self-assembly to form microtubules. Microtubules are a major component of the "skeleton" of cells. Two UH doctoral students, Hugo Sanabria and Gustavo Cardenas, are pursuing advanced degrees on this project.

Upon entering zero-gravity, the skeletal muscles of an animal begin to lose mass. A rat displays muscle loss in its hind legs when it is suspended by its tail so that only its forelegs contact the floor. Professors Charles S. Layne and Dr. Mark S. F. Clarke (UH, Health & Human Performance), Drs. Daniel A. Martinez and Dr. Dan L. Feedback (JSC, Space and Life Sciences), and Dr. Antonios Kyparos (UH PDAF) have now demonstrated that about 85 percent of the atrophy of type I muscle fibers can be prevented by dynamically stimulating the foot (DFS) of the suspended mouse. The effect was confined only to the soleus muscle within the leg that underwent DFS stimulus. Foot stimulation did not attenuate the atrophy of type II muscle fibers.

Research Professor Jarek Wosik (UH, TCSAM) works with students Maged Kamel, Lian Xue, Sarah Hirsh, and Nathan Withers in the development of magnetic resonance imaging of humans and animals. The group focuses on demonstrating MRI technology that uses low intensity magnetic fields and compact detectors. These advances will enable lower cost MRI medical applications on Earth and greater use of MRI in space.

Space Science

The magnetosphere of Earth contains electrically charged particles (electrons, protons, helium, etc.) moving at relatively high speed. Also, extremely high-speed solar and galactic cosmic rays course through the magnetosphere. All these particles cause damage to instruments and to people—directly when they impact and indirectly by generating secondary radiation as they plow into the upper atmosphere of Earth or into orbiting satellites. Professor Lawrence S. Pinsky (UH, Physics), Dr. Thomas L. Wilson (NASA-JSC), and Mr. Kerry Lee (UH, Ph.D. candidate) are applying physics-based models to predict the radiation induced in the upper atmosphere of Earth by particles trapped in the magnetosphere and by cosmic rays. They will test some of the predictions against observations of radiation produced as electrons precipitate out of the magnetosphere into the upper atmosphere. Dr. William Sheldon (UH, Physics) obtained the measurements.

Materials and Applications

Inorganic polymers offer new types of fire-resistant materials for use in aircraft interiors and in the molecular separation of pollutants from air and liquids such as water and foods. Professor Jack Y. Lu (UHCL, Chemistry) reports results from three years of ISSO seed grants for work on 2,2'-biphenyl-dicarboxylate and a copper based metal-organic polymer. He has demonstrated a unique stable 2-D open-channel polymer

for high temperature applications and several novel microporous metal-organic polymers for separation applications.

ISSO Short Reports

Several fellowship and seed-grant projects have been completed. UH and UHCL professors report on subsequent findings and achievements.

Professor Vemuri Balakotaiah (UH, Chemical Engineering) and Cesar E. Meza, Jr., are studying the flow of aerobic microbes along the inner walls of tubes that are transporting gas/liquid mixtures. Professor Demetre J. Economou (UH, Chemical Engineering) has extended his work on the use of electron beams in large-area manufacturing of microelectronics for sputtering of surfaces and removal of photoresists. Professor Jack Y. Lu (UHCL, Chemistry) is continuing the development of new types of metal-organic polymers for use in molecular separation systems. Professor Irving N. Rothman (UH, English) continues his examination of the literature of flight in England in the eighteenth-century and ballooning in the first decade of the nineteenth century in America. Dr. David Criswell reports his research on space industrialization.

New Projects for 2004 AND 2005-2006

In December 2003, ISSO requested proposals from UH and UHCL faculty for seed-level research projects and for joint Post-Doctoral Aerospace Fellowship projects with researchers at NASA-JSC. ISSO received letters of intent in February 2004 and 38 formal proposals in early March 2004. Dr. Criswell worked with Dr. Helen Lane (Director – University Programs) and Dr. Donn Sickorez (University Affairs Officer) at NASA-JSC to form a panel and conduct a peer review of the proposals. The 17-member review panel consisted of faculty from the University of Houston, University of Houston-Clear Lake, and Rice University and members of the technical staff of NASA-JSC. Care was taken to insure that the panel members had no conflict of interest with the faculty and JSC members proposing to ISSO. Panel members were provided the proposals in advance and encouraged to obtain, as necessary, external reviews on proposals. A chief and an associate reviewer were assigned to each proposal. Each proposal was reviewed and ranked in one of three discipline groups. The three groups were convened in a final plenary session and all the proposals were assigned rankings between 0 and 10.

