

The Director's Report

David R. Criswell

INTRODUCTION

The Institute for Space Systems Operations (ISSO) is the operating agency for the Houston Partnership for Space Exploration (HPSE) at the University of Houston and the University of Houston-Clear Lake. Dr. David R. Criswell directs ISSO and is responsible for both the UH and UHCL activities. In the period from September 1, 2006–August 31, 2007 (AY2007), the State of Texas SPSE Line Item provided \$355,986 in funding to ISSO programs, allocating \$278,990 to operations at the University of Houston and \$76,996 to UH-Clear Lake. The faculty reported obtaining more than \$1.9 million in new funding in 2007 from \$13 million in new proposals enabled by ISSO projects funded between 2003 and 2007. The ISSO 2007 *Annual Report* details these research activities. Since 1991, faculty supported by ISSO research funds have reported obtaining \$25.8 million of external funding, thus leveraging the research funds by 4.7:1 over the life of the program.

The two primary activities of ISSO in AY2007 were the new Aerospace Cluster and the continuing Post-doctoral Aerospace Fellowship (PDAF) projects between UH/UHCL and NASA-Johnson Space Center. Prior ISSO reports, available on request as hard copy and on the Web at <<http://www.issu.uh.edu>>, detail all ISSO projects. The PDAF program began in 1995. It and the Aerospace Cluster projects operate through a memorandum of understanding between JSC and the two universities. The MOU was converted to the Space Act Agreement in early 2006.

ISSO projects have established solid professional links with NASA, JSC, the Houston aerospace community, and UH and UHCL. ISSO provides the flexibility and resources for UH and UHCL faculty to participate in the rapidly evolving national space program.

The first section of this report summarizes the 2007 accomplishments of ISSO-supported researchers. A synopsis of each research activity is presented within the six study areas. The 11 new seed-grant projects approved in March 2008 are then listed.

The second section provides an overview of the ISSO program since 1992 and the career paths since 1995 of the 44 former and present Post-doctoral Aerospace Fellows. It is based on portions of the *Self-evaluation of the Houston Partnership for Space Exploration* requested by the Texas Higher Education Coordinating Board for review of the program in preparation for the 2008–2009 session of the Texas Legislature.

SUMMARY OF THE 2007 PROGRAM

ISSO carried over AY2006 UH funds and applied them to UH grants in 2007. In 2007, ISSO provided \$383,000 in research funds to 14 UH and UHCL faculty to support four new Aerospace Cluster projects, six ongoing Post-doctoral Aerospace Fellowship projects, two small special grant projects, and the director's research and program documentation. ISSO requires investigators to report results on projects for five years after completion of funding for a given project. Thirteen follow-up reports are included here.

In 2007, ISSO investigators reported 65 new professional papers, delivered 65 professional presentations and interviews, and submitted 40 new proposals that requested \$13 million in new funds. Twenty-nine undergraduates participated in the ISSO projects along, with 12 master's-level students, 14 doctoral candidates, and seven post-doctoral fellows.

Twenty-eight additional UH System faculty participated in the ISSO research, along with seven faculty members from other universities and eight NASA researchers. In addition to NASA-JSC, a total of 26 organizations representing the corporate and non-profit sector participated:

- Ad Astra Rocket Company
- M.D. Anderson Cancer Center
- Arizona State University
- Baylor College of Medicine
- Biotex, Inc.
- European Organization for Nuclear Research (CERN)
- Houston Baptist University
- Integrated Micro Sensors, Inc.
- Lamar University
- Loma Linda Medical School
- MERAD, Inc.
- The Methodist Hospital, Houston
- Nano EnerTex, Inc.
- NASA-Glenn Research Center
- NASA-Space Radiation Analysis Group
- NASA-Stennis Space Center
- National Institute for Radiological Sciences, Chiba, Japan
- National Science Foundation
- Opti-MS, Inc.
- Rice University, Department of Statistics
- Rice University, Smally Institute for Nanoscale Science and Technology
- Stellar Explorations, Inc.

- University of Michigan, Plasmadynamics and Electric Propulsion Laboratory
- University of Texas at Dallas, Department of Biology and Biochemistry
- University of Texas Medical Branch at Galveston
- University of Tlemcen, Tlemcen, Algeria

ISSO funded faculty at UH in the colleges of Natural Sciences and Mathematics, Engineering, Technology, and Liberal Arts, and at the Center for Advanced Materials. At UHCL, ISSO worked primarily with the School of Science and Computer Engineering. ISSO thanks these deans and department heads for their participation and support.

ISSO establishes new project grants through a request for proposals to all UH and UHCL faculty. These proposals are peer reviewed by researchers from UH, UHCL, other area universities, NASA-JSC, and companies in the Houston area. The reviewers are screened for no conflict of interest with respect to the proposals they evaluate. Drs. Helen Lane and Kamlesh P. Lulla, both of the University Research and Affairs Office at NASA-JSC, assisted in forming the review panels and participated in the reviews.

The following is an overview of the ISSO 2007 *Annual Report*.

STAFF REPORT

Professor Irving N. Rothman (UH, English Department) has compiled and edited the ISSO *Annual Reports* since 1992. In January 2008, Dr. Rothman suffered a heart attack, was hospitalized, and then entered medical leave. *Heart attack–NASA research on cardiac resynchronization therapy and defibrillators (CRT-D)* highlights the transfer of life-saving technologies from federally-funded research by NASA to medical technology companies. It is a well-researched report on the NASA-enabled technologies that eased his recovery and increased his expectations for returning to the classroom and his literary research. The ISSO community wishes Dr. Rothman, his wife, Hava, and his family the very best and thanks him sincerely for his many years of labor on the ISSO publication. The report starts on Page 13.

SUMMARY OF ISSO RESEARCH PROJECTS

As in 2006, the 12 projects funded in 2007 fall into six main categories, as does the follow-up research on 13 projects funded between 2004 and 2007. One difference, however, is that there are now more projects in the field of computer science and communications.

Computer Science and Communications
 Engineering and Sensors
 Astrobiology and Life Sciences
 Space Radiation Modeling
 Physical Sciences, Cosmology, and Defoe

AEROSPACE CLUSTER PROJECTS

In 1995, the University of Houston System and NASA-JSC established the Post-doctoral Aerospace Fellowship program. A UH or UHCL faculty member and a JSC scientist or engineer formed a team to conduct a joint research project. The team proposed to ISSO for 50 percent of the funding necessary to hire a Post-doctoral Aerospace Fellow. That fellow conducts the majority of the research, with the direction and cooperation of team members, using facilities at UH, UHCL, and JSC. ISSO and the team co-funded the salary of the fellow for two years. Many of the 44 teams have been funded for a third and final year.

