15th Year Evaluation

Covering the Period

February 1, 1998

to

January 31, 2003

Submitted By:

Dr. Wallace T. Fowler
Director
3925 West Braker Lane, Suite 200
Austin, Texas 78759

512-471-3583
512-471-3585 [fax]

fowler@tsgc.utexas.edu

on Behalf of the Consortium on

October 20, 2003
Table of Contents

Executive Summary and Consortium Impact

K-12 Education/ General Public Outreach Impact
Higher Education Impact
Research Infrastructure Development Impact

Introduction

National Program Emphasis

Diversity
Competitiveness
NASA Ties
Industry Relations
State Government Involvement

Program Elements

Consortium Management
General Description
Resources
Membership
Collaborations Outside the Consortium
Impact/Results
Fellowship and Scholarship Program
General Description
Core Criteria
Impact/Results
Research Infrastructure Development Program
General Description
Core Criteria
Programs
Impact and Results
Higher Education Programs
General Description
Core Criteria
Projects
Impact / Results:
Pre-College Education, Public Service, General Public, and External Relations Programs
General Description
Core Criteria
Projects
Impact/Results

Statement of Consortium Concurrence
Executive Summary and Consortium Impact

The Texas Space Grant Consortium [TSGC] was organized in 1989 as a team of academic, industry, state government, and non-profit institutions from all regions of the state in support of the National Space Grant College & Fellowship Program [NSGC&FP]. In the last five years TSGC has conducted twenty-four distinct programs specifically addressing the NSGC&FP objectives and priorities. In addition to the NSGC&FP funding of $2.5M for these programs, TSGC members provided additional direct and in-kind support, over $28.8M since 1998. These programs, most of which involve multiple institutions and disciplines, have involved every TSGC member institution, five NASA centers, eight formal K-12 education organizations, 5 industry/ non-profit research organizations, three extension service organizations, 34 of the 52 Space Grant Consortia, and many other organizations.

K-12 Education/ General Public Outreach Impact

Between 1998 and 2002 TSGC’s K-12 Education/ General Public Outreach program inspired grade school students to pursue careers in science, technology, engineering, and mathematics through enabling educators to integrate the exploration of space into classroom activities. During this period TSGC has conducted eight highly successful K-12 Education / General Public Outreach Programs. These programs have directly impacted over 6,000 K-12 teachers and 500,000 K-12 students though teacher workshops, classroom activities, and other programs. Although predominantly from the state of Texas, these teachers and students represent every state of the nation and 9 other countries around the world [Australia, Austria, Canada, India, Italy, Portugal, Spain, Great Britain, and Venezuela]. TSGC K-12 Education/ General Public Outreach programs have been featured in over 300 newspaper articles, TV programs, radio shows, and magazine articles reaching tens of millions of people. These publications include CNN, Discovery Channel, Washington Post, USA Today, Newsweek, Time Magazine, New York Times, Wall Street Journal, and many others.

In recognition of TSGC’s excellence in conducting K-12 Education/ General Public Outreach programs TSGC was able to obtain an additional $750,000 in funding from sources outside of the NSGC&FP. Additional support for TSGC K-12 Education/ General Public Outreach programs in the form of in-kind support increased this leveraging to over $4.4M of program activity.

Participants involved in TSGC K-12 Education/ General Public Outreach programs have conducted experiments on NASA’s KC-135A Reduced Gravity Research Aircraft, met with and taught Astronauts and Congresswomen, spoken to thousands of people about their life changing experiences, written curricula that have been adopted in over 5,000 classrooms nationwide, and conducted experiments on the International Space Station.

Higher Education Impact

Since 1998 TSGC has conducted eight Higher Education programs focused on enabling undergraduates of all levels to participate in real life research and design alongside NASA personnel. These programs have involved over 1,500 undergraduate students from widely varying majors [Art to Engineering to Physics to Business]. While conducting real life research and design these students worked alongside NASA personnel from the Johnson Space Center, Ames Research Center, Goddard Space Flight Center, and the Kennedy Space Center.

By focusing on these innovative programs, TSGC was able to secure significant outside funding to augment and complement its Higher Education programs. During this time TSGC was able to multiply its $385K investment in Higher Education programs to attract $1.6M of additional funding. This represents more than a three fold increase. This investment balloons to $13.8M [or 35.8 times TSGC original investment] when in-kind support and other matching are considered.

Participants involved in TSGC Higher Education Programs have conducted unique experiments on NASA’s KC-135A Reduced Gravity Research Aircraft, designed components for the International Space Station, redesigned entire design curricula at their institutions, and developed business plans for the human exploration of Mars.
Research Infrastructure Development Impact

Between 1998 and 2002, TSGC’s Research Infrastructure Development program focused on fostering the development of long-lasting partnerships between academia and industry in research that directly supports NASA’s mission. During this time, TSGC conducted eight highly successful Research Infrastructure Development programs that fostered industry sponsored research at its affiliates and facilitated faculty partnerships with NASA. Long-term partnerships with the United Space Alliance, Lockheed Martin, Los Alamos National Laboratory and may other organizations were formed.

These programs used TSGC’s $590K investment and more than doubled it to almost $1.3M of funded research at TSGC’s affiliate institutions. Each funded program established either new academia and industry relationships or strengthened existing relationships. Several research efforts lead to successful proposals to NASA and the State of Texas for follow-on funding.

These research programs investigated important topics such as aiding the International Space Station avoid collisions with space debris, radiating unwanted heat on the transit to Mars though miniature heat pipes, detecting and eliminating contaminants in closed-loop life support systems, and developing extremely low mass and low cost sensor platforms for Mars exploration.

Overall TSGC’s programs have touched the lives of hundreds of graduate students and professors, thousands of undergraduate students and K-12 educators, hundreds of thousands of K-12 students and parents, and millions of people in the general public. Though diligent use of NSGC&FP funding, TSGC has been successful in multiplying these modest investments to advance its goal of enabling the people of Texas, at all points in their lives and educational careers, to be inspired by and participate in the exploration of the great unknown of outer space.

Introduction

| TSGC’s mission is to enable the people of Texas, at all points in their lives and educational careers, to be inspired by and participate in the exploration of the great unknown of outer space. |

The Texas Space Grant Consortium [TSGC] was organized in 1989 as a team of academic, industry, state government, and non-profit institutions from all regions of the state in support of the National Space Grant College & Fellowship Program [NSGC&FP]. TSGC is currently comprised of 35 affiliate institutions, 3 Space Grant Colleges, 24 other academic affiliates, 3 commercial firms, 3 non-profit organizations, and 2 state agencies.

TSGC’s mission is to enable the people of Texas, at all points in their lives and educational careers, to participate in and be inspired by the exploration of the great unknown of outer space. To do this TSGC conducts programs that enable people to better understand and participate in NASA’s mission of space exploration. These programs are grouped into four major areas: K-12 Education/ General Public Outreach, Higher Education, Fellowships & Scholarships, and Research Infrastructure Development. TSGC strives to maintain a balance of funding and the application of other resources across these four programmatic areas.

In K-12 Education/ General Public Outreach programs TSGC’s primary focus is to inspire middle and high school students to pursue careers in Science, Technology, Engineering, and Mathematics [STEM] by enabling educators to integrate the exploration of space into their classroom activities. Focusing on the professional development of K-12 educators enables TSGC to directly impact the STEM pipeline with hundreds of K-12 educators, indirectly via thousands of other educators, and ultimately add to the education of hundreds of thousands of students and parents across the state of Texas and the nation.

In the words of one participant “LiftOff Summer Institute was an everlasting experience. I can’t wait until school starts! I am so excited about sharing everything that I experienced, not only with my students, but with fellow teachers and colleagues.”
TSGC’s Higher Education programs focus on enabling undergraduates of all levels to participate in real life research and design along side NASA personnel. While performing research and engaging in design challenges undergraduates are exposed to the real world applications of their ongoing education and are challenged to stretch themselves beyond the realm of the traditional classroom.

As so eloquently stated by one student “This program and this type of experience has helped each of the team members understand engineering and science more than they ever did before. Moreover, the team members were able to work with and learn from students from other universities around the country and with NASA employees. Such experiences are truly rare for most college students.”

Each year TSGC awards undergraduate student scholarships and graduate student fellowships to reward and motivate young leaders in science, technology, engineering, and mathematics to pursue further education and careers in direct support of NASA’s exploration mission. Concerning the impact of this program one scholar stated that “you have helped me to prove ‘dreams do come true!’ and ‘dreams will come true’.”

TSGC’s Research Infrastructure Development program focuses upon fostering the development of long-lasting partnerships between academia and industry in research that directly supports NASA’s mission. This program has assisted in establishing major academia-industry partnerships at eight TSGC academic institutions. Though this program, with a modest investment of $590K, TSGC has facilitated over $6M in research funding. As stated by one researcher concerning these relationships “[they have] enabled TCU to compete with much larger institutions for funding from State and federal agencies.”

TSGC’s programs form an integrated effort to increase the number of students understanding of science, technology, engineering, and mathematics [STEM] and to ultimately increase the number of students in the pipeline leading to careers in STEM related disciplines.

Just as importantly, many of TSGC’s K-12 efforts are designed to provide an appreciation of science and technology to those who do not or will not enter high tech careers. Using NASA’s mission as the focus of TSGC’s STEM based activities helps to generate a level of interest in science and mathematics by many in this important, but often neglected segment of the population.
The chart below demonstrates that TSGC’s broad range of educational programs support the STEM pipeline and provide opportunities in educational service areas spanning K-12, College, Graduate School and Faculty.

