National Space Grant College and Fellowship Program

20th Year Evaluation

Kentucky Space Grant Consortium Program Performance and Results 2003 - 2007

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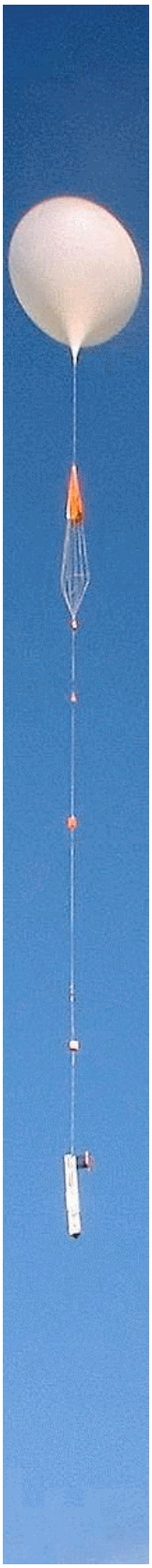

Kentucky Space Grant Consortium
Program Performance and Results
2003 - 2007

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Kentucky Space Grant Consortium

IV. Executive Summary and Consortium Impact

The Kentucky Space Grant Consortium (KSGC) serves the needs and emphases of NASA's National Space Grant College and Fellowship Program while serving the specific needs of the Commonwealth of Kentucky, through a program that enhances capabilities for space-related research and education in Kentucky, and develops future workforce for NASA, Kentucky, and the Nation.

Mission: To promote Educational Excellence through the advancement of expertise in space-related research, education, and public education in Kentucky, involving Kentucky's citizens at all levels of the education system and beyond.

Goal and Purposes: Within the structure of the national program, KSGC was a Capability Enhancement Program during the period 2003 through 2005 and a Designated Consortium beginning in 2005, with the primary goal of developing expertise and capacity for space-related research and education in Kentucky. In fulfilling its mission, the KSGC program serves several constituencies -- NASA, the Nation, and Kentucky, including Kentucky's university/college faculty, students, teachers, and general public of all ages. The KSGC "mix" of program elements and emphases is tailored to recognize the needs of Kentucky and its constituents, always as derived from the national program guidance.

Objectives: The Kentucky Space Grant Consortium's objectives are:

1. **Enhancement of research and education capabilities in space-related fields**
2. **Increased numbers of people training for the workforce in space-related fields**
3. **Greater public awareness of NASA and space-related research and applications**

Impacts, Accomplishments and Highlights: During 2003-2007, the KSGC enhanced researcher's capabilities and developed NASA- and space-related research capacity in Kentucky by supporting university faculty and students in 39 space-related "seed" research projects (of 49 activities including conferences), and 64 faculty-mentored research projects by 42 fellowship/scholarship students. Faculty "seed" research projects involved 153 undergraduate and 39 graduate students. **Funding was determined competitively**, with the goal of further developing the competitiveness of faculty for achieving follow-on funding and of students for placement in the workforce or advanced degree programs. Researchers with "seed" funding developed capabilities to achieve more than $6M in follow-on funding from other sources for sustaining their research. The "seed" research and fellowship/scholarship research projects together resulted in dissemination of results through 117 scientific papers and presentations. **NASA ties** included 441 collaborative ties in the research projects and the collective alignment of research with all of NASA's Mission Directorates. Other research relationships included **38 ties with industry,** 24 ties with other Space Grants, and 173 interdisciplinary collaborations.

Aerospace-related workforce development is central to the mission of the KSGC. Our objective is to develop students' capabilities for an aerospace-related workforce for NASA, NASA's contractors, and universities that conduct research in support of NASA's needs and interests. Our research-based fellowships and scholarships made major contributions in this area, training 42 students in aerospace-related degree programs, including three in science teacher preparation programs to support the development of future participants in the science, technology, engineering, and mathematics (STEM) workforce. **Diversity of participation was achieved**, with 10.9% from underrepresented groups (compared with 10.2% in the National Center for Education Statistics and 10.1% in Kentucky's population), and 50% women, commensurate with their representation in STEM enrollments in Kentucky. Ultimately, a major aerospace workforce development project involved 42 undergraduate students in a large-scale, NASA-like comprehensive flight mission experience related to future explorations of Mars.

Enhancement of the capabilities of Kentucky's teachers for teaching science and mathematics in inspiring ways is a recognized need in Kentucky that is supported by the KSGC's Higher Education and Precollege programs. Teacher workshops and professional development activities in these program areas provided 1,143 teachers with enhanced subject knowledge, teaching skills, and student-involvement activities to inspire participation-based learning in their classrooms. Our Higher Education Program, emphasizing undergraduate education, supported professional and educational development activities for 321 faculty members and 765 students at Kentucky institutions of higher education, including field trips to NASA Centers and other science and engineering facilities, participation in scientific meetings, and development of courses and activities for courses in the undergraduate curriculum. KSGC supported some special opportunities such as high-school Moon Buggy teams and FIRST Lego League competitions, to encourage students to pursue higher education in STEM areas.

Enhancement of the public's understanding of STEM disciplines and awareness of NASA- and space-related research and applications has important consequences in support for space-related enterprises and in encouragement of young people to prepare for STEM careers. For these purposes, KSGC served more than 122,191 people with NASA-based planetarium presentations. More than 137,825 people were served through other outreach activities, and an unknown number through media interviews on special astronomical events and the workforce development "Mars glider" and KySat projects. Important public service was also rendered by KSGC personnel **working with state government organizations**, such as reviewing teacher education programs for the Kentucky Department of Education. A major KSGC accomplishment was the maintenance of earth and space science at all levels of Kentucky's revised K-12 curriculum.

In summary, the Kentucky Space Grant Consortium is serving identified needs of NASA and Kentucky by developing a base of participants with capabilities for space-related research and education; by increasing the numbers of people training for space-related careers; and by enhancing education and public awareness of space-related research and exploration in the national interest. Special opportunities for the KSGC extend into the future in building capacity for space-related research and education in Kentucky, in relating to R&D in NASA Mission Directorates and Centers, in managing and complementing the Kentucky NASA EPSCoR Program, and in building research and education infrastructure. The KSGC provides in Kentucky an important two-way interface for the long-term, mutually beneficial relationship between NASA and the American people.

V. Foreword

Purpose and Mission

The Kentucky Space Grant Consortium (KSGC) is a network of 14 affiliates. The KSGC is a partnership between NASA and Kentucky, which brings benefits of NASA to Kentucky to inspire and guide research, education, and workforce development. Benefits to NASA from Kentucky include development of future workforce for NASA and its contractors and university researchers, and enhanced awareness and appreciation of NASA's benefits to the Nation among Kentucky's teachers, students, and general population.

Specific Charter: Capability Enhancement 2003-2004 Designated 2005-2007

Established in 1992 in Phase II of the National Space Grant College and Fellowship Program, the KSGC is a Capability Enhancement Program, which is tasked by NASA to develop space-related research and education capability in a state that has not traditionally participated at high levels of competitiveness in federally-funded research and development. Transition to Designated Space Grant Consortium brought the ability to focus more on workforce development of students.

Needs of Kentucky

The KSGC Program is designed to serve identified needs of the Commonwealth of Kentucky within the framework of national emphases for Space Grant programs. Relevance of KSGC to the needs of Kentucky is indicated by the following:

- Kentucky in 2003 ranked 39th in NASA funding and 40th in federal R&D funding
- Kentucky in 2004 ranked 48th in percentage of scientists/engineers in the workforce
- Kentucky in 2005 ranked 47th in educational attainment of the workforce
- Kentucky began in 1990 a process of thoroughly revising its system of public education

Kentucky has a population of 4.0 million (2000 U.S. census), of which 7.7% are African American, 0.9% are Asian, 0.6% are Native American, and 0.9% are other races (totaling 10.1% minority population). The Hispanic and Latino population of all races is 1.5%. The population distribution is nearly equally divided between rural and urban. Kentucky's economy was traditionally based largely on agriculture and mining; however, manufacturing and service industries now lead the economy. Kentucky's major industries include Ford, Toyota, and GM/Corvette manufacturing plants, Lexmark, GTE, GE, and a major UPS air hub. Kentucky has neither a NASA Center nor a significant aerospace industry presence. For the development of a technology-based state economy, Kentucky can benefit from involving more of its faculty and students in space-related R&D, working toward future opportunities for Kentucky's students for technology-based employment in Kentucky, with NASA, or in the aerospace industry.