In 2007, Dr. D. Birx (VP Research, UHS) urged the formation of aerospace research clusters that would build on the PDAF program by requesting faculty teams from multiple colleges at UH and UHCL and teaming with additional JSC and aerospace company researchers. Each team would be provided up to \$50,000 in summer research funds in 2007 and matching ISSO funds for support of a new Post-doctoral Aerospace Fellow starting as early as September 1, 2007.

The summer support was to be used to deepen and extend the project definition, extend the number of researchers and organizations in the cluster, conduct key preliminary research, submit proposals for external funding in 2007 and 2008, and initiate a search for a new Post-doctoral Aerospace Fellow to advance the cluster activities over the next two years. Seven cluster proposals were received and, following a peer review, five cluster teams were selected for summer funding. The reports on their 2007 summer research activities are summarized below and detailed in the first technical section of this 2007 *Annual Report*.

Professor Driss Benhaddou (UH, College of Technology) leads the team focused on *self-healing wireless smart sensor networks*. Primary team members included Xiaojing Yuan and Deniz Gurkan (UH, College of Technology) and Rong Zheng (UH, College of Natural Sciences and Mathematics). The team was awarded \$50,000. Complex systems such as the International Space Station and future lunar exploration vehicles and bases make extensive use of wireless technologies for communication between sensors and active devices such as robots. This cluster focuses on the development and definition of communication protocols that enable wireless systems to automatically detect faults in wireless networks and to correct them automatically. The report begins on Page 17.

Professor George E. Fox (UH, College of Natural Sciences and Mathematics) leads the UH-JSC team focused on *micro-organisms and the space environment*. Members include Professor Richard C. Willson (UH, College of Engineering) and Professor Yuriy Fofanov along with PDAFs T. M. Raghaven and David Warmflash, M.D. (College of Natural Sciences and Mathematics). Dr. Duane L. Pierson (NASA-JSC Life Sciences Research Laboratory), Dr. Janet Siefert (Rice University, Department of Statistics), and Dr. W.C. Jackson of the Houston firm Biotex, Inc., collaborate on the project. The project received \$46,200 for the summer start-up work. The collaboration focuses on understanding the origins of life and the development of technology to search for life



COLLABORATION—Members of the research cluster formed by the the Engineering Technology and Computer Science departments meet regularly to discuss progress and goals relating to the ISSO-sponsored project, “Self-healing wireless smart sensor networks.” (left to right) Jian Shen, M.S. student in engineering technology; Mukesh Rungta, graduate assistant; Sumegha Bagga, M.S. student in engineering technology; Manikandan Balakrishnan, post-doctoral fellow, engineering technology; Xiaojing Yuan, assistant professor of engineering technology; Haoying Liu, graduate student in network communications; Rong Zheng, assistant professor of computer science; Carlos Bernal Velazquez (kneeling), graduate student in engineering technology; Deniz Gurkan, assistant professor of engineering technology; Driss Benhaddou, assistant professor of engineering technology; and Cunqing Hua, post-doctoral fellow, computer science.

beyond Earth. Researchers also examine microbes that may be pathogenic to humans in the environments of crewed spacecraft and facilities.

Radiation is a major threat to humans in space. Professor Larry Pinsky has teamed with Alex Ignatiev and Ricardo Vilalta (UH, College of Natural Sciences and Mathematics) on *development of a Medipix2-based space radiation dosimeter*. This active device is approximately the size and mass of present passive, film-based monitors but can record and recognize a wide range of primary cosmic ray and secondary particles. The professors work with a small Houston company, Nano EnerTex, and with the NASA-JSC Space Radiation Analysis Group. The team received \$22,700 for summer research.

Professors Gangbing Song (UH, College of Engineering) and James B. Dabney (UHCL, School of Science and Computer Engineering) jointly lead the cluster project investigating *intelligent aerospace structures with solid-state sensors and actuators*. Team members include Matthew A. Franchek, Karolos Grigoriadis, and David Zimmerman (UH, College of Engineering) and Thomas L. Harman (UHCL, School of Science and Computer Engineering). This team focuses on the control of mechanical vibration onboard spacecraft. They consider the generation of vibration and noise, noise transmission, damping, and other drivers. The group examined control technologies such as gravity gradient stabilization, piezoceramics, carbon nanofiber composites, and fuzzy logic-based controllers. The UH and UHCL team was awarded \$27,000 in summer funding. The report begins on Page 33.

Professor George Zouridakis (UH, College of Natural Sciences and Mathematics) leads the team focused on creating *a wireless network for non-obtrusive continuous assessment of astronaut fatigue*. Members from the Computer Science Department include professors R. Zheng, Shishir Shah, Ioannis Kakadiaris, and Edgar Gabriel. The team includes Professor X. Yuan from the Department of Engineering Technology. This team received \$41,500 for the summer of 2007. The team has developed a wireless network of smart cameras and processors that can recognize fatigue in human facial expressions. The project will extend the technology so that it can monitor the crew of spacecraft and assess their levels of fatigue.

POST-DOCTORAL AEROSPACE FELLOWSHIP PROJECTS

As noted, the PDAF program was initiated in 1995. ISSO continued the funding of five PDAF projects in 2007.

Professor A. Bensaoula (Center for Advanced Materials) was funded from 2004–2006 for two related projects: *development of micro-column arrays (MCAs) for thermal management applications*; and *micro-column arrays (MCAs) for thermal management of spacecraft environments*. His team has successfully fabricated these miniature thermal control devices and demonstrated them in simulated space environments. They will explore the use of these devices on metal foils for acquisition and/or heat rejection on spacecraft. (Refer

to Page 49.) Dr. Bensaoula reports acquiring \$100,000 in funding to study the bonding of titanium to ceramic materials.

In 2007, ISSO initiated the PDAF project of Professor Edgar A. Bering (UH, College of Natural Sciences and Mathematics) on a *study of mechanics of plasma detachment in a magnetic nozzle*. Dr. D.S. Winter is the NASA-JSC (Shuttle and Exploration Division) co-investigator, and Dr. Benjamin W. Longmier is the ISSO PDAF. Mr. M.W. Brukardt is a UH physics student on the project pursuing his master of science degree.

Chemical rockets are the primary means of sending spacecraft from orbit about Earth into deep space. However, electric power can be used to eject atoms and molecules at much higher speeds from a propulsion unit and thus use much less propellant mass to send a space vehicle away from Earth. This project examines the operation of the Variable Specific Impulse Magnetoplasma Rocket Engine (VASIMR) that is operated at NASA-JSC by the Ad Astra Rocket Company. (Refer to Page 53.)