The panel selected five Post-Doctoral Aerospace Fellowship teams from UH/JSC and one from UHCL/JSC. This commits ISSO to \$100,000/year in academic years 2005 and 2006. The selected teams are listed in the following section. This third round of Post-Doctoral Aerospace Fellowships is a completely new set of projects.

ISSO allocated \$222,573 of 2004 funds to the new seed grant projects. Available 2004 FY funds were allocated to the 13 top ranked UH and five top ranked UHCL seed proposals. Titles and investigators of funded seed-grant projects are listed in the second and third following sections. Several other projects were worthy but could not be funded. The Texas Legislature sets the ISSO funds available at UH and UHCL.

UH/UHCL-JSC Post-Doctoral Aerospace Fellowship Projects (2004/2006).

A number of joint projects were selected for the third round of Post-Doctoral Aerospace Fellowship projects. A given project can begin as soon as 1 September 2004. The post-doctoral researcher is awarded a fellowship for two years with an opportunity to extend it for a third and final year. ISSO and the cooperating college, department, or institute jointly fund each fellowship. ISSO is committed to providing \$20,000/year to the funding of each fellow. The cooperating organization provides at least \$16,500/year to each fellow and \$3,500/year in the form of office, communications, travel, and miscellaneous expense. NASA-JSC, under the memorandum of understanding with the University of Houston System, supports all work done at NASA-JSC. Details on each project are available at <<http://www.issouh.edu>>. Projects are detailed in the following list:

Pre/Post-Flight Neuromuscular Control with Variable Resistance/Assistance Exercise Machine

Dr. Enrique Barbieri, Professor and Chair, Department of Engineering Technology, UH, and Dr. Don Hagan, Exercise Lead for the Human Adaptation and Countermeasures Office, NASA-JSC.

Development of Micro Column Arrays (MCA) for Thermal Management Applications

Dr. Abdelhak Bensaoula, Research Professor, TCSAM, UH, and Dr. Brian M. Mayeaux, Materials Research Engineer, Materials and Processes Branch, NASA-JSC.

Thrust Measurement and Plasma Detachment Characterization in a Magnetic Nozzle

Dr. Edgar A. Bering III, Professor of Physics and Electrical and Computer Engineering, UH, and Dr. John V. Shebalin, Advanced Space Propulsion Laboratory, NASA-JSC.

Subtractive Proteomic Profiling of Control, Atrophied and Protected Rat Skeletal Muscle by Dynamic Foot Stimulation (DFS)

Dr. Mark S. F. Clarke, Associate Professor Department of Health and Human Performance, UH, and Dr. Daniel L. Feedback, Head, Muscle Research Laboratory and STS Sortie Mission Scientist, Human Adaptations and Countermeasures Office, NASA-JSC.

The Effects of Simulated Microgravity and Radiation on Microbial Gene Expression

Dr. George E. Fox, Professor, Department of Biology & Biochemistry, UH, and Dr. Duane L. Pierson, Chief Microbiologist, NASA-JSC.

Investigation of Plasma Flow Characteristics in a Magneto-Plasma Rocket

Dr. David Garrison, Faculty Chair and Assoc. Professor of Physics, UHCL, and Dr. John V. Shebalin, Advanced Space Propulsion Laboratory, NASA-JSC.

Martian Soil Biosensors Based on Dielectric Spectroscopy

Dr. John H. Miller, Jr., Department of Physics and Texas Center for Superconductivity and Advanced Materials, UH, and Dr. David S. McKay, NASA-JSC.

Magneto-Plasma Propulsion

Magneto-Plasma Propulsion is a new topic for joint research between ISSO and NASA-JSC. Professors Edgar A. Bering (UH) and Professor David Garrison (UHCL) with Dr. John V. Shebalin (NASA-JSC) and Dr. Franklin R. Chang-Diaz (Director, NASA-Advanced Space Propulsion Laboratory [ASPL]) have worked as a team along with Laurie Carrillo (Rice U doctoral student), Verlin Jacobson (NASA-JSC research engineer), and Justin Hays (NASA-ASPL-JSC electronics technician). They provide an introductory report describing the Variable Specific Impulse Magneto-Plasma Rocket (VASIMR) and identifying projected work.