<table>
<thead>
<tr>
<th>Project</th>
<th>Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Space Explorers</td>
<td>95-P</td>
</tr>
<tr>
<td>A&amp;SS</td>
<td>01-02</td>
</tr>
<tr>
<td>Interactive Web</td>
<td>01-02</td>
</tr>
<tr>
<td>LiftOff Summer Institute</td>
<td>90-P</td>
</tr>
<tr>
<td>Protein Crystal Growth</td>
<td>98-P</td>
</tr>
<tr>
<td>GRACE EPO</td>
<td>99-P</td>
</tr>
<tr>
<td>Fly High</td>
<td>98-99</td>
</tr>
<tr>
<td>CC-ZERO G</td>
<td>00-01</td>
</tr>
<tr>
<td>RGSFOP</td>
<td>97-01</td>
</tr>
<tr>
<td>RGSFOP Student Supp</td>
<td>00-P</td>
</tr>
<tr>
<td>TSGC Design Challenge</td>
<td>02-P</td>
</tr>
<tr>
<td>TSGC Advanced Design</td>
<td>95-02</td>
</tr>
<tr>
<td>NASA Academy</td>
<td>96-P</td>
</tr>
<tr>
<td>Scholarship Program</td>
<td>92-P</td>
</tr>
<tr>
<td>NASA Means Business</td>
<td>98-P</td>
</tr>
<tr>
<td>Mars Port Design</td>
<td>01-02</td>
</tr>
<tr>
<td>Automated Robots</td>
<td>00-02</td>
</tr>
<tr>
<td>Tethered Satellite</td>
<td>01-P</td>
</tr>
<tr>
<td>Tumbleweed Sensors</td>
<td>02-P</td>
</tr>
<tr>
<td>Fellowship Program</td>
<td>90-P</td>
</tr>
<tr>
<td>Orbit Uncertainty</td>
<td>98-00</td>
</tr>
<tr>
<td>Mini-Heat Pipes</td>
<td>98-00</td>
</tr>
<tr>
<td>LIDAR Errors</td>
<td>00-01</td>
</tr>
<tr>
<td>Compact Nitrides</td>
<td>00-02</td>
</tr>
<tr>
<td>Combustion Perform</td>
<td>02-P</td>
</tr>
</tbody>
</table>

TSGC STEM PIPELINE - SERVICE AREAS

<table>
<thead>
<tr>
<th></th>
<th>Elementary School</th>
<th>Middle School</th>
<th>High School</th>
<th>College</th>
<th>Graduate School</th>
<th>Faculty</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>K</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Space Explorers</td>
<td>95-P</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A&amp;SS</td>
<td>01-02</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interactive Web</td>
<td>01-02</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LiftOff Summer Institute</td>
<td>90-P</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Protein Crystal Growth</td>
<td>98-P</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GRACE EPO</td>
<td>99-P</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fly High</td>
<td>98-99</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CC-ZERO G</td>
<td>00-01</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RGSFOP</td>
<td>97-01</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RGSFOP Student Supp</td>
<td>00-P</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TSGC Design Challenge</td>
<td>02-P</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TSGC Advanced Design</td>
<td>95-02</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
National Program Emphasis

From its inception the National Space Grant College & Fellowship Program has emphasized 5 major components in the implementation of this program.

1 Diversity - recruitment and/or participation of women, underrepresented minorities, and persons with disabilities throughout all aspects of the program.
2 Competitiveness – accessibility by a wide field of applicants and established review processes to select the most qualified individuals and programs.
3 NASA Ties – relationships that have been established with NASA Centers and Enterprises for the purposes of implementation, coordination, communication, or dissemination.
4 Industry Relations – relationships with private industry that have been established to increase the effectiveness of Space Grant programs through sharing of resources, including funds, facilities, and personnel expertise.
5 State Government Involvement – relationships that have been established with state government for the purposes of implementation, coordination, communication, or dissemination.

TSGC has interwoven each of these 5 emphases into each of its program elements

Diversity

TSGC actively recruits the participation of underrepresented groups in all of its programs. This philosophy runs as an unbroken thread through all TSGC activities from program management to General Public Outreach programs. Representatives from Minority Serving Institutions serves on every TSGC advisory panel, comprise half of the Consortium’s Fellowship Selection committee, and have a reserved seat on the Consortium’s Board of Directors. Ten of TSGC’s 27 academic affiliates are federally designated as Minority Serving Institutions. All TSGC programs not only encourage the participation of women, underrepresented minorities, and persons with disabilities but specifically target their inclusion.

Special programs have been developed for and implemented in areas of the state that have high concentrations of underrepresented minorities. Student organizations that cater to women and minorities are targeted in the distribution of program announcements. In 2002, even though severely hampered by the 1996 Hopwood vs. Texas ruling by the 5th Circuit Court of Appeals which prohibited public institutions from considering ethnicity their selection processes, TSGC’s Fellowship and Scholarship program was able to more than double the number of women and minority applicants and to increase the number of awards given to minorities by 67%.

Competitiveness

TSGC strongly embraces the philosophy of utilizing competitiveness to increase the quality of its programs. TSGC not only competitively awards all program, fellowship and scholarship funding but also emphasizes the competitive selection of program participants. All TSGC programmatic funds are awarded competitively through a peer-review selection process. TSGC maintains a proposal evaluation committee in each program area that routinely reviews incoming proposals. These committees are comprised of proven experts in their fields. Evaluation criteria include NASA focus, customer identification and service, diversity factors, partnership among consortium members, and how the program will be sustained in the future when TSGC funding ceases.

TSGC’s fellowship and scholarship funds are also awarded on a competitive basis. These programs are open to any student attending TSGC affiliate institutions.

The result of the competitive approach is that in the last 5 years no single institution has received more than 10% of TSGC program, fellowship, and scholarship funds.

NASA Ties

TSGC has long standing relationships with NASA centers and personnel. NASA centers and personnel are integrally involved in every aspect of the Consortium and in all programmatic areas. The Consortium conducts joint research with Langley Research Center in the area of sensor platform
development for Mars exploration. NASA personnel have participated in the development and implementation of over half of the Consortium’s Pre-College Education programs. All of TSGC’s Higher Education programs maintain close ties with NASA centers through: NASA mentors, NASA defined design projects, utilization of NASA equipment, NASA reviewers. Three of TSGC’s programs have been developed or greatly expanded at the specific request of the NASA centers that provided the majority of their funding. NASA/Johnson Space Center maintains an office in Austin at the Consortium for the specific purpose of fostering close ties with the Texas Space Grant Consortium and the University of Texas Center for Space Research. These partnerships include 5 different NASA centers representing over 4 man-years of collaborative effort.

**Industry Relations**

Since its inception TSGC has maintained close ties with private industry. Private industry consortium members routinely sponsor TSGC events, co-fund TSGC programs, participate in membership activities, and serve on the Consortium’s Board of Directors. Industry has contributed well over $600,000 to TSGC projects in the last five years through joint research with TSGC affiliates and sponsorship of Higher Education and Pre-College Education programs. TSGC’s Research Infrastructure Development program is specifically designed to foster strong ties between the Consortium’s academic affiliates and industry through jointly funded research. Boeing Company, United Space Alliance, and Lockheed Martin have played major roles in advising the Consortium on its activities through active participation on TSGC’s Board of Directors, speaking at its meetings, and serving on advisory panels.

**State Government Involvement**

TSGC maintains strong ties with several State of Texas government agencies. The two state agencies that most closely align with TSGC’s mission are the Texas Higher Education Coordinating Board and the Texas Aerospace Commission. These strong relationships have had a significant impact on the Consortium in two major areas [1] Implementation of new programs and [2] establishing partnerships with other organizations.

The Texas Higher Education Coordinating Board [THECB] holds a permanent position on the TSGC Board of Directors. This organization is responsible for working with the Legislature, Governor, and colleges and universities to coordinate Texas higher education and expand access, improve equality and promote efficiency in the system. The THECB has been extremely active in the Consortium by providing contacts at all Texas institutions of higher education, reviewing research proposals, and in the development of the Consortium’s Research Infrastructure Development program. Dr. Linda Domelsmith, Director of Research Programs and member of the TSGC Board of Directors, has played an integral role in the development of TSGC’s Research Infrastructure program which is based upon a state funded research program she oversees.

The Texas Aerospace Commission is responsible for the economic development of the Aeronautics and Aerospace Industries in the State of Texas. Bill Looke, the Executive Director, serves on the Consortium’s Board of Directors and plays an active role in the Consortium.

**Program Elements**

**Consortium Management**

**General Description**

TSGC’s structure is designed to provide a strong element of management oversight by representatives of its affiliate institutions. Each affiliate plays a vital role in defining Consortium operations, goals, and funding distribution. Affiliates are provided with several avenues for participation in the management of the Consortium.

TSGC’s Board of Directors holds responsibility for establishing overall policy and guiding principles, balancing program focus areas, and evaluating program impact. Board members are selected to provide balanced representation of the interests of the affiliates. The Board of Directors consists of: the Chair of the Board, the Director, three Associate Directors [one from each of the Space Grant Colleges], three elected representatives from the
Academic Affiliates [with at least one from a minority institution], three elected representatives from the commercial/non-profit affiliates, a representative from the Texas Aerospace Commission, and a representative from the Texas Higher Education Coordinating Board. The Board convenes two to four times a year.

TSGC activities within the areas of Research Infrastructure Development, Higher Education Programs, and K-12/Public Outreach are guided by Consortium standing committees. All three committees also have responsibilities in the area of enhancing the participation of underrepresented minorities and women. These committees are comprised of affiliate representatives, TSGC staff, Board members, and other parties that share common interest with the Consortium. The committees are responsible for evaluating current program areas, providing guidance to the Board on special topics, defining the broad structure of announcements of opportunities, and reviewing incoming proposals. TSGC also uses ad hoc committees. The following ad hoc committees have existed in the last five years: Program Element Planning, Proposal Review, Fellowship Selection, Scholarship Selection, Minority Involvement, Medical School Involvement, Consortium Documentation, Junior College Involvement, Industry Involvement, and Other Member Relations. These committees commonly meet at TSGC fall and spring membership meetings.

Resources

Staff

The Director and Associate Directors are supported through a 25% faculty release time arrangement with the Space Grant Colleges at no cost to TSGC. Affiliate representatives work under a similar release time arrangement at their respective organizations to support local TSGC activities. TSGC HQ maintains a slim staff of 1.5 FTEs dedicated to assisting the volunteers from its affiliates in the implementation of Consortium programs. TSGC has an additional 4.5 FTE staff, funded from external funds, that oversee administration of TSGC programs.

Office Space

TSGC’s office is located adjacent to the Pickle Research Campus, 12 miles north of the University of Texas at Austin main campus and is co-located with the Center for Space Research [CSR]. This location affords TSGC the benefit of extensive no-cost support from CSR, class A office space, and extensive meeting areas. This physical separation from the UT-Austin main campus helps ensure that the host institution does not disproportionately benefit from the Consortium. The Consortium has exclusive use of 8 offices, a storage room, and a reception area for a total of 2,210 ft². The Consortium has shared use of an additional 16,000 ft² which consists of 5 conference rooms, 4 labs, and other non-designated space.

Funding Distribution

TSGC strives to distribute available funding in an equitable manner to its affiliates. Each year, every affiliate is encouraged to complete, via a proposal process, for program funds. TSGC Headquarters is also allowed to compete for program funds for activities that benefit the Consortium as a whole.

In all Consortium activities, special consideration is given to proposals that benefit multiple affiliates, that implement partnerships among affiliates, that have strong diversity components, or are based at minority serving institutions.

With 27 academic members, representing the entire spectrum of academic institutions, from very large Research 1 institutions to community colleges, the competition for TSGC scholarships and fellowships has the potential for unfair distribution. The following process has been used since the founding of the Consortium to avoid unfairness in this area.

For graduate fellowships each affiliate receives and ranks all of its applicants prior to submission to the TSGC Fellowship Committee. To ensure no affiliate receives an unfair share of the graduate fellowships, each affiliate can only submit its highest ranked 3 applicants. The Fellowship Committee nominally recommends 20 recipients for TSGC fellowships. As an additional precaution to ensure fairness, representatives from the three Space Grant Colleges in the Consortium [Texas
A&M, U of Houston, and UT Austin] are barred from membership on this selection committee.

With respect to undergraduate scholarships, each educational affiliate with an undergraduate program is guaranteed at least one undergraduate scholarship per year provided that a nominee is submitted. On average, TSGC awards about 15 undergraduate scholarships each year.