Professors G.E. Fox (UH, College of Natural Sciences and Mathematics) and Richard C. Willson (UH, College of Engineering) and Dr. Duane Pierson (NASA-JSC) report on the final year of the PDAF project to study the *effect of simulated microgravity on microbial expression*. ISSO Fellow Dr. T. Madhan Raghaven, Ph.D., and F. Karouia, Ph.D. candidate, worked on the project. Bacteria can live and reproduce in a wide range of environments. This work identifies substantial differences in gene expression between *E. coli* grown in normal gravity and in a rotating container that simulates zero gravity. (See Page 58.)

Professor John H. Miller (UH, College of Natural Sciences and Mathematics) reports on the second year of the project to develop *Martian soil biosensors based on dielectric spectroscopy*. He worked with Jeffrey A. Jones, M.D., and Dr. David S. McKay at NASA-JSC, ISSO PDAF David Warmflash, M.D., and two doctoral candidates, Mr. Jie Fang and F. Karouia. The hypothesis of the research is that an oscillatory electromagnetic field can induce changes in macromolecules, such as those associated with life. Detectors can recognize these unique changes. The detectors focus on enzymes critical to the function of cells. Such technology may be applicable to monitoring human health.

Professor Larry H. Rohde (UHCL, School of Science and Computer Engineering) and Dr. Honglu Wu (NASA-JSC, Human Adaptation and Countermeasures Division) began research on the *biological effects of shielding parameters across the Bragg curve of energetic charged particles* before locating and hiring their PDA fellow. The new PDAF, Dr. Ye Zhang, is now onboard.

Cosmic rays penetrate human-rated spacecraft and often break apart into many new and more dangerous nuclei. A Bragg curve details how the high-energy particles deposit energy into the matter through which they pass. The original cosmic rays and the new secondary particles pass into and through humans and do damage to their cells. This team is investigating micronuclei in cells that are thought to mark the damage cosmic rays and the secondary particles do to living cells. The intent is to provide a biological basis for the design

of spacecraft shielding that can most effectively protect humans. (Please refer to Page 67.)

DIRECTOR'S GRANTS

In 2007, the great majority of ISSO funds were committed to the new Aerospace Cluster program and ongoing Post-doctoral Aerospace Fellowship projects. ISSO did not request proposals for seed grants. The ISSO director did allocate modest funds to faculty members at UH and UHCL.

At the suggestion of Interim Dean Sadeqh Davari (UHCL, School of Science and Computer Engineering) Professor Sharon P. Hall (Computing and Mathematics Division) was awarded \$7,200 for *undergraduate research projects in computing: HCI, RFID, and computer forensics*. This supported the research phase of a special senior-level course to give undergraduates the experience of working as members of a team project. Three teams worked on human-computer interactions (HCI), radio frequency identification (RFID), and methods for recovering data from damaged computer systems and authenticating accuracy. (See Page 71.)

ISSO *Annual Report* Editor Irving N. Rothman (UH, Department of English) is a noted authority in the life and writings of Daniel Defoe and many of his associates and critics. During the 17th and 18th centuries, these writers often thought about and speculated upon Earth's moon and the relation of humans to it. ISSO awarded \$1,500 to support a study of lunacy and "the man in the moon" based upon the writings of Thomas Gordon. The resulting paper, *Lunacy, Thomas Gordon, and the Man in the Moon*, focuses on Gordon's 1720 satirical essay attacking the irrational behavior of individuals in his society.

FOLLOW-UP REPORTS—INNOVATIONS AND NEW DEVELOPMENTS (2003–2007)

ISSO requires all principal investigators to submit both a full report on the results of their first year of funding and to submit at least one proposal for external funding within nine months of the start of funding or every year during multi-year funding. ISSO recognizes that proposals, presentations, and papers often are resubmitted or evolve from initial research. For this reason, ISSO requires that principal investigators report for five years any papers, presentations, proposals, or other evidence of progress that result from the initial funding. In 2007, 14 ISSO investigators reported progress on research funded between 2003 and 2006. Brief sketches of these reports are provided on pages 78-103.

Professor Gary D. Boetticher (UHCL, SEC) and UHCL student Jason Rudisill have continued work first funded in 2004 on *assessing lineage information in genetic programs*. Traditionally, genetic computer programs solve mathematical problems by generating a set of equations, termed chromosomes, that map between two sets of noisy data. They are exploring the use of the history of the growth of each chromosome to breed new chromosomes that more rapidly provide statistically significant relationships between noisy data sets. (Refer to Page 78.)

Professor Albert M.K. Cheng (UH, Computer Science) received three seed grants from 2004–2006 for his research on the management of power systems in spacecraft. His report beginning on Page 81 presents progress on *quality of service and systems for spacecraft and rovers*. Dr. Cheng has developed a method for scheduling an overloaded battery-powered system. This method has been tested and found superior to the only existing technique, REW-Pack, that also compares three constraints on system operations (time, energy, and reward). This work has resulted in a major proposal to NSF.

Beginning on Page 83, J.B. Dabney (UHCL, SEC) reports progress on the development of a *prototype micromanipulator for space robotic applications* resulting from ISSO seed-funding from 2004–2006. This experimental project focuses on the bending of piezoelectric layers that are bonded together and used to drive an end-effector of a robot. A proposal submitted in 2008 to the Texas Advanced Research Program was not funded.

In a related effort, *real-time active loading of piezoelectric ultrasonic motors for simulating space robotics applications*, Dabney and T.L. Harman (UHCL, Engineering Division) have extended 2004–2006 seed grants. They continue to test a piezoelectric motor that can sense the torque it applies and maintain a precise rate of rotation against that torque. This work resulted in a new publication (submitted in 2008) and presentation in 2007.

In 2006, Professor G.E. Fox (UH, College of Natural Sciences and Mathematics) received a seed grant to study *Bacillus pumilus* SAFR-032 in a model for planetary protection. In collaboration with colleagues at the Baylor College of Medicine Human Genome Sequencing Center, the complete genome sequence has been determined. The sequence will assist in determining the resistance of SAFR-032 to methods of decontaminating spacecraft prior to launch from Earth. See page 87. Four publications resulted from this work in 2007.

Professor Fox also provides a combined progress report on seed funding in 2004 and 2005 for a study investigating the *early origins of genetic systems and remnants of the RNA world*. His team assessed the conservation of gene organization of proteins from Archaea and Bacteria organisms. (See Page 89.) Funding will be sought in 2009 to continue these studies.

The origin of structure in the early universe from gravitational radiation was studied under a 2006 seed grant by Professor David Garrison (UHCL, Physics). He is developing models explaining how primordial plasma and gravitational fields could impact the structural formation of the cosmos. He submitted three proposals in 2007 and 2008. (Refer to Page 91.)

The ongoing results of Professor J.H. Miller's projects in 2004 on *low-frequency dielectric spectroscopy of Martian soil samples* and in 2005 on *electromagnetic probes of biological molecular motors* are integrated into his primary report. (See Page 93 and 61.)

