National Space Grant College and Fellowship Program

Kentucky Space Grant Consortium
Designated Space Grant Proposal

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Executive Summary

The Kentucky Space Grant Consortium (KSGC) 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*. The benefits of NASA include inspiration of the next generation of explorers, scientists, and engineers and support for universities to prepare the required workforce. Kentucky will benefit NASA by developing members of the STEM workforce who will enable NASA to achieve its *Vision for Space Exploration.*

Summary of Program Implementation: We propose a balanced program of Research, Education, and Public Service that emphasizes *involvement* of Kentucky's faculty, students, teachers, and general public. We will facilitate involvement in aerospace-related activities and with NASA, utilizing the motivational capabilities of NASA missions, activities, opportunities, knowledge, resources, and themes of exploration and scientific inquiry.

The overarching theme of our program is the development of aerospace and STEM workforce -- for NASA, Kentucky, and the Nation. Our comprehensive mix of program elements is based upon the needs and capabilities of Kentucky:

- **Aerospace Workforce Development** -- is KSGC's prime goal, supported by each of the following elements, and by interdisciplinary, team-mission projects and links with NASA
- **Faculty Researchers** -- are resources at the highest level in the workforce, to provide enhanced emphasis on student research, NASA collaboration, and Center visits
- **Graduate Fellowships** -- support mentored research for graduate student development, with enhanced NASA collaboration for Fellowship projects and NASA Center visits
- **Undergraduate Scholarships** -- support mentored research for undergraduate students, with enhanced participation in NASA internship programs
- **Teacher Training** -- prepares teachers for inspiring students in the STEM pipeline, with enhanced NASA-based materials for use in classrooms, and with pre-service internships
- **Public Support** -- is promoted through involvement for awareness of aerospace issues and NASA, with enhanced support for leveraging informal education partnerships

Existing and Planned Organizational Structure: The elements of our program are based on *competition* and *evaluation* to insure that we identify, develop, and maintain the best contributions that Kentucky can provide. The Kentucky Space Grant Consortium was established with, and will retain, a democratically-based, equal-opportunity organizational structure. The KSGC Committee, consisting of one voting member from each of the 14 member institutions, makes major policy decisions for the Consortium. Funds are awarded competitively, and faculty and students from all member institutions are eligible to propose. Awards are decided by the KSGC Committee. Day-to-day management of communications, RFP 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. The affiliate representatives reaffirm that the structure works well to bring the benefits of the Consortium to its constituencies in Kentucky. Their participation and contributions in the preparation of this proposal, concurrence with the proposed implementation and budget, and acceptance of their roles in the proposed Designated Space Grant Consortium, are indicated by their signatures on the Consortium Concurrence pages.

Kentucky Space Grant Consortium

I. Eligibility

The Kentucky Space Grant Consortium is eligible for consideration as a Designated Space Grant Consortium, based on the following descriptions of research, academic programs, and results of the 15th Year Evaluation. Evaluation quotes such as "This is an excellent, well-managed, well-balanced program" affirm our balanced program of Research, Education, and Public Service.

A. Current Aerospace Research

For the three fiscal years relevant to this competition (2001, 2002, 2003) Kentucky received an average of $3,420,515/year in NASA obligations to universities, as tabulated below:

NASA Funding to Kentucky Universities				
Year	2001	2002	2003	Annual Average
NASA Funding	$2,383,132	$2,703,413	$5,175,000	$3,420,515

The scope and extent of funded research in Kentucky are described in the following areas:

Areas and Focus of Active NASA-Funded Research: NASA-funded programs as listed in NASA's *University Program Management Information System*, Years 2001, 2002, 2003 are listed in Table 1 in the Appendix. Multiple-year entries have been reduced to single entries per program. Instutitions funded by NASA are listed in Table 1, including Eastern Kentucky University, Morehead State University, the University of Kentucky, the University of Louisville, and Western Kentucky University.

To fully characterize the scope of aerospace- and NASA-related research in Kentucky requires inclusion of the investigators and topic areas in projects initiated by KSGC, both under Research Infrastructure (Table 2) and Fellowship/Scholarship mentored research (Table 3), and research initiated under the Kentucky NASA EPSCoR Program (Table 4). These programs build connections with NASA, and their investigators and topic areas are extremely important for the future of aerospace- and NASA-related research in Kentucky. They provide a major foundation for faculty-mentored student research opportunities in our programs.

As Tables 1-4 indicate, Kentucky's aerospace and NASA-related research capabilities include the areas of aerodynamics; computational fluid dynamics (CFD) and planetary atmospheres; sensors; microgravity effects in chemistry, genetics, and physiological response; nanomaterials and nanotechnology; remote sensing; dynamics of inflatable space structures and optics; and astronomical/astrophysical topics including stars, interstellar medium, galaxies, and cosmology.

Active Aerospace Research Sponsored by Non-NASA Sources: Table 5 in the Appendix lists NSF-funded research in Kentucky in aerospace-related STEM fields for the past five years. The research topics in these projects (and in 70 other projects funded by DoD, DOE, and NIH, not listed due to space limitations) include a broad range of departments and disciplines, including astrophysics; biology and genetics; fundamental and applied chemistry; computational science and computer engineering; geosciences; basic and applied mathematics; and basic and applied physics.

B. Current Aerospace Academic Programs

Kentucky's two doctoral granting institutions are the University of Kentucky (UK, in Lexington) and the University of Louisville (U of L). These consortium member institutions offer a total of fifteen active doctoral degree programs in twelve aerospace disciplines as defined by NASA. The programs are presented in the table below, including current enrollments and the numbers of degrees granted in the past 5 completed years.

Relevant Doctoral Programs in Kentucky
Current Enrollment and Five-Year Total Doctoral Degrees Granted

Ph.D. Program	Program Enrollment Fall of 2004/2005		Degrees Granted 1999-2004		Enrollment Total	Degree Total
	Univ. of Kentucky	Univ. of Louisville	Univ. of Kentucky	Univ. of Louisville		
Biology	43	22	36	-	65	36
Biomedical Engineering	35	-	3	-	35	3
Chemical Engineering	33	18	17	13	51	30
Chemistry	100	38	47	18	138	65
Civil Engineering	29	11	5	3	40	8
Computer Science/Engr	-	48	-	23	48	23
Electrical Engineering	32	35	14	-	67	14
Geology	13	-	4	-	13	4
Indust/Mfg Engineering	-	27	-	12	27	12
Mathematics	50	-	27	-	50	27
Mechanical Engineering	41	24	23	-	65	23
Physics	50	3	25	-	53	25

Kentucky's aerospace doctoral programs currently enroll a total of 652 students, and awarded 270 doctoral degrees in the last five years. The above institutions also offer masters degrees and baccalaureate degrees in the listed fields or in fields that prepare students to enter advanced degree programs in those fields. Throughout Kentucky, six comprehensive state universities and numerous private universities and colleges provide baccalaureate and some masters programs that prepare students for the doctoral programs at the University of Kentucky, the University of Louisville, and other institutions throughout the Nation.

