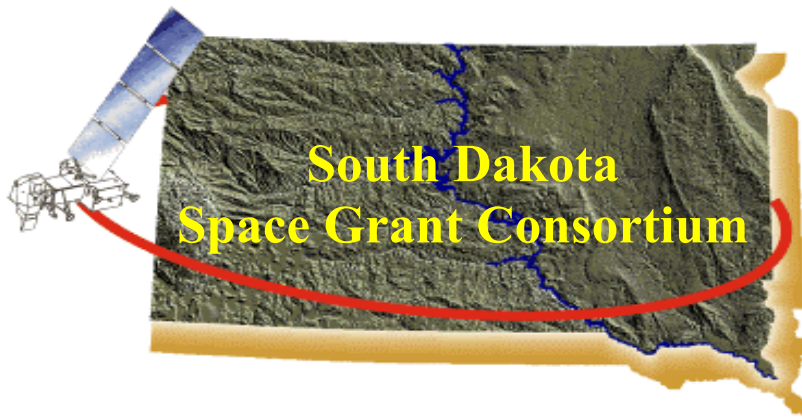


NASA's
South Dakota Space Grant Consortium
15th Year Evaluation
National Space Grant College and Fellowship Program
Program Performance and Results (PPR) Report



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Executive Summary and Consortium Impact

The South Dakota Space Grant Consortium (SDSGC) has facilitated tremendous advances in educational outreach and research in subject areas critical to NASA's unique mission. Over the past 12 years since its inception, the SDSGC has greatly stimulated the growth and impact of our expanding network of industry, academic, and governmental organizations; thereby bringing the Consortium's educational and research programs to a broader audience in South Dakota.

During the past 5 years, the Consortium has continued to broaden and strengthen its fundamental role in communication of educational and technological issues. SDSGC has now become one of the key organizational forums in South Dakota for bringing together talented people, their ideas, and collaborative projects in research, education, and technology-based economic development. We have worked to expand opportunities for all the people in South Dakota to understand and participate in NASA's aeronautics and space programs by supporting and enhancing science and engineering education, research, and outreach programs. The scientific and technological interests of both NASA and South Dakota have benefited as a result of the Consortium's educational and research efforts in remote sensing, satellite imagery, GIS, global and regional geoscience, environmental science, and K-12 educational outreach. This report summarizes key accomplishments made since 1998, along with a discussion of strengths and weaknesses.

The Consortium's general goal is to enhance the capabilities for earth-, space-, and aeronautic-related education, research, and economic enterprise in South Dakota. The original three institutional members: 1) the South Dakota School of Mines & Technology (SDSM&T), 2) South Dakota State University (SDSU), and 3) the USGS EROS Data Center, along with Augustana College which joined in 1996, remain as the backbone of the Consortium. The SDSGC has grown from its fledgling stage of three institutional members and three industrial affiliates in 1991, to its current network of thirty-four organizations spread across the state in a geographically representative manner (see Figure 1).

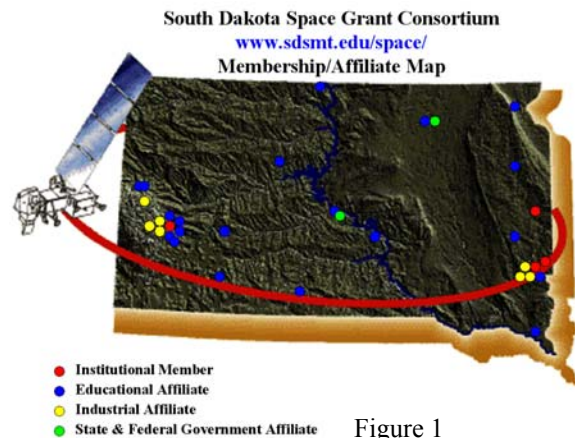


Figure 1

The primary themes that brought the original institutions together were the use of remote sensing, GIS, image processing and enhanced computer networking in earth systems science research and education programs. Throughout its significant evolution since 1991, the Consortium has continued to concentrate on these themes. We have maintained our focus on Earth System Science as the specific area of emphasis for the SDSGC. Collaborative projects and programs are fostered that complement the Consortium's research and educational efforts mentioned above. Many of these collaborations would not have otherwise developed without Space Grant's influence via starting, pushing and pulling. The Consortium's communication system avoids duplication of efforts between members.

One of the strengths of South Dakota’s Space Grant Consortium is the partnership with the six Native American colleges and universities in our state, namely: Oglala Lakota College, Sinte Gleska University, Si Tanka College, Lower Brule Community College, Sisseton Wahpeton Community College, and Sitting Bull College. These six institutions represent 18% of the thirty-three Native American Tribal Colleges in the U.S. Close collaborations with the Consortium’s Native American affiliates have been successfully fostered in areas such as: native student fellowships, internships for native students at EROS Data Center, Program Initiation Grants through Space Grant, and numerous specific projects and programs such as NativeView, Scientific Knowledge for Indian Learning and Leadership (SKILL), the local chapter of American Indian Science and Engineering Society (AISES), Flandreau Indian School Success Academy, FIRST Robotics, Rez Mapper (Interactive Community Mapping Program for the Rosebud Lakota Nation), etc. As indicated by Dr. Lionel Bordeaux, President of Sinte Gleska University, we feel there is value in “... bringing two of the essential points of life, the sky and the earth, together spiritually and technically.”

The active participation of the USGS EROS Data Center in Sioux Falls, SD (host to the world’s largest civilian archive of remotely sensed land data) as an institutional member of the Consortium is a key factor to our success. Among EROS’s missions is to promote new uses, new users, and new understanding of land information, so that others can better understand our planet. While many of EROS programs are nationally and globally focused, SDSGC provides an important communication forum for earth remote sensing topics in the state and relates the EROS mission to the state and university population. EROS also ensures that scientists, researchers, businesses, decision makers, and the public have ready access to the land-related information they need. SDSGC provides a convenient vehicle by which state and regional users, scientists, and researchers can become educated on the availability of Earth resources data and can provide feedback on information and data requirement to EROS.

SDSGC promotes early math, science, & engineering education of the future workforce through its many educational endeavors. We provide

ready access to future employees through internships of university students. In 2002, SDSGC received funding to initiate an “Expanded NASA Workforce Development (WFD) Program in Science, Engineering, and Technology for South Dakota”. Figure 2 shows a simplified schematic of the NASA pipeline envisioned and implemented under SDSGC’s WFD project. By establishing connections from various feeder lines to the main NASA pipeline, the end result is a higher number of well-trained individuals that can enter the NASA workforce directly as employees or indirectly as contractors and PI’s. Creating internships and fostering eventual workforce staff at participating institutions will not only benefit NASA’s

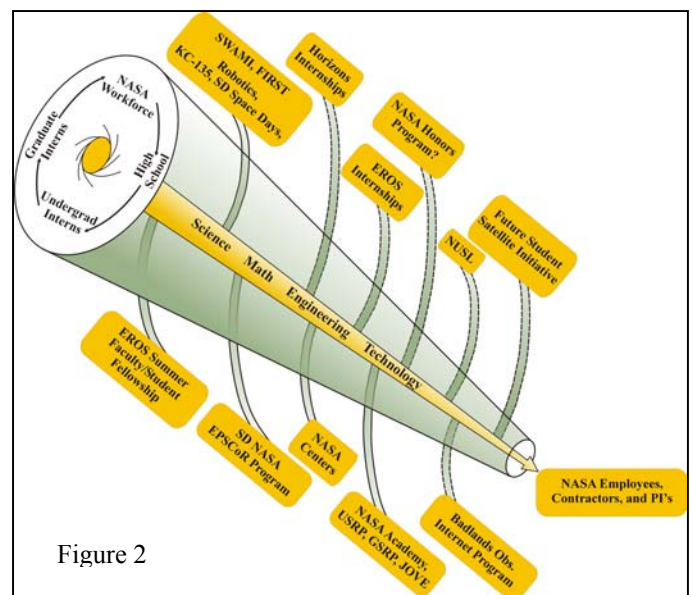


Figure 2

workforce development goals, but will also help to bolster much needed workforce development

opportunities within SD. If WFD funds continue to be available, our plan is to target an increasing portion of those funds toward projects that attract even more participation from Native Americans and females.