Professor LieJune Shiau (UHCL, SEC) received seed grants in 2004 and 2006 to research *computational methods in non-smooth mechanics and their application to dry friction-constrained motions*. This work has potential application to remote manipulation systems such as on the Space Shuttle and International Space Station. A proposal was submitted to the



MCA—Clement Joseph (left), Ph.D. candidate, and Pranob Misra (right), Ph.D., investigate applications for micro-column arrays. Misra is a research scientist with Integrated Micro Sensors, Inc.

Texas Higher Education ARP.

A report on seed grants in 2004 for *efficient space radiation computation with parallel FPGA* and in 2005 for *high-performance Martian space radiation mapping* is provided by Professor Liwen Shih (UHCL, SEC). Her work continues to use larger computer clusters and Open MP software to decrease the cost of modeling space radiation in the lunar and Martian environments. Dr. Shih proposed for and received 30,000 Standard Units of computational time on the NSF TeraGrid network. (Refer to Page 94.)

Professor Wajiha Shireen (UH, Engineering Technology) received a 2004 seed grant to develop *an AC-DC-AC converter with smaller DC-link capacitor for space power distribution systems*. Results of the demonstration unit are presented in figures 2 and 3 on Page 97. Dr. Shireen was awarded \$49,000 by the California Energy Commission to continue this work.

Professor J. Wosik (UH, Electrical and Computer Engineering) used 2004 and 2005 seed grants to develop *a radio probe to measure the complex permittivity of single-walled carbon nanotubes*. These earlier studies focused on magnetic microscopy studies of magnetotactic fossils on Martian meteorite ALH84001 and related earthbound analog systems and high-frequency dielectric and magnetic susceptibility measurements of Martian soil. (Refer to Page 99.) Two publications, nine presentations, and two proposals have grown out of this work.

Professors T. Andrew Yang and Sadegh Davari (UHCL, SEC) received seed-grant funding in 2004 for the *development of wireless stations for distributed field operations*. In 2007, they extended their work to methods for handling failure of wireless nodes and sensors, in cooperation with Professors B. Sun and L. Osborne at Lamar University. They have submitted three new papers and two proposals that generated \$127,000 in external funding.

Follow-up reports were not received in this cycle from seven investigators funded in the 2003–2006 time frame. In most cases, follow-up reports were published in an earlier annual report. ISSO hopes that future annual reports will carry

SEED-GRANT PROGRAM FOR 2008

On February 29, 2008, ISSO requested seed-grant proposals from the UH and UHCL faculty for work to be conducted during the spring and summer of 2008. ISSO received 27 proposals that requested a total of \$296,000 from UH and \$119,000 from UHCL faculty. ISSO worked with a 37-member peer review panel consisting of NASA-JSC staff, faculty from Prairie View A&M University, the Universities Space Research Association, UH, UHCL, and professional staff from Boeing, Clarkson Aerospace, and the EHG Company. ISSO awarded \$176,000 in seed grants to the following 11 principal investigators.

University of Houston

Fox, G.E. (Biology and Biochemistry)

High throughput DNA sequencing as a tool for studying microorganisms and microbial communities relevant to space exploration

Lapen, T.J. (Geosciences); Co-I A. Brandon (NASA-JSC)

Isotopic and geochemical investigations of Lunar and Martian meteorites

Mohammadpour, J. (Mechanical Engineering); Co-I K. Grigoriadis (UH)

Microgravity vibration isolation in space using semi-active devices

Pinsky, L. (Physics)

Continued development of a Medipix-based space radiation dosimeter

Sharma, P. (Mechanical Engineering); Co-I D. Zimmerman (UH)

Energy harvesting through "super-piezoelectricity" in sub-micron structures

Yuan, X. (Engineering Technology); Co-I D. Benhaddou (UH)

Hierarchical cross-layer optimized wireless networking platform for reliable astronaut health monitoring

University of Houston-Clear Lake

Dabney, J.B. (Computer Engineering); Co-I G. Song (UH)

Active multimodal vibration suppression for a space-based flexible manipulator

Ding, W. (Computer Engineering); Co-I T. Stepinski (Lunar and Planetary Institute)

Computer-aided detection of sub-kilometer craters in high resolution planetary images

Shiau, L. (Computer Engineering); Research Colleague M. Golubitsky (UH)

Sensitive signal detection through feed-forward-like oscillator network

Shih, L. (Computer Engineering); Co-I P. Saganti (PVAM)

Nuclear structure space radiation computation expansion on TeraGrid

Yang, T.J. (Computer Engineering); Co-I R. Sbrusch (UHCL)

Secure and effective wireless sensor networks for tracking objects



Photo courtesy of Benjamin Longmier

VACUUM—Ben Longmier, ISSO PDAF, installs and calibrates the plasma momentum force sensor within a 5 cubic meter vacuum chamber. The graphite target measures the thrust from the VASIMR plasma exhaust.

new information on additional results of ongoing, interesting research. Perhaps readers of this report will be inspired to contact investigators and pursue additional joint projects.

Clarke, M.S.F. (UH)

2005: *Validation of a novel micro-capillary array fluid collection technology for the determination of biomarkers of bone metabolism in human sweat*

2004: *Development of a microgravity-compatible slide staining device*

Gunaratne, G. (UH)

2004: *A theoretical analysis of vibrational modes aimed at their use as measures of bone damage*

Hadjiev, V.G. (UH)

2004: *Raman scattering test of mechanical and sensor properties of advanced nanocomposites*

2004: *Development of advanced Raman spectroscopic methodology for analysis of cometary materials*

Hollingsworth, D.K. (UH)

2005: *The effect of Martian dust on radiator performance*

Malki, H. (UH)

2005: *PWM control of a formation flying space vehicle*

2004: *A neural-network-based approach for control of vibration in a Black Hawk helicopter*

Al-Mubaid, H. (UHCL)

2005: *Natural language interface models for fast responsiveness applications*

2005: *Text-mining technique for literature profiling and extraction of information from biomedical literature*

Dickerson, E. (UHCL, emeritus), A. Dickey (JSC), and D. Ni (former PDAF)

2005 and 2006: *UWB tracking system design with a TDOA algorithm for space applications*

Lu, J. (UHCL)

2006: *Superior adsorbents for aerospace applications*

2005: *Contaminants removal from fuel cell for aerospace applications*

The peer-review committee determined that UH proposals for an additional \$40,000 were worthy of funding. However, funds were not available.

DIRECTOR'S RESEARCH AND ADMINISTRATIVE ACTIVITIES

Dr. Criswell directs the Institute for Space Systems Operations at the University of Houston and the University of Houston-Clear Lake. His primary research interests are in industrial development of the Moon and the economic benefits to Earth of a sustainable global economy. He is a member of the Houston Chapter of the International Association of Energy Economists and attends the monthly fall and winter meetings at the Houston office of the Dallas Federal Reserve. He also maintains his involvement in the lunar and planetary community through the programs of the USRA Lunar and Planetary Institute and the annual Lunar and Planetary Conference.