C. Results of the 15th Year Evaluation

Summary of Overall Results: The Kentucky Space Grant Consortium passed all three elements of the 15th Year Evaluation, and the communication of our 15th Year Evaluation results stated:

> "The Kentucky Space Grant Consortium performed at the highest level for all Capability Enhancement consortia."

In lieu of being able to include our 15th Year *Progress and Performance Report* (PPR), and rather than paraphrasing, we cite summary evaluative comments on KSGC strengths through the following quotes from the reviewers:

Executive Summary and Consortium Impact:

- "Kentucky presents an impressive report of accomplishments. The Program is well aligned with national priorities and with the needs of Kentucky. This is an excellent and well-managed, well-balanced program."
- "The data supports the impact Kentucky Space Grant is having on the state. They are clearly working all angles of the state government to be an important presence in the state. They are collaborating with as many constituencies as they can and are getting results."

Introduction:

- "The goals and objectives of the KSGC have been clearly stated. Also these have been connected to both NASA's strategic plans and to the needs of Kentucky."
- Excellent analysis, responsive planning and plans with a broad and appropriate mix of programs."

National Program Emphasis:

- "Minority participation exceeds state enrollment. Excellent work with NASA -- lots of ties and active mechanisms to insure connections. Good review of research and follow-on funding. Excellent involvement and leveraging with industry."
- "Demonstration of excellent results in Competitiveness, NASA ties, industry relations, State/Gov't involvement."

Consortium Management:

- "It is clear that the consortium is well managed. The space grant network in KY is inclusive and involves everyone in a competitive way. Excellent overall."
- "They meet as appropriate to discuss the needs of the consortium as well as funding proposals and assessing funded projects."
- "Kentucky has a nice variety of higher education institutions in their consortium. It's evident that the institutions can utilize each other's strengths."

Fellowship and Scholarship Program:

- "Overall the fellowship/scholarship program is excellent. It is a well-managed, competitively selected program. They show considerable attention to diversity issues."
- "Good results in recruiting and awarding minorities. Good process to insure mentoring and faculty involvement in processes. Excellent tracking and details. Metrics for success are appropriate."

Research Infrastructure:

- "Overall program element is excellent. The impact/results are significant for the limited resources."
- "The Kentucky Space Grant clearly demonstrated the number of collaborations with NASA centers and enterprises as well as collaborations among their institutions and faculty."

Higher Education:

- "Kentucky is doing an outstanding job with their efforts in Higher Education. From teacher workshops to conferences and from student/faculty development activities to curriculum development, they are making a huge impact."
- "Results are very good -- strong for the funding involved."

Precollege Education:

- "Excellent connections with the state department of education; excellent reach with minimal devotion of resources."
- "The Consortium justifies precollege expenditures extremely well. Their work in systemic enhancement through the state channels is a strong plus. The high number of participants per dollar expended is commendable, and the list of activities is comprehensive."

Public Service:

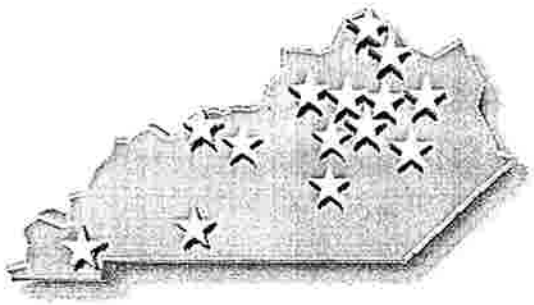
- "A high amount of leveraging is evident among the Consortium partners."
- "Excellent involvement of many different media. Good response to opportunities in the state."
- "Good use of a wide array of vehicles to promote aerospace."

Incorporation of Reviewer Guidance: Of course, the reviewers in some cases suggested possible specific improvements for our programs, based on their experiences and values. In the pursuit of continuous improvement, KSGC utilizes this valuable input in planning future program activities, and we consider it to be excellent guidance for inclusion in our plans for a Designated program. We will describe how the results of the evaluation will be utilized to enhance our consortium operations and programs in the corresponding program sections that follow in this proposal.

II. Proposed Management and Organizational Structure

The organizational structure of KSGC has facilitated a program that received excellent evaluations, with reviewer quotes such as the following specifically noting that:

> "KSGC is a well-thought out, well-executed, well-managed consortium."



Kentucky's Space Grant Network.

The KSGC organizational structure has worked well in achieving effective decision-making, policy-making, assessment, and evaluation. With the concurrence of our membership, KSGC will maintain its successful structure that values the views and contributions of all members equally, and that democratically determines policy and decides on competitive awards. We will describe planned enhancements following an overview of our membership and structure.

Membership: The fourteen affiliate members of KSGC, distributed throughout Kentucky, are listed alphabetically and characterized below:

Kentucky Space Grant Consortium Network		
Institution	**Location**	**Description**
Bellarmine University	Louisville	Private Parochial University
Centre College	Danville	Private College
Eastern Kentucky University (EKU)	Richmond	Public Comprehensive University
Kentucky Center for Space Enterprise	Lexington	Non-profit Organization
Kentucky State University	Frankfort	Public Comprehensive HBCU
Morehead State University	Morehead	Public Comprehensive University
Murray State University	Murray	Public Comprehensive University
Northern Kentucky University (NKU)	Highland Hgts.	Public Comprehensive University
Thomas More College	Crestview Hills	Private Parochial College
Transylvania University	Lexington	Private University
Tribo Flow Separations, LLC	Lexington	Industry
University of Kentucky (UK)	Lexington	Public Doctoral Granting University
University of Louisville (U of L)	Louisville	Public Doctoral Granting University
Western Kentucky University (WKU)	Bowling Green	Public Comprehensive University

A. Structure, Policies, 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 (above). 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 is vested in the staff at the Lead Institution, Western Kentucky University (WKU).

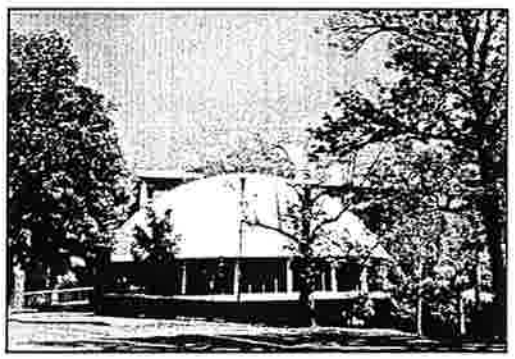
Technical Expertise, Administrative Experience, and Management Skills of the Director and Immediate Associates: KSGC management staff at the Lead Institution, Western Kentucky University, includes the Director, Associate Director, and Secretary. The Director and Associate Director are Professors in the Department of Physics and Astronomy, have doctoral degrees in Astronomy, and have undergraduate degrees in Engineering Physics. They have extensive backgrounds in research, in involving students in research, and in conducting teacher training workshops. Administrative experience has been gained primarily through 13 years of administering KSGC and 11 administering the Kentucky NASA EPSCoR Program. The Director also served as Acting Head of the Department of Physics and Astronomy for two years. The Associate Director has served as President of the Kentucky Association of Physics Teachers and Director of WKU Student Physics Laboratories. She serves on state education committees and review task forces, in shaping STEM education in Kentucky. The Secretary has 13 years of experience as Secretary of Hardin Planetarium and of KSGC. She is experienced in financial management and in facilitating visitation of teachers and students at the planetarium.