Additionally, establishing closer linkages with SD State Government was a significant accomplishment during the past 5 years. In 2002, SDSGC was successful in obtaining over \$23,000 in State funds from then Governor William J. Janklow in support of an educational project titled "Dark Skies & Bright Minds". In addition, the State Office of Aeronautics affiliated with SDSGC in 2001. SDSGC also serves as the lead entity for the National Council of Space Grant Directors "State/Regional/Local/Tribal Government Involvement Committee".

Introduction

The SDSGC provides the state and its citizens with leadership on issues pertinent to space and earth system sciences. The Consortium's major objectives include:

- 1) Improving the human and physical infrastructure in South Dakota for research and educational competitiveness in areas of relevance to NASA and the State;
- 2) Promoting a strong and active K-U educational base for careers in science, mathematics, engineering, and technology;
- 3) Integrating the SDSGC mission with South Dakota's NASA EPSCoR Program, the USGS EROS Data Center, and NASA Centers;
- 4) Conducting educational outreach to teachers, students and the public via our SDSGC network of organizations and people; and
- 5) Providing encouragement and opportunity for underrepresented groups to participate in NASA and SDSGC programs.

The Consortium establishes links and affiliations with academic, industry, and local, state, federal, and Tribal government organizations in South Dakota for various endeavors exemplified in the bullets below. Our Consortium network brings our research and educational programs to a broader audience in South Dakota. Consortium partners work together on activities mutually beneficial to SDSGC and its individual members and affiliates, to jointly mold a Consortium that optimally benefits the scientific and technological interests of both NASA and South Dakota. We do this, for example, by:

- establishing project- and people-based links between higher education, government, and industry in SD,
- promoting education in NASA-supported fields of science, math, engineering, and technology (SMET),
- closely integrating Space Grant research activities with SD's NASA-EPSCoR Program,
- developing earth systems science and aerospace infrastructure in SD,
- enhancing faculty and student development through summer faculty fellowships at the USGS EROS Data Center,
- providing graduate and undergraduate training through student fellowships, scholarships and assistantships,

- enhancing research collaborations, mentorships, and other opportunities for faculty and student partnerships with NASA Centers,
- using our network of scientists, engineers, and educators to develop of a more diverse workforce of future scientists, engineers, technology professionals, and educators,
- focusing on involving women and underrepresented groups such as Native Americans in all aspects of education, including fellowship awards, curriculum development, and degree programs in scientific and technical fields,
- conducting outreach to pre-college teachers and students,
- annually sponsoring the highly successful South Dakota Space Days, and
- providing additional information and activities to increase public appreciation for the direct and indirect benefits of NASA-sponsored research and education.

The Consortium's general goal is to enhance the capabilities for space-, earth-, and aeronautic-related education, research, and economic enterprise in South Dakota. We focus on Earth System Science as the specific area of emphasis for the SDSGC collaborative projects. Hence, programs are fostered that complement the Consortium's research and educational efforts in earth science, remote sensing, satellite imagery, GIS, global and regional geoscience, environmental science, and K-12 educational outreach. Many of these collaborations would not have been established without Space Grant.

As evidenced in CMIS summary tables II-A and I-A on the Space Grant 15th Year Evaluation website, 682 collaborative efforts across programs have been reported over the past five years, averaging 140 collaborations per year. SDSGC is now recognized as one of the key organizational forums in South Dakota for bringing together talented people, their ideas, and collaborative projects in research, education, and technology-based economic development.

SDSGC programs emphasize the diversity of human resources, the participation of students in research, and the communication of the benefits of SMET to the general public. South Dakota's main underrepresented group is Native American Lakota People, and all six Tribal colleges and universities in our state are educational affiliates of the SDSGC (Oglala Lakota College, Sinte Gleska University, Si Tanka College, Lower Brule Community College, Sisseton Wahpeton Community College, and Sitting Bull College). We have placed special emphasis on building linkages to this group and developing SDSGC Program Initiation Grants that enhance their ability to participate in the Consortium's programs.

Since the Tenth Year Evaluation Report in 1998, the SDSGC has exactly doubled its membership roster. In the past five years, SDSGC has grown from 17 members and affiliates to a network of 34 organizational partners. New affiliates are depicted with an arrow in Fig. 3. Our statewide network of partners from universities, industry, museums, science centers, and State and Federal Government agencies work together as fully engaged partners to pursue state and national

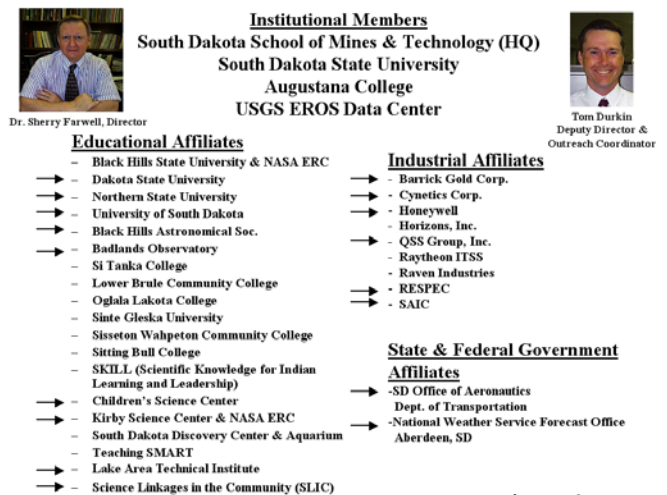


Figure 3

aerospace research, education, and economic development goals.

Over the past five years, our largest program element was fellowships, representing ~28% of our Consortium expenditure of NASA funds. We awarded 119 Space Grant Fellowships and Scholarships totaling \$355,432 (of which \$323,132 was NASA funds) and used our network of scientists, engineers, and educators to develop a diverse workforce of current and future professionals. Approximately 50% of these awards (58 of the 119) have gone to support female and underrepresented students.

SDSGC consistently and actively participates in all six NASA Space Grant program areas/elements. Our second through sixth largest program areas, in order of NASA funds expended over the past 5 years are: consortium management, research infrastructure, higher education, pre-college (K-12) outreach, and public service/external relations.

National Program Emphases

Diversity

During the past 5 years, the Consortium has evolved into a highly networked organization with a fundamental role in communication of educational and technological issues. SDSGC has now become a functional organizational forum in South Dakota for bringing together talented students of all ages and races for mutual discussions of their ideas and potential collaborative projects in research, education, and technology-based economic development.

The SDSGC has a dedicated, productive, and, multifaceted approach to diversity. Over the past 5 years, approximately 50% of SDSGC's Fellowship awards (58 of the 119 awards totaling \$355,432) have been made to female and underrepresented students.

Timothy "Bull" Bennett is an example of a successful Native American Space Grant fellow at SDSM&T. He is a PhD candidate in the Atmospheric, Environmental and Water Resources (AEWR) Program and his research project is based on ungulate interactions in managed short grass prairie systems using remote sensing and GIS. In addition to previous support from Space Grant, Mr. Bennett successfully secured a NASA Earth Systems Science Fellowship to fund his graduate work.

Ms. Charnel Petersen, the Outreach and Education Coordinator at the SDSU branch of the SDSGC, is an enrolled SD tribal member. In addition to her normal duties as the Education Outreach Coordinator, she provides an active connection to SD tribal leaders. She is currently working with this tribal leadership group to select a site for the 2005 SD Space Day. SDSU also has a growing program working with the Flandreau Indian School (a boarding school run by the Bureau of Indian Affairs) in which each class makes several visits to the campus during the school year. The program ranges from hands-on workshops in science, engineering, math and technology, to preparing for the ACT, to an SDSU 3-credit class in astronomy for 10 seniors. This "Success Academy" program at SDSU works to encourage minority students to consider higher education as their next step after high school. Likewise, SDSU also works with Native American students at Sisseton High School in the FIRST Robotics program. Flandreau Indian School is planning to be a new FIRST Robotics participant in 2003/2004.

One of the strengths of South Dakota's Space Grant Consortium is its partnership with the six Native American colleges and universities in our state, namely: Oglala Lakota College, Sinte Gleska University, Si Tanka College, Lower Brule Community College, Sisseton Wahpeton Community College, and Sitting Bull College. The Consortium has successfully fostered partnership initiatives with these SD Tribal colleges and universities in areas such as: Native American student fellowships, internships for native students at EROS Data Center, Program Initiation Grants through Space Grant, and numerous specific projects and programs such as NativeView, Scientific Knowledge for Indian Learning and Leadership (SKILL), the local chapter of American Indian Science and Engineering Society (AISES), Flandreau Indian School Success Academy, FIRST Robotics, Rez Mapper (Interactive Community Mapping Program for the Rosebud Lakota Nation), etc.