Dr. Criswell works extensively with Dr. H. Lane (Director of University Programs at the Johnson Space Center) and Dr. K.P. Lulla (University Program Officer) in coordinating the ISSO research program with primary program goals of NASA-JSC.

Since April 2007, Dr. Criswell has delivered invited papers to professional societies and provided interviews and one invited editorial to members of the general and aerospace press.

Professional Conferences and Workshops (invited)

Workshop on Research Enabled by the Lunar Environment, NASA Sponsored, Session 2 (presentation): Challenges in Power Generation and Storage, National Academy of Sciences, Washington, D.C. (June 12–15, 2008) (workshop available online).

Space Based Solar Power: Charting a Course for Clean Energy, USAF Academy Center for Space and Defense Studies and the National Security Space Office, Breckenridge, CO (Sept. 6–7, 2007).

Workshop on Managing Solar Radiation, NASA-Ames Research Center, Moffett Field, CA (Nov. 18–19, 2007).

Interviews

THRESHOLD: Hosts UH Professors George Reiter and John McNamara (Oct. 11, 2007, 11 AM–noon) KPFT Radio Houston, open mike discussion of the Lunar Solar Power System.

Brent Clanton Show (Oct. 31, 2007) bizradio, 1320-AM, Houston.

Presentations (invited)

Criswell, D.R. Robustness,* reliability, and flexibility (R*R&F) of power generation and storage systems (11 pp). Session 2: Challenges in Power Generation and Storage, National Academy of Sciences Workshop on Research Enabled by the Lunar Environment, Washington, D.C., June

12–15 (2007) (workshop available online).

Criswell, D.R. Sustainable human prosperity: Earth, Moon, & Sun (18 pp). XIVth International Workshop on Quantum Atomic and Molecular Tunneling in Solids and Other Condensed Phases, Organized by G. Reiter (UH Physics), Space Center Houston, Houston, TX, Oct. 30 (2007).

Criswell, D.R. (plenary) Earth-Moon electric economy (15 pp). Space Technology and International Forum, Albuquerque, NM, Feb. 11 (2008).

Criswell, D.R. Lunar solar power system to seed human habitation of the solar system. Space Technology and International Forum, E-CONFERENCE: 6th Symposium on Space Colonization, Albuquerque, NM, Feb. 11 (2008).

ISSO Program Documents and Reviews

Criswell, D.R. (director), Rothman, I. (editor), and Bush, D. (associate editor) (2007 Spring) Y2006 Annual Report of the Institute for Space Systems Operations of the University of Houston and the University of Houston-Clear Lake, 123 pp., Houston, TX

Criswell, D.R. (director) and H. Lane (JSC) (May 22, 2007) Peer review of proposals submitted by University of Houston and University of Houston-Clear Lake faculty to ISSO for Aerospace Cluster projects by faculty and research staff from UH, UHCL, and NASA-Johnson Space Center.

Criswell, D.R. (director) and H. Lane (JSC) (March 28, 2008) Peer review of proposals submitted by University of Houston and University of Houston-Clear Lake faculty to ISSO for seed-grant projects by faculty and research staff from UH, UHCL, and NASA-Johnson Space Center. This RFP suggested that proposers consider opportunities offered by the U.S. Department of Defense and recommended that they contact Taylor R. Locker in the College of Technology, who was on assignment to UHS from the DoD R&D program.

ACKNOWLEDGMENTS

It is a pleasure to acknowledge the people who assembled and produced the ISSO 2007 *Annual Report*. Prior to his heart attack in January, Professor Irving Rothman organized the layout of the report and the initial photographic schedule for investigators, post-doctoral fellows, students, NASA participants, and others. Ms. Debbie Bush, who has been the associate editor and Web site manager and designer since 2000, took over all production tasks and organized additional help to complete this issue. She has done an admirable job in difficult circumstances. Ms. Julie Brown assisted with editing, Ms. Linda Poole assisted with proofreading, and Mr. Kurt Bush completed the graphic design elements. It is also a pleasure to acknowledge the ISSO administrators at UH, Ms. Jennifer Chin-Davis (Physics), and at UHCL, Ms. Lee Folk and Ms. Roberta Hohmann (Office of Sponsored Programs).

It is an honor to acknowledge the more than 100 professionals from the Houston area who have given their time to participate in reviews of the proposals submitted to ISSO for seed grants, Post-doctoral Aerospace Fellowship projects, and Aerospace Cluster programs.

OVERVIEW OF THE ISSO PROGRAM SINCE 1992

In preparation for the 2008–2009 session of the Texas Legislature, the Texas Higher Education Coordinating Board requested a self-evaluation of the Houston Partnership for Space Exploration by the director of the Institute for Space Systems Operations. The materials provide an overview of the program and an opportunity to evaluate many of its outcomes. Sections of the self-evaluation are provided that were not covered in the foregoing director's report. The underlined text constitutes instructions and questions posed by the THECB.

Executive Summary (200-word description of mission, objectives, benefits to State):

The Houston Partnership for Space Exploration (HPSE) mission is to advance the economic and intellectual development of high-technology communities associated with NASA-Johnson Space Center, the University of Houston, UH-Clear Lake, and the State of Texas. The Institute for Space Systems Operations (ISSO) implements HPSE.

HPSE was established in 1992. In 1995, HPSE/ISSO established a unique State of Texas-federal partnership between UH/UHCL and the NASA-Johnson Space Center that now operates under a three-year Space Act Agreement. Teams of UH/UHCL faculty and JSC R&D personnel conduct joint projects at UH and UHCL and at NASA-JSC using federal in-kind resources. The seven established and new teams each hired, for up to three years, a UH/UHCL Post-doctoral Aerospace Fellow. The fellows bring the research results to UH/UHCL, publish papers, write proposals for external funds to extend the research, work with professors and JSC researchers in supervising new graduate students, and produce intellectual property.

The PDAF, seed grants, and post-2003 follow-ups generated over \$4.7 million in new external funds in those two years and all projects over \$26.8 million since 1991. The external funds flow almost completely to the colleges and the UHS Research Division and not to ISSO. The HPSE/ISSO program is described in detail on the ISSO Web site <<http://www.issu.uh.edu>>.

ISSO is a "mini-granting" research unit of the University of Houston System.

Describe the goals and objectives of the research activities of this program.

The objectives of the Houston Partnership for Space Exploration (HPSE) are to advance the intellectual and economic development of high-technology communities associated with NASA-Johnson Space Center, the University of Houston, UH-Clear Lake, and the State of Texas. The Institute for Space Systems Operations (ISSO) operates HPSE.