KSGC Goals

The Kentucky Space Grant Consortium has as its overall goal the development of expertise in space-related research and education needed by NASA and by Kentucky. We seek to enhance the quantity and quality of space-related research and education in Kentucky, and to contribute to the development of the technological workforce that is needed for the future in NASA, NASA's contractors, university research endeavors, and the Commonwealth of Kentucky.

KSGC Program Mix and Funding Opportunities

Consistent with national program goals, the Kentucky Space Grant Program is designed to address specific needs of the Commonwealth of Kentucky. The identified needs of Kentucky are the basis for Kentucky's mix of relative emphases on program elements (indicated in **boldface** below). The emphasis in each area is indicated by the average percent of our program's NASA budget (base plus other NASA support) devoted to it: **Fellowship and Scholarship** awards (25%), **Research Infrastructure** "seed" awards (14%), **Higher Education** teacher workshop awards and an aerospace workforce development project (21%), **Precollege** projects (6%), and **Public Service** activities (1%). For the latter two areas, funding requirements are minimal, as activities are conducted with contributions of time and effort by Consortium members.

Objective 1 - Enhancement of research and education capabilities in space-related fields: In order to develop space- and NASA-related **Research Infrastructure** in Kentucky, KSGC competitively awards "seed" funding to initiate research by faculty at Kentucky institutions, and **Fellowships/Scholarships** for faculty-mentored student research. The need for development of space-related research capability in Kentucky is evidenced by the ranking of Kentucky among the states in regard to research funding from NASA (39^{th}) and all federal agencies (40^{th}), and the anticipated increased dependence of Kentucky's economy on manufacturing and technological applications. Research and scientific training in Kentucky are major components of the legislatively-mandated reformation efforts in Kentucky higher education. The state seeks to develop its two Doctoral/Research Universities to high levels of national competitiveness, and to engage its six public Comprehensive Universities in research with relevance to their regions. KSGC recognizes the need for excellent K-12 teaching to inspire and prepare students to pursue STEM careers.

Objective 2 - Increased numbers of people training for the workforce in space-related fields: The KSGC seeks to develop human capital for participation in the future workforce of NASA, its contractors, aerospace industry, and universities involved in space-related R&D. Workforce development is facilitated both by KSGC **Fellowships/Scholarships** and by components of our **Higher Education** Program. Future population of these programs depends upon early entry of students into the "pipeline" of preparation for careers in science, technology, engineering, and mathematics (STEM). Our **Precollege** programs develop teachers' capabilities for inspiring and preparing students for STEM careers.

Objective 3 - Greater public awareness of NASA and space-related research and applications: Broad public support is needed for NASA, space-related research endeavors, space exploration, and the ongoing development of a technology-based economy. Through the contributions of Consortium members, KSGC provides **Public Service** to enhance the public's understanding of the space-related sciences; to inform the public about NASA- and space-related science and technology; and to motivate future support for, and participation in, these endeavors.

VI. Programmatic Elements

A. Consortium Management

Description

Management Structure, Operations, Decision and Policy Making, and Procedures: The Kentucky Space Grant Consortium management is democratically based in the KSGC Committee, which consists of a voting representative from each affiliate member institution. The Committee is chaired by the (non-voting) Director of the KSGC. The Committee makes major decisions of policy for the Consortium, and determines awards for projects through statewide proposal competitions. Day-to-day management of communications, RFP preparation and distribution, receipt and distribution of proposals, organization of meetings and conferences, distribution of awarded project funding, fiscal monitoring of project expenditures, collection of data, and program reporting, are vested in the management staff at the Lead Institution.

Self-Assessment and Evaluation through Collaborative Participation: Reflective self-assessment and evaluation of the operation and effectiveness of the KSGC program is accomplished collaboratively by the governing Committee, primarily through two processes. On a continuing basis, policies and practices are assessed and modified as needed through discussions and analysis at the annual meetings. Periodically, as in the case of the 20th year evaluation, the affiliate representatives on the Committee collaborate in producing the Consortium's performance report, including a self-evaluation of the program and its effectiveness. Each member provided input, analysis, and text from his/her perspective, and certified agreement with this PPR document by signing the concurrence statement.

Analysis of Core Criteria

KSGC Strategic Plan

The Plan for our consortium changed and developed during the past five years through the whole process of writing the proposal for upgrade to Designated status. Strategic objectives for the Kentucky Space Grant Consortium are established in the areas of research, education, and public service. A common focus in all of these areas is to involve women, underrepresented groups, and persons with disabilities.

Our strategic objectives provide the framework of principal activities and emphases by which the KSGC achieves its goals and objectives in support of the identified needs of Kentucky and its citizens, of NASA and the national Space Grant program, and of the Nation.

Consortium Structure/Network (Internal)

Affiliates: Our fourteen affiliate members are listed and characterized below:

- Bellarmine University ..... Private, Parochial University
- Centre College ..... Private College
- Eastern Kentucky University ..... Public Comprehensive University
- Kentucky Center for Space Enterprise ..... Non-profit Organization
- Kentucky State University ..... Public Comprehensive University, HBCU
- Morehead State University ..... Public Comprehensive University
- Murray State University ..... Public Comprehensive University
- Northern Kentucky University ..... Public Comprehensive University
- Thomas More College ..... Private, Parochial College
- Transylvania University ..... Private University
- Tribo Flow Separations, LLC ..... Industry
- University of Kentucky ..... Public Doctoral Granting University
- University of Louisville ..... Public Doctoral Granting University
- Western Kentucky University ..... Public Comprehensive University

Effectiveness, Degree of Participation: Participation in proposal submissions by faculty and students at member institutions is variable from year-to-year, and is affected by the research emphases and workload demands on the faculty of the institutions. Most of the research-based applications come from the larger, public institutions. The smaller, private institutions are not research-intensive, and participate more through local education and public outreach activities. Campus Directors note that the Consortium has worked effectively since its creation in 1992, attributing its strength to the fact that, while collegial, the members have been very open in expressing their objective opinions about the merits of projects and proposals. Upon identifying the lack of industry affiliates as a weakness, the Consortium added one in 2001 and is planning to add more in the future. Another weakness may be in the numbers of institutions submitting proposals, which is being addressed by consulting Campus Directors about factors that could improve responses on their campuses. Campus Directors at private institutions note that more cooperation between public and private institutions might help, and that start-up is difficult at private institutions with little infrastructure or history of support for research.

Campus/organization representatives: Each affiliate member institution is represented by a Campus or Institutional Director, who serves on the KSGC Committee for policy making and awards selection. The affiliate representatives participate in Consortium operations, communicate program opportunities to their constituents, and contribute to a NASA presence and involvement at their institutions. Campus Directors organize NASA interactions with their campuses, and are viewed as a NASA presence. All Campus Directors have participated in meetings and conferences, and have contributed to determinations of policy, procedures, and reviews of program effectiveness. A strength of this representation is that each Campus Director conveys the perspective of his/her institution, in relation to its characteristics, values, needs, and opportunities. A weakness may be that the degree of attention and aggressiveness in performing Campus Directors' duties is variable and dependent upon the individual and his/her circumstances. Recognizing that this factor affects the degree of participation of faculty and students at the member institutions, we continue to have Campus Directors share "best practices" in our meetings.

Communication: Communication within the KSGC network throughout most of the year is primarily "vertical" (Center Office to/from affiliate members), including distribution of the annual RFP for dissemination to faculty and students at member institutions, announcement of special opportunities of interest to members, collection of data for program reporting requirements, and requests to/from Campus Directors for special assistance with projects at their institutions. "Horizontal" communication among member institutions and their representatives mainly occurs as part of the annual KSGC Aerospace Forum and KSGC Committee meetings.

Policy for adding and dropping affiliates/consortium members: Kentucky institutions of higher education and industries are eligible to join the Consortium, at no cost other than the commitment of effort by a Campus Director. Three educational institutions and an industry affiliate have joined since the founding of the KSGC. An invitation for recruitment of new affiliates is included in webpage announcements of program opportunities. There is no existing plan for dropping affiliates, except that they could be dropped at their own request. Funding for projects is open on a competitive basis to members of all affiliate institutions. Strengths of our Consortium are our openness to membership and the ability of members to participate at levels depending on circumstances and needs at their institutions.

Coordination between and cooperation among affiliates: The KSGC program is based primarily upon competitive proposals from faculty and students at member institutions. Eligibility for funding and the procedures of the Committee insure fair competition and fair distribution of funds. Faculty and students at all member institutions are eligible for funding in the competitions, and all institutions are equally represented on the Committee that decides the awards. The Committee is especially sensitive to opportunities that maximize participation among all of the member universities. A major strength of our program is the willingness of our Committee members to cooperate and emphasize the overall good of the program.