Competitiveness

We endeavor to have a gender balanced selection committee whenever applicants are selected for SDSGC sponsored awards. When awarding SDSGC Program Initiation Grants to successful applicants, the selections are always made on a competitive basis to projects that promote and advance the objectives of the SDSGC.

NASA Ties

Space Grant has helped enable our member institutions to develop a) earth systems science programs with strong ties to NASA Centers and NASA ESE, and b) interactive research programs with the USGS EROS Data Center and some of our industrial affiliates. The Land Processes Distributed Active Archive Center (LPDAAC) at the EROS Data Center in Sioux Falls, SD is often referred to as a "NASA Center", which we are both fortunate and proud to have within the borders of South Dakota. The LPDAAC was established as part of NASA's EOS Data and Information System (EOSDIS). It participates in collaborative efforts such as Augustana College's NASA EPSCoR Program Initiation Grant project to recalibrate historical AVHRR vegetation index data to current and future MODIS products (this collaborative project involves Augustana College, SAIC, USGS, and NASA).

Typically, NASA personnel will attend our annual SDSGC-sponsored SD Space Days events, offering various AESP programs, astronaut presentations, and the popular International Space Station traveling exhibit trailers.

During the past 5 years, SDSGC has sponsored numerous students in research internships at various NASA Centers through programs such as NASA Academy, NASA's Undergraduate Student Research Program, NASA's Reduced Gravity Student Flight Opportunity Program, and NASA's Student Involvement Program. Good examples of linkages between SDSGC and NASA in regard to student projects are the ties that SDSM&T has established with individual JSC employees in Houston. These JSC contacts often organize tours of JSC facilities (as well as open their home!) for our KC-135 students when they are at the Center for the Reduced Gravity Student Flight Opportunity Program.

A good example of ties between NASA and SDSM&T researchers as a result of Space Grant and NASA EPSCoR involvement is that of Dr. Lee Vierling at SDSM&T and Drs. Don Deering and

Jeff Masek of Goddard Space Flight Center regarding the Northern Eurasia Earth Science Partnership Initiative (NEESPI) project. Jeff Masek recently presented on this subject at the Western Regional Space Grant Meeting in Rapid City, SD.

SDSU has a particularly strong connection to the Stennis Center through the Image Processing Lab. The connection is evidenced by funding and collaboration in the calibration of various space-borne sensors, viz., Landsat. The SDSGC sponsors a graduate assistant who works in the lab on engineering and calibration research. NASA-EPSCoR has also funded a major project, Cross Calibration of IKONOS and Landsat TM data for Precision Agriculture, again with a strong connection to Stennis. Individuals from Goddard have also been collaborators in the calibration efforts of the Image Processing Lab. SDSGC Associate Director Kevin Dalsted, serves on an ad hoc committee SAR Users Working Group, which has involved JPL and NASA Headquarters, toward the goal of having a dual frequency RADAR satellite in orbit.

Industry Relations

SDSGC has nine industry affiliates, seven of which are within the borders of South Dakota. Industry affiliations include the following:

- Science Applications International Corporation (SAIC), as the current USGS EROS Data Center contractor, has become a close collaborator of the SDSGC. In particular, faculty and students actively work on-site and through network connections with EROS. Personnel are shared for a variety of activities, from office/facility usage, to course teaching, to research collaboration, to equipment and field-based research projects.
- Raven Industries - A thirty-year leader in specialty polyethylene films for high-altitude research balloons. Raven Industries shares a multifaceted connection to the SDSGC, as they participate in various advisory boards and contribute equipment support.
- Cynetics Corporation - Designs, develops, and builds radio and microwave frequency digital data communication systems for terrestrial and spacecraft applications.
- Raytheon - An industry leader in defense, government and commercial electronics, space, information technology, technical services, and business aviation and special mission aircraft.
- Horizons, Inc. - Specializes in providing comprehensive photogrammetric and remote sensing services for environmental, municipal and engineering applications.
- RESPEC - Provides professional services and consulting in engineering, environmental, and information technologies.
- Barrick Gold Corp. – A leading international gold company and owner of the now closed Homestake Mine in SD that has been proposed as the potential site for a National Underground Science and Engineering Laboratory.
- Honeywell Technology Solutions – A diversified technology and manufacturing leader of aerospace products and services, etc.
- QSS Group Inc. - Provides advanced aerospace technology and information technology enterprise solutions to federal agencies.

State Government Involvement

Establishing closer linkages with SD State Government was a significant factor accomplished by the SDSGC during the past 5 years. The State Office of Aeronautics affiliated with SDSGC in 2001.

SDSGC is well connected in state government from the Governor's Office to field personnel. The SD NASA-EPSCoR "Technical Advisory Committee" (TAC), while a part of our NASA EPSCoR Program, typifies how state government employees bring their expertise into SDSGC. For example, TAC membership includes representatives from the State Bureau of Information and Telecommunications (with specialty in geospatial information technology) and the State Dept. of Environment and Natural Resources. Through the Department of Education, teacher training has just started for GIS technology and all SD state schools are licensed for ArcView software. Additionally, GIS and remote sensing training for K-12 teachers has been conducted for the past several years through SDSGC's participation in the Upper Midwest Aerospace Consortium (UMAC) EdPARC efforts. Various SDSGC staff support have been allocated to assist in these endeavors. Likewise, an AmericaView activity has been funded for South Dakota called SDView. AmericaView is a consortium to expand remote sensing education through a network of numerous state consortia. In the SDView project, remote sensing imagery will eventually be made available to a variety of researchers, government employees and other end users. The SDSGC supports this activity through sharing of staff.

In 2002, SDSGC was successful in obtaining over \$23,000 in State funds from then Governor William J. Janklow in support of an educational project titled "Dark Skies & Bright Minds". This project, which was jointly supported by the Governor's Office and the SDSGC, provided for modifications of the 26-inch telescope located at Badlands Observatory in Quinn, SD that enables it to be used online, via the Internet as an educational and research tool.

Additionally, during the past 5 years, SDSGC agreed to serve as lead entity for the National Council of Space Grant Directors "State/Regional/Local/Tribal Government Involvement (SRLT) Committee". SRLT efforts focus on ways to involve more government entities (largely State Government) in Space Grant Consortia activities and to improve the effectiveness of such partnerships. The intents are: (1) to increase knowledge about NASA and Space Grant in State offices; (2) to encourage governing entities to utilize Space Grant as a NASA point of entry for aerospace information and assistance, and (3) to build appropriate partnerships (when and where appropriate) that will help Space Grant projects be farther-reaching, more self sufficient, and less dependent on NASA funding for long term success (i.e., to build a stronger and more diversified portfolio of funding sources).

Program Elements

1. Consortium Management

Description

The SDSGC management team has jointly molded the Consortium into its present role of serving as one of the key organizational forums in South Dakota for connecting talented people, their ideas, and collaborative projects in research, education, and technology-based economic

development. The management team consists of representatives from SDSM&T, SDSU, Augustana College, and the USGS EROS Data Center. Management team organizations and most of the personnel have remained consistent during the past 5 years, offering stability to Consortium activities. The Consortium Management Team consists of:

- Dr. Sherry Farwell, Director. Dr. Farwell is also Dean of Graduate Education and Research at SDSM&T.
- Mr. Tom Durkin, Deputy Director and Outreach Coordinator. This is a full time position at SDSM&T in the Consortium's headquarters office.
- Mr. Kevin Dalsted, Associate Director at SDSU.
- Dr. Daniel Swets, Associate Director at Augustana College.
- Mr. Gregg Johnson, Science Dept. Manager at USGS EROS Data Center.

Our goal is to continue to develop education, research, and outreach programs focused on earth systems science that interactively involve the 17 new affiliate members acquired during the past 5 years with our more longstanding members and affiliates. To continue developing effective Space Grant programs, we strive to enhance our funding base by fortifying our ties with our existing industrial affiliates, recruiting new industrial affiliates, and pursuing further federal, state, and private funding opportunities.