The goals of HPSE are to increase the level, range, and scope of UH and UHCL participation in the advanced research, development, and operations activities pursued by NASA-JSC, its contractors, and other companies and institutions in the Houston area and throughout Texas. The program

enables UH and UHCL to serve as key members of national programs supporting the new vision for America's space program established on January 14, 2004 by the President of the United States. HPSE enables faculty to work on selected portions of the joint projects. HPSE provides seed funding for faculty to pursue funding of multi-disciplinary projects and requests for proposals by non-NASA organizations, such as NSF, NIH, DoD, DoE, and others that are related to the core joint research with NASA-JSC. Since 1992, ISSO has enabled UH and UHCL faculty and UH/UHCL-JSC teams to obtain external funds through proposals. ISSO-funded professors have generated professional publications and direct master's and doctoral projects as a result of exceptional item funding.

When did the program first receive special item funding? (Indicate any interruptions in state funding.) If the program existed prior to receiving special item funding, what was the source of funding?

The 72nd Texas Legislature funded the Houston Partnership for Space Exploration in 1992 as a special item. Approximately 80 percent of its funds are committed to UH, with 20 percent to UHCL.

The initial 1992–1993 special item funding was \$580,800/biennium. Funding increased in 1996 to \$860,000/biennium to establish the joint UH/UHCL-NASA Johnson Space Center Post-doctoral Aerospace Fellowship program. Special item funding decreased in 2000 and 2004 to the present \$711,972/biennium. HPSE did not exist before 1992.

How has the purpose of this program changed since it was created?

The purpose of the program has not changed.

List other programs in Texas with comparable goals and objectives and comment, to the extent possible, on the similarities and differences.

- Texas Space Grant Consortium (Headquarters: University of Texas at Austin)

The Texas Space Grant Consortium was established in 1986 under the National Space Grant and Fellowship Act of the United States Congress. It focuses primarily on educational and outreach programs and faculty research. NASA, its member organizations, and grants jointly fund TSGC. Its members are primarily Texas universities, colleges, companies, state agencies, and non-profit organizations. Both UH and UHCL are associate members and receive TSGC funds for scholarships, fellowships, and short-term research projects. (See <<http://www.tsgc.utexas.edu>>.)

Unlike HPSE, the Space Grant is not focused exclusively on the Houston area, and its research programs are shorter-term.

- Center for Advanced Materials (University of Houston)

The Center for Advanced Materials (CAM) addresses R&D of advanced materials and their fundamental science while maintaining an applications focus. HPSE, unlike CAM,

enables faculty from all UH and UHCL colleges to propose and pursue aerospace projects across all disciplines of aerospace.

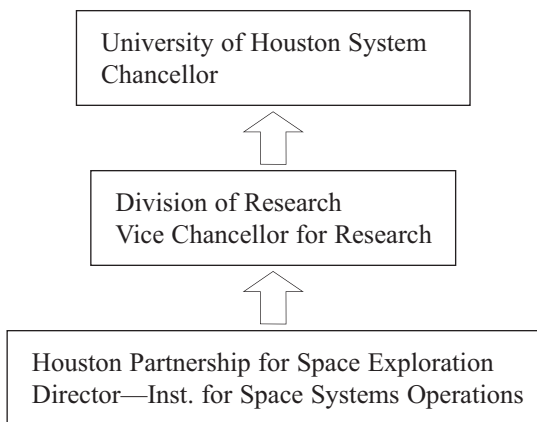
- Lunar and Planetary Institute (of the Universities Research Association)

LPI is funded primarily by NASA as a center for planetary research and a supporter of the planetary research community both nationally and worldwide. UH and UHCL are members and have received modest funding for joint research and educational activities. Unlike HPSE, the LPI is not focused on UH, UHCL, or the Houston area.

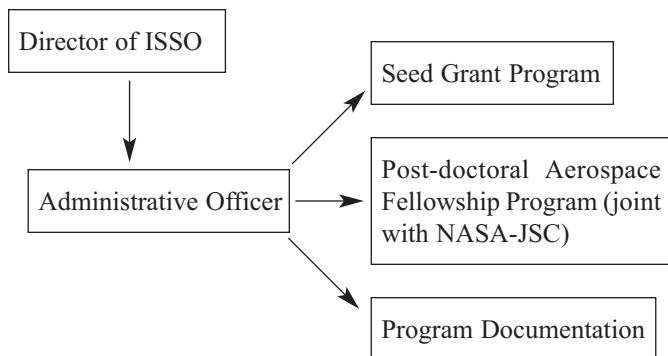
- Aerospace Companies

The major aerospace companies have significant aerospace operations near NASA-Johnson Space Center that focus on contract support. UH and UHCL faculty supported by HPSE conduct joint research projects with the majority of these companies.

Provide an organizational chart that shows how the program fits into the university structure.



Provide an organizational chart that shows the major functional components of the program.



Personnel Summary

Provide a list of all individuals who received financial support from the program during fiscal year 2008. Include name, full/part time (%), and status (faculty, other professional staff, support staff, students). If more than 12 people were supported, show the number and full-time equivalent (FTE) of each category of employee. If the program is new, show projected staffing for FY2009.

FY2008

<u>Name/Title</u>	<u>Status</u>	<u>Percent Time</u>
Program Staff		
D.R. Criswell (Director ISSO)	Prof. Staff and Faculty	75%
J. Chin-Davis (Administrator)	Prof. Staff	10%
I. Rothman (Editor, <i>Annual Report</i>)	Faculty	10%
D. Bush (Associate Editor)	Staff	30%

The following are detailed in the 2007 ISSO *Annual Report*.

Faculty (supported by seed grants)	41	6.8 FTE
Post-doctoral Aerospace Fellows (UH/UHCL-NASA JSC Program)	5	5.0 FTE
Graduate and undergraduate students	26	5.8 FTE

How is the special item program integrated into the academic program of the institution? Include a description of student exposure to or participation in advanced or emerging technologies as a result of this program.

Graduates and undergraduates are invited by faculty to participate directly in the seed grant, Post-doctoral Aerospace Fellowship, and ISSO consortium projects as student researchers. Their participation is described in both the 2006 *Annual Report* (p. 120-121, 67 students) and in this 2007 *Annual Report*.

Does the program have an advisory group? If so, provide a list of members, dates convened during 2007 and 2008, and most significant contributions to the program to date.

ISSO did not utilize a program advisory group in AY2007 or AY2008. However, ISSO makes extensive use of a formal peer-review process to select faculty members and UH/UHCL-JSC teams to conduct ISSO research projects. The ISSO director and the director of university relations at NASA-JSC organize these reviews.