One major strength of TSGC’s committee supported management approach is the equitable distribution of Consortium funding to competitively selected projects, fellowships and scholarships. As a result in the last five years no single institution has received more than 10% of program, fellowship, and scholarship funding combined. This excludes programs administered by TSGC headquarters, as each of these programs by definition, benefits the Consortium as a whole and often do not even involve faculty or students from the host institution.

The funding distribution chart provided shows how TSGC has distributed program, fellowship and scholarship funds during the period of this review.

TSGC’s broad range of programs fall under four major categories: Higher Education, Research Infrastructure Development, Fellowships/ Scholarships, and K-12 Education/General Public Outreach. Although the percentage of funding received by each program element varies each year, TSGC strives to maintain a balanced distribution of funding. In the last five years TSGC has placed a special emphasis upon fostering Academia-Industry ties through a program focused on research infrastructure development. The increased funding of research resulting from this emphasis is apparent on the next chart. This program emphasis will be discussed later in this report. The 28% of program funds going toward fellowships and scholarships has been approximately constant over the past five years and this level of funding is expected to continue.

**Average Distribution of Funds Across Program Elements**

- Fellowships: 28%
- Research: 30%
- K-12/GP: 20%
- Higher Edu: 22%
- Other Affiliates: 18%
- TAMU: 10%
- Tech: 7%
- TCU: 9%
- UTSA: 6%
- UH: 7%
- UTD: 5%
- PV: 4%
- TSGC HQ: 24%

**Matching and Leveraging**

As part of the overall leadership role the three Space Grant colleges [Texas A&M, U of Houston, and U of Texas at Austin] have committed to providing the matching funds that are required for this grant. The amount provided by each Space Grant college is relatively stable and is comprised of three components: cash for program funds, faculty release time for directors, and administrative support for the directors. On average the three Space Grant Colleges in TSGC provides 122% of the required matching funds.

University Abbreviations: TAMU – Texas A&M University, UT Austin – University of Texas at Austin, TCU – Texas Christian University, Tech – Texas Tech University, UH – University of Houston, UTSA – University of Texas at San Antonio, UTD – University of Texas at Dallas, PV – Prairie View A&M University.
In addition TSGC also provides a significant amount of leveraged funding supplied primarily by program participants and its affiliates. On average over $6 million in matching and leveraged funds is provided each year. This is a return of more than 12 to 1 on the NASA Space Grant funding.

The following chart depicts the percentages of leveraged fund contributions from the various categories Consortium affiliates. The very large percentage of leveraged funding from program participants was predominately driven by the extremely successful NASA Reduced Gravity Student Flight Opportunities Program created by TSGC and managed by TSGC for NASA for its first 5 years.

Source of Leveraged Funds

![Source of Leveraged Funds Chart]

The dramatic decline in this area for 2002 reflects NASA’s movement of the program RGSFOP management to one TSGC's affiliates in Houston, at which point, the leveraging from these program participants was no longer counted by TSGC. The rapid growth of leveraged funds from TSGC affiliates in 2002 corresponds to the redesign of its capstone Higher Education project into the TSGC Design Challenge, the primary component of its Workforce Development award. The large increase in leveraging from state and local government is due to continued focus on professional development of K-12 educators which lead to the adoption of TSGC developed activities by 3,000 educators across the state of Texas and an additional 2,500 teachers nation-wide.

**Management Costs**

TSGC aggressively pursues ways to minimize management costs. TSGC HQ administers the program on behalf of the entire Consortium and most administrative costs that its affiliates incur are provided at no costs to the Consortium. TSGC provides centralized project services to affiliate led projects whenever this will reduce overall costs. This usually eliminates duplication of effort and costs allowing the Consortium to maintain a low 18% operational average for administrative costs. When indirect costs are included this average increases to 30%. A driving philosophy in choosing programs to support has been to augment existing programs where possible rather than create new programs. However, in order to create a highly visible TSGC impact in each program area, one flagship program has been created in each program area that is wholly sponsored by TSGC. This philosophy avoids having large program implementation costs in most programs. All administrative costs are closely monitored by the Program Manager and the Board of Directors to ensure the most efficient use of Consortium funds.

**Membership**

TSGC is currently comprised of 35 affiliate institutions, 3 Space Grant Colleges, 24 other academic affiliates, 3 commercial firms, 3 non-profit organizations, and 2 state agencies. A recent tabulation of data shows that 70% of all undergraduate students who earn degrees in Science, Engineering, and Mathematics in the state of Texas attend a Texas Space Grant institution.
TSGC actively seeks participation of Minority Serving Institutions [MSI] in the Consortium. As a result, 10 of TSGC’s 27 academic affiliates are MSIs and in the last five years two additional MSIs have been added to the Consortium. Minority Serving Institutions are integrated into all areas of planning and implementation of the Consortium. MSI representatives serve on all planning committees. Of the three elected Board of Directors positions for academic affiliates one is reserved for a representative from an MSI. MSI representatives are also eligible to be elected to other Board positions. Half of the membership of the Fellowship Selection Panel is from MSI. Half of the members on proposal evaluation panels are from MSI.

TSGC’s structure allows its affiliate representatives to participate in the Consortium at levels which are best suited to their interests and the needs of their home institutions. Acceptable activity ranges from involvement in every program that conducted to involvement in only a single program.

TSGC has established policies for both adding and removing affiliate members. Organizations desiring to be considered for membership must submit an application to the director of the Consortium. This application provides a description of the organization, its involvement in space-related activities, and includes a brief statement describing potential contributions the applicant brings to the Consortium. Applications are circulated to the current membership for a comment period before being reviewed by the Board. The applicant is afforded the opportunity to present to the Board, if desired. Membership is awarded upon recommendation of the affiliate representatives and a vote of the Board of Directors.

The Program Office monitors the participation level of each affiliate and proactively encourages more active participation by those that are marginally engaged. If a member institution continues to be marginally active even after the encouragement of the Director and the Program Office a letter is written to the institutional representative informing them that their organization has not met the requirements for continuation of membership and that their organization is subject to being removed from membership in the Consortium. The organization is afforded the opportunity to show cause why they should not be removed from membership in the Consortium. On several occasions, a visit to the affiliate by program office staff has revitalized activities at an affiliate. In the last 5 years 4 institutions have been removed from membership and 5 institutions have been added to the membership.

TSGC holds semi-annual meetings of the Board of Directors and the representatives of the affiliate institutions. Typically one meeting is devoted to Consortium business and the other has a topical space-related science focus. At the business meetings the Consortium reviews program performance, modifies existing programs, and establishes new programs. The TSGC Board of Directors usually meets in conjunction with the TSGC general meetings and additional Board of Directors meetings are held when necessary.

The need to provide continuity of organizational involvement in TSGC during times of transition of affiliate representatives was identified as a potential weakness in its organizational structure. With the approval of the Board and affiliates, TSGC has asked that a second representative be appointed by each of affiliates. This will [1] give local representatives a backup, [2] increase TSGC exposure at its affiliates, and [3] will increase the multidisciplinary span of representatives associated with the Consortium.
Collaborations Outside the Consortium

TSGC has developed strong ties with organizations that are not members of the Consortium but have complementary objectives. These partnerships play an integral role in TSGC programs and enable TSGC to multiply its impact on the state and the nation.

In the last five years TSGC has formed over 60 major partnerships for the express purpose of expanding the impact of the program. These partnerships fall into 5 major categories:

- Formal K-12 Education Organizations [8]
- Industry/ Non-Profit Research Orgs [5]
- NASA Centers [5]
- Extension Services [3]
- Other Space Grant Consortia [34]
- Other [8]

**Formal K-12 Education Organizations**

TSGC has 8 major ongoing partnerships with formal K-12 education organizations which include individual schools, school districts, and Professional Organizations for K-12 teachers. Overall these partnerships included over 7,500 man hours of collaborative work which impacted over 140,000 people.

<table>
<thead>
<tr>
<th>Organizations</th>
<th>Scope</th>
<th>People Man-hours #s Impacted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Texas School for the Blind and Visually Impaired</td>
<td>Space Camp, Joint Project, K-12 Prol Development, Curriculum Development</td>
<td>5 people 40 hrs New Partnership</td>
</tr>
<tr>
<td>Amarillo ISD, Elisabeth Board of Education, Killeen ISD, Llano ISD, Mid Prairie Community SD, Sunray ISD,</td>
<td>Curriculum Development, K-12 Prof Development, GP Outreach</td>
<td>48 people 7,520 hrs 2,000 teachers 140,000 students</td>
</tr>
<tr>
<td>Rio Grande Valley Science Association</td>
<td>K-12 Professional Development</td>
<td>3 people 20 hrs 200 teachers</td>
</tr>
</tbody>
</table>

**Industry/ Non-Profit Research [5]**

TSGC has established 5 major research partnerships in conjunction with its Research Infrastructure program. Each of these partners contributed matching funding to a TSGC academic affiliate along with additional in-kind support. These partnerships included over 8 man-years and $500K in matching funding.

<table>
<thead>
<tr>
<th>Organizations</th>
<th>Scope</th>
<th>People Man-hours Ext Funding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ionwerks, Los Alamos National Laboratory, The Michigan Technic Corporation, Schlumberger Inc, Techathlon</td>
<td>Joint Research</td>
<td>18 people 17,000 hrs $500K funded</td>
</tr>
</tbody>
</table>

**NASA Centers [5]**

TSGC has established major partnerships with 5 NASA centers spanning Research, Higher Education, K-12 Education, and General Public Outreach. These partnerships represent over 4 man years of collaborative effort.

<table>
<thead>
<tr>
<th>Organizations</th>
<th>Scope</th>
<th>People Man-hours #s Impacted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Langley</td>
<td>Joint Research</td>
<td>14 people 600 hrs 4 Researchers 10 U Students</td>
</tr>
<tr>
<td>JSC, KSC</td>
<td>Workforce Development</td>
<td>15 people 5,500 hrs 15 Researchers 2,000 U Students 1 M Others</td>
</tr>
<tr>
<td>JPL, GSFC</td>
<td>K-12 Prof Development, GP Outreach</td>
<td>15 people 2,500 hrs 5 Researchers 2,000 Teachers 140,000 Students</td>
</tr>
</tbody>
</table>

**Cooperative Extensions Services [3]**

In an effort to be more closely tied with the Land Grant program TSGC has established partnerships with 3 cooperative extension services organizations. These efforts represent more than 3,000 man hours of joint projects which impacted over 2,700 people.

<table>
<thead>
<tr>
<th>Organizations</th>
<th>Scope</th>
<th>People Man-hours #s Impacted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Travis County 4-H &amp; Youth Program, 4-H CAPITAL Project, Texas Extension Service</td>
<td>Space Camp, Children &amp; Parents Involved in Technology and Literacy, Youth Development and Space Education</td>
<td>100 people 3,000 hrs 2,200 students 500 others</td>
</tr>
</tbody>
</table>
**Other Space Grants [34]**

Linking closely with other Space Grants TSGC has partnerships with 34 of the 51 other state organizations. These partnerships are comprised primarily of Space Grant sponsorship of student teams and K-12 educators who participated in TSGC developed and administered programs.