Representatives of SDSGC's management have attended and consistently participated in all National Council of Space Grant Director's meetings and most of the Western Regional meetings, which was just hosted by SDSGC in Rapid City, SD in September 2003. Attendance at these meetings has contributed to the development of professional relationships with a variety of NASA people and projects.

Office space and facilities

The SDSGC Headquarters Office has approximately 250 square feet of dedicated office space in room 228 of the Mineral Industries Building on the campus of SDSM&T in Rapid City, SD. The office houses Consortium educational and outreach materials, displays the SDSGC exhibit booth, and is equipped with standard office computer equipment, telephone, and fax.

Matching funds and leverage

The capability enhancement efforts of the SDSGC over the past 5 years have promoted a valuable synergism between SDSGC-sponsored research activities and other research groups across the state and region. In awarding funds to support its research priorities, SDSGC seeks to leverage the impact of those funds through cost-sharing and other collaborative agreements. One example of this strategy is the 2003 SDSGC Summer Faculty Fellowship awarded to Dr. Edward Duke at SDSM&T titled "Integrating Biweekly AVHRR Satellite Data and Historic Surface Hydrology Data to Model Missouri River Water Quality and Sedimentation." Dr. Duke was able to leverage the SDSGC Fellowship into a \$25,000 research project by utilizing funds from a SD NASA EPSCoR Program Initiation Grant, the Engineering and Mining Experiment Station (SDSM&T), the Nelson Research Program (SDSM&T), and the Earth Science Information Partner program (SDSM&T and the Upper Midwest Aerospace Consortium).

Similarly, Dr. Daniel Swets from Augustana College received funding to continue the initial progress made in algorithm development on behalf of the USGS EROS Data Center in the robust statistical smoothing of the Normalized Difference Vegetation Index (NDVI) data. Due in part to the connections and initial activities performed under the Space Grant, Dr. Swets was able to secure additional federal funding to further pursue these algorithmic needs at EROS, from NSF in the amount of \$97,910 and from USGS in the amount of \$45,845. In addition, the Space Grant activities have enabled Dr. Swets to secure institutional grants from Precision Computer Systems, Inc., Sioux Falls, SD, for computer equipment, in the amount of \$30,000; from Borland International for software, in the amount of \$6,450; and from Microsoft Corporation for software, in the amount of \$4,950. This is an 18:1 payoff for the activities sponsored by NASA under the Space Grant program.

Management expenses/administrative costs

Management activities represent about 27% of our Consortium expenditure of NASA funds.

Consortium Structure/Network

Our statewide network of partners from universities, industry, museums, science centers, and State and Federal Government agencies work well together to pursue state and national aerospace research, education, and economic development goals. The SDSGC has grown from its fledgling stage of three institutional members and three industrial affiliates in 1991, to its current network of thirty-four organizations spread across the state in a geographically representative manner as depicted earlier in Figures 1 and 3. In the past 5 years, the Consortium has exactly doubled its network of partners from 17 to 34 organizational members and affiliates as seen in Fig. 3.

Meetings

SDSGC holds quarterly meetings to discuss and plan Consortium projects and business, and to evaluate the success of our efforts. These meetings are held either face-to-face (at least once or twice per year) or via telecon, and are in addition to the daily/weekly communication between Consortium partners. They are open to all Consortium members/affiliates, but typically are limited to the organizations that are involved in the agenda items for that particular meeting. The management team members have established good working relationships amongst themselves. In working with each other and with other Consortium personnel from different institutions, we have demonstrated the ability to productively work together on a number of research, education, and outreach programs.

Collaborations and Partnerships

SDSGC has been extremely successful in promoting the unifying theme of Earth System Science in South Dakota, so that it is now one of the cornerstones of research infrastructure statewide. For example, SDSM&T staff with ties to SDSGC recently joined with Oglala Lakota College (OLC), an educational affiliate of the Consortium, in their proposal to the NSF Tribal Colleges and Universities Program that resulted in a five-year, \$2.5M award. Through this collaboration, SDSM&T is assisting OLC in 1) general earth and environmental science training, 2) instrumental analysis to support earth and environmental science education, and 3) applications of geographic information systems and remote sensing technology. OLC is a tribally controlled and community governed four-year academic institution with 1,300 students located in ten

college centers across the Pine Ridge Reservation in South Dakota. The student base is approximately 90% American Indian. As one of six NSF-designated Model Institutions for Excellence (MIE), OLC has developed the infrastructure to offer Science, Engineering, Math and Technology degrees and increase the number of Native Americans continuing on to graduate school.

Specific accomplishments in the first year of the program include installation of a new X-ray diffractometer, X-ray fluorescence spectrometer, portable UV-Visible-NIR spectroradiometer, and remote sensing software at OLC, and training of students and staff. SDSM&T and OLC are actively developing collaborative research projects in geology, geochemistry, environmental science, and remote sensing. Most recently, SDSM&T participated in mentoring Earth science research projects for ninth-grade students in the NASA Honors Program, a six-week, pre-college summer residential program at SDSM&T cosponsored by NASA and OLC. This Consortium-linked project aims to increase the participation and success of American Indians in science, math, and technology.

Sinte Gleska University, a Consortium educational affiliate, recently was awarded a \$5M NASA Earth Science “Research, Education and Applications Solutions Network” (REASoN) grant for a project proposed in collaboration with the USGS EROS Data Center, NASA Ames, and others. The winning proposal “A Geospatial Extension of the NASA Information Power Grid”, will develop policy and resource management decision support systems, and generate educational tools to inspire and train current and future generations of Native and non-native scientists. SDSGC is already acting as a “Clearinghouse” to identify expertise in training in areas that are required for the Native American community to successfully implement the work plan of the funded proposal.

2. Fellowship/Scholarship Program

Description

Over the past five years, our largest program element was fellowships, representing ~28% of our Consortium expenditure of NASA funds. As evidenced by Table IV-A on the 15th Year Evaluation Website, SDSGC awarded 119 Space Grant Fellowships and Scholarships (totaling \$355,432, of which \$323,132 was NASA funds), several of which were to awardees participating in projects at NASA Centers. They are too numerous to mention here individually. We used our network of scientists, engineers, and educators to develop a diverse workforce of current and future scientists, engineers, technology professionals, and educators. Approximately 50% of these awards (58 of the 119) have gone to support female and underrepresented students. Of these 119 awards, 73% were undergraduate awards and 27% were graduate awards.

As part of our fellowship program, the SDSGC sponsors Summer Faculty and Student Fellowships tenable at the USGS EROS Data Center. These fellowships enhance the coordination of research activities among Consortium members and strengthen the research infrastructure component by building up the state’s capabilities in remote sensing and GIS. Over the past 5 years, faculty fellowships went to Dr. Maribeth Price and Dr. Lee Vierling from SDSM&T, Dr. Madeleine Andrawis, Dr. George Hamer, and Dr. Alex Moutsoglou from SDSU,

and Dr. Gil Blankespoor of Augustana College. Student fellowships tenable at EROS Data Center went to SDSM&T graduate students Pat Kozak and Timothy “Bull” Bennett.

We have established a Diversity Enhancement Fellowship program to provide research and educational opportunities for faculty and students at Tribal Colleges and other Native American institutions in South Dakota.

The average amount of Consortium support for student and faculty fellowships/scholarships has been \$64,626 per year (NASA funds) over the past 5 years.

Impact/Results

Several of our Space Grant fellows have gone on to work for NASA contractors. A good example of a current undergraduate student that is in the NASA pipeline as a result of receiving Space Grant fellowship funds is SDSM&T student John Keefner. Mr. Keefner began his involvement in Space Grant as a ground crew member of SDSM&T’s first KC-135 team. In a subsequent year, he advanced up to flier status. In a third KC-135 project, he participated as a critical member of a multi-institutional team. He has written proposals and helped build several KC-135 experiments that test solar sail propulsion and deployment for future application to space flight. He went on to participate in a 15-week Fall NASA USRP project at JSC, a NASA summer internship at the University of Minnesota with the Planetary Geology and Geophysics Undergraduate Program, and he recently completed the 2003 NASA Astrobiology Academy at Ames. Mr. Keefner’s case exemplifies the success of SDSGC as a workforce broker for students pursuing future careers in SMET.