HPSE/ISSO special item funds are restricted to research activities. ISSO releases “requests for proposals” to both the UH and UHCL faculties. Faculty at UH-Downtown and UH-

Victoria can participate as co-investigators. Requests for proposals to the Post-doctoral Aerospace Fellowship program require a team of UH and/or UHCL faculty and a research staff member of the NASA-Johnson Space Center.

See the 2006 and 2007 ISSO annual reports for recent progress.

Who are the program's clients, how are they identified, and how are their needs determined?

The primary clients are UH and UHCL faculty and research staff at NASA-JSC who participate as co-investigators in the seed-grant, fellowship, and cluster projects. Investigators are identified through requests for proposals and selected through the peer-review process described above.

How does the program contribute to the economic development of Texas?

NASA-JSC is a powerful tool bringing to UH and UHCL, and to Texas, top-level graduates from across the state, the nation, and the world. These new doctoral graduates provide UH and UHCL with exceptional talent for the development, under other funding, of advanced educational offerings in all aspects of aerospace and its related fields. On January 14, 2004, the President of the United States established a new vision for space exploration and the goals of NASA. These goals are also the goals established for the joint UH/UHCL-JSC Post-doctoral Aerospace Fellowship program (PDAF) of the Houston Partnership for Space Exploration (HPSE).

HPSE programs have linked 12 UH/UHCL colleges and research institutes and their research faculty to the NASA-JSC community through the PDAF program (44 teams), seed grants (more than 200), graduate students (more than 250), other professors and NASA and industry researchers (~500), other organizations (more than 100), and more than \$26.8 million in external funding won by HPSE investigators from 1992 through 2007. HPSE line item funds were leveraged by 4.7 over the 15 years and by 6.6 for 2006 through 2007.

HPSE links UH/UHCL statewide through the Texas Space Grant Consortium. This increased funding will greatly enhance the research and graduate educational capabilities of UH and UHCL, NASA-JSC, and Texas.

Budget Summary Table FY2007 to FY2008

Source of Funds:	FY2007	FY2008	FY2009 (est.)
Special Item	\$355,986	\$355,986	\$300,000
Other State Support	0	0	0
Federal	0	0	0
Private	0	0	0
Other (cum. avail. Overhead)	0	0	\$ 19,000
Total Operating Budget for Entity	\$355,986	\$355,986	\$319,000

List external support received for FY2007 and FY2008.

Details of the following summary numbers are presented in the 2006 and 2007 ISSO annual reports available in hard copy, on the Web, or as attached PDF files.

All funds external to ISSO go to the departments, colleges, or institutes that proposed the projects.

Period Covered	Source	Total Amount
a. Federal research		
FY2007 AND BEYOND	NASA, NIH, NSF, DOD, OTHERS	\$3,983,000
b. Federal other		
FY2007 AND BEYOND	NIH, NSF, OTHERS	\$51,500
c. Industrial research		\$0
d. Private and foundation		
FY2007 AND BEYOND	UH GEAR	\$442,300
e. State and local agency		
FY2006 AND BEYOND	ARP, UHS Colleges, PDAF Matches	\$242,500
f. Other		\$0

List names, companies, and locations of students supported by the program who accepted industrial positions during FY2007 and FY2008.

The 2006 and 2007 ISSO annual reports list 113 undergraduate and graduate students who participated in the seed-grant, Post-doctoral Aerospace Fellowship, and Aerospace Cluster projects. The advisors, student names, and departments are listed in these reports. The various UH and UHCL departments, rather than ISSO, track some of the students after graduation.

ISSO has sponsored 44 prior and active Post-doctoral Aerospace Fellows. The following data were obtained from the UH or UHCL investigators, e-mails to the fellows, and searches on the Web. There are 38 former PDA Fellows. Sixteen of the former fellows have remained in Texas universities, private companies, or at NASA-JSC. Twenty-six UH and UHCL professors have directed the 44 separate PDAF projects. There are six post-doctoral fellows at UH and UHCL and two openings in Aerospace and Cluster projects. Thirty-six of the 38 former PDA Fellows are known to have moved on to professional positions with universities, companies, non-profits, or government agencies.

Investigator	PDAF Last	First	Organization	City	Position	Last Date
Balakotaiah, V.	Jayawardena	Subach	Shell - Houston	Houston	Research Scientist	2008
Balakotaiah, V.	Lastochkin	Dmitri	University of Notre Dame	Notre Dame	Research Assistant	2007
Bedell, H. D.	Patel	Saamil S.	University of Texas Medical School	Houston	Professor	2008
Benhaddou, D.	TBD	NA	NA	NA	Senior Research Scientist	2008
Bensaoula, A.	Boney	Chris	University of Texas Medical School	Houston	Researcher	2008
Bensaoula, A.	Carreno	Angela	University of Houston	Houston	PDAF	2005
Bensaoula, A.	Misra	Pranob	University of Houston	Houston	PDAF	2008
Bering, E. A.	Longmier	Benjamin W.	University of Houston	Houston	PDAF	2008
Chen, G. Ron	Dowell	Mike	NA	NA	NA	2008
Chhikara, R.	Koti	Kallappa M.	United States Food and Drug Administration	Silver Springs	Staff	2008
Chhikara, R.	Chen	Huann-Sheng	Michigan Technological University	Houghton, MI	Associate Professor	2004
Chhikara, R.	Thompson	Laura A.	United States Food and Drug Administration	Rockville, MD	Staff	2008
Chu, Wei-Kan	Yu	Jang-Horng	Virginia Polytechnic Institute and State University	Blacksburg, VA	NA	2003
Chu, Wei-Kan	Lee	Eunjeong	Korea Advanced Institute of Science and Technology	Daejeon	Visiting Professor	2008
Chu, Wei-Kan	Postrekhin	Yevgeniy	University of Houston	Houston	Researcher	2002
Dickerson, E.	Ni	Jianjun	NASA-Johnson Space Center	Houston	Contractor	2008
Fox, G.	Maillard	Karine	Laboratoire Départemental Frank Duncombe	Caen	NA	2004
Fox, G.	Schultze	Gary E.	National Institute of Environmental Health Sciences	Research Triangle Park, NC	Research Staff	2008
Fox, G.	Tucker	Don	SeqWrite Inc.	Houston	Fellow	2008
Fox, G.	Stepanov	Viktor	NA	NA	PDAF	2004
Fox, G.	Raghaven	T. Madhan	University of Houston	Houston	PDAF	2008
Fox, G.	Karouia	Fathi	University of Houston	Houston	PDAF	2008
Harman & Tittle	Bakhirkin	Yuri	Rice University	Houston	Research Scientist	2008
Harman & Tittle	Kosterev	Anatoliy	Rice University	Houston	Senior Faculty Fellow	2008
Iliev, M.	Hadjiev	Victor	University of Houston	Houston	Professor	2007
Kakadiaris, I.	Martinez	Geovanni	University of Costa Rica	San Jose, Costa Rica	Professor	2008
Kakadiaris, I.	Barron	Carlos	University of Costa Rica	San Jose, Costa Rica	Professor	2008
Layne & Clarke	Kyparos	Antonios	University of Thessaly Department of Biochemistry and Biotechnology	Thessaloniki	Adjunct Lecturer of Animal Physiology	2008
Loftin, G.	Yang	Jian	NA	NA	NA	2008
Miller, J.	Claycomb	James R.	Houston Baptist University	Houston	Assistant Professor	2008
Miller, J.	Warmflash	David	University of Pennsylvania	NA	Senior Research Associate	2008
Pedemonte, C.	Riggs	Penny K.	Texas A&M University	College Station	Assistant Professor	2008
Pinsky, L.	Anderson	Victor	Aurora Community College	Aurora, CO	Tenure-track	2008
Pinsky, L.	MacGibbon	Jane	University of North Florida	Jacksonville, FL	Professor	2008
Pinsky, L.	TBD	NA	NA	NA	NA	2008
Rappole, C.	Vodovotz	Yaei	Ohio State University	Columbus, OH	Assistant Professor	2008
Rappole, C.	Vittadini	Elena	University of Parma	Parma	Adjunct Professor	2008
Rappole, C.	French	Stephen J.	Lockheed Martin Corp.	Houston	NA	2006
Rohde, L.H.	Zhang	Ye	UH-Clear Lake	Houston	PDAF	2008
Sanchez, R. (dec.)	Lubertino	Graciela	Houston-Galveston Area Council	Houston	Policy Planner	2008
Sanders, R.	Morano	Eric	California Inst. Technology	Pasadena, CA	Air Quality of Mobil Sources	2003
Song, G.	Huo	Linsheng	Dalian University of Technology	Dalian	NA	2007
Song, G.	Gu	Haichang	University of Houston	Houston	Faculty	2008
White, S.	Lemus Olalde	Cuauhtemoc	Centro de Investigación en Matemáticas A.C. (CIMAT)	Calle Jalisco	PDAF	2008
Zimmerman, D.	James	George	NASA-JSC	Houston	Professor	2008
Zouridakis, G.	Hua	Cunqing	University of Houston- Clear Lake	Houston	Civil Servant PDAF	2008