<table>
<thead>
<tr>
<th>Organizations</th>
<th>Scope</th>
<th>People Man-hours</th>
<th>#s Impacted</th>
</tr>
</thead>
<tbody>
<tr>
<td>AZ,ID,MA,MT,NV,PA,VA,W,AL,CA,CO,GAYIA,N,Y,ND,NM,OR,UT,W,W,W,Y</td>
<td>Workforce Development, Undergraddesign</td>
<td>386 people</td>
<td>3,600 hrs</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>450 U students</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1 M others</td>
</tr>
<tr>
<td>AK,AR,AZ,IL,KS,LA,MA,MI,MN,NE,NH,NV,NY,OK,PA,TN,VA,WA</td>
<td>K-12 Prof Development</td>
<td>50 people</td>
<td>2,000 hrs</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>40 Teachers</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3,600 Students</td>
</tr>
</tbody>
</table>

**Other [8]**

TSGC has also established 8 other major partnerships with other organizations. These collaborative relationships represent over 1,700 man hours of joint effort which impacted over 28,000 people.

<table>
<thead>
<tr>
<th>Organizations</th>
<th>People Man-hours</th>
<th>#s Impacted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Travis County Character Counts Collaborative, Earth Science Career Day</td>
<td>Teen Leadership Conference</td>
<td>22 people</td>
</tr>
<tr>
<td></td>
<td></td>
<td>750 Students</td>
</tr>
<tr>
<td></td>
<td></td>
<td>50 Teachers</td>
</tr>
<tr>
<td>Challenger Centers [3], Space Center Houston, Informal Science Educators Association, McDonald Observatory</td>
<td>K-12 Prof Development</td>
<td>60 people</td>
</tr>
<tr>
<td></td>
<td></td>
<td>28,000 Students</td>
</tr>
<tr>
<td></td>
<td></td>
<td>400 Teachers</td>
</tr>
</tbody>
</table>

**Impact/Results**

TSGC’s management structure has proven to be of great value to the Consortium in meeting its goals and objectives. The flexible structure not only allows but also encourages participation by all affiliate members in defining and operating the Consortium while preventing domination by the lead institution in funding distribution, authority, and influence.

TSGC’s structure is centralized enough to facilitate rapid response to opportunities for multi-affiliate partnering, but de-centralized enough to allow affiliate representatives to take the lead when they so desire. Any representative of any affiliate who wants to become heavily involved in Consortium activities has the opportunity to do so. Good examples of this are [1] the TSGC Research Infrastructure Development Program designed by representatives from Texas A&M University in 1998, [2] the 15 years that the representative from Texas Tech has served as Chair of the Fellowship and Scholarship Selection Committee, and [3] the participation of faculty and students from ten Consortium affiliates in the Advanced Design / Design Challenge Programs.

With its flexible management structure, TSGC has been able to expand its funding base beyond the NASA Space Grant Funding. In the last five years TSGC has received $2.9M of funding in addition to the $2.5M provided by the NSGC&FP. All of these additional funds were managed under the umbrella of the Consortium. Without this flexible structure this multiplication of funding would be impossible.

**Fellowship and Scholarship Program**

**General Description**

TSGC has established graduate student fellowship and undergraduate student scholarship programs that are designed to recognize high-quality students at TSGC institutions and encourage then to remain in the educational pipeline in further pursuit of space-related careers. Between 1998 and 2002 TSGC awarded over $590,000 in fellowships and scholarships to 173 students - more than 25% of the TSGC NSGC&FP budget. The students’ disciplines range from Aerospace Engineering to Neuroscience to Biomedical Engineering.

The National and Texas Space Grant Programs have established 6 major Fellowship and Scholarship goals.

1 Provide undergraduate training through the mechanism of fellowship and scholarship awards
2 Emphasize awards with effective student research and mentoring components
3 Recognize high achieving students who have strong interests in careers in space related fields
4 Encourage high achieving students to pursue graduate studies in space related fields
5 Encourage high achieving women and underrepresented ethnic groups to pursue careers in space related fields
6 Maintain a balance of awards across academic member institutions

Each year, TSGC's fellowship program awards about 20 competitively selected $5,000 supplemental fellowship award to graduate students who are receiving half-time support from their local institution. The fellowships stress excellence in academics, participation in space related research projects, exhibited leadership qualities, and faculty recommendations. With the large number of affiliates and limited fellowship funds, TSGC has chosen to award supplemental fellowships in order to keep good students in the educational pipeline at TSGC institutions. Recipients may apply to renew the fellowship for up to three years.

TSGC's Scholarship program consists of a competitively selected $1,000 award to encourage undergraduate students at each of its Academic Institutions to pursue graduate studies in space related disciplines. Selections are made based upon excellence in academics, participation in space education projects, participation in research projects, and exhibited leadership qualities.

The TSGC Fellowship and Scholarship selection committees also evaluate the effectiveness of the advertising of the program by evaluating the number of applicants and the quality of the applications. This information is presented to the general membership at the spring membership meetings. As part of these assessments, committee members recommend ways to improve the program.

As a way to alleviate the challenges presented by the 1996 Hopwood vs. Texas ruling by the 5th Circuit Court of Appeals which prohibited public institutions from considering ethnicity in their selection process, TSGC began to allow minority serving institutions to compete for additional undergraduate scholarships. This competition, while not restricted to minority students, has increased the number of minority recipients of TSGC scholarships.

Core Criteria

Diversity Objectives
The NSGC&FP has set an ethnic diversity objective of matching the percentage of Fellowships and Scholarships awarded underrepresented groups to their enrollment in higher education in the state. According to the National Science Foundation 30.0% of students enrolled in Texas four year schools were from underrepresented ethnic backgrounds in the fall of 1998. Between 1998 and 2002 TSGC awarded 173 fellowships and scholarships, 40 (23%) of which were to students from underrepresented ethnic backgrounds. During this period, enforcement of the Hopwood ruling severely impaired TSGC ability to meet its ethnic percentage goals. With the program modifications previously mentioned in 2002 TSGC was able to meet this objective by awarding 10 of its 36 awards to minorities.

Competitive Awards
Each fall TSGC announces and distributes information about the Fellowship program for the following academic year. Graduate students can either receive an application from their TSGC representative or download it from the TSGC website. Applications are submitted to the affiliate's representative who is responsible for the initial pre-selection process. Each affiliate may submit up to three applicants to a Consortium-wide selection committee. The selection committee is made up of faculty from the Academic Affiliates, excluding the Space Grant Colleges. This committee ranks the applicants considering their difficulty of class work, personal statement, grade point average, Graduate Record Examination score, and letters of recommendation. These rankings are sent to the Director who, based on budgetary constraints, determines how many fellowships to award each year. TSGC typically awards 20 fellowships each
year. In an average year, this includes students at 12 affiliates.

Each fall TSGC announces and distributes information about the Undergraduate Scholarship program for the following year. Students at affiliate institutions can either receive an application from their local TSGC representative or download it from the TSGC web site. Applications are submitted to the affiliate representative who is responsible for the local selection process. Selections are made based upon excellence in academics, participation in space education projects, participation in research projects, and exhibited leadership qualities. TSGC typically awards 15 undergraduate scholarships each year at 12 affiliate institutions.

Impact/Results

TSGC continuously monitors the effectiveness of its scholarship and fellowship program through data analysis conducted by its Fellowship and Scholarship committee. This evaluation mechanism has proven to be extremely effective in maintaining a high quality program.

No single affiliate or group of affiliates have dominated the program. All active academic affiliates have received at least one award during the review period and 15 affiliates have averaged one award per year.

Another major strength of the programs is TSGC’s responsiveness to its affiliates. This is demonstrated below by the modifications to the program that were implemented at the direction of its affiliates.

In 1999 the F&S committee noted that there was a 60% drop in applications by minority students. This occurred without any changes in the way that the programs were advertised, administered, or awards were given. Since then, TSGC has implemented efforts to increase the number of applications submitted by minority students. These efforts have included [1] special advertising to student groups that cater to minorities, [2] emphasis on the program at minority serving institutions, and [3] special efforts on behalf of its affiliates to recruit minority students. The result of these efforts has been a 650% increase in the number of minority applicants for TSGC fellowships and scholarships.

A second example of TSGC’s responsiveness to its affiliates occurred in 2002. The Scholarship committee noted that the number of total scholarship applicants had leveled off at a level that was determined to be insufficient. In response to this problem, an on-line version of the scholarship application was developed and electronic advertising of the program was increased. In its first year of operation, the new procedure resulted in a 100% increase in the total number of applications and a 140% increase in the number of female applicants. A similar system is under development for the fellowship program.

Some comments by recipients of TSGC’s scholarships and fellowships are provided below:

Receiving this fellowship is for me, the culmination of a life-long interest in space science.

This has given me the opportunity to pursue my research desires.

Awards such as these help students to fulfill their careers without worrying about financial problems.

Some people say dreaming of being an astronaut is childish and unattainable, but you have helped me to prove ‘dreams do come true!’ and ‘dreams will come true’.

Research Infrastructure Development Program

TSGC’s Research Infrastructure Development program focuses on fostering the development of long-lasting partnerships between academia and industry in research that directly supports NASA’s mission.

General Description

In 1998, in response to affiliate input that the Research Infrastructure Development activities were ineffective, representatives from Texas A&M University proposed a new comprehensive research infrastructure development program. After discussion and amendment by interested affiliate
representatives, the new program was instituted. All research programs funded since 1998 are part of this program. This program, the Cooperative Space Research Program [SRP] had the objectives of stimulating institutional research that [1] is aligned with NASA long range research goals, [2] fosters partnerships between industry and academic organizations, and [3] encourages collaborative research among TSGC members. TSGC committed 25% of its program funds plus an additional quarter million dollars of reserve funding to operate the SRP for an initial period of five years.

The SRP program guidelines allowed faculty members at any TSGC academic affiliate to propose to TSGC for funding. The guidelines called for a 50%-50% sharing of project costs by TSGC and industry on a space-related project of mutual interest to the proposing faculty member and the industry. It was hoped that the industries involved would be TSGC affiliates, but this was not required. The TSGC portion of the funding was overhead free, and TSGC’s contribution occurred early in the project. All programs also strongly encouraged direct faculty involvement with appropriate NASA personnel.

Eight multi-year research efforts were funded under this program at 8 member institutions for a total TSGC funding of over $590,000 with industry and affiliate cash leveraging of over $690,000.

The National and Texas Space Grant Programs have established 10 major research goals.

1. Fund research opportunities in line with the NASA Strategic Enterprises
2. Stress programs for faculty who have not yet become established researchers
3. Coordinate with other NASA programs
4. Enhance faculty NASA partnerships
5. Link research infrastructure universities with research intensive universities, industry, and NASA
6. Encourage collaborative research among member institutions
7. Encourage academic and industry partnerships
8. Focus on topical research consortia
9. Pursue long-range research goals
10. Maintain a balance of participation across academic member institutions

The following table lists the 8 SRP programs that TSGC conducted during the period of this review. The table provides the following information: the year the project was funded, the project partners [academic, industry, and federal], and the National and Texas goals that the research addresses.