3. Research Infrastructure Program

Description

The SDSGC has focused on development of research infrastructure primarily in the area of Earth System Science (Code Y), with the major themes being remote sensing, geographic information systems, and advanced image processing methods. Research infrastructure activities represent about 19% of our Consortium expenditure of NASA funds. Many of these projects feature close collaboration with the USGS EROS Data Center, which is an institutional member of SDSGC and one of the world’s leading organizations in the key areas mentioned above. Examples of research infrastructure projects in Earth System Science that SDSGC has supported during the past 5 years are:

- Upper Missouri River Basin (UMRB) Hydrology Pilot Project - The goal of this interdisciplinary project was to study links among hydrology, weather and climate using the Black Hills as a laboratory to provide an understanding that can be applied across the central region of the North American continent.
- SD NASA EPSCoR Program – Specifically in the use of remote sensing for monitoring, predicting, and managing hydrologic, agricultural, and ecological processes in the northern Great Plains. Details are not reported here, but can be found at <http://www.sdsmt.edu/space/nasaepscor/>
- Collaboration with the State’s NSF EPSCoR initiative in Biocomplexity.

- The South Dakota Carbon Sequestration Project – Focuses on both basic and applied research into carbon sequestration and provides a traceable method to determine the Carbon Emission Reduction Credits (CERCs) for registered land. SDSM&T received over \$450,000 from SD's former Governor William J. Janklow for research into carbon sequestration.
- Research conducted at Augustana College such as NDVI smoothing and land cover analysis, use of satellite imagery to document timber harvest activity and other land cover changes in northwestern Montana, seasonality metrics for phenology and drought analysis, etc.
- Image Processing Laboratory at Augustana College - Augustana College leveraged Space Grant funding to secure NSF funds to develop and operate a parallel- and image-processing laboratory that provides support for many Space Grant projects. One such project is a study to combine paleolimnology, remote sensing, and image processing; a seasonality smoothing and metrics algorithm development project to assist the USGS EROS Data Center personnel and colleagues with obtaining more useful data for their particular applications; a Beowulf cluster implementation of several image processing applications.
- Specific remote sensing-precision agriculture projects at SDSU including successful Science Data Buy proposals to Stennis Space Center.

Although Earth System Science is the main area of emphasis within the SDSGC, there are several other active areas of research infrastructure development, including:

Space Flight (Code M)

- KC-135 – Student research and publications in thin membranes and solar sails.

Aerospace Technology (Code R)

- Upper Midwest Aerospace Consortium (UMAC) - SDSU and SDSM&T continued active participation in UMAC's activity with precision agriculture and remote sensing. SDSGC provided financial and personnel resources for UMAC EdPARC teacher-training workshops in GIS, GPS and remote sensing.
- Space materials and structures work such as NASA projects undertaken by Dr. Christopher Jenkins and Dr. Jon Kellar, etc. at SDSM&T, which include gossamer structures, optical diagnostics systems for solar sails, free form functionally graded materials, membrane applications, coating design, interphase curing and properties, etc.

Space Science (Code S)

- Badlands Observatory – An educational affiliate of SDSGC in Quinn, SD has become nationally recognized for its Near Earth Object (NEO) asteroid observations and participation with the international Spaceguard Foundation. Participating observatories around the world are cataloguing all of the NEO's that may represent a global impact hazard to the Earth. The dark skies in western SD, combined with the extremely sensitive research-grade telescope at Badlands Observatory, places the observatory in the company of some of the world's best astronomical research facilities. It is host to an f/4.8 Newtonian Telescope with a 26" diameter mirror, the largest telescope in the local three-state area. Observations are reported to the Minor Planet Center at the Harvard-Smithsonian Center for Astrophysics. Since beginning operations in 2001, a total of 28 new main belt asteroids have been discovered by Badlands Observatory, along with 126 NEO confirmations. In the summer of 2002, SDSGC was successful in obtaining over \$23,000 in State funds from the former Governor of South

Dakota William J. Janklow in support of a project titled “Dark Skies & Bright Minds”. This project provided funding for modifications of the 26-inch telescope located at Badlands Observatory in Quinn, SD so that it can be used online, via the Internet as an educational and research tool.

Other basic research infrastructure programs during the past 5 years that SDSGC has been actively involved with include:

- NASA Student Research Programs – Numerous SDSGC students have participated in NASA’s Undergraduate Student Research Program, Student Involvement Program, Reduced Gravity Student Flight Opportunity Program, and NASA Academy, all with SDSGC support.
- Western Research Alliance - SDSGC provided administrative assistance for this broad based organization whose objective is to provide a regional forum for academic researchers, entrepreneurs, state and federal agencies, and local economic developers who are interested in the promotion of research, technology transfer, and business development.
- Small Business Innovative Research (SBIR) and the Western Research Alliance (WRA). Dr. Farwell and other Consortium members continue their involvement in the WRA, an organization dedicated to the expansion of regional R&D and high tech business opportunities in SD.
- Technical and financial support for GIS-remote sensing and image processing laboratories at member universities and educational affiliates, including Native American Tribal Colleges. This support is for research and educational projects involving GIS and remote sensing curriculum development, precision agriculture, algorithm development for NDVI data, plant science, climate change, and land surface processes.
- Numerous research collaborations, mentorships, and other opportunities for faculty and student partnership with NASA Center personnel.

Additionally, a major effort by SDSGC personnel during the past two years that is worthy to mention here has focused on a collaborative proposal that was submitted to the National Science Foundation to convert the closed Homestake Gold Mine in Lead, SD into a National Underground Science and Engineering Laboratory (NUSEL) <<http://mocha.phys.washington.edu/NUSEL/>>. During the past 30 years, scientists have developed an amazing way to view the Universe with deep underground neutrino "telescopes". The results obtained from this growing cadre of underground detectors now promise new insights into the Standard Model of Elementary Particles and Forces. In addition to subterranean physics, a whole range of "underground science" has become evident during the past few years. Specific subterranean research topics include solar, atmospheric, long-baseline, supernova and high energy astrophysical neutrinos, double beta decay, and dark matter searches; precision and sensitive assay of radionuclides (with applications to enforcement of disarmament treaties and environmental effluent studies); materials science and engineering; nuclear astrophysics cross-section measurements; hydrology, seismology, rock mechanics and other topics in geoscience; microgravity experiments via long drop tubes; and the study of the evolution and subsistence of biological organisms under extreme environmental conditions. There is also considerable industrial interest in underground laboratories because of materials activation issues, cosmic-ray-induced error rates in microelectronics, quantum computing, and the production and storage of ultra-pure materials.

With proximity to Mt. Rushmore and the fact that most people find understanding the Cosmos so exciting, NUSEL has the potential to interest many Americans in science and engineering. In addition to an extensive outreach program for tourists, if NUSEL were to become a reality, it could potentially provide on-site and distance education curricular experiences for K-PhD students, distance education opportunities for the general public, astrophysical data outreach to scientists around the world, and special participation opportunities for individuals and institutions in EPSCoR. In its interpretative activities, NUSEL could recognize the special significance of the Black Hills to the Native American community and could use both its special place and the excitement of its science to reach out to all communities, especially those underrepresented in U.S. science and technology. The existing outreach network contained within the Space Grant and NASA EPSCoR programs will continue to be relied upon extensively for this purpose.

Impact/Results

SDSGC's focus on promoting Earth System Science as a unifying theme has resulted in it becoming one of the cornerstones of research infrastructure statewide. As exemplified above in more detail under "Collaborations and Partnerships", SDSM&T's partnership with Oglala Lakota College (OLC) resulted in the installation of a new X-ray diffractometer, X-ray fluorescence spectrometer, portable UV-Visible-NIR spectroradiometer, and remote sensing software at OLC and training of students and staff. SDSM&T and OLC are actively developing collaborative research projects in geology, geochemistry, environmental science, and remote sensing. Other Native American Tribal College affiliates of the SDSGC have acquired significant laboratory equipment to bolster the research infrastructure on their campuses and within the State, such as GIS laboratories, new computer equipment and software.

Providing some examples of success stories regarding faculty research development resulting from Space Grant support is an appropriate way to measure impact. One faculty member from each of SDSM&T, SDSU, and Augustana College are included here as examples.