Meetings: The KSGC Committee normally meets annually in the spring to select awardees and to discuss programmatic issues. The annual meeting is timed in conjunction with the annual statewide KSGC Aerospace Forum, in order to evaluate outcomes from presentations of project results from the preceding year. A strength has been the communication of results and the cooperative selection of funding recipients. A possible weakness suggested by a Campus Director is the lack of time at one busy meeting to communicate more about program goals and needs and to share ideas and best practices. We have added additional meetings for these purposes and set aside specific time particularly at our evening meeting.

Diversity

The Consortium Director is a woman with a disability. Another woman with a disability as well as a male with a disability, and a native American serve on the KSGC Committee that makes award selections and other decisions concerning the activities of the Consortium. Representation from Kentucky's public HBCU serves on the KSGC Committee. The diversity represented on our Committee is a strength; however, there is room for growth in future additions.

Consortium Operations

Facilities: The KSGC Center Office is housed in the Hardin Planetarium at Western Kentucky University in Bowling Green, Kentucky. The KSGC office facilities include the main office, which includes space for the KSGC Director, a dedicated telephone (270-745-4156), and word-processing equipment. The secretary shares duties with the planetarium, with a half-time effort devoted to the KSGC. The secretary's office in the planetarium provides word-processing

equipment and a FAX machine (270-745-4255). The KSGC offices are in a landmark building located near a major campus entry point. Additional space is conveniently available for meetings, multi-media presentations, and workshops including the planetarium chamber, museum area, lecture hall, and rooftop observatory.

Staffing Levels: KSGC management staff at Western Kentucky University includes the Director (average 0.8 FTE/year) and Associate Director/Program Manager (average 0.5 FTE/year). Combined support staff had variable totals, including Coordinator and Administrative Secretary, averaging a total of 0.8 FTE/year during 2003-2007. The Consortium experienced a change in directorship during the past five years due to the passing of Richard Hackney, with the leadership transition to Karen Hackney, the long-time Associate Director/Program Manager, occurring at the spring 2007 Committee Meeting. The impact on consortium operations has been minimal. Affiliate representatives (Campus or Institutional Directors) are volunteer representatives from each member institution who serve on the KSGC Committee and facilitate Consortium activities at member institutions. If their time-and-effort contributions are accounted as in-kind match for projects at their institutions, the contributions are reported with the projects.

Composition, role and purpose, and meeting frequency of Executive Committee: The KSGC Committee is composed of one representative from each of the 14 member institutions. The KSGC Committee makes major policy decisions and selects awardees for project funding based on an annual statewide proposal competition. The Committee normally meets annually in the spring to select awardees and to discuss programmatic issues. Major strengths include fair representation of all affiliates in decision-making, and the expertise of committee members in several disciplines that relate to NASA's mission. A weakness may have been meeting only once per year, with many things to accomplish. We held an additional meeting in 2003, the Southeast Regional Meeting in 2006, and an additional meeting in 2007, and are planning more frequent meetings to share ideas and information about programming at the affiliate institutions.

Resource Management

Consortium Budget: For reference, NASA Space Grant funding for KSGC was $256,250 in 2003 and $293,000 in 2004, and there was an additional, competitively awarded workforce augmentation of $100,000 each year. With the achievement of Designated status, the amounts have been $542,936, $580,000, and $589,399 as reported by CMIS.

Matching Funds and Leverage: KSGC matching funds derive primarily from three sources: (1) institutional (affiliate and lead) and industrial cost sharing on awarded project funding, (2) provision of some management costs by the lead institution, and (3) state-derived funding for program facilitation. Some projects also leverage additional funding support from federal, state, or other sources. An indication of the relative contributions of sources of match and leveraged funding is given by the five-year averages of combined match and leverage in the Consortium Management Information System (CMIS) and reproduced for reference below:

Matching and Leveraging ($) -- Averages for 2003-2007								
Matching Funds			**Leveraged Funding**					**Combined**
Lead Inst	Affil Inst's	Industry	State Gov't	Other Federal	Non-Profit	Partici-pants	Other	Total
117,285	283,457	3,540	25,079	203,300	39,476	240	11,400	683,777

In the detailed year-by-year data in *CMIS Summary III-A*, significantly higher leveraging of other federal funding occurred during the second half of the period, which is indicative of the success of program participants. A significant achievement is that we have exceeded the basic non-federal matching requirement by an average of $132,365 per year. In earlier years, it was difficult to make the match, and a challenge that remains is getting institutions to report the match properly. Progress has been made by requiring the reporting of cost share as it used.

Allocation of funding across affiliates for Fellowship/Scholarship is reported (in *CMIS Summary III-B*) as combined matching-plus-leveraging. Since our program does not have block allocations for affiliates, the matching-plus-leveraging figures for the affiliates reflect relative levels of proposal submissions, success in competitive awards from KSGC, and leveraging of other agencies by the affiliates.

Management expenses/administrative costs: Management and administration costs for the statewide KSGC program are accounted to the lead institution and are listed in *CMIS Summary III-A*. Direct labor costs for management are provided jointly by NASA and the lead institution. Other costs include travel to Space Grant meetings and functions, supplies/services for printing program information and educational resources, and other direct costs supporting conferences, meetings, and dissemination of program information. Overall, the administrative costs experienced a steady rise during 2003-2007. Strengths include dedicated management that works to facilitate all levels of program function, including financial management assistance for affiliates, and sharing of management costs by the lead institution. Another strength has been minimal assessment of indirect costs (an average of $23,559 or 4.8 % in 2003-2007).

Allocation of funds across program elements: The *CMIS Summary III-A* table *Program Allocation - NASA Dollars* reflects relative program emphases and costs, as discussed and justified in the program element sections of our report. Differences within the period 2003-2007 are indicative of the proposals received and funded in the areas, and no significant trends are evident. The *CMIS Summary III-A* table *Match and Other Federal Funds* indicates the leveraging capabilities and accomplishments of the projects funded in the program elements.

Collaborations and Partnerships Outside the Consortium

Collaborative Linkages with NASA and Other Space Grant Consortia: NASA linkages play important roles throughout our programs. **NASA ties** included 441 collaborative ties in the research projects and the collective alignment of research with all of NASA's Mission Directorates and 24 ties with other Space Grants. A strength is that the program and its participants have established many collaborative linkages with NASA, contributing to the effectiveness of all parts of our program. A weakness is that more linkages could be established, and we plan to place even more emphasis on this objective.

Other governmental and non-governmental national/state/local entities: These linkages have been a major strength of our program, and have affected both education policy and evolution of economic development plans in the state. KSGC coordinates with the Kentucky NASA EPSCoR program through shared management staff, partial overlap of membership of committees, and interaction among researchers at the annual KSGC Aerospace Forum and statewide Kentucky EPSCoR Conference.

Impact/Results

The accomplishment of our Consortium goals and objectives is strongly supported and directly facilitated by our network, our management structure, and our operating policies. Our network is broadly based in academic institutions of various types and emphases, including all of Kentucky's public universities, and NASA-interested private institutions. Strength is added by an industrial affiliate and a non-profit organization. Our affiliate representatives bring expertise in an array of STEM disciplines. Our organizational structure is democratically based with equal representation from all affiliates. Our members work well together in a cooperative spirit for the overall good of the Consortium and its impact statewide. Our funding distribution is based on statewide competition, with Consortium members working together to select the strongest proposals for funding. Faculty and students from all affiliate members are eligible and invited to propose projects. Dedicated management in the central office organizes the competitions, the meetings of the Committee, and the annual Aerospace Forum, and provides year-round monitoring of funded projects, financial management, communications, collection of project data, reporting of results to NASA, and interaction with other consortia and the national program. The structure and policies of the Consortium provide an effective framework for achieving Consortium goals. Within this framework, the hard work and cooperative efforts of the people who comprise the Consortium are responsible for the success of the KSGC program.

B. NASA Education Outcome 1: Consortium Programs

Fellowship/Scholarship Program

Description

Purpose and Goal: Our Fellowship/Scholarship Program facilitates research-based training of students for the workforce in space-related fields.

Objectives of our Fellowship/Scholarship Program are:

- **Increased numbers of people training for the workforce in space-related fields**
- **Effective preparation based upon research experience for the student**

Characteristics: Awards of **Graduate Fellowships** and **Undergraduate Scholarships** are competed statewide, and require a research component. Awards are based both on student qualifications and on a proposal for a faculty-mentored student research project in a space-related field or teaching specialization. Students at all Consortium member institutions are eligible to submit proposals, and the Consortium-wide Committee of all Campus Directors decides on awards. **Graduate Fellowship** awards are in amounts up to $18,000 per year. **Undergraduate Scholarship** awards are up to $5,000 per year. Fellows and Scholars must be U.S. citizens and must be accepted for admission to a program at a Consortium institution leading to a degree in a space-related field or teaching specialization. We encourage applications from women and underrepresented minorities, and from students involved in NASA projects such as NASA EPSCoR. The NASA Academies have provided NASA-mentored summer research opportunities for students at NASA Centers.