<table>
<thead>
<tr>
<th>Program/ Years</th>
<th>Partners</th>
<th>Goals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orbit Uncertainty 1998-00</td>
<td>Texas A&amp;M University United Space Alliance</td>
<td>1, 3, 4, 6, 7, 9, 10</td>
</tr>
<tr>
<td>Mini Heat Pipes 1998-00</td>
<td>Texas A&amp;M University Lockheed Martin</td>
<td>1, 3, 4, 7, 9, 10</td>
</tr>
<tr>
<td>LIDAR Errors 2000-01</td>
<td>U of Texas at Austin Schlumberger Inc.</td>
<td>1, 4, 9, 10</td>
</tr>
<tr>
<td>Compact Nitriles 2000-02</td>
<td>University of Houston Ionwerks, Inc.</td>
<td>1, 3, 4, 7, 9, 10</td>
</tr>
<tr>
<td>Autonomous Robots 2000-02</td>
<td>UT at San Antonio Techathlon, Inc</td>
<td>1, 2, 3, 4, 5, 7, 9, 10</td>
</tr>
<tr>
<td>Tethered Satellite 2001-pres</td>
<td>UT Dallas, TCU, Lamar Michigan Technic Corp</td>
<td>1, 2, 3, 4, 5, 6 7, 9, 10</td>
</tr>
<tr>
<td>Combustion Performance 2002-pres</td>
<td>Texas Tech Los Alamos National Lab</td>
<td>1, 2, 3, 4, 9, 10</td>
</tr>
<tr>
<td>Tumbleweed Instrument Carriers 2002-pres</td>
<td>Texas Tech NASA/Langley</td>
<td>1, 2, 3, 4, 9, 10</td>
</tr>
</tbody>
</table>

In addition to these 8 SRP efforts several of TSGC Higher Education projects also involved NASA related research through capstone design classes and reduced gravity programs. In many cases these efforts were initiated at the direct request of NASA personnel. Such cross-over activities are typical of many TSGC projects. Because such activities involve both higher education and research they are difficult to report without some level of confusion and/or duplication, but in the present report and structure and in CMIS. These higher education research projects contributed an additional $4.1M in research
infrastructure development, predominately at academic institutions.

Core Criteria

Interdisciplinary Collaborations

TSGC requires that all funded research programs be interdisciplinary in nature. Each research project is required to secure an industry, non-profit, or federal partner who is willing to contribute considerable funding to the research. For example the Combustion Performance of Energetic Materials in Microgravity research project is a close melding of the following 5 major disciplines: Aeronautical and Aerospace Engineering, Chemical Engineering, Mechanical Engineering, Material Science, and Chemistry. Other research projects incorporate non-technical disciplines such as Marketing, Education, Business, and Journalism.

Alignment With NASA Enterprises

All research programs funded by TSGC are directly aligned with NASA’s Strategic Enterprises. NASA personnel routinely serve as proposal reviewers, mentors for both students and faculty, and participate in yearly program updates. This alignment with the NASA strategic Enterprises is an integral component of all TSGC activities. Alignment with NASA Enterprises is called for in the TSGC program announcements and is monitored by TSGC staff, through periodic review by NASA personnel, through program review by TSGC Board of Directors, and through review by the affiliate representatives. More information about the alignment of specific projects with NASA Enterprises is provided in the discussions of specific projects.

Programs

Flexible Mini Heat Pipe Radiators for an Inflatable Mars Spacecraft [1998-00]

In a partnership between Texas A&M University and Lockheed Martin new flexible materials were researched for use as thermal radiators for the proposed Mars human transit habitat, TransHab. Lockheed Martin provided half of the funding for this research effort. During the research, the potential for use of these materials was increased by incorporation of miniature heat pipes directly into the flexible material to further enhance fin efficiency. Research proved that miniature integral heat pipes could be successfully incorporated into rigid sheet aluminum radiator fins. The end objective of this project was to develop and demonstrate analogous designs for flexible radiator fin materials. The project addressed flexible miniature heat pipe concepts for integration into the fins, the thermal interface between the mini-heat pipes, and the interfacing loop heat pipe or fluid flow tubes. The final product was a highly efficient flexible mini-heat pipe, which can be embedded into a flexible material.

This project clearly focuses on the development of technology that promises to improve spacecraft designs in direct support of NASA’s Earth Science Enterprise, its Space Science Enterprise, and its Space Flight Enterprise.

Characterizing Orbit Uncertainty Due to Atmospheric Drag Uncertainty [1998-00]

In a partnership between Texas A&M University and United Space Alliance of Houston Texas this program developed and demonstrated mathematical models for representing the orbit uncertainty of the International Space Station. These models enable timely collision-avoidance maneuver decisions to be made based on more accurate information. This research had direct utility by USA in defining the details of ISS re-boost and collision-avoidance maneuvers. Furthermore, the problem addressed is of fundamental significance since space debris is a pervasive problem and collision avoidance is desirable for all spacecraft. This research supports NASA’s Earth Science Enterprise, its Space Science Enterprise, and its Space Flight Enterprise.

Investigations in LIDAR Errors Sources for Enhanced Terrain Mapping [2000-01]

In a partnership between The University of Texas at Austin and Schlumberger Inc. of Austin, Texas developed new methodologies for reducing errors in LIDAR based terrain mapping. The study focused on [1] characterizing and reducing the errors introduced into the data by navigation and calibration and on [2] developing new methods for extraction bare earth topography, vegetation, and
buildings from the two-return point data. The software developed during the project is now an operational product for the UT Center for Space Research and the Bureau of Economic Geology airborne LIDAR mapping program. The software system was recently used for experiments associated with calibration experiments for the NASA Geoscience Laser Altimeter System [GLAS] which flies on the Ice, Cloud and Land Elevation Satellite [ICESat]. It also provided the foundation for demonstrating the need for hardware upgrades and for new waveform digitizing technology that was recently funded by the Army Research Office. This project clearly supports NASA’s Earth Science Enterprise.

**Compact III-V Nitrides-Based Integrated Multifunctional Optoelectronic Sensors for Contaminant Characterization in Enclosed Space Environments [2000-02]**

This partnership between the University of Houston and Ionwerks, Inc of Houston, Texas investigated the advanced sensors to detect and characterize contaminants in enclosed space environments. Optical sensors utilizing excitation and simultaneous detection of fluorescence are mature instruments for environmental control, chemical analysis, and biomedical studies. Other optical methods relying on absorptions/reflection are simpler but usually are less sensitive than fluorescence spectroscopy. The research involved the integration of a light source, a sensing media, optical spectral filters, and detectors in a single chip to allow the fabrication of miniature, inexpensive, rugged, low mass, and reliable devices, ideally suited for environmental control in space. This project clearly supports NASA’s Space Flight Enterprise.

**Microsensor-based Autonomous Robots for MARS Greenhouse Operation [2000-02]**

The University of Texas at San Antonio in partnership with Techathlon, Inc. of San Antonio, Texas investigated the application of micromechanical systems technology in autonomous systems for robotic aids to astronauts. Microsensor/Microactuator [M/M] technologies with on-board intelligent control systems have allowed breakthroughs in sensing, task-level control, fault detection, accommodation, diagnosis, and prognosis. The robots on-board intelligent control systems allowed breakthroughs in sensing, task-level control, fault detection, accommodation, diagnosis, and prognosis. The ultimate goal of the research is to pave the way for development of prototypes for robots to perform repetitive, tedious, and/or dangerous tasks at a Mars base. This project clearly supports NASA’s Space Flight Enterprise.

**Dynamics and Stability of a Tethered Satellite with Similar-Sized End-Masses [2001-pres]**

This unique partnership among the University of Texas at Dallas, Texas Christian University, Lamar University, and The Michigan Technic Corporation of Holland, Michigan developed a tether deployer that will be tested in the micro gravity environment of space in a Space Shuttle Getaway Special Canister. It is a prototype of a tethered handling mechanism that will be used to actually deploy a pair of tethered satellites in a subsequent flight. Two prototype tether experiments will be flown, one to demonstrate the deployment of a tether and the other to demonstrate tether rewinding, both operations are required for a tethered satellite flight. In the later flight, two satellites, connected by a tether will be deployed, the tether will extend fully, a translation impulse will be applied to one satellite, and then the tether will partially rewind, producing a spin-up which will result in a sensed acceleration [artificial gravity] on the tethered satellites.

In addition to the TSGC SRP funding, this project recently received additional funding through the Texas Advanced Technology Program. This additional funding has allowed UT Dallas to initiate add-on projects for the tethered satellites. The first add-on will accommodate 6 to 8 university student experiments from UTD, TCU, and Lamar University as well as several high school groups from the Dallas-Fort Worth and Beaumont areas. This project clearly supports NASA’s Space Flight Enterprise.
Combustion Performance of Energetic Materials in Microgravity [2002-pres]

Texas Tech University in partnership with Los Alamos National Laboratory investigated the use of nanocomposite energetic materials for propellant applications. The nanocomposites are a mixture of nano-scale fuel and oxidizer particles that when reacted, exhibit high combustion temperatures and high energy densities. These materials can be used in a variety of space applications including as igniters, as propellants for space travel, and for stationary energy generation in reduced gravity environments. Preliminary studies on nanocomposite combustion show that nanoparticles produce higher reaction rates and propagation velocities than traditional composites. The objective of this research is to understand the role of nanoparticles in combustion reactions under conditions where gravity-related effects are suppressed. Results from this work have improved understanding of fundamental aspects of combustion processes relevant to space exploration. Because it involves fundamental propulsion and energy generation technologies in space, this research supports NASA’s Earth Science Enterprise, its Space Science Enterprise, and its Space Flight Enterprise.

Development of a Tumbleweed Inspired Instrument Carrier for Mars [2002-pres]

This partnership between Texas Tech University and NASA/Langley Research Center of Hampton, Virginia found its origins in work conducted by undergraduate students who were participating in the TSGC Advanced Design Program. A capstone design project at Texas Tech University produced a new sensor for Mars – instruments mounted on artificial tumbleweeds. This academia/ NASA partnership is developing an extremely low mass and low cost, wind driven instrumented artificial tumbleweeds that self-deploy from miniature packages for use in Martian exploration. The idea is to store “tumbleweeds” in nooks and crannies on all future Mars spacecraft, to deploy a large number of “tumbleweeds”, and to collect environmental data as long as they are able to transmit. It is predicted that this system will be several orders of magnitude cheaper than robotics based sensor platforms. This project supports both NASA’s Space Flight Enterprise and its Space Science Enterprise.

Impact and Results

The SRP was highly successful in fostering industry sponsored research at TSGC’s affiliates and facilitating faculty partnerships with NASA. TSGC’s $590K investment over five years was more than doubled by its partners to almost $1.3M of funded research. Each funded program established either new academia and industry relationships or strengthened existing relationships. Several research efforts lead to successful proposals to NASA and the State of Texas for follow on funding.

In summary, each of the SRP research programs provided seed funding to an academic affiliate in direct support of a specific NASA Strategic Enterprise focused research project. Long-term partnerships with industry, federal research labs, and NASA centers were developed as a direct result of TSGC funding. These relationships continue to have significant impact on the Consortium even after the completion of the research. For instance, the funding of programs at UT Dallas and TCU directly lead to the expansion of research labs and the infusion of additional funds through the State of Texas Advanced Technology Program.