Dr. Edward Duke (SDSM&T) – Dr. Duke was an SDSGC Summer Faculty Fellow at EDC in 1991 and subsequently received travel support to NASA's Jet Propulsion Laboratory and the U.S. Geological Survey's Spectroscopy Laboratory in Denver. Based on these experiences, Dr. Duke developed a successful research program focusing on geological applications of remote sensing and field spectroscopy. Under a unique collaborative arrangement, NASA acquired a large volume of new hyperspectral imagery for the research and NSF provided funds to support the basic research aspects of the work. As an outgrowth of this work, Dr. Duke currently is funded by NSF to implement technology transfer programs with Oglala Lakota College on the Pine Ridge Reservation in South Dakota and with the Geological Survey of Namibia. Both projects feature the use of remote sensing data from NASA or other sources as a critical tool for resource evaluation and management.

Dr. Dennis Helder (SDSU) – Dr. Helder is a successful NASA PI who was an SDSGC Summer Faculty Fellow in 1991. He went on to the NASA JOVE Program in 1992-1995, was awarded a Summer Fellowship at Goddard Space Flight Center in 1993, and was a member of the Landsat 7

Science Team from 1996-2000, the EO-1 Science Validation Team from 1999-2002, and the JACIE Team at Stennis Space Center from 1999 to the present.

Dr. Daniel Swets (Augustana College) – Dr. Swets was awarded a Fulbright grant in 2002 for a project titled “NDVI Smoothing and Land Cover Analysis, University of Mauritius”. NASA Space Grant supported activities by Dr. Swets that led to the receipt of this grant. While on the Fulbright experience in Mauritius, Dr. Swets participated in the regular course load at the University of Mauritius, initiated a collaborative research group in image processing and remote sensing, and developed a mentoring relationship for operations research with members of staff at the University of Mauritius. These ties will allow Dr. Swets to expand research capabilities both at Augustana College and at the University of Mauritius, and pursue further funding for such research and this relationship.

According to Table V “Research Report” accessible from the 15th Year Evaluation Website, SDSGC reported 32 publications during the past 5 years, with 24 proposals submitted and 9 funded (a success rate of 38%).

4. Higher Education Program

Description

Purpose, Goals, and Objectives

SDSGC’s Higher Education Program is in alignment with Space Grant education priorities by providing promising undergraduate students with opportunities to experience cutting-edge research. These students work with scientists at NASA Field Centers and at local and nationally-based industries, and some also participate in various NASA-funded projects at South Dakota universities.

The Consortium’s goal for higher education is to focus on developing high quality Earth Systems Science programs at institutional member universities while supporting the educational goals and objectives of the NASA Enterprises in general, and Space Grant specifically. SDSGC’s education objectives in South Dakota include the following:

1. Establish links between higher education, government, and industry in South Dakota.
2. Develop earth systems science, space science, and aerospace education infrastructure in South Dakota.
3. Encourage students and faculty to participate in various NASA-sponsored programs.
4. Enhance faculty and graduate student development through summer faculty/student fellowships at the USGS EROS Data Center and NASA Centers.
5. Provide graduate and undergraduate training through student fellowships, scholarships and assistantships.
6. Use our network of scientists, engineers, and educators to develop of a diverse workforce of future scientists, engineers, technology professionals, and educators.
7. Involve women and underrepresented groups such as Native Americans in all aspects of education, including fellowship awards, curriculum development, and degree programs in scientific and technical fields.

8. Instill an intrinsic interest in the Earth and space sciences in students and faculty.

Over the past five years, SDSGC's Higher Education Program has received about 16.5% of NASA dollars from our Space Grant budget.

Minorities, women, and other underrepresented groups are a critical aspect of SDSGC's higher education program. There are a number of reservations that host six Tribal Colleges in South Dakota, along with numerous reservation schools. All six Tribal Colleges mentioned earlier in this report are SDSGC affiliates. We have initiated and encouraged participation of Native American students and faculty in our programs and have developed SDSGC-funded Program Initiation Grant (PIG) opportunities for Native American educational institutions in South Dakota. Likewise, our Diversity Enhancement Fellowship program has provided educational and research opportunities for faculty and students at Tribal Colleges and other Native American institutions in South Dakota. SDSGC also assisted in the curriculum augmentation of astronomy courses to both science oriented and non-science oriented students to promote an interest in science, math, and technology at the undergraduate level by incorporating NASA resources and materials.

At the graduate level, students can take advantage of faculty that have developed connections with NASA Centers through collaborative research and educational efforts, utilize facilities at various NASA Center's for Excellence, such as the GIS Learning Center at SDSM&T, and private industrial affiliates that are collaborating with NASA, such as Horizons, Inc.

A number of graduate and undergraduate students in South Dakota have been awarded SDSGC scholarships/fellowships for their participation in NASA programs such as the Undergraduate Student Research Program (USRP), Graduate Student Research Program (GSRP), the RGSFOP (KC-135), and NASA Academy. Likewise, faculty members from various Space Grant educational affiliates in South Dakota have also participated in Summer Faculty Fellowship Programs at NASA Centers. Overall, SDSGC's Higher Education Program features a variety of projects and initiatives that include faculty, undergraduate students, graduate students, women, and Native Americans.

Specific characteristics of a few of the various Higher Education programs and initiatives supported by SDSGC are summarized below as examples.

- SDSGC has helped fund three highly successful teams of students, faculty, and staff from SDSM&T that have participated in NASA's KC-135 Reduced Gravity Student Flight Opportunity Program (RGSFOP). This program is an excellent example of the interdisciplinary nature of many SDSGC projects, where we see student teams form with members from a wide range of scientific and engineering disciplines to work together on a given problem. Although not necessary as a review item for this report, websites for various SDSM&T team projects can be found at <http://www.solarvision.org/>
- In 1999, SDSGC held a competition targeted on Native American institutions in SD for Program Initiation Grants (PIG). Six proposals were submitted and three were supported out of the SDSGC Diversity Enhancement funds. Funded projects were: "Life Through Water", Loneman School Corporation, Oglala, SD; "Computer Science Degree with Emphasis on

GIS/RS Technologies", Si Tanka College, Eagle Butte, SD; and "Learn About the Earth: A Hands-On Environmental Earth Science Education Program", Wounded Knee District School, Manderson, SD. Arrangements were made with authors of the nonfunded proposals (Sitting Bull College, Ft. Yates, ND; Enemy Swim Day School, Waubay, SD; and Sicangu Policy Institute and Sinte Gleska University, Mission, SD) to work with other SDSGC members to enhance their proposal's competitiveness for later PIG competitions.

- SDSGC funded a Program Initiation Grant (PIG) for Oglala Lakota College (OLC) in 2000 titled "Evaluation of Watershed and Water Quality Assessment Techniques for use on the Pine Ridge Reservation". The project, overseen by SDSM&T, provided undergraduate research opportunities for several OLC students enrolled in the earth science or the conservation biology track of the Environmental Science Degree program and/or students enrolled in the Models in Excellence (MIE) program at OLC. Research activities involved the evaluation of a watershed and water quality assessment technique for use on the Pine Ridge Reservation.
- In 2000 and 2001, SDSGC funded a Program Initiation Grant (PIG) for Sinte Gleska University, Sicangu Policy Institute titled "Ethno-Geographic Information Systems". In this project overseen by SDSU, ethno-geographic information (i.e., Native American cultural information) was integrated into an ArcView program to manage Rosebud Sioux Tribe cultural resource data.
- SDSGC supported and moderated SDSM&T's participation in the "Space Mission Design Seminar" Internet course offered as a cooperative effort between SDSM&T and eight other universities that make up the Upper Midwest Aerospace Consortium (UMAC). The course was operated out of the University of ND and focused on the concept, design, construction, and scientific applications of a satellite imaging system proposed to be built by UMAC.
- SDSGC supported Sinte Gleska University's "GIS Day" in 2000 on the Rosebud Sioux Reservation.
- SDSGC supports "NativeView" <<http://www.sinte.edu/nativeview/>>, a partnering and merging of Western Geo-Science and empirical Native American knowledge. NativeView is a geospatial data accessibility project spearheaded by the USGS-EROS Data Center, Sinte Gleska University and Industry Partners to integrate Earth Science data and related technologies. Driven by relevant needs, NativeView is an innovative approach to technology transfer and empowerment within Indian Country through access to geo-spatial/spectral data and existing research.
- SDSU was a successful recipient of a "SouthDakotaView" (SDView) project through the USGS and AmericaView. The project will develop a plan to index and provide for distribution of remote sensing data to SD users. AmericaView is a consortium to expand remote sensing education through a network of numerous state consortia. AmericaView is a locally controlled and nationally coordinated program to advance the availability, timely distribution, and widespread use of remote sensing data and technology through education, research, outreach, and sustainable technology transfer to the public and private sectors.
- Augustana College conducted work on paleolimnology and the effects of land use on sedimentation and erosion rates. Undergraduate students and faculty were involved in this study, which leveraged NSF and Bush Foundation funds to purchase equipment and software. Their research was documented to showcase their research for new students, colleagues, and the worldwide web.