Consortium Budget: Fellowships and scholarships are a major emphasis of our program, consistent with the goals of the National Space Grant College and Fellowship Program and our emphasis on workforce development. On average, we devote about 25% of the Consortium's NASA budget to our Fellowship/Scholarship Program. No trends are evident.

Assessment and Evaluation: Awards are based on student credentials and the quality of their proposal for a faculty-mentored student research project. Preliminary assessment is made by the KSGC Committee in judging quality and potential in both areas. Evaluation of project results is based on presentations at the annual KSGC Aerospace Forum and a project report describing project results and output measures. Renewal of a graduate project or funding of a subsequent undergraduate project is based on the student's academic performance and presentation of results.

Analysis of Core Criteria

Diversity

KSGC Fellowship/Scholarship awards in the reporting period exceeded the diversity objectives of the National Space Grant College and Fellowship Program in reference to awards to underrepresented minorities and women. Our average 10.9% of awards for minorities is at the level of 10.2% in the National Center for Education Statistics and 10.1% minority enrollment in Kentucky universities. In Kentucky, women constitute only 19% of the bachelors degree graduates in engineering and computer science and 44% in science and mathematics (R. Sugarman, "The Status of Women in Higher Education", in *The Future Well-Being of Women in Kentucky*, published by The Kentucky Long-Term Policy Research Center, 1999, pp. 47-55). Our average of 50% of awards to women exceeds the statistical populations for which data are available. Recruitment depends upon affiliate-member faculty researchers who want to work with students in mentored research projects, finding and recruiting qualified students who are interested in the research area. Affiliate researchers are aware of the need for diversity, and they attempt to engage students in the targeted groups among students who have been admitted to their degree programs. Success is gauged by involving students in targeted groups at levels at or above their enrollment levels in eligible majors.

Competitiveness

Fellowships and scholarships are competitively awarded through a statewide proposal competition. A faculty mentor and student jointly submit a proposal, and awardees are selected by the KSGC Committee of Campus Directors, with representation from all member institutions. The potential distribution of the awards among affiliates depends upon voluntary faculty participation in proposals from the affiliate institutions. Selections are made primarily on the basis of student qualifications and proposed research, with sensitivity to fostering participation among the affiliates and by underrepresented groups. Awards were made to all of the seven institutions that submitted proposals, which are the more research-active institutions with active faculty mentors. Our *CMIS* data contain only actual awardees and therefore do not reflect the award rate. In all cases, the awards are competitive and based on quality, and mentors typically recruit highly qualified students for the applications.

Consortium Specific

Supported both graduate and undergraduate students: Both graduate and undergraduate students were supported, with nearly equal numbers of awards (34 graduate, 30 undergraduate).

Effective student research and mentoring components for undergraduate scholarships: All KSGC fellowships and scholarships require and are based upon faculty-mentored student research projects. Undergraduate research involvement helps determine career directions, and is a motivating factor for persistence in challenging degree programs. Outcomes include oral and/or written presentation of project results and progress toward earning a STEM degree.

Effective student research and mentoring components with NASA field centers and industry: We have achieved student research with NASA field centers primarily through the NASA Academy programs at the centers. Our participants in these programs were mentored by NASA researchers in research projects conducted at the centers. With most of our student research projects conducted at universities while taking courses for degrees, mentoring is primarily by a faculty member on-site, with consultations with NASA or industry personnel as needed for the project. Space Grant ESMD awards have funded five industry internship students.

Impact/Results

The major strength and impact of our program is the level and quality of the participants who have applied, have been competitively selected, and have been successful in achieving their degrees. Those who have finished their initial program are now either continuing their formal education in higher degree programs or have entered the workforce, and will serve Kentucky, NASA, and the Nation by contributing to the future workforce and accomplishments in aerospace-related fields and education. During 2003-2007, 64 awards (34 fellowships, 30 scholarships) were made to 42 different students, including 16 funded for more than one year. More graduate students competed for second year (7) or third year (1) or fourth year (1) awards, as they progressed in their graduate degree programs, compared with 7 undergraduate students who received second awards for new projects in subsequent years. Scholarships were provided for NASA Academy participants.

KSGC Undergraduate Scholarship awards to 24 students contributed to 18 BS degrees. **KSGC Graduate Fellowship** awards to 18 students contributed to 13 degrees, with 5 students still working toward their degrees. A significant strength was that **diversity objectives were met**, as indicated by 10.9% minority awards (relative to 10.2% minority enrollment) and 50% awards to women, commensurate with Kentucky enrollments in STEM fields. Some of the scholarships involved **mentoring of student research at NASA Centers**. The student research projects resulted in 73 **papers and presentations**. A weakness of the program has been lack of participation by students/mentors from some member institutions, and lack of even broader representation of eligible fields. These issues are being addressed in discussions within the KSGC Committee, and we are working to find ways to motivate broader participation by faculty mentors.

Research Infrastructure Program

Description

Program

Purpose and Goal: The purpose and goal of our Research Infrastructure Program is for faculty to provide research experiences for students, thus

developing and increasing capabilities of Kentucky researchers at all levels in contributing to the aerospace workforce.

Objectives of our Research Infrastructure Program are:

To use our research infrastructure to enhance the aerospace workforce in Kentucky, through:

- Increasing the numbers of Kentucky student and faculty to become aerospace-related researchers
- Providing connection among Kentucky research efforts and NASA interests and researchers
- Enhancing competitiveness of Kentucky researchers for NASA and other related funding

The aerospace workforce consists of employees of NASA, employees of NASA contractors, employees of aerospace industries, and university faculty engaged in aerospace and NASA research. Our Research Infrastructure Program develops research capabilities and connections with NASA, and is especially important as a platform for involving students in research as a basis for their development as members of the aerospace workforce in any of the listed roles.

A major contribution of the Research Infrastructure projects is the involvement of students in research experiences, with several of them being female. The faculty continue seeking women and minority students. The students are involved in all phases of the research, including experimental design, collection of data, analysis and presentation of results. Through their participation in these experiences, the students gain an understanding of the process of scientific investigation, interaction with others in the field including NASA personnel and/or data, and skills for communicating scientific results. Retention rates are usually high, as these students are motivated to pursue their fields with purpose; with many graduates inspired to pursue advanced degrees appropriate for advanced goals for achievement in the field.

Program Characteristics: Each year, the KSGC invites proposals for up to $15,000 in support of space-related research capability enhancement projects by faculty at Consortium affiliate institutions. Research "seed funding" is intended to enhance the investigator's competitiveness for future funding. Eligibility for renewal is contingent upon indication of application for other sources of funding. Investigators develop projects related to NASA Mission Directorates. The proposals are externally reviewed, and decisions on awards are made by the KSGC Committee.

Consortium Budget: Development of Research Infrastructure through competitive awards of "seed" funding for research is a major goal of our program and is supported by a substantial portion of our budget. On average, we devote 14% of the Consortium's NASA budget to our Research Infrastructure Program. There are no significant trends in the funding, as variations are attributed to year-to-year variations in submitted proposals and quality. The research awards provide a substantial portion of the Consortium's non-federal matching requirement, averaging $166,110 per year in cost sharing by the institutions as a commitment to the research projects.

Assessment and Evaluation: Research proposals are reviewed and assessed by the KSGC Committee before consideration for funding. Performance of awardees is evaluated in terms of a final report of accomplishments of the project, including metrics such as publications, presentations, proposals, and follow-on funding. Eligibility for further funding is evaluated on the basis of progress and efforts to secure external funding, as reported in subsequent proposals.

Analysis of Core Criteria

Interdisciplinary

Overall, our program is a multi-faceted cooperation of many disciplines of study that relate to NASA and to space. The Research Infrastructure projects involved 68 interdisciplinary (interdepartmental) collaborations. Examples include mechanical engineering and astrophysics in computational fluid dynamics, computer science and space science in coding ground station software, physics and electrical engineering for microelectromechanical systems (MEMS), environmental engineering and geography using remote sensing and geospatial tools for Thematic Mapper and Thematic Mapper+ data, aeronautical/aerospace engineering and physics for the study of ice on the wings and various parts of aircraft and the external tanks of the space shuttle, physics and computer science in the study of dark neutral supersymmetric matter, chemistry and electrical engineering in the study of the self-assembly of nanoparticles on solid surfaces, application of chemistry and physics in combustion and propellant studies, materials science and mechanical engineering in space structure studies, and physiology and physics in studies of effects of prolonged exposure to reduced gravity.