Three metrics that TSGC used to evaluate the effectiveness of its research efforts are [1] Involvement of NASA personnel in the project, [2] the ability to attract external funding, and [3] the involvement of partners within the Consortium. All of the funded SRP projects have scored well against these metrics.

After a complete evaluation of the program the Research Planning Committee determined that although the program exceeded its stated objectives TSGC should refocus its research efforts in such a manner as to provide benefits to more academic affiliates. The committee has begun the development of a new research program that will be focused on opportunities for not-yet established faculty researchers to build partnerships with NASA.
programs and personnel. This program will begin in 2003. Some quotes from researchers participating in TSGC’s research program are provided below.

The seed money provided by TSGC was critical in performing initial studies which led to much larger awards from Texas and federal funding agencies.

The most valuable part of participation was the opportunity to conceive, design, develop and implement a solution to a real world problem and experience.

Our partnership with UT-Dallas, which was facilitated by TSGC, has enabled TCU to compete with much larger institutions for funding from State and federal agencies.

**Higher Education Programs**

TSGC’s Higher Education programs focus on enabling undergraduates of all levels to participate in real life research and design alongside NASA personnel.

**General Description**

The Texas Space Grant Consortium’s higher education initiatives foster development and sharing of space-related educational resources and experiences among undergraduate and graduate students enrolled in Consortium member-institutions within the state of Texas. Limited sharing of resources with other consortia has also occurred. Through a series of design-focused multi-disciplinary programs, faculty at TSGC affiliates endeavor to inspire the next generation of science, technology, engineering, and math explorers, inventors, and designers. Through implementation of the following goals and strategic objectives, TSGC is able to focus program initiatives toward achieving the overall aim of its mission.

TSGC has committed 22% of its project budget to Higher Educational programs [roughly $500K over 5 years]. An additional $13.5M in leveraged funds was provided by JSC, KSC, Florida SG, Program Participants, and TSGC’s Affiliates. Counting the leveraged funds, more than 96% of total resources expended on TSGC Higher Education programs over the past five years have been provided by outside sources with less than 4% provided by the NSGC&FP and matching funds.

TSGC and the National Space Grant Program established the following goals and objectives for Higher Education Programs.

1. Stress development of interdisciplinary courses and curriculum
2. Provide opportunities for university students to participate in space-based research and exploration
3. Stress development of introductory courses designed for students not majoring in scientific or technological disciplines
4. Facilitate mentor relationships between university students and NASA employees
5. Enhance pre-college teacher education
6. Coordinate with existing state and local systemic reform efforts and with state science, mathematics, and technology coalitions
7. Forge cooperative partnerships with informal education vehicles
8. Develop community college initiatives
9. Focus on involving women, underrepresented groups, and persons with disabilities in all aspects of education
10. Develop instructional technology, technology transfer, and other technological courses that use emerging NASA developed technology
11. Provide meaningful support to NASA research activities through university student involvement in research, design, and development
12. Maintain a balance of participation across academic member institutions

The following table lists TSGC’s major Higher Education projects. As noted in the 3rd column all of these projects also overlap into other programmatic areas. The table also indicates the years the projects were conducted, the scope of the project, which National and Texas goals it addresses, and

<table>
<thead>
<tr>
<th>Project Title</th>
<th>Year(s)</th>
<th>Scope</th>
<th>National Goals</th>
<th>Texas Goals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project A</td>
<td>2003-2005</td>
<td>Research focused on materials science and engineering applications</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Project B</td>
<td>2004-2006</td>
<td>Development of educational technologies for space exploration</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Project C</td>
<td>2005-2007</td>
<td>Integration of space-based projects into classroom curriculum</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Project D</td>
<td>2006-2008</td>
<td>Exploration of new educational models for astronomy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Project E</td>
<td>2007-2009</td>
<td>Development of collaborative learning environments for science</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The table indicates the years the projects were conducted, the scope of the project, which National and Texas goals it addresses, and
the NASA center which is participating in the project.

<table>
<thead>
<tr>
<th>Program/Years</th>
<th>Scope</th>
<th>Goals Objectives</th>
<th>NASA Centers</th>
</tr>
</thead>
<tbody>
<tr>
<td>TSGC Advanced Design</td>
<td>Non-competitive; Texas; TSGC, UG</td>
<td>1, 2, 4, 6, 9, 11, 12; OR, R</td>
<td>JSC</td>
</tr>
<tr>
<td>Advanced Design</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1995-02</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NASA Academy</td>
<td>Competitive; Texas; TSGC, UG, GR</td>
<td>2, 4, 9, 11, 12; R</td>
<td>Ames GSFC</td>
</tr>
<tr>
<td>1996-pres</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RGSFOP</td>
<td>Competitive; Nationwide; EF, UG</td>
<td>1, 2, 3, 6, 8, 9, 11; OR, PR, R</td>
<td>JSC GSFC MSFC</td>
</tr>
<tr>
<td>1997-01</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NASA Means Business</td>
<td>Competitive; Nationwide; EF, UG, GR</td>
<td>1, 2, 4, 6, 9, 11; OR, R</td>
<td>JSC</td>
</tr>
<tr>
<td>1998–pres</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CC Zero-G</td>
<td>Competitive; Texas &amp; New Mexico; EF, CC</td>
<td>1, 2, 3, 6, 8, 9, 11; OR, PR, R</td>
<td>JSC</td>
</tr>
<tr>
<td>2000-01</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RGSFOP Support</td>
<td>Competitive; Texas; TSGC, UG</td>
<td>2, 4, 6, 8, 11, 12; OR, PR, R</td>
<td>JSC</td>
</tr>
<tr>
<td>2000-pres</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MarsPort</td>
<td>Competitive; Nationwide; EF, UG</td>
<td>1, 2, 4, 6, 11; OR, R</td>
<td>KSC</td>
</tr>
<tr>
<td>2001-02</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TSGC Design Challenge</td>
<td>Non-competitive; Texas; TSGC, UG</td>
<td>1, 2, 4, 6, 7, 9, 11, 12; OR, R</td>
<td>JSC</td>
</tr>
<tr>
<td>2002-pres</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TSGC-TSGC Funded</td>
<td>GR-Graduate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EF-Externally Funded</td>
<td>OR-Outreach</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CC-Community College</td>
<td>PR-Public Relations</td>
<td></td>
<td></td>
</tr>
<tr>
<td>UG-Undergraduate</td>
<td>R-Research</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

During the five year evaluation period covered by this report, the Hopwood vs. Texas ruling severely constrained some higher education program objectives. Working under this constraint TSGC chose to focus its efforts to recruit women and underrepresented minorities through targeting Minority Serving Institutions [MSI] in its Higher Education Programs. Special emphasis was placed on recruiting participation of MSIs in the TSGC Advanced Design Program. As a result half of the institutions which participated in the program were MSI. Recruitment for NASA Academy applicants was focused on MSI as well as through student organizations which catered to minorities.

Core Criteria

Undergraduate Education

Almost all of TSGC’s Higher Education Programs focus on undergraduate education. Ninety percent of the students who participated in TSGC higher education programs were undergraduate students.

Interdisciplinary Collaborations

The primary focus of TSGC Higher Education programs over the past five years has involved undergraduate interdisciplinary design teams. These design teams, varying in size from 3 to 10 students from a variety of majors have worked on a wide array of space-related designs. Students from the following disciplines have participated in these teams: Mechanical, Industrial, Aerospace, Civil, Electrical, and Materials Engineering, Physics, and Computer Science. Many of these design projects were suggested by NASA personnel who then served as mentors for the teams.

Projects

TSGC Advanced Design Program [1995-02]

The TSGC Advanced Design Program [TADP] was initiated in 1995 as a follow on to the highly successful NASA/USRA Advanced Design Program to give undergraduate students a hands-on, interactive, team-based, interdisciplinary spacecraft design experience. Promoting cooperation and knowledge sharing among its academic institutions, TADP provided a mechanism for universities with rich histories in spacecraft design to mentor universities who were newcomers to the area.
Eleven universities participated in the program, 6 of which are minority serving institutions. Representatives from the JSC, Lunar & Planetary Institute, the Canadian Space Agency, and Boeing Company participated in the program as mentors and reviewers. Design topics ranged from the extraction of Oxygen from the lunar regolith to low mass, low volume, and low power experiment platforms for Mars exploration.

**NASA Academy [1996-pres]**

The NASA Academy is a unique educational, training and research internship for undergraduate and graduate students interested in pursuing professional and leadership careers in aerospace-related fields. Through this 10-week resident summer internship program [co-sponsored by the National Space Grant College and Fellowship Program], exceptional students are shown how the success of the aerospace program results from the interaction of government, academia, and the private sector. Since 1998 TSGC has sponsored 5 students to participate in the NASA Academy program.

**RGSFOP Student Support [2000-pres]**

TSGC established this program to assist Texas undergraduate students in participating in the NASA Reduced Gravity Student Flight Opportunities Program. Once selected to participate in the RGSFOP the students may apply for matching funds from TSGC to help defray the costs of participation. TSGC awards up to $3,000 for each team. In order to claim the TSGC funding the students are required to secure at least equal funding from other sources including their university. TSGC has provided funding for 11 Texas based student teams at 8 different universities.

**TSGC Design Challenge [2002-pres]**

As a response to NASA’s Workforce Development Initiative, the TSGC Design CHALLENGE was initiated in Spring 2002 for undergraduate students. Although it encompasses some of the same program highlights as its precursor, TADP, its program features are unique in there own right.

Program features:

- Open to students of any disciplinary track
- Recruitment efforts include traditionally underrepresented groups and non-traditional disciplines
- Course credit is required of all participants
- Provides students with design topics from NASA scientists, which are researched and developed over one or two semesters
- Topics are solicited by all work-areas involved in NASA-related research, including the liberal arts, engineering, human factors, nutrition
- Each design topic includes an associated NASA mentor
- An award program based on milestone completion enables teams to move at an individual pace and academic level while earning funding to support design project
- Incentives include: curriculum support materials, avenues for team building and collaboration, travel for site visits, resume book, career information, NASA workplace tours, design Showcase presentations

**Impact / Results:**

Since 1995, TSGC has steadily incorporated innovative and unique programs into higher education curricula in an effort to further its mission and goals, directly impact interest in students pursuing STEM studies and related careers, and build public interest and enthusiasm for NASA and its mission.

In an effort to reach students who may not, on a daily basis, be exposed to STEM related activities and space-related concepts in the classroom, effort has consistently been placed on recruiting students from disciplines that are not thought of as "space-related" as well as students from rural or underrepresented communities.

Many participants of TSGC’s higher education programs have expressed interest in going onto graduate degrees in STEM studies, or work with NASA.

By focusing on these innovative programs TSGC was able to secure significant outside funding to augment and complement its Higher Education programs. During this time TSGC was able to multiply its $385K investment in Higher Education...
programs to $1.6M of additional funding. This represents more than a three fold increase. This investment balloons to $13.8M [or 35.8 times TSGC original investment] when in-kind support and other matching are considered.