Organizational Position and Responsibilities of the Director: The Director is the Chair of the KSGC Committee and provides overall coordination of the Consortium program. The Director is responsible for the day-to-day management of the Consortium, including 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.

Composition, Role/Purpose, and Meeting Frequency of Committee: Each affiliate member institution is represented by a Campus Director 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 coordinate KSGC and partner activities at their institutions. Each Campus Director conveys the perspective of his/her institution, in relation to its characteristics, values, needs, and opportunities. Currently, the Committee meets face-to-face once per year in the spring, in conjunction with our annual Aerospace Forum, timed to provide project review and selection of awards for scholarships, fellowships, research, and workshop that will start in the summer and fall.

How the Organizational Structure will be Enhanced: The increased scope of the Designated Consortium will entail more frequent communication with Campus Directors, both to provide details of new proposal opportunities for their faculty and to monitor needs of program partners such as planetaria on their campuses. There will likely be need for face-to-face meetings in addition to the annual awards decision meeting in order to develop and implement new program projects. At these meetings, an added purpose will be to have each Campus Director report on KSGC campus activities and share best practices. We also plan to augment management of the larger program by adding a Program Manager when the transition to Designated program funding is fully established in the steady-state. During the transition, the Director will provide additional FTE to implement the program enhancements described in this proposal.

On-Campus Location of the Space Grant Program Office: The KSGC Center Office is housed in Hardin Planetarium, a distinctive landmark structure at Western Kentucky University in Bowling Green, Kentucky. The KSGC office facilities include the main office, with space for the KSGC Director and Associate Director, a dedicated telephone, and word-processing equipment. The secretary's office in the planetarium provides word-processing and printing equipment, and a FAX machine. The KSGC offices are easily (and handicapped-) accessible in a conspicuous domed structure 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, laboratories, and adjacent roof-top observatory.



KSGC Center Office in Hardin Planetarium, adjacent to the WKU Science Complex and roof-top observatory.

Affiliate Relationships and How the Network, Management Structure, and Operational Policies and Procedures Influence the Accomplishment of Consortium Goals and Objectives: The capabilities, contributions, and interrelationship of affiliate institutions are detailed as part of the basis for program implementation in Section III. In the operation of the Consortium and interaction among affiliate representatives, the relationship is highly collegial and mutually supportive of every institution's needs and capabilities. Faculty and students at all

member institutions are eligible for funding in the competitions, and all institutions are equally represented on the Committee who decide on the awards. The Committee is especially sensitive to opportunities that maximize participation among all of the member universities. The industry and non-profit-organization affiliates contribute advice to the program and its educational institutions based on unique perspectives, and are supportive of the efforts and activities of all members. A major strength of our network and program operation is the willingness of our Committee members to contribute unselfishly in emphasizing the overall goals and objectives of the program.

Mutual support is a founding principle of the State of Kentucky and of KSGC.

B. Program Evaluation

Assessment of the KSGC Program will be accomplished on two levels:

1. Overall, each major program element will be evaluated for achievement of its objectives **using metrics that are specific and measurable**, and **targets that are realistically achievable within a specified period of time**, normally a year (see table below).

2. At the level of delivery of services, performance in individual projects will be evaluated based upon required reports providing performance data, such as publications, presentations, proposals submitted, follow-on grants, NASA ties, and numbers of constituents served.

   A. **Quality of performance** in projects such as workshops and workforce development experiences, will be assessed based on evaluation responses of the participants, which must be included in reports and subsequent proposals for assessment by the KSGC Committee in competition for renewal. Performance metrics in research awards and fellowships/scholarships will be assessed by the Committee in competitions for renewal.

   B. **Longitudinal tracking of each student** receiving KSGC support, will extend for five years and will be achieved using the method that resulted in 100% response as reported in our 15th Year PPR. Our strategy for maximizing responsiveness is organized in the following order: (1) Contact past mentors, asking them to gather the data from their students and to determine up-to-date contact information for their students (who respond based on a personal appeal from someone with whom they have a personal bond); and (2) for those instances for which that might not get results, the program will email or mail requests to students using permanent addresses from CMIS, annual reports, and program files.

External Metrics: For overall evaluation of the success of the program, data from within the required project reports (2-A, above), and from the longitudinal tracking of students' progress following the support period (2-B above), will contribute to the external metrics described below. Annual performance targets are included to illustrate the measurability and to guide our program efforts. These targets are based ultimately on anticipated steady-state annual funding levels for Designated Space Grant Consortia.

Quantifiable Metrics and Performance Targets

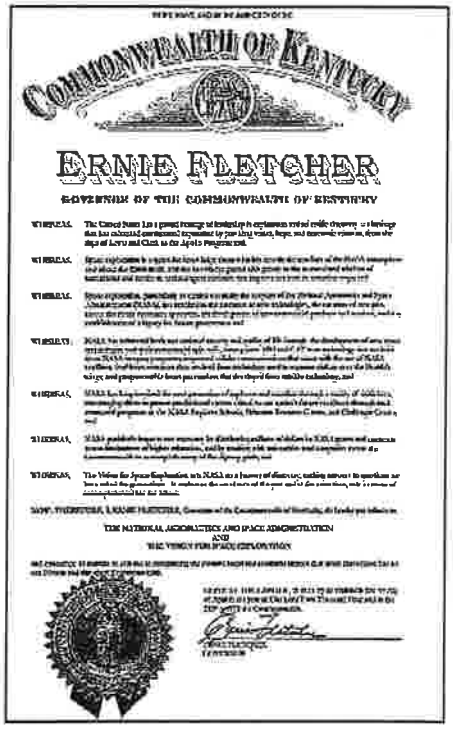
Metric	Annual Performance Target
Fellowships/Scholarships Program	
Number of students achieving research-based competitive F/S awards	9
Percentage retained to graduation	95%
Percentage of graduates entering advanced studies or STEM employment	90%
Research Infrastructure	
Number of Kentucky faculty and students in research funded by KSGC	10
Number of collaborations with NASA	8
Competitiveness of researchers	Total follow-on funding for the RI program at least twice the program investment
Number of publications and/or presentations	Average at least 1 per project
Precollege Education Program	
Numbers of workshops awarded	4
Number of teachers intensively trained	50
Higher Education/Workforce Development	
Number of students participating	70
Number of student interactions with NASA Centers, installations, or contractors	50
Percent of participants retained to graduation	95%
Percent of graduates either applying for NASA or aerospace employment or pursuing advanced degrees in aerospace-related fields	80%
Public Service	
Number reached with information/activities for awareness of STEM, NASA, and aerospace	50,000

III. Proposed Program Implementation

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 basic facts:

- Kentucky in 2003 ranked 39th in NASA funding and 40th in federal R&D funding
- Kentucky in 2002 ranked 47th in percentage of scientists/engineers in the workforce
- Kentucky in 2002 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.