Alignment with NASA

KSGC research activities support and are aligned with three of NASA's Mission Directorates: Science, Exploration Systems, and Aeronautics Research Mission Directorates. Each project must have a NASA collaborator.

Consortium Specific

- **Opportunities for not-yet-established faculty:** KSGC funding provides opportunities to "seed" research projects by not-yet-established faculty researchers. The funding, including institutional matching time to facilitate the research, enables entry-level researchers to establish projects as the basis for competing for future national-level funding.
- **Coordination with other NASA programs:** The KSGC Research Infrastructure Program operates in tandem with NASA's Experimental Program to Stimulate Competitive Research (EPSCoR) in Kentucky. Coordination is achieved through shared management of the programs and some overlap in the membership of the Committees that oversee them. Several researchers who had initiated space-related research efforts with KSGC funding progressed to a higher level of competition and achieved subsequent funding through NASA EPSCoR.
- **Enhanced collaborations for faculty partnerships with NASA personnel:** Faculty research projects involved 441 collaborations with NASA.
- **Activities linking academic affiliates and industry:** Our main workforce development projects link to industries including Belcan, ILC Dover, and space-related SBCs.

Recruitment and/or participation of women, underrepresented minorities, and persons with disabilities: In our solicitation of proposals for research projects, we encourage participation by women, underrepresented minorities, and persons with disabilities. In Kentucky, these groups are very poorly represented in the faculty composition in STEM disciplines, and there are few available to apply. We try to personally encourage applications when we know of a member from an underrepresented group who has research training in a space-related discipline. During 2003-2007, we had one African American awardee, who went on to successful

competition at the next level of Kentucky-based space-related opportunities -- NASA EPSCoR. Several female faculty members proposed and received KSGC funding.

Impact/Results

The strength of the KSGC Research Infrastructure Program is its impact on Kentucky's capacity for research in NASA- and aerospace-related fields. The program supported Kentucky researchers in developing 39 aerospace-related research projects (of 49 including conferences), enhancing the researchers' capabilities for service to NASA in future R&D projects. Our investment of $340,429 in "seed" funding resulted in more than $6M in follow-on funding obtained by KSGC-funded researchers. The "seed" projects included $61,276 in support for student participants. Follow-on funding further enhances the researcher's capabilities, and provides continuing opportunities for students to participate in the research programs. The impact on the development of human capital in Kentucky is only partially conveyed by the output metrics, as there are many other immediate and lasting effects for individual faculty and students.

Research Infrastructure Program 2003-2007		
Metric	**Previous 5 Years**	**Current 5 Years**
Follow-on proposals submitted	67	61
Follow-on proposals funded	36	25
Follow-on funding awarded	$7,604,770	$6,220,450
Collaborations with NASA	35	441
Collaborations with Industry	15	38
Collaborations with other Space Grants	14	24
Publications/Presentations	166	117

The KSGC-funded "seed" research project **results were conveyed to the scientific community at large by 117 papers and presentations**. The principal investigators reported a total of 556 people involved in the projects, including 153 undergraduate and 39 graduate students, and other collaborators at the same or other institutions and in NASA and industries. **Collaborative interactions included 441 with NASA, 38 with industries, and 24 with other Space Grants.** In all, there were 556 direct participants in all areas. Infrastructure conferences and development programs involved 300 people (including some of the project participants). The "seed" funding and/or institutional match typically **included "release" time from teaching load assignment to facilitate the research**, helping to establish research programs in some institutional environments with heavy teaching loads, providing the basis for research projects that can be maintained into the future by attracting follow-on funding. We maintain a database of space-related projects and investigators, and coordinate with the Kentucky NASA EPSCoR program to avoid double-funding and to aid progression to higher levels of funding. A particular strength continues to be involving students in original research. We would like to achieve wider distribution of research areas, and greater participation by women and minorities choosing to propose for KSGC funding. We are addressing these points in the preparation of future RFPs and in their distribution and emphasis on the campuses by the Campus Directors.

Higher Education Program

Purpose and Goal: The purpose and goal of our Higher Education Program is to utilize NASA- and space-related resources and subjects to enhance STEM teaching and learning in and through Kentucky's institutions of higher education.

Objectives and Program Characteristics:

- **Special workforce development opportunities for faculty and students:** This rapidly growing area includes unique, interdisciplinary opportunities for faculty and students in higher education to interact in project experiences that develop practical and collaborative skills in preparation for participation in the STEM workforce.
- **Enhanced higher education development experiences for faculty and students:** These experiences are typically specific to individual member campuses, and many are supported by small "Campus Objectives Grants" (up to $1,500) to Campus Directors. Examples include field trips to NASA Centers, participation in scientific meetings, participation in NASA launches, planetarium presentations, development of participatory classroom activities, and development of new courses.

Consortium Budget: During 2003-2007, Higher Education projects were facilitated by an average of 21% of the Consortium's NASA budget. In 2003 and 2004, the Consortium received a competitive award of an additional $100,000 each year for workforce development, of which 100% is reported in *CMIS* under the Higher Education Program. Our Higher Education expenditure for 2003 and 2004 amounted to 31% of the total NASA budget including this augmentation funding.

Assessment and Evaluation: Projects are assessed and evaluated based upon the communication of results at the KSGC Aerospace Forum, the reporting of previous results in proposals for support of subsequent workforce development or other projects, and in final reports at the end of the award period.

Analysis of Core Criteria

Interdisciplinary

Of 44 reported programs, with 172 projects, 68 reported interdisciplinary involvement of other departments at their institutions. Interdisciplinary collaboration is an essential part of our Higher Education workforce development program, in which the design and execution of a student flight mission involved expertise in several component disciplines. The project's mentors came from mechanical engineering, aeronautics, electrical engineering, and physics, and the collaborating students were majors in mechanical engineering, electrical engineering, and computer science. Development of interdisciplinary courses and curriculum occurred through senior design courses in the workforce development inflatable-glider project, which combined elements from several engineering disciplines into an integrated, interdisciplinary project.

Consortium Specific

Recruitment and/or participation of women, underrepresented minorities, and persons with disabilities: The development of scientific talent among women and minorities in Kentucky depends upon female and minority role models.

Higher education program places an emphasis on undergraduate education: In most of our Higher Education projects, the emphasis is on the education of undergraduate students. The new courses created under the program are for undergraduates. The primary focus of our Higher Education aerospace workforce development project was on its 408 undergraduate and 93 graduate participants.

Impact/Results

Workforce Development: Our projects recognize the continuing of a growing emphasis on workforce development within the KSGC and national Space Grant programs. In 2003-2007, additional program funding was competitively secured from NASA for an Aerospace Workforce Development Program. Our program involved interdisciplinary faculty, 388 undergraduate students, and NASA and industry partners in a comprehensive NASA-like inflatable-wing "Mars glider" project and KySat experiences.

Student/Faculty Developmental Activities: Projects served the professional and educational development of 321 faculty members and 765 students at institutions of higher education through activities including field trips to NASA Centers and other science and engineering facilities, participation in scientific meetings, and participation in NASA scientific balloon launches. Including these and all other Higher Education activities, the program involved 80,722 participants who were served in higher education activities, including planetarium experiences, balloon launch participation, field trips to NASA Centers, field trips to other federal research facilities, and activities developed for undergraduate courses.

Conferences: The annual KSGC Aerospace Forum and NASA EPSCoR Conference provided opportunities for student participation and information exchange.

Curriculum development: University of Kentucky Aerospace Certificate Program – The Mechanical Engineering Department and College of Engineering approved an Aerospace Engineering Certificate option to provide students with a formalized recognition of an emphasis in aerospace subjects as part of their undergraduate Mechanical Engineering degree program. This certificate program will also increase state-wide and nation-wide recognition of UK's involvement in aerospace education and research. At UK, fundamental and applied courses necessary for a career in aerospace engineering are offered in various departments. Mechanical Engineering is the first department at UK to offer the Aerospace Certificate option, but other departments can also participate, tailoring the offerings to their discipline.

As part of the course offerings for the Aerospace Certificate program, a new undergraduate technical elective in Systems Engineering has been developed. Notes and assignments were prepared in Fall 2007 as the course was offered to 19 students including both mechanical majors and electrical and computer engineering majors. The class was comprised of approximately 2/3 undergraduates, with 1/3 graduate students. In addition to the majority of students with an interest in aerospace careers, five were planning on careers in the automotive industries, which also include complex multi-disciplinary design challenges requiring Systems Engineering approaches.