- Development and implementation of SDSGC's Diversity Enhancement Fellowship program provides research and educational opportunities for faculty and students at Tribal Colleges and other Native American educational institutions in South Dakota.
- SDSGC partially funded the South Dakota Student Research Balloon Project for the launching of free and tethered balloon systems for generating weather, climate and hydrology data. These balloon-based measurements were conducted during the Intensive Observation Period of the NASA-funded UMRB hydrology project.
- SDSGC-funded students are involved with the precision agriculture, climate change, environmental science, algorithm development, paleolimnology, and land surface processes research at the GIS-Remote Sensing and Image Processing Laboratories at SDSGC institutions.
- SDSGC developed and maintains its "Educational Opportunities (Higher Ed.)" website <<http://www.sdsmt.edu/space/EdOpp-HigherEd.htm>>.
- Funding was also provided for faculty educational and travel enhancements to attend Space Grant and other professional meetings and well as travel support for American Indian Science & Engineering Society (AISES) members to travel to national meetings.
- SDSM&T's GIS Learning Center offers quality GIS training in South Dakota at the lowest possible cost. <http://www.sdsmt.edu/online-courses/geology/mprice/gis/>
- Dozens of student and faculty publications and presentations on SDSGC-related projects. According to Table VI "Higher Education Report" accessible at the 15th Year Evaluation Website, SDSGC reported 49 publications during the past 5 years.

Impact/Results

Several of our Space Grant fellows have graduated and went to work for NASA contractors. A good example of a current undergraduate student that is in the NASA pipeline is John Keefner. Mr. Keefner is a student at SDSM&T. He first got the attention of SDSGC management when he expressed interest in the KC-135 program and we learned of his outstanding success in local, regional, national, and international science fairs. Mr. Keefner was a ground crew member of SDSM&T's first KC-135 team, advanced with the program as a flier in the next selected KC-135 team, and then participated as a critical member of a third, multi-institutional team. He has written proposals and helped build several KC-135 experiments that test solar sail propulsion and deployment for future application to space flight. He went on to participate in a 15-week Fall NASA USRP project at JSC, a NASA summer internship at the University of Minnesota with the Planetary Geology and Geophysics Undergraduate Program, and he recently completed the 2003 NASA Astrobiology Academy at Ames. He has done an outstanding job of outreach at the pre-college, university, and general public level. Mr. Keefner exemplifies the success of SDSGC-sponsored higher education programs for students.

One of the weaknesses of our Consortium's Higher Education Program becomes periodically evident. Although we strive for success in our Program Initiation Grant efforts with Native American institutions, like any educational institution, there is periodic turnover of key players and changes in priorities at Tribal schools. There is the rare occasion when a Space Grant project does not come to full fruition. Depending on how success is gauged, such a situation may be judged as a failure or a learning experience. It is our position that building effective relationships with Tribal entities is not necessarily a linear process. What may be seen as a minor setback is not judged as a failure, but rather seen as a reality that can be expected to occur

at times. With this approach, we strive to maintain a respectful and trusting relationship with our Native American colleagues through both successful and “not-so-successful” projects. Each project is a learning experience from which we can all grow and improve. It should be pointed out that most of our collaborative projects involving Native Americans have been extremely favorable and yielded quality results, while further strengthening partnerships.

5. Precollege Education Program

Description

Purpose, Goals, and Objectives:

The purpose of NASA’s South Dakota Space Grant Consortium’s precollege education program is to promote science, math, and technology at the K-12 level and better prepare students and teachers to learn science by infusing an intrinsic interest in Earth science, space science, and remote sensing through dynamically structured content- and experience-based programs. To better align South Dakota teachers with national science standards, curriculum standards in South Dakota’s primary and secondary schools were enhanced in 2000, leaving many teachers in the state ill-prepared to teach Earth and space science with confidence. An additional change in many local school districts required teachers to use experiential learning methods to teach the new content. Therefore, the SDSGC found it paramount to assist local teachers and students by providing quality professional development programs, experiential learning opportunities for students during the school year and summer, and successful NASA-funded curriculum programs. Consortium precollege goals and objectives in South Dakota are to:

1. help teachers develop the skills necessary to implement inquiry-based experiential instructional methods,
2. apply current scientific and instructional technology in the classroom,
3. integrate science content areas and technology into a multidisciplinary approach,
4. have educators become science teacher leaders in progressive districts,
5. assist teachers in preparing science curricula using current, cutting-edge data and concepts utilizing NASA resources and materials,
6. help make science less intimidating and more understandable to students, and
7. instill an intrinsic interest in the Earth and space sciences in students and teachers.

Science content is continually increasing and changing. Therefore, a science teacher must keep pace with such change in order to provide students with a quality education. Teachers that participated in the various professional development programs supported by Space Grant over the past 5 years gained an ability to integrate the newly implemented South Dakota science curriculum standards with inquiry-based instructional methods. The primary outcome goal of the various educational programs that we offer is to improve the physical science content knowledge of secondary school teachers consistent with the new state and national science curriculum standards through direct participation in collaborative learning and the use of the scientific method. By having learned science through lesson models that use inquiry methods, it is hoped that the teachers come away with an understanding of how to use inquiry methods in their classroom. Students will then benefit directly from their teacher’s experiences in inquiry methods. All professional development programs were constructed in accordance with National

Science Education Standards (1996), which are very specific about professional development programs.

Program Characteristics:

A multifaceted and multicultural approach is used to achieve our goals for precollege education. Key individuals associated with SDSGC initiated programs in various parts of the state that helped to facilitate our education goals. Several SDSGC representatives and South Dakota educators attended a NASA Educator Workshop at Goddard Space Flight Center in 2002, which helped initiate and support various Space Grant educational efforts. Various SDSGC institutional members and affiliates collaborated to develop a variety of education and outreach opportunities in South Dakota. These initiatives included professional development programs, an educational website, a NASA funded elementary school curriculum project, enhancement of various education efforts through cooperative efforts of various state and national agencies, funded PIG grants to support science-based Native American programs, creation of middle school science clubs, production of a newsletter, and successful "South Dakota Space Day" public and K-12 annual outreach efforts, along with many other successful initiatives.

Specific characteristics for a few of the various Precollege Education programs and initiatives supported by SDSGC are summarized below as examples.

- Educational Opportunities (K-12) website <http://www.sdsmt.edu/space/EdOpp-K-12.htm>
- Supported "Scientific Knowledge for Indian Learning and Leadership" (SKILL) Program at SDSM&T. The SKILL program is partially funded by SDSGC and has an average student base that is comprised of about 50% female Native American students.
- "Augustana College Science Day" provides hundreds of southeastern South Dakota high school juniors and seniors a day filled with hands-on science opportunities/experiences.
- Supported Aerospace Career and Education (ACE) Camp at SDSU to encourage high school students to consider a career in fields related to aerospace science.
- SDSGC supported the SDSU/Flandreau Indian School Success Academy
- As overseen by Augustana College, SDSGC funded a Program Initiation Grant (PIG) to Enemy Swim Day School titled "Toka Nuwan Space Camp". This project provided educational opportunities to generate interest in aeronautics and space while promoting the advancement of Native Americans (in the Toka Nuwan Native American community near Waubay, SD) in aerospace careers.
- South Dakota Signatures in Space Program.
- Supported student participation in the American Indian Science and Engineering Society (AISES).
- Supported Earth and Space Science Camps for middle school students and secondary teachers at SDSM&T during the past 3 years.
- "Earth Systems Connections" – A curriculum enhancement project funded by NASA and developed at Virginia Tech, University of Colorado, and SDSM&T. This initiative is a hands on, multifaceted, interactive mathematics, science, and technology curriculum where elementary students are challenged to explore how many of the Earth's systems operate and connect with one another. SDSGC provided funds for the addition of Native American video clips into the curriculum of this project, which are an exciting way to get Lakota culture into a nationally-available curriculum for elementary children. <http://www.ias.sdsmt.edu/esc/>