COMMONWEALTH OF KENTUCKY

ERNIE FLETCHER

GOVERNOR OF THE COMMONWEALTH OF KENTUCKY

WHEREAS,

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THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
AND
THE VISION FOR SPACE EXPLORATION

Needs of Kentucky are addressed through the following KSGC objectives, by using the inspiration of aerospace- and NASA-related subjects and activities to achieve:

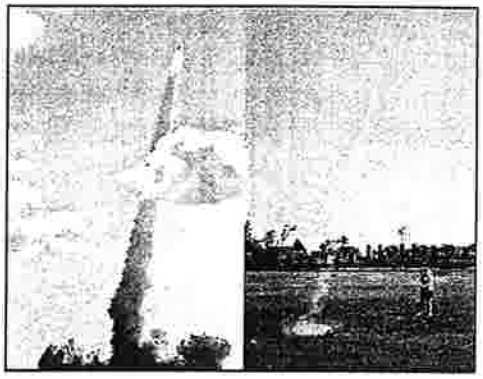
- Enhancement of research and education capabilities in space-related fields
- Increased numbers of people training for the workforce in space-related fields
- Greater public exposure to NASA and space-related research and applications

Kentucky's Governor Ernie Fletcher has recognized the value and the motivational potential of NASA and space exploration in his April 5, 2004, proclamation of tribute to NASA and *The Vision of Space Exploration.*

The State of Kentucky, through the Statewide EPSCoR Program, is contributing $100,000 cash match toward the matching requirement for the Designated Space Grant Consortium proposal.

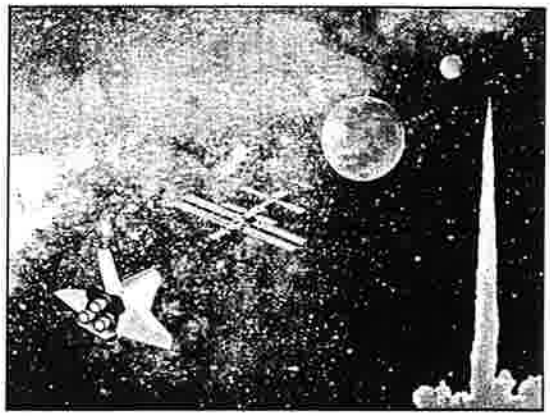
From the Appalachian mountains in the east to the Ohio and Mississippi Rivers in the west, Kentucky's population is mostly rural, and its economic base is changing from agriculture and mining toward service and manufacturing. All areas of its economy depend increasingly on technology and require a technological workforce for the future.

Strategies for Strengthening the STEM Education Base in Kentucky: Strengthening the STEM education base in Kentucky begins with a need for improvement of teachers' abilities to relate both content and motivational learning experiences in ways that encourage more students to prepare for STEM careers. Cultivating the natural interest in science and space in early grades is critical. Inspiring and channeling students through the STEM "pipeline" is a major challenge for teachers and parents. Students who do not choose the path of STEM preparation at critical junctures are simply not prepared and cannot be recruited later without substantial re-preparation. For the students in the ever-narrowing STEM pipeline, the inspiration provided by high school and college teachers and the students' personal *involvement* in interesting ways are critical for retention and continuation to achieve STEM careers. KSGC strategies for addressing these needs are described in all of the elements of the program.



NASA- and space-related activities bolster interest in STEM in early grades.

Increasing KSGC's Capacity to Support the Direction of NASA: The direction of NASA is charted in the Presidents' *Vision for Space Exploration.* The *Vision* sharpens NASA's focus on objectives that have long existed implicitly within the Agency and that capture the imagination of both the public and the scientific community. Major features of the NASA's direction include human and robotic missions to the moon, Mars, and beyond, returning the Space Shuttle safely to flight, completing the International Space Station, and preparation for long-duration space flight.



Major elements of NASA's Vision and direction.

KSGC recognizes that the current generation of students will provide most of the workforce who contribute to NASA's realization of the *Vision for Space Exploration.* The preparation of workforce to support the direction of NASA is a central mission of KSGC.

For years prior to the 2004 formalization of NASA's *Vision*, KSGC has been involved in research activities related to human factors in long-duration spaceflight, effects in reduced gravity environments, space structures, utilization of resources in situ on the moon and Mars, and robotic exploration of Mars. Many of the topics have also been central in the NASA-related topics in our teacher workshops, and in our planetarium presentations for engaging the public in appreciation of NASA's results and direction for the future. The topics are the core of NASA's *Vision* because they answer compelling questions and engage the interest and support of a broad constituency. For the same reason, they are central motivational elements in the KSGC mission to increase scientific capacity, to develop the technological workforce for the future, to improve the STEM pipeline, and to promote public appreciation and support. The elements of the Vision are directly incorporated into all of our programs, and all of our programs support NASA's direction. We will describe our enhanced efforts for this purpose in each program area.

Needs, Strengths, and Potential Capabilities of the Consortium Affiliates: KSGC affiliates consist of 12 institutions of higher education, one industry, and one non-profit organization dedicated to the promotion of aerospace science and technology.

The institutions of higher education are the primary means of interacting with faculty, students, teachers, and the public, for the purposes outlined in previous sections. The needs and capabilities of the institutions differ in some ways, but taken together they can complement and benefit each other. All of the KSGC institutions of higher education have baccalaureate majors in aerospace-related fields, and two have doctoral programs in aerospace-related disciplines. The doctoral institutions, the University of Kentucky and the University of Louisville, generally have more faculty with more combined research experience. Their faculty sometimes serve as mentors for faculty getting started in research at other colleges and universities. They typically provide mentoring and role modeling for graduate students in their doctoral programs. Many of the graduate students come to their programs after baccalaureate preparation at the non-doctoral institutions, public and private, described below.

Students in Summer Science Camp conducted by Transylvania University, the 14th university established in America.

Kentucky's six comprehensive state universities are distributed geographically across the state. Eastern Kentucky University, Kentucky State University (HBCU), Morehead State University, Murray State University, Northern Kentucky University, and Western Kentucky University provide important regional accessibility for Kentucky students and also serve students from throughout the state and the Nation. Two private institutions, Centre College and Transylvania University, and two parochial-based institutions, Bellarmine University and Thomas More College, serve students from within Kentucky and beyond, in the liberal arts tradition. The comprehensive public and private institutions prepare students well, and serve their communities of schools and the public with opportunities as discussed in section III-E Public Service.

Our industrial member Tribo Flow Separations, LLC, develops methods for extreme purification of powders, such as metals used to minimize flaws in the production of turbine blades for aircraft. The founder and president of the company brings to KSGC the combined perspective of a former university researcher, then successful inventor, and now industrial entrepreneur.