C. NASA Education Outcome 1: National Program Emphases

Diversity of Participants

A fundamental premise of the KSGC is that scientific and technological talent is distributed without regard to geography, genealogy, or gender. Geographically, every state has scientific talent to be developed for the benefit of NASA and the Nation -- both among the faculty employed by the state's universities and among the state's students. Special efforts are required to reach potential participants, to inspire them early in life to follow an educational track that equips them for advanced scientific studies, and to provide them with training by teachers who are well-prepared for teaching the sciences. These needs are especially acute for women, minorities, and persons with disabilities, who have been underrepresented traditionally in STEM disciplines. Engagement of members of underrepresented groups benefits from role models and early encouragement and support to enter the "pipeline" for preparing for careers in science, technology, engineering, and mathematics (STEM).

Diversity of participation was achieved, with 10.9% from underrepresented groups (compared with 10.2% in the National Center for Education Statistics and 10.1% in Kentucky's population), and 50% women, commensurate with their representation in STEM enrollments in Kentucky. KSGC Fellowship/Scholarship awards in the reporting period exceeded the diversity objectives of the National Space Grant College and Fellowship Program in reference to awards to underrepresented minorities and women. In Kentucky, women constitute only 19% of the bachelors degree graduates in engineering and computer science and 44% in science and mathematics (R. Sugarman, "The Status of Women in Higher Education", in *The Future Well-Being of Women in Kentucky*, published by The Kentucky Long-Term Policy Research Center, 1999, pp. 47-55). Recruitment depends upon affiliate-member faculty researchers who want to work with students in mentored research projects, finding and recruiting qualified students who are interested in the research area. Affiliate researchers are aware of the need for diversity, and they attempt to engage students in the targeted groups among students who have been admitted to their degree programs. Success is gauged by involving students in targeted groups at levels at or above their enrollment levels in eligible majors. In our Higher Education Program 5% of our participants in long-term activities are minorities, and in our Research Infrastructure Program 8% of our participants are underrepresented.

Workforce Development

Workforce Development permeates throughout the Kentucky Space Grant Consortium (KSGC) which is a partnership between NASA and Kentucky for the purpose of *bringing the benefits of NASA to the people of Kentucky* and *bringing the benefits of Kentucky to NASA*. T*he benefits both to and from* Kentucky center around **Workforce Development.** Kentucky's

benefits from NASA include inspiration of the next generation of explorers, scientists, and engineers and support for universities to prepare the required workforce. NASA benefits from the development of STEM workforce, who will enable NASA to achieve its **strategic goals.** Over the course of the past five years, the term "workforce development" became an important *lens* through which KSGC viewed existing activities. Essential components have encompassed effective student research and mentoring with NASA field centers and industry as well as an emphasis on undergraduate training.

The KSGC Fellowship/Scholarship Program facilitates research-based training of undergraduate and graduate students for the workforce in aerospace-related fields. The recipients generally advance through graduate studies and/or take employment in STEM areas. Many will eventually be employed either by NASA, by NASA contractors, or by universities as faculty members working in NASA-related research. Most come to the program motivated by an abiding interest in aerospace, NASA, and NASA-related fundamental sciences.

Objectives of our Fellowship/Scholarship Program are:

- Increased numbers of people training for the workforce in space-related fields
- Effective preparation based upon research experiences for the students

Metrics, Targets, and Effects: The metrics used to evaluate the success of the program derive directly from the objectives of (1) increased numbers of people training for the workforce in space-related fields and (2) effective preparation based upon research experiences for the students. The quantifiable metrics and annual targets are established each year for the program. Our competitively selected, mentored-research-based Fellowships and Scholarships contribute to the support of NASA's direction through enhanced development of aerospace workforce with degrees in higher education and experience in research.

Fellowship/Scholarship Metrics	Targets
Number of research-based Fellowship/Scholarship awards	10/yr
Percent retained or graduated	95%
Percent of graduates entering advanced studies or STEM employment	90%

The purpose and goal of our Research Infrastructure Program is for faculty to provide research experiences for students, thus developing and increasing capabilities of Kentucky researchers at all levels in contributing to the aerospace workforce.

Objectives of our Research Infrastructure Program are:

To use our research infrastructure to enhance the aerospace workforce in Kentucky, through:

- Increased numbers of Kentucky student and faculty aerospace-related researchers
- Connection of Kentucky research efforts to NASA interests and researchers
- Enhanced competitiveness of Kentucky researchers for NASA and other funding

The aerospace workforce consists of employees of NASA, employees of NASA contractors, employees of aerospace industries, and university faculty engaged in aerospace and NASA research. Our Research Infrastructure Program develops research capabilities and connections

with NASA, and is especially important as a platform for involving students in research as a basis for their development as members of the aerospace workforce in any of the listed roles.

A major contribution of the Research Infrastructure projects has been the involvement of students in research experiences, with several of them being female. The faculty have sought women and minority students. The students are involved in all phases of the research, including analysis and presentation of results. Through their participation in these experiences, the students gain an understanding of the process of scientific investigation, interaction with others in the field including NASA personnel or data, and skills for communicating scientific results. Retention rates are high at greater than 95%, as these students are motivated to pursue their fields with purpose; with many graduates inspired to pursue advanced degrees appropriate for advanced goals for achievement in the field.

Metrics, Targets, and Effects: The quantitative metrics and annual targets by which we evaluate success of the Research Infrastructure Program are established each year for the program. Meeting the objectives serves to develop enhanced research infrastructure at all levels in higher education in Kentucky, contributing to the development of aerospace workforce that supports the direction of NASA and enables its future.

Research Infrastructure Metrics	Annual Target
Number of faculty and students supported	10
Number of collaborations with NASA	8
Competitiveness of researchers	Overall 2x investment
Number of publications and/or presentations	Average 1 per project

The KSGC Education Program is designed to provide a continuum of support for improvement of the STEM education base in Kentucky. At the earliest level in developing the STEM pipeline, our Precollege Program emphasizes improvement of teachers' capabilities to implement content standards in ways that inspire more precollege students to pursue preparation for STEM careers. Our Higher Education Program emphasized involvement of college students in interdisciplinary, team-based workforce development projects, relating to NASA and the workforce that will support its future. The program activities support the direction of NASA by:

- Using elements of NASA's direction as motivational features in our activities
- Preparing members of the aerospace workforce to support NASA's direction

Higher Education is the ultimate arena for refining career directions and developing students' fullest abilities to become part of the aerospace workforce of the future. In addition to our mentored research opportunities for individual students in Fellowship, Scholarship, and Research Infrastructure projects, we provide targeted higher education workforce development projects that *involve teams of students* in projects beyond the traditional disciplinary bounds of the curriculum and of individual-based research. The goal of the program is to attract, motivate, and prepare students for technological careers in support of NASA, its missions, and its research efforts. We reach outstanding Kentucky students to provide experiential learning directed specifically toward personal preparation for entering the aerospace workforce. The program

provides an effective ***interface*** between the education "pipeline" and the workforce consumers -- NASA, its contractors, and its principal investigators.

Objectives of our Higher Education Program are:

- Increased numbers of students training for the STEM workforce
- Development of student experience with interdisciplinary, team-based, mission-oriented aerospace projects supporting the direction of NASA

Basis, Need, and Scope: The scope and scale of our **workforce development (WFD)** program were developed through competitively awarded Space Grant WFD augmentations, and KSGC successfully proposed and was awarded full funding of $100,000 in each of the three years of competition.