Seed Funding For Research By University of Houston Faculty (April-August, 2004)

ISSO awarded a total of \$167,581 for 13 seed grants for work performed between April and August 2004. More funds were available for seed grants than is normally the case. Funding of post-doctoral fellows was decreasing in the 2002/2003 academic year as the second round of fellowships was ending. Changes in the accounting system of the University of Houston System lead to permission to carry over 2003 funds into 2004. The majority of these funds were applied to the UH seed grants. A similar carry over of UHCL funds was not allowed. All available UHCL 2004 funds were expended in that academic year. Final reports on the seed grant research projects are due on 15 December 2004 for inclusion in the ISSO 2004 report to be published in the summer of 2005. Proposals must be submitted to external funding agencies by early 2005. Investigators are required to provide short follow-up reports on publications and proposals enabled by this funding for five years after the completion of the project.

Micro Column Arrays for Thermal Management of Spacecraft Environments

Abdelhak Bensaoula, Dept. of Physics and Texas Center for Superconductivity and Advanced Materials, College of Natural Science and Mathematics

Optimizing System Reward in Battery-Powered Spacecraft and Rovers

M. K. Cheng, Dept. of Computer Science, College of Natural Science and Mathematics

Development of a Microgravity-Compatible Slide Staining Device

Mark S. F. Clark, Dept. of Health and Human Performance, College of Education

Remnants of the RNA World: RNA Structures Associated with Gene Regulation

George E. Fox, Dept. of Biology and Biochemistry, College of Natural Science and Mathematics

A Theoretical Analysis of Vibrational Modes Aimed at their Use as Measures of Bone Damage

Gemunu H. Gunaratne, Dept. of Physics, College of Natural Science and Mathematics

Development of Advanced Raman Spectroscopic Methodology for Analysis of Cometary Materials

Victor G. Hadjiev, Texas Center for Superconductivity and

Advanced Materials, College of Natural Science and Mathematics

Raman Scattering Test of Mechanical and Sensorial Properties of Advanced Nanocomposites for Space Flight Applications

Victor G. Hadjiev, Texas Center for Superconductivity and Advanced Materials, College of Natural Science and Mathematics

Adaptive Vibration Modeling and Control for Helicopter Reliability and Performance Enhancement

Heidar A. Malki, Dept. of Engineering Technology, College of Technology

Low-Frequency Dielectric Spectroscopy of Martian Soil Samples

John H. Miller, Jr., Dept. of Physics, College of Natural Science and Mathematics

Initiating the Development of Measurement Enhancements for the Existing NASA Space Radiation Shielding Consortium

Lawrence S. Pinsky, Dept. of Physics, College of Natural Science and Mathematics

Preparation of a Proposal to Investigate the Steady-State Interaction of the Outer Van Allen Belt with the Atmosphere Using Sounding Rockets

W. R. Sheldon, Dept. of Physics, College of Natural Science and Mathematics

An AC-DC-AC Converter with Smaller DC-Link Capacitor for Space Power Distribution Systems

Wajiha Shireen, Dept. of Engineering Technology, College of Technology

High-Frequency Dielectric and Magnetic Susceptibility Measurements of Martian Soil

Jarek Wosik, Texas Center for Superconductivity and Advanced Materials, College of Natural Science and Mathematics

Seed Funding For Research By University of Houston-Clear Lake Faculty (April-August, 2004)

ISSO awarded a total of \$54,992 for five seed grants for work to be performed between April and August 2004. Final reports on the seed grant research projects are due on 15 December 2004 for inclusion in the ISSO 2004 report to be published in the summer of 2005. Proposals must be submitted to external funding agencies by early 2005. Investigators are required to provide short follow-up reports on publications and proposals enabled by this funding for five years after the completion of the project.