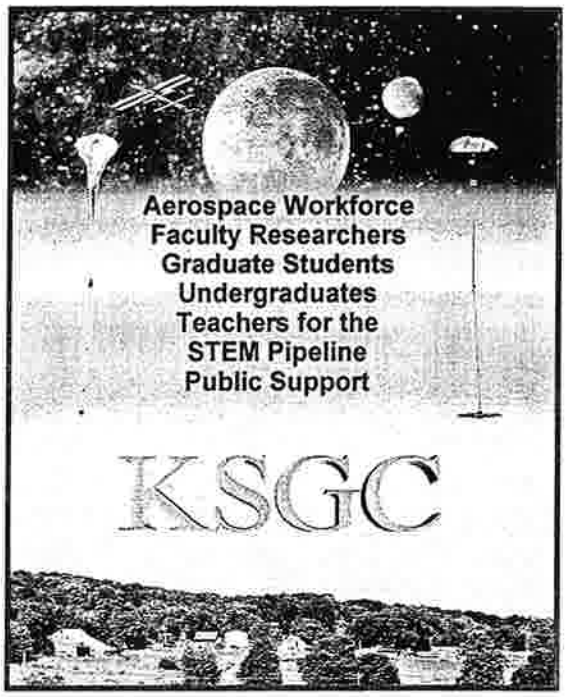
Our non-profit organization member is the Kentucky Center for Space Enterprise, within the Kentucky Science and Technology Corporation. These organizations promote and develop scientific R&D in Kentucky, are were responsible for initiating EPSCoR programs in Kentucky, for developing the Kentucky Science and Engineering Foundation, and for developing Kentucky's Strategic Plan for Science and Technology, among many other accomplishments for science and education in Kentucky. The KSGC Institutional Director for KSTC recently developed an agreement between NASA Ames Research Center and the state of Kentucky to foster cooperative research and to establish a facilitating Kentucky office at the Center.

Throughout the membership of KSGC, the attitude is one of mutual support and promotion of student development in all of the institutions. Competition is not based upon the universities but upon the quality of the proposals and potential of the applicants. The representatives on the Committee work well together to select the best projects wherever they originate, with special sensitivity to including the widest possible participation consistent with quality project proposals.

A. Strategic Implementation/Program Plan

KSGC's member institutions of higher education and their programs of *involvement* provide fundamental support for strengthening the STEM education base in Kentucky and for the direction of the Agency through the following spectrum of strategic program elements:

- **Aerospace Workforce Development** -- is KSGC's prime goal, supported by each of the following elements, and by interdisciplinary, team-mission projects and links with NASA
- **Faculty Researchers** -- are resources at the highest level in the workforce, to provide enhanced emphasis on student research, NASA collaboration, and Center visits
- **Graduate Fellowships** -- support mentored research for graduate student development, with enhanced NASA collaboration for Fellowship projects and NASA Center visits
- **Undergraduate Scholarships** -- support mentored research for undergraduate students, with enhanced participation in NASA internship programs
- **Teacher Training** -- prepares teachers for inspiring students in the STEM pipeline, with enhanced NASA-based materials for use in classrooms, and with pre-service internships
- **Public Support** -- is promoted through involvement for awareness of aerospace issues and NASA, with enhanced support for leveraging informal education partnerships



The details of how these program elements will be conducted, to strengthen the education base in Kentucky and to support the direction of NASA, are addressed in the following sections of this proposal. Our program elements specifically address key national program emphases including **competitiveness, research opportunities, diversity, student mentoring, and interdisciplinary education and research.**

B. Fellowship/Scholarship Program

The KSGC Fellowship/Scholarship Program facilitates research-based training of undergraduate and graduate students for the workforce in space-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, or 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

Characteristics: Awards of **Graduate Fellowships** and **Undergraduate Scholarships** are competed statewide, and require a faculty-mentored research project. Awards are based 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 co-written with a faculty mentor. The KSGC 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 $4,000 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 other NASA projects such as EPSCoR and SHARP. The NASA Academies have also provided NASA-mentored summer research experiences for our students.

Recruitment of applicants for fellowships and scholarships is naturally vested in the faculty mentors, who are willing to commit to the effort mentoring a year-long student research project. The potential faculty mentor is in the best position to know the local pool of potential student researchers and to judge those who are likely to maintain interest and succeed in a project in the mentor's field of expertise. Each fellowship or scholarship is awarded to a particular student, based on that student's academic credentials and the mutual commitment between the student and mentor in their proposed research project. Retention is achieved through the positive effects of research experience and success on the student's motivation to continue to graduation in preparation for a research-based career.

Fellowship and Scholarship students make public presentations of results.

Diversity: KSGC strongly encourages the inclusive participation of women, underrepresented minorities, and persons with disabilities. Reviewers of our 15th Year PPR repeatedly complimented our efforts and success in involving members of underrepresented groups, and in using faculty mentors to recruit them. Our faculty mentors are supportive of this goal as they seek students to propose for fellowships and scholarships for projects under their mentorship. Their success in achieving this goal is highly dependent on the pool of students enrolled in their discipline. In STEM areas, populations of women and underrepresented minorities are typically well below the population percentages of each in the overall university population (mostly non-STEM disciplines) and of the state (see Table below). This situation is one reason for the term "underrepresented", and the roots of the problem are in the earlier pipeline of too-few students who focus on STEM directions early enough to prepare to pursue them when they get to college.

Kentucky Population Statistics, and Women and Minorities Prepared for STEM Participation in Higher Education		
Population Data from 2000 Census, Enrollments/Degrees 2001	**Women**	**Minorities**
Kentucky's General Population	51%	10.1%
Kentucky's University Population (All Disciplines)	58.6%	9.4%
*Eligible University of Kentucky STEM-Enrolled Pool (#Degrees)	*30.5%	*2.6%
*These are the most optimistic indicators, based on the largest and most attractive programs in the state.		

Although fellowship and scholarship resources applied at the higher-education level cannot significantly increase the available STEM population at that point, they can be very effectively applied within this population to help retain capable students to the point of graduating and pursuing advanced STEM studies. They can also steer some of the STEM population specifically toward aerospace and NASA-related career tracks.

The numbers in the table reflect the realistic situation in the most optimistic fashion by using the best case of the University of Kentucky enrollment statistics as our target basis. If we are fortunate enough, through the research-recruiting efforts of the mentors, to have eligible minority students apply in larger numbers, we will make special effort to award them. During the period of the 15th Year PPR, the exceptional efforts of our mentors achieved minority involvement at 14.6%, which is above the level in the general population of the state.

Enhancement Plan: We have recently been awarding averages of about 3 graduate fellowships and 3 undergraduate scholarships per year, budgeting $65,000/year. This year, with the 18.5% reduced base, we budgeted $50,000, and are still awarding a total of $65,500 at the expense of other areas of the budget. Scholarships and fellowships are very important as effective means of retaining STEM students to graduation and advanced studies, as indicated by the high success rate of previous recipients noted by the reviewers of our 15th Year PPR. Beyond the awards we are making, we should have funded others, but did not have enough funding to do it. The demand -- backed by quality of students and of proposals -- is above $100,000/year ($125,000 this year).

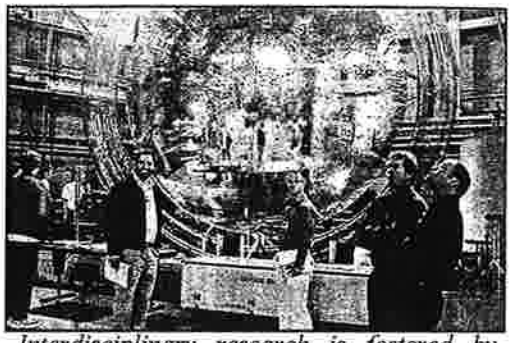
For our enhanced program offerings as a Designated Space Grant Consortium, we will budget $100,000/year for Fellowships and Scholarships, and we anticipate making awards slightly above that level to benefit as many high-quality students as possible. Fellowship awards will require visiting the NASA collaborator, with travel costs supported by state matching funds.