Program Characteristics -- Teamed Student Involvement in Interdisciplinary Mission-Oriented Experiences: Mission-based student team experiences are the crowning achievement and centerpiece of our program's contribution to aerospace workforce development. The missions are goal driven, requiring integration of interdisciplinary expertise, learning to work in teams to achieve shared goals, coordinating among teams to achieve the highest level project goals, and incorporating NASA resources, expertise, and inspiration to reach the goals. The projects emulate NASA missions, with students working in teams to define mission objectives, design and construct mission hardware, solve problems along the way, "fly" or otherwise execute the mission, interpret data from the mission, and present their results. In our WFD program, dedicated faculty have worked with students on mission-oriented projects, based at several member institutions. All supported NASA's direction in the *Vision for Space Exploration.*

Longitudinal Tracking

We have always kept up with our students through their mentors. In FY 2005, the longitudinal tracking requirement was established for students receiving “significant support” in our Fellowship/Scholarship, Research Infrastructure and Higher Education programs. Our strategy for longitudinal tracking has been to rely primarily on the faculty mentors' continued connections with their students to provide longitudinal information concerning retention, graduation, pursuit of advanced studies, receipt of advanced degrees, and employment of the students whose career development has been assisted through KSGC support. The foundation of this process is that all Fellowships and Scholarships are based on student research performed under close advisement by a faculty mentor. The faculty mentors get to know the students well, and bonds are formed through working on a project for a common goal. The mentors are most knowledgeable about the students' abilities and their progress toward their careers. It has enabled us to accurately track all significant award recipients through their “next educational step” beyond Space Grant support. We have enjoyed a 100% response rate, and plan to continue to measure the success of our longitudinal tracking system with the response rate metric. Mainly because of the definition of a significant award being a monetary award, internship or experience which includes one or more of the following: (a) has a value of greater than or equal to $5,000; (b) participation of greater than or equal to 160 hours; and/or (c) through a cost-benefit analysis proves to have significant impact on the student's academic achievement and employment, we are going to the National Space Grant Foundation to implement their longitudinal tracking system. The quantitative and qualitative evidence of progress and success made toward the full implementation of this successful longitudinal tracking strategy beginning in FY 2005 is the inclusion of a National Space Grant Foundation Longitudinal Tracking System line in the submitted budget for $5,300.00. The new process will now allow us to track students falling under (b) and/or (c) of the

definition, where the connections may not have been with a single a faculty mentor, such as in the workforce development projects with multiple mentors including student team leads as mentors. As a result of longitudinal tracking specific language is being incorporated into our documents.

Minority Serving Institutions

Kentucky State University is our HBCU. It has been an affiliate since the inception of the Kentucky Space Grant Consortium. Minority students in Kentucky are so well sought after that it is difficult to find those interested in applying for the funding. It is the case particularly for undergraduates that if they have other government financial aid, our scholarships will displace other funds, such that the student will not have any more income for having accepted our scholarship. We therefore used the Campus Objectives Grants to bring the benefits of NASA to the students at Kentucky State University, focusing on the minority students at other institutions who may not have been as well nurtured as those at Kentucky State. Previous strategies to involve Kentucky State University students in the large workforce development project Big Blue based at the University of Kentucky had changed due to project changes to accommodate health issues for the PIs on both campuses. With the request in FY 2006, to be particularly attentive to opportunities for *meaningful involvement* of minority-serving institutions in the activities of the consortium, and with there being no requirement that research-based, institutional relationships be limited by state boundaries, strategies now changed focus. Elaborate plans were derived to present to the Tennessee Space Grant Consortium and its affiliate Tennessee State University to involve students at TSU, an HBCU in Nashville where the then KSGC Director Richard Hackney traveled often for medical services. Tennessee State is a much more research-oriented university than Kentucky State, which is an undergraduate comprehensive university. TSU had been a partner in the past where we worked with them relative to their NASA Minority University Research Center. We met with them briefly at the Southeast Regional Space Grant Meeting in 2005. With the passing of Richard Hackney and the improvement of health issues at Kentucky State University, we are redoubling our efforts at KSU. KY NSF EPSCoR is experiencing a heightened interest in minorities in the state, and we are looking for ways to combine our strengths in this area. The Campus Director is working with NSF. After a hiatus Kentucky State University is again receiving funding from the Kentucky Space Grant Consortium.

D. NASA Education Outcome 2: Consortium Programs

Precollege Education

Description


Moon Buggy

NASA has instructed all programs to minimize expenditures for precollege activities. We have taken this instruction to mean that we should not expend significant funds to directly educate or provide direct experiences for K-12 students. However, we have always maintained that the K-12 pipeline is essential to the future of our capability enhancement efforts. The students who receive our undergraduate research scholarships must, at earlier points in their education, have been inspired to prepare for college programs in STEM areas. Hence, we recognize the importance of

providing precollege teachers with training and means with which *they can inspire and motivate their K-12 students* to enter and remain in tracks of preparation for STEM careers.

Purpose and Goal: The purpose and goal of our Precollege Program is to enhance and maintain the "pipeline" flow of students preparing for eventual studies and careers in STEM fields.

Objectives of our Precollege Program are:

- **To enhance the preparation of K-12 teachers for activity-based teaching to inspire and motivate their students to pursue preparation for careers in STEM disciplines**
- **To incorporate space-related topics into the state's science education standards**
- **To aid in maintaining standards in Kentucky's teacher-preparation programs**

Program Characteristics: The KSGC Precollege Program supports (1) systemic enhancement, (2) teacher preparation enhancement, and (3) some special-opportunity student activities. Our greatest impact and perpetuated effects are achieved through the first two elements, with minimal emphasis on the third, in line with our national program mandate.

1. **Systemic Enhancement:** Kentucky is currently involved in a sweeping reformation of its system of K-12 education, under the Kentucky Education Reform Act of 1990 (*KERA*), affecting the education of those we seek to attract to STEM areas. The universities provide a vital service in the development of materials and techniques, and in the training of teachers in the needed new ways of teaching. KSGC contributes to the systemic enhancement of teacher preparation through service to the Kentucky Department of Education in reviewing teacher preparation programs at Kentucky's universities.
2. **Teacher Preparation Enhancement:** Workshops and professional development activities to enhance the preparation of teachers in space-related topics in Kentucky's science education standards are the primary KSGC Precollege Program emphasis. Elements of the program include planetarium activities, Hands On Universe workshops, and JPL Solar System Educator workshops.
3. **Student Activities:** Precollege Program activities that directly involve students are accomplished with minimal financial resources through volunteer efforts of Consortium personnel, including Campus Directors at affiliate institutions. Examples include planetarium programs for K-12 students and opportunities for motivational competitions such as NASA's Moon Buggy, Physics Olympics, and the Science Olympiad.

Consortium Budget: Our direct expenditure for Precollege projects is minimal, averaging 6% of our basic budget during 2003-2007, ranging from 2% to 8%, with no significant trend. Planetarium and Science Center NASA- and space-related activities are provided by the institutions as part of their mission and operation. Other functions are supported by volunteer effort from Consortium personnel. Minimal funding has been provided by Campus Directors using their small Campus Objectives Grants to facilitate projects such as Moon Buggy.

Assessment and Evaluation: Projects are assessed and evaluated based on presentation of results at the Aerospace Forum, on final reports due following the end of the award period, and on reporting of results included in proposals for subsequent workshops. Most workshops include internal evaluations by the participants. These assessment instruments are used to evaluate the impact and effectiveness of the projects and to determine the course of future support.

Support of Education Priorities

- **Enhancement of precollege teacher education:** We seek to use the excitement of NASA and space-related topics to inspire students to pursue preparation for STEM careers. Our primary approach to achieving this goal is to help teachers incorporate NASA- and space-based activities in their classrooms, through workshops on the materials and activities.
- **Cooperative partnerships with informal education organizations**: Our cooperative partnerships with informal education organizations such as the Hardin Planetarium, the Louisville Science Center, and the East Kentucky Science Center, involve precollege students in exciting opportunities that can inspire continuing interest in science as a prerequisite for possible preparation for STEM careers.

Recruitment and/or participation of women, underrepresented minorities, and persons with disabilities: Every student is welcomed and encouraged to participate in KSGC precollege activities. Class-based activities naturally involve *all* members of the class as participants, including females, underrepresented minorities, and persons with disabilities. Efforts are made as needed to provide special accommodations for persons with disabilities. In our workshops, we address the issue of gender equity and seek to remove barriers that tend to discourage participation by females.

Analysis of Core Criteria

Emphasis on teacher preparation and development: KSGC has a longstanding emphasis on teacher preparation for effective teaching and inspiration of interest in science. In the Precollege Program, professional development was provided for 1,143 teachers through planetarium activities, Hands On Universe workshops, and JPL Solar System Educator Program workshops.

Consortium Specific

Alignment with the state's science, mathematics, and technology education standards and existing state systemic reform efforts: KSGC personnel were instrumental in developing the earth and space science standards and objectives at all levels K-12 in Kentucky's systemic education reform. We continue to work with members of NASA's Aerospace Education Specialist Program (AESP) to align the selection of NASA materials used in KSGC-sponsored teacher workshops with Kentucky's science, mathematics, and technology education standards.