- In cooperation with UMAC and NASA's EdPARC program, SDSGC helped organize and present several intensive one-week teacher-training workshops titled "Earth Science Tools for Educators" at various locations around the state. The workshops focused on GIS, GPS, Remotely Sensed Imagery (Satellite and Aerial), and curriculum integration and standards. Instructors from SDSGC (SDSU and SDSM&T) and several K-12 teachers combined to team-teach these well-received workshops.
- For the past 3 years, SDSGC has supported teams from about 10 high schools throughout the state to participate in the FIRST Robotics program, an exciting competition that teams professionals and young people to solve an engineering design problem in an intense and competitive way. Mentoring universities for the high school teams include Consortium members SDSM&T, SDSU, and Augustana College. Although not included here nor necessary as a review item for this report, a letter of appreciation from a SD school administrator is at <http://www.sdsmt.edu/space/FirstFaulktonLet.htm>. Another good example of the success of this program in peaking student interest is an offer made by one of the students from a high school that SDSU mentored. This particular student was a participant in FIRST for 2 years while in high school, is now attending SDSU, and has offered to help with FIRST this year.
- Participation of South Dakota schools in NASA NSIP competitions. Hill City Middle School in Hill City, SD placed 1st in two categories of 2000 NSIP competition <<http://www.sdsmt.edu/space/NSIP1999-2000WinnersSD.htm>>.
- "South Dakota/NASA Space Days" – An annual event that reaches thousands of students and members of the public each year. Students and teachers from throughout South Dakota are invited to participate in hands-on educational activities in science, math and technology and to visit with experts in aerospace, aeronautics, earth science, engineering, computer science, physics, etc. Synergies with other relevant events are sought. For example, a recent Space Day at SDSU was held in conjunction with the Regional Science and Engineering Fair, thus co-mingling the participants. Guest speakers with nationally recognized credentials, such as NASA astronauts, scientists, and managers present programs and meet with students. Numerous exhibits on earth science, space science and technology are provided. Students are exposed to the excitement and opportunities of various careers in science, math and technology and the impact that NASA has on their lives. See <http://www.sdsmt.edu/space/SpaceDays.htm>
- SDSGC representatives make frequent visits to schools and youth groups to promote interest in space and earth science, and in NASA's unique mission.
- SDSGC solicited participation from several K-12 schools in Project Starshine 3, in which students polished mirrors for the Starshine 3 satellite launched in October 2001. In addition, Starshine 3 contains clusters of experimental solar cells. Data on these solar cells is collected by a computer designed and built at SDSM&T by the Center of Excellence for Advanced Manufacturing and Production (CAMP) and the Electrical and Computer Engineering Department. The data are radioed to the ground with a transmitter built by Cynetics Corporation, an industrial affiliate of SDSGC. SDSGC helped fund the SDSM&T and Cynetics portions of the Starshine project.
- SDSGC developed and maintains working relationships with the two NASA Educator Resource Centers (ERC's) in South Dakota to help assure their use by teachers and students. Both ERC's joined the Consortium in 2000 as educational affiliates.

- Badlands Observatory “Dark Skies & Bright Minds” project. In the summer of 2002, SDSGC was successful in obtaining over \$23,000 in State funds from then Governor William J. Janklow in support of a project that provided for modifications of the 26-inch telescope located at Badlands Observatory in Quinn, SD that enables it to be used online, via the internet as an educational and research tool for schools. SDSGC agreed to provide \$5,000 per year in co-funding to help participating schools pay the use-rate costs for remote operation of the telescope. This project takes advantage of the common attraction that most students have toward space, astronomy, and the study of the universe. NASA and the South Dakota Space Grant Consortium have used the “attention grabbing effect” that space science offers to students as a platform for teaching math, science, engineering, and technology. This program takes advantage of the dark skies in western South Dakota and Badlands Observatory’s extremely sensitive research-grade telescope, which places the Observatory in the company of some of the world's best astronomical research facilities.
- A Rapid City Steven’s High School student provides a recent example of how effectively Badlands Observatory has interfaced with students. Ms. Ashley Nord was awarded the top prize at the March 2002 High Plains Regional Science and Engineering Fair for her project that involved astronomical observations performed at Badlands Observatory. This allowed her to compete in the Intel International Science and Engineering Fair in Louisville, KY where she faced the world’s best science-fair projects and was a finalist. As a result of her success at the Intel International Science and Engineering Fair, she was honored by having an asteroid named after her. Allowing other students to experience the excitement of conducting their own astronomical observations at Badlands Observatory via the Internet will provide them with similar opportunities to expand their scientific interests beyond the classroom.

The Badlands Observatory project is a good example of the SDSGC’s role of facilitator in helping a member secure outside funding for a worthy, relevant project. This cooperative endeavor is also a measure of SDSGC’s success in building educational, research, public service projects and partnerships with State Government and the Governor’s Office.

Over the past five years, SDSGC’s Precollege Education Program has received about 6.5% of the NASA funds from our Space Grant budget.

South Dakota does not have a NASA Explorer School. The Consortium plans to establish an Explorer School within our state in the future, preferably at a Native American school.

Informal Education Collaborations:

Collaborative efforts and partnerships were developed between SDSGC institutional members and a variety of informal education organizations as well as many SDSGC educational and industrial affiliates. Some specific collaborations included the Rapid City Children’s Science Center, Museum of Geology at SDSM&T, Badlands Observatory, Loneman School Corporation, "Toka Nuwan Space Camp" through Augustana College, High Plains Regional Science Fair, and Little Wound School.

Participation of Underrepresented Groups and Persons with Disabilities:

One of SDSGC's primary concerns in relating to minority populations is that students should develop an understanding of what science is, what it is not, and how science contributes to culture. Many individuals have contributed to the traditions of science, and science has been practiced in many different cultures. To communicate science to various cultures, one has to be able to develop a mechanism to relate to various cultures. With the native population in South Dakota, we found earth and space science to be ideal mechanisms for building these relations since the native culture is rooted in the earth and sky. As indicated by Dr. Lionel Bordeaux, President of Sinte Gleska University, we feel there is value in "... bringing two of the essential points of life, the sky and the earth, together spiritually and technically."

6. Public Service Program

Description

This service area includes various informational presentations and press releases about Consortium activities, noteworthy celestial events, aerospace programs, etc. to groups such as local Science Day fairs, the Civil Air Patrol, Chambers of Commerce, civic groups, municipal leagues, museums, astronomical societies, Girl and Boy Scouts, Youth and Family Services, and other members of the general public. SDSGC representatives also serve as judges at regional science fairs.

SDSGC continued its support of StarDate, a daily PBS radio broadcast in South Dakota as part of the McDonald Observatory astronomy program. This broadcast provides a very effective means of informing the public about the Consortium's resources.

SDSGC continues to support South Dakota's Solar System Ambassador, Dr. Bob Polcyn of Hot Springs, SD who gives talks throughout South Dakota on specific NASA missions and astronomy.

SDSGC representatives present a course entitled "Introduction to Astronomy and Current Events in Space" through the Community Education Program in Rapid City. This has been a very well received course by the general public.

Consortium Concurrence Statement

Representatives of SDSGC's four institutional members consisting of SD School of Mines & Technology, SD State University, Augustana College, and the USGS EROS Data Center have attended meetings, teleconferences, and/or had e-mail discussions regarding this Program Performance and Results (PPR) Report. The signatures below indicate their agreement to the contents of the PPR Report.

(Note: The signatures are on file and are included in the original "hard copy" document sent to NASA on October 17, 2003. The signatures are not included on this document, which has been uploaded on the web).

Sherry O. Farwell, Ph.D. – Director, SDSGC
SD School of Mines & Technology

Kevin Dalsted – Associate Director, SDSGC
SD State University

Daniel Swets, Ph.D. - Associate Director, SDSGC
Augustana College

Gregg Johnson – Science Dept. Manager
USGS EROS Data Center