We will increase the emphasis on connecting to NASA Center intern programs, as suggested by the reviewers of our 15th Year PPR. We have previously supported successful NASA Academy applicants; however, it was not feasible to fund wide participation in other NASA internship programs. With Designated Space Grant Consortium funding, and state matching funds, we will support more students in more NASA programs such as Student Internship (SIP), Robotics Internship, Independent Verification & Validation Internship (IV&V), Summer Aerospace Workforce Development Research Internship (SAWDRIP), and the NASA/Johns Hopkins APL Student Internship Program. For students accepted in programs for which NASA pays the full stipend, such as Langley Aerospace Research Summer Scholars (LARSS), we can assist with costs of round trip travel for Kentucky participants using state matching funds.

EKU KSGC Scholarship recipient in the NASA Academy at GSFC.

Metrics, Targets, and Effects: The metrics to be 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 described in Section II-B Program Evaluation. Our competitively selected, mentored-research based Fellowships and Scholarships will contribute to the support of NASA's direction through enhanced development of aerospace workforce with degrees in higher education and experience in research.

C. Research Infrastructure Program



Interdisciplinary research is fostered by collaboration with NASA, as in KSGC projects in inflatable structures with LaRC.

Purpose and Goal: The purpose and goal of the Research Infrastructure Program is to develop capabilities of Kentucky researchers at all levels, with strong emphasis on including student researcher in aerospace-related projects.

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.

Program Characteristics and Planned Enhancements: In the years of operating as a Research Capability Enhancement program, KSGC, as its major goal and mandate, emphasized Research Infrastructure development through "seed" grants to faculty for initiating aerospace- and NASA-related research in Kentucky. As noted by the reviewers of our 15th Year PPR and as indicated by the current research areas listed in the Appendix, our program has achieved a very high degree of success in developing Research Infrastructure. Kentucky's capabilities for aerospace- and NASA-related research have been significantly enhanced by our co-managed KSGC and NASA EPSCoR programs. Kentucky's ranking among the states in total NASA obligations for the years 2001-2003, reported in the *NASA University Program Management Information System*, progressed as follows:

Progression of Kentucky's Ranking in NASA Obligations to Universities			
Year	2001	2002	2003
Rank	45th	43rd	39th

KSGC will increase the opportunities for engagement of students in research by emphasizing faculty research activities that involve students. Our enhanced goals for Research Infrastructure development are:

1. Increased emphasis on involving students in research.
2. Increased emphasis on recruiting women, underrepresented minorities, and persons with disabilities through these research opportunities
3. Sharpened focus on connecting research with NASA collaborators

A strong emphasis in making "seed" awards will be placed on the **faculty's involvement of students in the research**, specifically hiring students as full participants in the research effort. Proposers will be instructed that additional scoring points will be given in the reviews for the **recruitment and involvement of women, underrepresented minorities, and persons with disabilities in research experiences**. Since our awards are competitively based, they provide both motivation and mechanism for recruitment of targeted populations on-site, where the research opportunities exist and can directly attract participation.

KSGC research projects in NASA's reduced-gravity facilities attract student participation.

Collaboration with NASA ensures an **interdisciplinary** dimension. NASA's projects and interests are generally interdisciplinary -- there is a problem to be solved or a mission component to be developed. By engaging in a project of interest to NASA, and working with a NASA collaborator, the researcher participates in an interdisciplinary effort and gains an interdisciplinary perspective and appreciation that might never have been acquired otherwise.

KSGC has heretofore invited proposals for amounts up to $10,000 in "seed" funding to initiate aerospace-related research projects by faculty at member institutions. This "seed funding" is intended to enable a new faculty member to initiate NASA/aerospace-related research, or to enable other faculty to establish new research directions in NASA/aerospace-related areas. In some cases, it is a unique avenue for faculty at non-doctoral, comprehensive universities and private colleges to initiate research that establishes future opportunities for themselves and students at these institutions. The project is also intended to **enhance the investigator's competitiveness** for future funding. Eligibility for renewal is contingent upon quantifiable **performance metrics** including publications and presentations, technology transfer, and follow-on proposals to NASA or other agencies. KSGC proposals are externally reviewed, and decisions on awards are made by the KSGC Committee using these reviews for guidance. We have previously awarded an average of 5 projects/year, averaging $7,500 per award.

To take the program to new levels as a Designated Space Grant Consortium with the achievement of the strengthened focus outlined above, KSGC needs to be able to provide somewhat higher levels of "seed" funding. It is essential that the awards provide adequate faculty time to permit a significant dedication of effort to the research and to the involved students. A faculty member needs at least a reduction of one course per semester (essentially 25% effort) for an academic year to focus efforts and complete a research project. That translates into approximately $13,000 - $18,000 for salary and fringe, of which a part should be contributed as part of the institutional match required for the award. Strengthening the emphasis on involvement of students is achieved by including funds for direct student support in the proposals. Other requirements include travel to NASA Centers to meet and work with NASA collaborators. For projects with significant involvement of graduate or undergraduate students, our awards will be increased to a maximum of $15,000, subject to inclusion of significant student funding and commitment to visit the NASA collaborator at the Center. Upon request and justification, additional travel to Centers can be supported from the state matching funds.

The state matching funds for KSGC as a Designated Space Grant Consortium will be used to support all program elements for needs exceeding what is afforded by the NASA funding. It is particularly significant to be able to provide minor items of state-funded equipment where

needed to enable initiation of research projects. Such items (typically limited to a few thousand dollars for any project) can make a critical difference in the type and level of research that can be initiated at some institutions. This capability will enable the institutions to fill a niche in providing research experience for undergraduate students throughout the state.

Metrics and Targets for Evaluation of Success: The quantitative metrics and annual targets by which we evaluate success of the Research Infrastructure Program are given in Section II-B Program Evaluation. Meeting the objectives will serve 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 contributes to its future.

D. Education Program

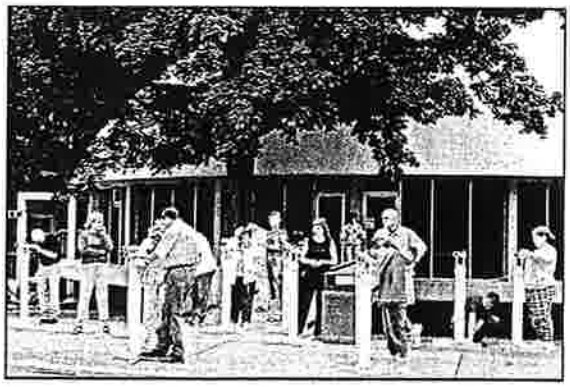
Overview of Purpose and Organization of Program: The KSGC Education Program is designed to provide a continuum of support for improvement of the STEM education base in Kentucky. At the earliest level in developing the STEM pipeline, our Precollege Program emphasizes improvement of teachers' capabilities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

1. Precollege Program

The major emphases in our Precollege Program are all directed toward teacher training for hands-on activities to involve their students in exciting participatory learning, including enhanced understanding of content in state and national STEM standards. Emphases include:

- Workshops for In-Service Teachers
- Mentored/Modeled Teacher Preparation (pre-service)
- State and National Content Standards



In-service teachers testing telescopes that they built during a KSGC workshop.