The Impact of Chromosome Lineage Upon Genetic Program Modeling and Genetic Program Optimization through Equation Reduction

Gary D. Boetticher, Dept. of Computer Science, College of Science and Computer Engineering

Real-Time Torque Sensing of Piezoelectric Ultrasonic Motors for Space Robotics Applications

James B. Dabney, Dept. of Computer Science, College of Science and Computer Engineering

***Computational Methods in Non-Smooth Mechanics:
Applications to Dry Friction Constrained Motions***

Lie June Shiau, Division of Computing and Mathematics,
College of Science and Computer Engineering

High-Performance Martian Space Radiation Mapping

Dr. Liwen Shih, Division of Computing and Mathematics,
College of Science and Computer Engineering, UHCL

***Development of Wireless Stations for Distributed Field
Operations***

Dr. T. Andrew Yang, Dept. of Computer Science, College
of Science and Computer Engineering, UHCL

Texas Space Grant Consortium (TSGC)

The University of Houston is a charter member, along with the University of Texas-Austin and Texas A&M University, of the Texas Space Grant Consortium. Congress created the National Space Grant Program in 1987. Congress provides approximately 24 million a year in funding to the national program. The states, primarily through their university members, match these funds directly and in-kind. TSGC is the largest of the 52 consortia in terms of membership, total funding, and number of research, outreach, and educational programs and the number of fellowship and scholarships granted each year.

The ISSO director is an associate director of TSGC. The director of the Texas Center for Space and Advanced Materials (TCSAM) is now the University of Houston representative to TSGC. TSGC is headquartered in UT-A facilities in Austin. Professor W. Fowler is the TSGC director. As a charter member, UH pays an annual membership fee of \$50,000 and provides \$50,000 of in-kind support each year. TSGC membership includes 27 Texas educational institutions, three commercial firms, three non-profit organizations, and two agencies of the State of Texas. The extensive TSGC Web site details all activities: <<http://www.tsgc.utexas.edu>>.

In the 2003/2004 academic year, UH professors and students received \$31,900 in grants from TSGC:

Fellowship (\$5,000 per year; three year maximum):
Benjamin Fasenfest, Electrical Engineering, and Kerry
Lee, Physics

Scholarship (\$1,000): Joy Chavez, Physics

Design Challenge Project

Space Robotic Assembly for Science & Exploration

Space RASE

Faculty Advisor: Dr. Paul Ruchhoeft, Department of
Electrical & Computer Engineering

Amount: \$875

<<http://www.tsgc.utexas.edu/challenge/>>

Space Architecture Project

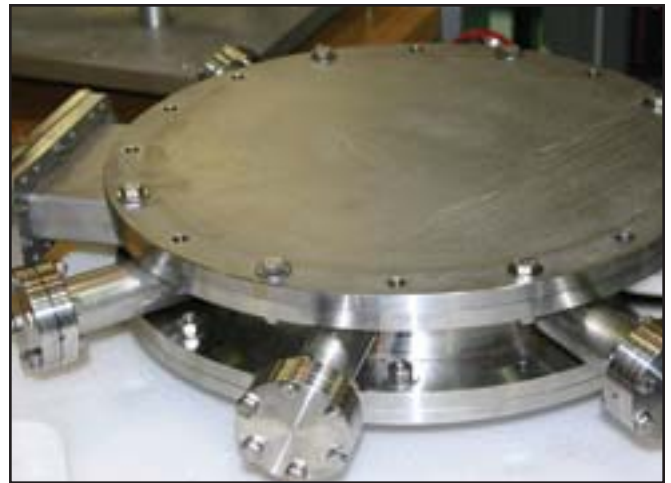
Dr. Larry Bell

College of Architecture-SICSA Room 122

University of Houston

Houston, Texas 77204-4000

\$20,000



DESIGN—University researchers working with NASA contractors such as the Boeing Company gain access to the finest engineers and advanced equipment designs.



Columbia Space Shuttle License Plate Fund

In 2003, the Texas Legislature established the Space Shuttle Columbia Special License Plate Fund in honor of the seven astronauts who lost their lives. The Texas Department of Transportation and the non-profit Aviation and Space Foundation of Texas offer the specialty license plate. Out of the \$30 application fee, \$22 goes to Columbia Crew memorial scholarships and to further aviation and space activities in Texas. Details are available at <<http://www.dot.state.tx.us/vtr/spplates/specialplate.htm?nbr=127>>.

The Texas Space Grant Consortium administers this program and makes the scholarships available to students of TSGC universities. It is reasonable to anticipate that this fund will grow to annually fund several hundred scholarships.