Public service in FY2008. List workshops, symposia, etc.

ISSO worked with the Texas Space Grant Consortium from 1992–2006 to organize and operate workshops and symposia at both the state and national level. However, in 2005, UH decided to reduce its participation in the TSGC from charter membership, with UT-Austin and TAMU, to associate status. This reduced UH community expenditures from \$50,000/year to \$2,000/year.

ISSO sponsors such a wide range of research topics across UH and UHCL that campus lectures and workshops are best left to the participating departments, colleges, and other UHS institutes. The ISSO annual reports and Web site provide all UH and UHCL faculty and staff with detailed knowledge of ISSO activities. In addition, over the years many UH and UHCL faculty have participated in peer reviews of more than 500 proposals. The peer-review process introduces faculty to each other and to the faculty of other universities, as well as to research professionals from private companies, non-profits, and NASA-Johnson Space Center.

Do you expect to request continued special item funding for FY2010-2011 and subsequent biennia?

No Yes, how much? \$600,000

Describe the major opportunities facing the program in the next five years.

NASA-JSC and local contractors now expend more than \$2 billion/year in the Houston area and across Texas. There are no other research universities located near the NASA-Johnson Space Center that can devote significant faculty, student, and staff time to developing the potential of resources associated with NASA-JSC. NASA-JSC is ramping up the program for a return to and a permanent human presence on the Moon in 15 to 20 years.

HPSE has demonstrated that UH and UHCL faculty can team with NASA professionals as well as faculty of other universities, companies, and non-profit organizations. Since 1992, ISSO-sponsored faculty members and teams have obtained more than \$26.8 million in external funds. There is no fundamental reason that this success can not be extended.

On the basis of four peer reviews of 42 proposals in AY2007 and AY2008, ISSO established 18 seed-grant projects and eight new joint UH/UHCL-NASA JSC Post-doctoral Aerospace Fellowship and Aerospace Cluster teams. The fellowship teams will conduct two to three-year research projects.

ISSO anticipates that the above new seed-grant and fellowship projects will produce for UH and UHCL: more than 250 publications and presentations; 50 graduate degrees; research relations with more than 25 organizations; more than 80 proposals for external funding; \$2 million in new external funds.

The research fields include aerospace and systems engineering; robotics; computer science; use of computers in advanced education; wireless communications; effects on microbial gene expression by radiation and reduced gravity; advanced heat control systems; advanced plasma rocket engines; life sciences; crew systems; space science; space exploration; and exploration of the Moon and Mars.

Describe the major problems facing the program in the next five years.

Without an appropriately funded HPSE/ISSO, Houston and the State of Texas will not cultivate many of the benefits of the presence of NASA-JSC. Opportunities will be lost to cost-effectively transfer the benefits of NASA-JSC advanced technologies, spin-offs, and practices to Texas universities and industries and barring deeper Texas links to NASA. NASA-JSC designs, buys, and operates systems that monitor and control international space missions for the United States and international partners.

ISSO was funded at ~\$570,000/biennium from 1992 to 1996. In 1996, funding was increased to ~\$860,000/biennium and maintained through 2002 to support the new, unique Post-doctoral Aerospace Fellowship program. During that time, HPSE/ISSO was able to support 15 to 16 Post-doctoral Aerospace Fellows at UH, UHCL, and NASA-JSC. This is twice the number that can be supported at the present level. These multi-year projects enabled faculty funded by ISSO to submit, by 2002–2003, more than \$29 million in proposals and obtain \$4 million in external funds. Subsequently, the HPSE budget declined by approximately \$150,000 and forced ISSO to reduce the Fellowship program to approximately six fellows per year. This strongly reduced the amount of in-kind benefit that UH and UHCL received from NASA-JSC in terms of support facilities, presence of fellows and faculty at JSC, the number of JSC researchers with whom UH and UHCL could collaborate, and the ability of ISSO to assist UH in retaining charter membership in the Texas Space Grant Consortium.

In August 2008, the University of Houston System decided to reduce the HPSE line item request to \$600,000/biennium. As has been true since 1996, there was no UHS discussion with the ISSO director as to the ramifications of the budget, the many successes of the program, or strategies for interacting with NASA-JSC. It may be that the University of Houston System—and all university systems in Texas—is too small and narrowly focused on immediate cash-flow concerns to take advantage of the more than \$2 billion dollars/year in opportunities that NASA-JSC presents to the State of Texas and higher education in the Houston area. A Texas Partnership for Space Exploration with commensurately larger funding could enable far greater returns to the university systems and to the State of Texas for an annual expenditure on the order of \$2 to \$5 million dollars.