Workshops for In-Service Teachers: The principal application of precollege funding resources will be in conducting teacher workshops in STEM fields to enhance in-service teachers' preparedness for teaching their subjects in exciting ways that directly *involve* students in activities and inspire greater interest in STEM subjects. This purpose is driven by a fundamental need of Kentucky -- it helps fulfill the explicit expectations of the Kentucky Education Reform Act of 1990. That act provided only the expectation and did not provide means of "re-training" teachers who had traditionally taught with less student involvement in activities. Beginning with its founding in 1992, KSGC worked to help fill this need of the systemic education reformation in Kentucky. The Eisenhower Math and Science Program in Kentucky also addressed this need, but that program in the state no longer

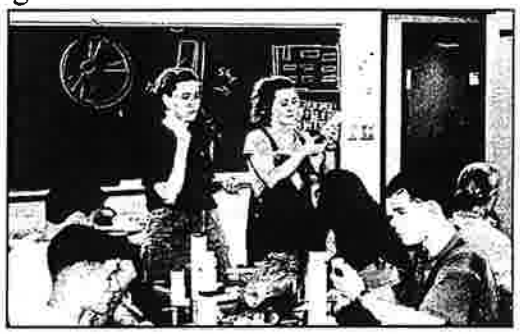
supports the types of workshops it once did. With the change in the Eisenhower Program, KSGC experienced a rise in the number and scope of workshop proposals. While this occurrence presented an opportunity for KSGC to train in-service teachers based on aerospace and NASA concepts, our budget as a Research Capability consortium could apply only minimal resources to precollege efforts. Still, the need and importance of training teachers is so vital to the development of the STEM pipeline for Kentucky that we funded as many as we could, to achieve the widest impact on the needs of the state.

KSGC can more effectively strengthen the STEM education base for the precollege pipeline by conducting more workshops to reach more teachers each year, with increased funding levels made possible by the Designated Space Grant Consortium budget. Our workshop funding will be awarded to faculty at member institutions on the basis of proposals for particular workshops meeting specific goals and needs of the state. The awards will be **competitive**, with the KSGC Committee selecting the best offerings that **fulfill identified needs of Kentucky's education system**. Each workshop will be evaluated during its course with questionnaires in which the participants evaluate workshop delivery, relevance of the material to their teaching needs in regard to state standards, and applicability of the techniques in their class settings. Some workshops will have follow-on sessions in which the participants return after having time to apply and test the methods and activities learned in the workshop. These evaluations will help identify what works best in the workshops to meet actual needs and to facilitate continuous improvement in subsequent offerings. Awards will be re-competed each year, and the **evaluations** will be included in proposals and reviewed as one basis for continuation.

The current maximum workshop award is $8,000, and we propose to increase it to $10,000, based on adequate justification in proposals, particularly for providing more materials that the teachers are provided to use in their class activities. The workshops each typically serve about 10 teachers with individual attention from the staff in learning to apply the provided materials in their classes. We will be able to award at least five per year at up to $10,000 each, totaling $50,000/year (up from our current average of 2.5/year totaling about $20,000).

Teachers in our workshops identify needs for larger items of minor equipment that they could borrow for use in their classes and other student-participation projects. State matching funds will enable KSGC to purchase such items, to prepare materials and instructions to facilitate their use, and to ship them to teachers anywhere in Kentucky for short-term use. The central library of instructional items will grow with time and serve increasing numbers of teachers and classes.

Enhancement of Pre-Service Teachers: KSGC has developed two avenues for enhancing the preparation of pre-service teachers with guided experience in hands-on involvement of students in aerospace topics to promote interest in STEM. Both avenues involve tutoring by practicing master teachers. First, some pre-service education majors are included in the workshops described above, where they "learn by doing" from master teachers on the workshop staff and also learn from practical experiences related by the in-service participants.



Pre-service intern (right) teaches with mentoring master teacher (left) in KY Governors Scholars.

A more intensive "learn by teaching" experience with master teachers as mentors and models is provided through **preservice-teacher internships** in Kentucky's Governors Scholars Program. This program provides intensive summer learning experiences for talented Kentucky precollege students, and KSGC initiated internships for preservice college education majors to teach along

with the master teachers who conduct the program. Each year, we plan to provide (partial) support for up to two pre-service teaching interns at $3,000 each, jointly with the Governor's Scholars Program, with options to support similar experiences with master teachers as they arise in other summer programs. The responsible master-teacher staff will recruit applicants and select the most promising candidates for the internships. They will subsequently evaluate each intern's progress in teaching side-by-side with the master teachers in the summer program.

Support of State and National STEM Standards: During the development of systemic reform of precollege education in Kentucky in the 1990s, KSGC's Associate Director was instrumental in developing Kentucky's science education standards in earth and space sciences at all levels, including extending them through high school. The standards were derived from the National Science Education Standards. Kentucky teachers in all KSGC workshops are particularly interested in methods of teaching that will help them achieve these standards. The standards are fundamental to the curriculum and to the student success that is ultimately part of the evaluation of the performance of the teachers and of their schools.

A teacher examines NASA lunar samples at a KSGC workshop.

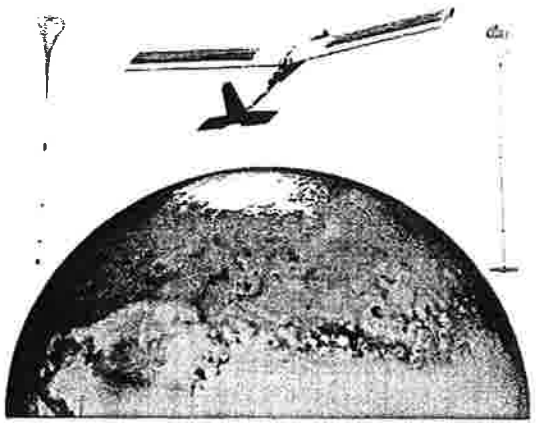
Proposals for teacher workshops will be required to address how the workshop will directly support the standards and how NASA-based topics and materials will be used to achieve the goals. NASA has provided assistance from AESP personnel in reviewing Kentucky's standards and in selecting NASA resources to support them. Materials for the teachers to use for student involvement activities will be selected to support NASA's *Vision* and direction, as the basis for inspiring the interest of students at an early age. Some of the workshops include NASA certification of the teachers to borrow lunar samples for their classes -- for the new generation who will be a part of NASA's return to the moon and preparation for Mars.

Support for Diversity: We ask proposers of workshops to appeal to and encourage participation of underrepresented groups and persons with disabilities in their workshops, and we give priority to those who can demonstrate ability to **recruit diverse participation**. In addition, some workshops involve expertise of college of education personnel in teaching how to recognize and **ameliorate gender-based obstacles** to the inspiration and involvement of all students.