Impact/Results

Overall, the KSGC Precollege Program served more than 184,477 people. Major Precollege service is provided through planetarium presentations to visiting K-12 student/teacher groups. During 2003-2007, planetarium presentations were made to 117,418 students and 1,143 teachers, parents, and administrators. Planetarium statistics were re-reported for this report. Hands On Universe and JPL Solar System Educator Program workshops served teachers and parents in developing applications for classroom participation by students. Moon Buggy competition projects for high school students involved students and teachers. Physics Olympics and Science Olympiad student competitions involved students and teachers. We have funded projects at planetaria for teacher training, and have provided space-related materials for planetarium and science center presentations. We use our teacher workshops to leverage NASA resources to provide direct student participation in precollege space-related activities, by introducing teachers to NASA AESP members who later conduct NASA-based K-12 student activities at their schools.

Additional contributions include, for example, informing teachers of NASA program opportunities and educational materials, and providing access to educational software and materials. Examples included promotion of the NASA Office of Space Science broker/facilitator Southeast Regional ClearingHouse (SERCH) for access to Science educational materials and providing access to the Eisenhower National Clearinghouse.

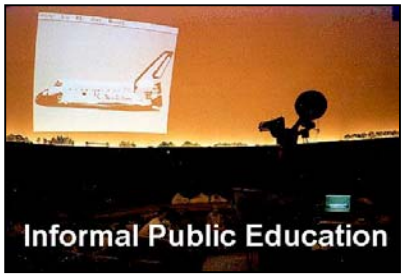
KSGC's role in the promotion of a strong science, mathematics, and technology education base within Kentucky: The KSGC supports the Kentucky education reformation (*KERA*) at all levels, beginning with workshops for teacher training and development of activity-based teaching materials for NASA- and space-related topics. KSGC has maintained interaction with the KERA/College Interface and the NSF Appalachian Rural Systemic Initiative (*ARSI*). Our most important contribution to systemic science education throughout Kentucky has been in working with the Kentucky Department of Education (KDE) in developing science curriculum and assessment incorporating National Science Education Standards into Kentucky's science education standards, including extending the study of earth and space science into Kentucky's high school curriculum. Our teacher-training activities strengthen the base of STEM education in Kentucky through teachers and the students they inspire.

A major strength has been in reaching more than 117,000 students and teachers through planetarium presentations, at minimal cost to our program. This accomplishment is especially significant in providing for female and underrepresented minority students, as they occur in the general population, important exposure to the excitement of science and space exploration as potential career choices. Kentucky astronaut Col. Terry Wilcutt has given generously of his time and enthusiasm to motivate students during campus visits. For many students, campus presentations provide the first exposure to a university as a potential avenue for higher education in their future. A weakness of our precollege efforts is the lack of more intensive student experiences for large numbers of students that should be inspired to prepare for STEM careers. However, we recognize that this approach would be counter to our national program mandate, and we approach the need through preparing *teachers* to motivate interest in STEM disciplines and careers.

E. NASA Education Outcome 3: Consortium Programs

Public Service: General Public and External Relations

Description



Purpose and Goal: The overall purpose and goal of our Public Service Program is to facilitate greater public awareness of science and technology and NASA- and space-related research and applications.

Objectives:

- **To enhance the communication of science and technology and NASA- and space-related research and applications to the general public of all ages in Kentucky**
- **To increase scientific literacy and understanding, bridging the divide between scientists and the general public**
- **To develop working relationships with public constituencies for enhancing research and educational opportunities for Kentucky's citizens**

Program Characteristics: Major KSGC activities designed to enhance public awareness of science and technology and results of NASA and space-related research include: planetarium presentations, television, radio, and newspaper interviews, webpage presentations, and sponsorship of NASA- and space-related programming on educational and public television. As opportunities arise, KSGC personnel support or initiate public activities on affiliate campuses, such as bringing lecturers to campus, as well as activities with external informal education partners such as museums and science centers. KSGC public service also includes working relationships with external science, education, and planning organizations within and beyond Kentucky.

Consortium Budget:

The KSGC public service activities are conducted with minimal use of budgetary resources. Our General Public program costs averaged about 1% of our NASA budget, we enjoyed a slight upward trend from 2003-2006, only to fall to our lowest in 2007. Our outreach is leveraged by volunteer effort from Consortium personnel at affiliate institutions. Planetarium and Science Center activities are provided by the institutions as part of their mission, extended to include NASA and space.

Assessment and Evaluation: We assess our activities by the level of interest and participation they generate, as indicated by the numbers of people who choose to participate. The activities are evaluated by the public, as indicated by their participation in continuing public offerings.

Support of Public Service Priorities

- **Cooperative partnerships with informal education partners:** KSGC maintains cooperative partnerships with informal education partners including planetaria, StarDate radio, NOVA television, and the Louisville Science Center.
- **Public appreciation of NASA-sponsored research:** Our planetarium presentations, StarDate public radio presentations, and NOVA public television programs reached thousands of Kentucky's citizens (see below) with results of NASA-sponsored research to enhance public appreciation of the results and their significance.

Participation and/or inclusion of women, underrepresented minorities, and persons with disabilities: Every member of the public is welcomed and encouraged to participate in KSGC services for the general public. Opportunities are broadcast by way of public media such as newspapers, radio, and television. Women, underrepresented minorities, and persons with disabilities participate as distributed in the general population. Efforts are made as needed to provide special accommodations to enable access by persons with disabilities.

Analysis of Core Criteria

Alignment with NASA Informal Education Definition

In FY 2007, the Kentucky Space Grant Public Service projects began assembling standards-based education materials to be used as **Handouts** to supplement and enrich the experience, visual, or activity. The programs had always met the **Staffing** and **Content** components to be aligned with the NASA guidance for Informal Education.

Consortium Specific

Promotion of understanding of science, technology, engineering, and mathematics (STEM) disciplines and the NASA mission: This major objective of our Public Service Program was

promoted for thousands of people in the state by planetarium presentations (113,623 people), public lectures, and outreach activities (78,784), and StarDate radio and NOVA television presentations throughout the year (estimated audience, 82,000), as detailed in *Impact*, below.

Impact/Results

General Public: During 2003-2007, an estimated 256,000 people were served by the program. The largest audiences were served through planetarium presentations, through a daily StarDate radio segment and a weekly NOVA television science program, and by way of webpage announcements referred by the radio and television spots. Public planetarium attendance was counted, and totaled 180,480 in 2003-2007. Planetarium statistics were re-reported for this report. The "broadcast" audiences were necessarily estimated, reaching approximately 82,000 for the period. Public events including NASA Benefits of Space Exhibit and Space Day Activities at the Louisville Science Center involved 2,965 people. About 41,638 members of the public were served through outreach activities on affiliate campuses (lectures, *etc.*), and through interactions with educational and professional organizations. We have not estimated the considerable audiences reached by way of event-based radio, TV, and newspaper interviews, as the media sought information about NASA- and space-related events, such as the local Moon Buggy, LEGO League Kentucky Statewide Robotics Competition and special astronomical events. Some KSGC-funded efforts such as the student KC-135A reduced-gravity flight projects contain publicity and public-outreach components, and the workforce development Martian glider project served approximately 1000 members of the public, with Engineering Day activities. Information about KSGC programs and funding opportunities is presented at each meeting of the Kentucky Academy of Science, the Kentucky Association of Physics Teachers, and the Statewide Kentucky EPSCoR Conference. The annual KSGC Aerospace Forum showcases faculty and student space-related projects, and facilitates interaction among the education and research communities and other members of the public.

External Relations: Working relationships with science, education, and planning organizations are an important aspect of KSGC public service. The KSGC cooperates with the Kentucky Science and Technology Corporation (KSTC, a non-profit science advisory and development organization) in promoting the development of infrastructure for science and technology in the state, and in obtaining state funding augmentations for KSGC and NASA EPSCoR. The KSGC Director serves as a member of the Kentucky Statewide EPSCoR Committee, established by the KSTC. The KSGC Director serves as a Kentucky representative to the Aerospace States Association. The Director also works with the Kentucky Department of Education (*KDE*) in developing curriculum and teacher certification criteria. The KSGC interacts with professional organizations such as the Kentucky Academy of Science, the Kentucky Association of Physics Teachers, and the Kentucky Science Teachers Association. The KSGC participates in the NASA Marshall Space Flight Center SCICOMM Roundtable to develop NASA-science-based web presentations for the public. We also work with the NASA Aerospace Education Specialist Program (AESP) to provide NASA education resources to the teachers and students of Kentucky, including certification for borrowing and displaying NASA lunar samples. Internally, we assist affiliate universities in financial management issues of grant invoicing and cost share reporting.

A major strength of our Public Service Program is the breadth of participation in opportunities provided by our network of affiliates, and the broadcasting of information to reach other areas of the state. A weakness is the difficulty in capturing the reach of the distributed efforts. We plan to develop better means of gathering data during public events.