**Leveraged Projects**

**NASA Means Business [1998-pres]**

The NASA Means Business [NMB] student competition is a national program that involves a multi-disciplinary track of university students - from business majors to space science students - in exploring real-world NASA program and mission needs. Six student teams selected each spring semester embark upon a mission to develop both an "architecture" and "user requirements" for integrating NASA "Customer Engagement" processes into NASA's Mars mission planning. Selected teams receive cash awards of $1,000, travel grants to Johnson Space Center to present their work, and recognition for their contributions to NASA's Mars exploration planning effort. This program was developed through a partnership between TSGC and the NASA/JSC Exploration Office and is being administered by TSGC.

**NASA Reduced Gravity Student Flight Opportunities Program [1997-01] & Community College Zero-G [2000-01]**

These TSGC initiated and managed programs provided undergraduate students with a unique academic experience: propose, design, fabricate, fly and evaluate a reduced gravity experiment of their choice. The overall experience provided each student team with opportunities in scientific research, hands-on experimental design, test operations, educational/public outreach activities, and media coverage. Teams were joined by a faculty advisor and a journalist and obtained review briefings from NASA JSC professionals. During the five years, the NASA Reduced Gravity Student Flight Opportunities Program was administered by TSGC, it continued a remarkable rate of interest and growth - from hosting four Texas-based student teams during the pilot program [SURF] to flying over 300 teams from 45 states.

Two spin-off programs resulted: Fly-High designed for Texas high school students and CC-Zero-G focusing on students enrolled in community colleges in both Texas and New Mexico. The program continues under the administration of a TSGC affiliate located in closer proximity to NASA/JSC.

**MarsPort Engineering Design Student Competition**

The NASA MarsPort Engineering Design Student Competition was a national program administered in association with the Kennedy Space Center that sought to provide university students with an opportunity to get involved in a "capstone" educational activity, while at the same time, making a real contribution to NASA’s human exploration of Mars. Based on the strength of student proposals, up to six teams were selected to perform engineering trade studies to design optimal configurations for a MarsPort Cryogenics and Consumables Station - a vital element of the complex infrastructure needed to launch spacecraft from the Martian surface. This program was jointly developed and administered by Texas Space Grant, Florida Space Grant, and NASA/Kennedy Space Center.

Some quotes from participants in TSGC’s Higher Education Programs are provided below.

*This program and this type of experience has helped each of the team members understand engineering and science more than they ever did before.* – Undergraduate student

*Team members were able to work with and learn from students from other universities around the*
country and with NASA employees. Such experiences are truly rare for most college students. – Undergraduate student

Participating in the TSGC Design Challenge made me more interested in NASA. I've always thought it was cool, but it was neat to see all the different aspects - - like how it's not just astronauts and stuff. It's something I am most likely going to look into now as a career. – Undergraduate Student

It also provides incentives and opportunities to the students to develop many of the so called soft skills, e.g. skills for working in teams, skills to ensure productive group meetings, and skills to make oral and visual presentations. – Faculty Advisor

Each of the team members has enjoyed presenting to the over 2600 students and adults that have attended our outreach presentations. Watching the elementary students' eyes light up with excitement showed those students were being inspired - and that having real people and science standing in front of them made that inspiration more real. – Faculty Advisor

Pre-College Education, Public Service, General Public, and External Relations Programs

TSGC’s goal is to inspire grade school students to pursue careers in science, technology, engineering, and mathematics though enabling educators to integrate the exploration of space into classroom activities.

General Description

TSGC’s Pre-College Education, Public Service, General Public, and External Relations Programs have been efficiently combined into one programmatic area, K-12 Education/General Public Outreach [K-12/GP Outreach]. This grouping to TSGC programs resulted because many of TSGC’s programs span multiple program areas and can not be clearly placed into one distinct category.

TSGC’s primary focus in K-12/GP Outreach is in the professional development of K-12 educators. Utilizing the train the trainer model TSGC has trained “master teachers” how to incorporate various NASA related activities into their curriculum. These master teachers share their knowledge and materials with other teachers at local workshops around the state. This model recognizes that teachers in Texas have no room to expand their curriculum and that all lessons are focused on preparing students for periodic assessment exams. By capitalizing on the excitement of exploring space, TSGC enables teachers to motivate their students to learn state mandated curriculum elements using space-related learning materials.

In conducting these programs TSGC routinely forms partnerships with educational organizations that are not members of the Consortium. Examples of these partnerships are discussed in the next section of this report. TSGC also structures its K-12/GP Outreach programs so that they effectively communicate NASA’s mission to the general public.

TSGC committed 20% of its project budget to K-K-12/GP Outreach Programs [roughly $428K over 5 years]. An additional $4.0M in leveraged funds was provided by TSGC affiliates, program participants, and other sources.

TSGC and the National program have established the following goals for its Pre-College Education, Public Service, General Public and External Relations Programs.

1 Cooperative extension
2 Topical Consortia
3 Stimulate public interest in aerospace sciences and lifelong learning
4 Increase public appreciation for the benefits of NASA-sponsored research
5 Assist K-12 teachers in exciting their students to learn math and science through space based activities
6 Increase K-12 students knowledge in math and science through space related activities
7 Increase K-12 educator knowledge in space related fields
8 Enhance pre-college teacher education
9 Partner with informal education organizations
The following table lists TSGC’s major Pre-College Education, Public Service, General Public, and External Relations Programs. The table also includes the years the projects were conducted, the scope of the project, and which National and Texas goals it addresses.

<table>
<thead>
<tr>
<th>Program/ Years</th>
<th>Scope #s Impacted</th>
<th>Goals</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Public Outreach 1990-pres</td>
<td>MD, SP, TX, GP</td>
<td>1, 3, 4, 5, 6, 7, 8, 9</td>
</tr>
<tr>
<td>LiftOff Summer Institute 1990-pres</td>
<td>PD, MD, NASA, N 150 Teachers 100,000 Students</td>
<td>1, 3, 4, 5, 6, 7, 8, 9</td>
</tr>
<tr>
<td>SpaceExplorers Middle School Activities 1995-pres</td>
<td>CD, PD, I 3,400 Teachers 240,000 Students</td>
<td>1, 3, 4, 5, 6, 7, 8, 9</td>
</tr>
<tr>
<td>Protein Crystal Growth Experiment 1998-pres</td>
<td>SP, PD, MD, TX, NASA</td>
<td>1, 3, 4, 5, 6, 7, 8, 9</td>
</tr>
<tr>
<td>FlyHigh 1998-99</td>
<td>SP, GP, N, NASA</td>
<td>3, 4, 5, 6, 7</td>
</tr>
<tr>
<td>GRACE/ICESat EPO 1999-pres</td>
<td>PD, MD, CD, NASA, SP, I 2,200 Teachers 144,000 Students</td>
<td>1, 3, 4, 5, 6, 7, 8, 9</td>
</tr>
<tr>
<td>Astronomy and the Solar System 2001-02</td>
<td>PD, MD, NASA, TX</td>
<td>3, 4, 5, 6, 7</td>
</tr>
<tr>
<td>Interactive Web Site 2001-pres</td>
<td>GP 74,700 Unique Visits</td>
<td>3, 4</td>
</tr>
</tbody>
</table>

Each program’s success is measured by compilation of comments and criticisms received by all participants, and effectiveness indicated by associated faculty advisors and TSGC institutional representatives.

TSGC seeks evaluations and critical comments from each participant in each of its teacher targeted K-12 programs, including: students, educators, and administrators. Input is used to [1] provide additional resources, opportunities, and services for the teachers involved in TSGC programs, [2] improve the program overall quality, [3] better tailor the program to satisfy Texas and NSGC&FP goals, [4] tailor the program to better meet state and national educational standards.

TSGC has established major partnerships with Cooperative Extension organizations and routinely has 4-H extension agents attend TSGC professional development workshops. These partnerships include advisory panels, joint programs, TSGC participation in existing extension programs, and extension agents participating in TSGC projects. Some examples of these partnerships include but are not limited to the following.

SpaceExplorers – This is a middle school program based on a collection of lessons for use in mathematics, language arts, social studies, science, computer, theater, physical education, and art classes. These activities were created and distributed in partnerships with Capital 4-H.

General Public Outreach - As a part of the General Public Outreach program TSGC staff serves as advisors for and participants in [1] the Capital 4-H Space Camp - a summer day camp for 100 disadvantaged youth, [2] 4-H CAPITAL Project – Children & Parents Involved in Technology and Literacy after school science enrichment, [3] Travis County Character Counts Collaborative - 10 state and county agencies collaborating on this statewide teen leader conference, and [4] more than 30 other partnerships.

TSGC actively recruits the participation of underrepresented groups in all its K-12/ General Public Outreach programs. TSGC primarily does this by specifically targeting areas of the state that have large population concentrations of underrepresented groups in STEM careers. Some examples follow. [1] specifically recruiting teachers from areas of the state with high concentrations of underrepresented groups for its week long, residential LiftOff Summer Institute professional development program [2] conducting several teacher workshops to train teachers to implement TSGC developed space related classroom activities in areas of the state that are predominantly Hispanic, [3] partnering with organizations that specialize in the professional development of teachers from districts that are largely comprised of minority students, and [4] participation in and

26
advisory groups for Minority Introduction to Engineering and Careers in Engineering for Women.

Core Criteria

Alignment with State Education Standards
All TSGC developed classroom activities are directly aligned to state and national standards in science, mathematics, and technology. The specific standards that the activity addresses are clearly identified for the educators’ reference.

Emphasis on Teacher Preparation & Development
TSGC’s primary focus in this program area is the professional development of K-12 educators including 4-H extension agents. Each year TSGC trains over 150 teachers how to implement various space related activities in their classroom. TSGC also incorporates the train the trainer model of professional development. This secondary training expands the number of teachers that TSGC trains each year to over 750.

Promote Understanding of and Interest in STEM Disciplines & NASA Mission
TSGC strives to promote a deeper understanding of science, technology, engineering, and mathematics disciplines and the NASA mission in all of its activities. Some examples of this emphasis include: TSGC has developed a web site that enables visitors to engage in an interactive educational experience related to various space activities. Since its launch in July of 2001 it receives an average of 3,400 unique visitors per month. Every two weeks TSGC distributes “Voyage to Spread Space Excitement”, an educator newsletter, to over 1,600 educators state wide. This newsletter informs educators of upcoming space related workshops, cool web sites, effective classroom activities, and many other tools for their classroom.

Projects
LiftOff Summer Institute [1990-pres]
Liftoff Summer Institute is an ongoing workshop organized around an aerospace or space science theme drawn from the many research and engineering programs pursued by NASA. The goal of these workshops is to enrich teaching of math, science, and technology by providing teachers with information, ideas, activities, and materials that can be used both to augment the regular curriculum and to be shared with colleagues. Themes have included International Space Station, Lunar Bases, and Space Biomedicine. This program also incorporates the train the trainer model. Each program alumni returns to their home district and trains additional teachers through district professional development workshops, regional math and science teacher meetings, and state and national teacher conferences.