Partner Leveraging: KSGC and partner organizations on the campuses provide a wide range of supporting opportunities for Precollege STEM interest and development. KSGC distributes information about opportunities such as the NASA Student Involvement Program (NSIP), and KSGC Campus Directors make presentations to winners at their schools. KSGC provides information to help with viewing the International Space Station and listening to radio contacts between the astronauts and schools. Planetaria reach thousands of precollege students and their teachers each year with information from NASA's space exploration and science missions. Astronomy partners in Louisville are implementing the NASA Night Sky Network and the NASA After School Astronomy Program. The NASA Educator Resource Center at Murray State University provides NASA educational materials for teachers throughout the state. The KSGC website maintains links to the NASA Central Operation of Resources for Educators (CORE), and to the NASA Education website, where teachers can learn about NASA opportunities.

Metrics and Targets for Evaluating Success: The quantitative metrics and annual targets by which we evaluate success of the Precollege Education Program are given in Section II-B Program Evaluation. Meeting the objectives will increase the capabilities and capacity of Kentucky teachers for teaching in ways that both instruct and inspire students toward career aspirations in STEM fields. The direction of NASA is supported by using NASA missions and resources as bases for inspiration, role models, and content delivery.

2. Higher Education Program



Purpose and Goal: 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.

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 in relation to aerospace and 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. This year, there was no offering of competition for WFD funds from NASA, and our current base cannot support the KSGC workforce development projects that were developed over the last three years without the augmentation.

Designated Space Grant Consortium funding is the needed basis for being able to continue and build upon our successful WFD program, providing adequate budgetary support for WFD and including new opportunities for enhancement (described below) that have developed from program experience. We will describe our successful design, and our proposed continuation and enhancement of the program, based upon a budget level of $100,000/year.

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 programs, dedicated faculty have worked with students on three types of mission-oriented projects, based at five member-institution sites. All support NASA's direction in the *Vision for Space Exploration.*

Diversity: Faculty who recruit student participation in WFD projects seek the widest possible participation by women, members of other underrepresented groups, and persons with disabilities. All opportunities are equal opportunity and are open to all students who are interested in participating in the team-based mission.

Student Payload-to-Altitude Comprehensive Experiences ("SPACE" Missions): More than 150 students (mostly undergraduate, some graduate students) have worked with several faculty members at the University of Kentucky in developing and running three missions of BIG BLUE -- the **B***aseline* **I***nflatable-wing* **G***lider* -- **B***alloon* **L***aunched* **U***nmanned* **E***xperiment*. The students work with ILC Dover, Inc., and NASA resources to design, build, and fly hardware to demonstrate the concept of inflatable fabric wings that can be compactly stowed, inflated, and used to fly exploration missions in the rarefied atmosphere of Mars. The missions use helium-filled balloons to carry the complex payloads to the "edge of space" -- altitudes near 100,000 ft in the earth's atmosphere, which simulate Mars' atmospheric density. The missions directly support NASA's *Vision* of robotic exploration of Mars. The students visit NASA Centers and are advised by engineers and researchers both in NASA and in aerospace industries.

NASA Reduced Gravity Student Flight Opportunity Missions: In the past three years, a team of students at Eastern Kentucky University and two teams at the University of Kentucky's Paducah Campus successfully proposed and executed scientific and engineering investigations on board NASA's KC-135 reduced gravity facility. During the six years prior to that, seven student teams from the University of Kentucky and its Paducah Campus conducted "Weightless Wildcat" missions in NASA's KC-135 program. The missions directly support the direction of the Agency in utilizing its resources to investigate effects in microgravity with a view toward preparing for long-duration spaceflight and engineering support for future explorations. They all provide exciting motivational experiences in team-based mission projects including all stages of proposing, designing, constructing, flying the mission, and analyzing and presenting the results.

NASA Moonbuggy Competition Missions: Undergraduate student teams at Murray State University and Northern Kentucky University have designed, constructed, and demonstrated successful performance of "moonbuggies" in NASA's Moonbuggy Competition at Marshall Space Flight Center. Faculty advisors at Murray State University subsequently proposed and were awarded KSGC funding to conduct a workshop for area teachers to develop moonbuggy teams at their schools. They then held a regional competition, and four high school teams went on to compete in the NASA event at MSFC. The leveraging of this higher education activity makes a major contribution to pipeline for future aerospace careers. It is inspired by, and directly supports, NASA's *Vision* of returning to the Moon.

Enhancements for Increasing Achievement of Workforce Goals in Kentucky: The excitement and impact of the WFD programs are contagious and far-reaching. Department heads and deans have observed the effects at the institutions, have provided additional

funding support, and have even participated in some of the missions. **Curriculum improvements** have resulted, including senior design courses have shaped by project components, interdisciplinary involvement, and systems-engineering concepts added to courses. KSGC enhancements for existing WFD efforts will include support for bringing external expertise in systems engineering to assist with curriculum modifications. State matching funds will enable KSGC to purchase minor equipment needed for active workforce missions. Such items would be loaned to the project for its duration and returned afterward to a central repository for use by other workforce projects. Faculty who have developed workforce missions with their students are invigorated by the experience and its benefits for their students. Some faculty have expressed eagerness to share their experience and expertise with others who might be encouraged to develop WFD efforts.

WFD Program Workshops to Leverage Expertise and Opportunities: The extensive faculty expertise developed in three years of the Big Blue project, as well as six Reduced Gravity Student Flight Opportunity missions, is available to help faculty at other institutions learn how to design and coordinate large-scale WFD projects, including Aerospace Apprentice projects. As the expertise grows within the state, others who have gained experience will also be able to share their knowledge and experience with still more faculty who are interested in conducting WFD programs. We envision one workshop each year, costing about $10,000, awarded competitively on the basis of proposals. Renewal proposals will be required to demonstrate the success of previous offerings and WFD projects. In this way, our most successful WFD projects can serve both as models and guides for other projects in Kentucky, and elsewhere with possible participants from other states.

Apollo 17 Asrronaut Harrison "Jack" Schmitt discusses Big Blue planning with the students.

Aerospace Apprentice WFD Projects: Faculty mentors with extensive WFD experience have proposed a novel curriculum concept that would utilize the experience of NASA engineers and scientists to both inspire students and guide their preparation for the aerospace workforce. The idea is to bring to campus NASA personnel and retired NASA personnel, representing vast practical aerospace and NASA experience, for the purpose of interacting with students in engineering classes over a term. The engineers would relate to the students the engineering, management, and resource considerations that shape complex aerospace projects and missions. They would work with students in several senior design courses in different disciplines to coordinate and advise a student WFD mission. Any member institution could propose such a project as a major WFD component, with competitive selection based on its design, numbers of students involved, and cost. Depending on their scale, projects would require funding in the range of $10,000 to $40,000 each. Travel can also be supported from state matching funds. In addition to direct benefits to students in WFD experiences, the projects will improve curricula through interdisciplinary interaction.

Metrics, Targets, and Effects: The quantitative metrics and annual targets by which we evaluate success of the Higher Education Program are given in Section II-B Program Evaluation. Meeting the objectives will serve to enhance the aerospace workforce with increased numbers who have gained experience in an interdisciplinary, team-based, mission-oriented project to prepare for involvement in the future of NASA and aerospace.