The TSGC Board of Director's met on 27 February 2004 and elected to submit a statement to the Presidential Commission on Implementation of United States Space Exploration Policy concerning the important roles Space Grant universities must undertake in support of the emerging national goals. The Board requested Dr. Criswell to draft that letter. The Board reviewed the letter and submitted it to the chair of the commission on 12 March 2004. The letter and signature sheet of all TSGC board members follow:



Academia, Government and Industry Reaching for the Stars

March 12, 2004

Edward C. "Pete" Aldridge, Jr.
President's Commission on Implementation of
U.S. Space Exploration Policy
2900 South Quincy Street, Suite 800
Arlington, VA 22206

Pete Aldridge:

On January 14, 2002, President George W. Bush challenged America to "set a new course for America's space program," and he noted, "We may discover resources on the moon and Mars that will boggle the imagination, that will test our limits to dream." Similarly, midway through the 1800s, congress realized that our still new nation of farmers needed colleges to continuously advance the agricultural and industrial arts and bring the benefits of higher education to all Americans. In 1850, over 90% of all Americans lived and worked on farms or supported agriculture. Today, less than 2% of Americans work in agriculture, less than 15% work in physical industries, and Americans are far wealthier and more secure.

Some Americans question the presidential challenge because, based on the history of the space program, they believe that Americans will not have an economic payback from Moon and Mars exploration programs. Since 1958, Americans have invested over 700 billion dollars in NASA programs. From that sum we have a work force and industries that can build and fly very large spacecraft, deploy industrial-scale facilities beyond Earth, and land sophisticated robots on the Moon, Mars, and asteroids. As a result of the Apollo and later lunar programs, we now understand that the known resources of the Moon are useful. We have clear visions of essential new lunar industries that will be energized by abundant and dependable solar power in space. However, virtually no NASA funding has been directed to learning how to create growing new wealth using the resources beyond Earth and how to enable widely accessible and sustainable net new wealth for the developed and developing nations.

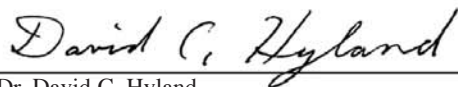
In 1987, Congress enacted the National Space Grant College and Fellowship program to do *beyond Earth* what the Land Grant Colleges have done on Earth. Most Land and Sea Grant Colleges are in the fifty-two Space Grant Consortia. Given adequate resources and intense focus, the National Space Grant Colleges, working with industry and government, can adapt known technologies, provide new tools, and educate Americans to the new skills necessary to create new sustainable wealth on the Earth, its Moon, Mars, and beyond. New terrestrial and lunar industries can pay for a much larger scale of solar system exploration than is possible from Earth alone.

The Board of Directors of the Texas Space Grant Consortium requests that the *President's Commission on Moon, Mars, and Beyond* recommend that America utilize the wealth of intellectual capital in the nation's universities by empowering and funding the National Space Grant Consortia to expeditiously do on the Moon and, later, throughout our solar system what the Land and Sea Grant Colleges have done for Americans on Earth.

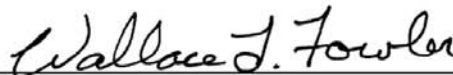
Sincerely,

Texas Space Grant Consortium Board of Directors

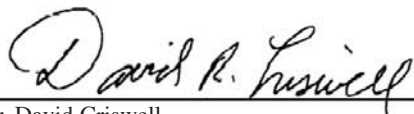
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Dr. David C. Hyland
Chairman of the Board
Texas A&M University



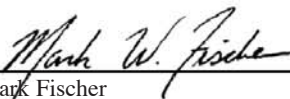
Dr. Wallace T. Fowler
Director
University of Texas at Austin



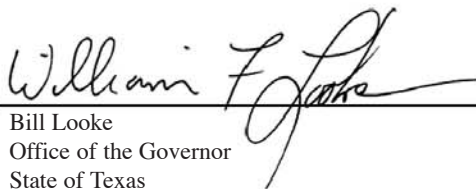
Dr. David Criswell
Associate Director
University of Houston



Dr. Linda Domelsmith
Texas Higher Education Coordinating Board
State of Texas



Mark Fischer
Program Manager



Bill Looke
Office of the Governor
State of Texas



Dr. Robert McLauchlan
Texas A&M University Kingsville



Dr. James Smith
Texas Tech University



Dr. Srinivas Vadali
Associate Director
Texas A&M University



Dr. Fred Young
Lamar University