Space Station Protein Crystal Grown Experiment [1998-pres]
Across Texas, high school students and middle school teachers have had the unique opportunity to prepare protein crystal growth experiments to be flown on the International Space Station. In this program, they prepare, package, and [sometimes] see their experiments launched to the ISS. In partnership with the University of California - Irvine and the Marshall Space Flight Center, TSGC has provided the opportunity for over 2500 Texas middle and high school students to participate in this program. Students and teachers prepared protein crystals for flight at more than 10 workshops across the state.

Prior to the launch of the crystals, each class where teachers and students had packed protein crystals was provided with the grade-level appropriate science background and the rationale behind growing protein crystals in zero-gravity. Furthermore, TSGC sponsored the trips of twenty students and three teachers to watch a Shuttle launch STS-104 and STS-110 that carried a set of protein crystals to the ISS.
Interactive Web Site Development [2001-pres]

This program is designed to capitalize on the rapidly expanding use of the internet for education and entertainment. TSGC had designed over 80 online activities that were designed to not only entertain but also educate the participant. These activities focus on developing a deeper understanding and appreciation of the NASA mission and STEM fields of discipline. Since its launch in July of 2001 it has had over 74,700 unique visitors. For example, one of the activities titled “Who Wants to be a Martian”, based upon the popular TV show “Who Wants to be a Millionaire” takes its visitors through a set of 15 questions of increasing difficulty about Mars.

Space Explorers Middle School Activities [1995-pres]

Space Explorers is an interdisciplinary space exploration curriculum designed for middle school students. The curriculum includes lessons in mathematics, language arts, social studies, science, computer, theater, physical education, and art. Students broaden their knowledge and comprehension STEM careers and NASA’s mission through interactive, hands-on learning activities. All activities are aligned with state and national educational standards. The curriculum is divided into four content areas: Overall Introduction to Space Exploration, Life Sciences, Remote Sensing, and Orbital Mechanics. Activities are designed to be part of an interdisciplinary program. To date 3,400 teachers and 240,000 students have had direct experience with these materials in the classroom.

Impact/Results


Between 1998 and 2002 TSGC has directly impacted over 6,000 K-12 teachers and 500,000 K-12 students through teacher workshops, classroom activities, and other programs. Although predominantly from the state of Texas these teachers and students represent every state of the nation and 9 other countries around the world. TSGC programs have been featured in over 300 newspaper articles, TV programs, radio shows, and magazine articles reaching tens of millions of people. These publications include CNN, Discovery Channel, Washington Post, USA Today, Newsweek, Time Magazine, New York Times, Wall Street Journal, and many others.

Participants in TSGC K-12/GP Outreach programs routinely describe their experiences as “the best conference I have every attended”, “an everlasting experience”, and “life changing”. High school teachers have tailored entire curriculum around their workshop experiences, students have regained their love for math and science because of their experiences, and people have thanked TSGC for opening their eyes to real world science.

Web-based programs are a new phenomenon, and developing effective web programs is difficult. In the past 5 years several weaknesses in TSGC’s web-based activities have been identified and the Consortium has changed its web presentations to address these concerns. Three major weaknesses were identified: [1] Weak Web Presence, [2] limited material distribution, and [3] a smaller number of program applicants than we expected.

In 1998, TSGC’s web site consisted of over 20,000 html pages loosely tied together in an effort to communicate the Consortium’s activities. In the last 5 years, TSGC redesigned its web site and more efficiently utilized its web site to support its programs. Over the last five years, the number of unique visitors to TSGC’s web site has increased by more than a factor of 3 to over 27,000 unique visitors per month.

Some examples of web site improvements made as the result of customer feedback are: [1] LiftOff applications are submitted on-line, [2] educational materials are distributed directly to teachers over the web, and [3] interactive educational activities for K-12 have become a prominent feature of TSGC’s web site. These improvements are considered in more detail below.

Although program evaluations by participants ranked TSGC programs as among the best they had ever attended, the number of applications to these programs was decreasing. The Consortium initiated an intense advertising campaign. This included the establishment of a list serve that gives
us direct contact with more than 2,000 key K-12 educators and a smaller number of regional science coordinators. We also increased the mass distribution of program applications. These efforts, along with placing the applications on-line, lead to a tripling of the number of applicants to the Consortium’s programs during the past application cycle.

Through discussions with K-12 teachers, it was determined that TSGC-developed materials and training were not reaching many potential users. In an effort to reach more educators, TSGC increased the distribution of materials at teachers’ conferences and established easy on-line access to the activities. In the last 6 months over 5,500 teachers have utilized TSGC developed activities with over 380,000 students across the state and nation. These usage figures are based on teacher-reported data obtained through a web survey attached to each learning modules that can be downloaded from the web.

TSGC has also been able to leverage the funding provided by the NSGC&FP for K-12/General Public Outreach programs by 10 fold. The NSGC&FP funding of $428K was leveraged into $4.4M of program activity. Below is a list of some of the projects that resulted from this leveraging.

**Leveraged Projects**

**FlyHigh [1998-99]**

This program was specifically designed to encourage High School students to pursue careers in Science, Technology, Engineering, and Mathematics. Modeled after the NASA Reduced Gravity Student Flight Opportunity Program, FlyHigh provides a unique educational experience for Texas high school students by giving them an opportunity to fly and operate a microgravity experiment aboard the Johnson Space Center’s KC-135A reduced-gravity aircraft. Students from High Schools in Texas and New Mexico participated in this program. This program was phased out due to a restructuring of priorities at NASA/JSC.

**GRACE/ICESat Education and Public Outreach [1999-pres]**

In partnership with the University of Texas at Austin Center for Space Research TSGC had developed comprehensive Education and Public Outreach programs in support of the Gravity Recover and Climate Experiment [GRACE] and Ice, Cloud and land Elevation Satellite missions. Master teachers from across the nation were selected through an application and review process to be actively involved in these missions. They have created, evaluated, and promoted mission related materials. Most importantly, they have introduced other teachers to these materials through teacher training workshops. To date over 2,000 teachers and 140,000 students have had direct experience with these materials.

**Astronomy and the Solar System [2001-02]**

The Astronomy and the Solar System program was developed to address the growing need of quality STEM-focused professional development for middle school teachers. This program focused on 6th grade teachers who lack training in teaching astronomy in the classroom. Astronomy was recently added as a required subject content for the 6th grade and many of these teachers are not prepared to teach this subject. In two years this small [$10K] program trained over 100 teachers across the state of Texas.

Some quotes from participants in TSGC’s K-12/ General Public Outreach Programs are provided below.

*When I loaded samples I became the NASA scientist.*

*This opportunity has opened my eyes to new professions and horizons.*

*This is the ability to see what a difference I can make with my own hands.*

*One of the greatest accomplishments of my life!*
It's really thrilling that even students can be part of one of the first experiments on the International Space Station.

You think of EVERYTHING. I wish I would be able to work with you again some day. – Former President of National Science Teachers Association

Liftoff was easily the best conference I have ever attended!

LiftOff Summer Institute was an everlasting experience. I can't wait until school starts! I am so excited about sharing everything that I experienced, not only with my students, but with fellow teachers and colleagues.
Statement of Consortium Concurrence

Strongly embracing the objectives of the National Space Grant College and Fellowship Program, the undersigned have entered into agreement for participation in an exemplary alliance of Universities, Industries Non-Profit Organizations and State Government agencies in a coordinated effort to help maintain America's preeminence in aerospace science and technology. On behalf of our institutions, we hereby pledge to support the National Aeronautics and Space Administration in the conduct of the National Space Grant and Fellowship Program. We are proud to have participated in the development and completion of this self-evaluation of Texas Space Grant Consortium's participation in the National Program.

TSGC Board of Directors
Note: Original signatures are available upon request at TSGC Headquarters.

Fred Young
Lamar University

James Smith
Texas Tech University

Bill Looke
Office of Aerospace and Aviation

David Criswell
University of Houston

Robert McLauchlan
Texas A&M University - Kingsville

Wallace T. Fowler
University of Texas at Austin

Linda N. Domelsmith
Texas Higher Education Coordinating Board
### TSGC Institutional Representatives

Note: Original signatures are available upon request at TSGC Headquarters.

<table>
<thead>
<tr>
<th>Name</th>
<th>University</th>
<th>Name</th>
<th>University</th>
</tr>
</thead>
<tbody>
<tr>
<td>Truell Hyde</td>
<td>Baylor University</td>
<td>U. Narayan Bhat</td>
<td>Southern Methodist University</td>
</tr>
<tr>
<td>Ganesh Ganpat</td>
<td>Don Harrington Discovery Center</td>
<td>Kevin M. Urbanczyk</td>
<td>Sul Ross State University</td>
</tr>
<tr>
<td>Paul Corder</td>
<td>Lamar University</td>
<td>Walter Haisler</td>
<td>Texas A&amp;M University</td>
</tr>
<tr>
<td>David R. Wright</td>
<td>Lockheed Martin</td>
<td>Grady Price Blount</td>
<td>Texas A&amp;M University – Corpus Christi</td>
</tr>
<tr>
<td>Bill Looke</td>
<td>Office of Aerospace and Aviation</td>
<td>Robert McLauchlan</td>
<td>Texas A&amp;M University – Kingsville</td>
</tr>
<tr>
<td>Thomas Hill</td>
<td>Rice University</td>
<td>W.R.M. Graham</td>
<td>Texas Christian University</td>
</tr>
<tr>
<td>Name</td>
<td>Institution</td>
<td>Name</td>
<td>Institution</td>
</tr>
<tr>
<td>---------------------</td>
<td>--------------------------------------------------</td>
<td>---------------------</td>
<td>--------------------------------------------------</td>
</tr>
<tr>
<td>Linda Domelsmith</td>
<td>Texas Higher Education Coordinating Board</td>
<td>Don Wilson</td>
<td>University of Texas at Arlington</td>
</tr>
<tr>
<td>James Smith</td>
<td>Texas Tech University</td>
<td>John H. Hoffman</td>
<td>University of Texas at Dallas</td>
</tr>
<tr>
<td>Mahbub Uddin</td>
<td>Trinity University</td>
<td>Scott A. Starks</td>
<td>University of Texas at El Paso</td>
</tr>
<tr>
<td>Alex Ignatiev</td>
<td>University of Houston</td>
<td>A.C. Rogers</td>
<td>University of Texas at San Antonio</td>
</tr>
<tr>
<td>James B. Dabney</td>
<td>University of Houston, Clear Lake</td>
<td>Michael Wiederhold</td>
<td>University of Texas Health Science Center, San Antonio</td>
</tr>
<tr>
<td>Caroline Jurgens</td>
<td>University of Houston, Downtown</td>
<td>David Niesel</td>
<td>University of Texas Medical Branch, Galveston</td>
</tr>
<tr>
<td>Ed LeMaster</td>
<td>University of Texas – Pan American</td>
<td></td>
<td></td>
</tr>
<tr>
<td>---------------------</td>
<td>------------------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Perrie Adams</td>
<td>University of Texas Southwestern Medical Center</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>