

# **Progress Report for Year 1 of the NASA PAIR Project at South Carolina State University (NCC 5-454)**

***January 4, 2001***

The following report is submitted as a Progress Report for Year 1 and as part of the Renewal Request for Year 2 of the NASA PAIR project at South Carolina State University (SCSU) known as "Curriculum Enhancement Through Space Science Research" (CESSR). The format and content of this report follow the template and other instructions provided with the November 17, 2000, packet of materials from Mr. Michael Hester, NASA Peer Review Services.

## **RELEVANCE TO NASA**

### **Item 1: Relation to MUREP, Strategic Enterprises and Center Core Area**

The CESSR mission (see Item 2) contributed to the Minority University Research and Education Programs (MUREP) goal in Year 1 of facilitating activities at an MI (SCSU) that related to NASA's mission to "communicate scientific knowledge of the universe". The MUREP goal of systemic and sustainable change by incorporating current NASA research results and modern teaching strategies into the curriculum was also achieved as described in Item 2. These activities have better prepared SCSU faculty to participate in competitive research and education processes in the NASA Strategic Enterprises by familiarizing faculty with both the subject content and the methods employed by NASA in implementing such projects. Underrepresented minority students at SCSU have become better prepared for graduate school or employment in fields of interest to NASA through various research and learning experiences supported by CESSR.

Student research projects and curriculum development in Year 1 are clearly related to the goals and objectives of the Space Science Enterprise, in particular Enterprise Goal #4: "Contribute measurably to achieving the science, mathematics, and technology education goals of our Nation, and share widely the excitement and inspiration of our missions and discoveries."

The SCSU PAIR partnering center is the Goddard Space Flight Center (GSFC) which has been designated the NASA Center of Excellence in Scientific Research, and whose Mission Area includes Earth Science, Physics and Astronomy. The SCSU PAIR activities are based on NASA astrophysical research conducted by the PAIR PI. Some space science topics which were explored in Year 1 included radio astronomy, CCD camera design and construction and database management of CCD images.

### **Item 2: Mission of the Project and Specific Outcomes**

The mission of CESSR is, "To enhance undergraduate faculty teaching and student education across mathematics, science and engineering technology (MSET) disciplines by integrating the existing NASA research in space science at South Carolina State University into the MSET courses and curricula. Faculty training, undergraduate research and coursework development will be pursued through exposure to cutting-edge science and technology concepts, as well as introducing modern, innovative teaching techniques into the classroom and laboratory."

Year 1 project activities have supported this mission. Several representative examples include: (1) Seventeen undergraduate students, divided into four interdisciplinary research teams have completed year-long research projects which focused on topics in radio astronomy, database management of CCD images, design of a basic robot and virtual-instrument

management across the web; (2) Courses in physics and electrical engineering technology incorporated the industry standard LabVIEW design software into their coursework; (3) several new astronomy lab exercises were developed for non-MSET majors taking a physical science course; (4) An innovative learning tool known as the “Concept Map” was used in an advanced physics course on quantum mechanics as well as in a computer science programming course; and, (5) faculty and students attended workshops on UNIX, LabVIEW, astrophysics, and metacognitive tools used in MSET teaching.

## **INTRINSIC MERIT**

### *Objectives and Implementation*

#### Item 3: Project alignment with original objectives

Our original proposal listed “Objectives and Assessment” under the Project Description. Those items are more accurately described as milestones rather than objectives. Therefore, a set of objectives was created by the CESSAR Steering Committee (PI, Co-PI and Co-Is) which is in-line with the objectives stated in the original NRA. These objectives are as follows:

1. Integrate cutting-edge science and technology concepts, practices and teaching strategies into the MSET curriculum at SCSU.
2. Increase the number of SCSU MSET graduates who have been competitively trained, have discipline-related work experience and who will attain advanced degrees in fields of interest to NASA.
3. Foster cross-departmental collaborative research and curriculum activities among students and faculty members at SCSU.
4. Significantly improve undergraduate teaching and learning in the technical fields at SCSU including the use of modern teaching techniques and methodologies in introductory and advanced MSET coursework for majors and non-majors.
5. Promote faculty and student interest in NASA space science discoveries.
6. Create an advisory board to include individuals from a wide range of backgrounds and experiences who will provide insight, knowledge and professional contacts to further enhance the development of the various activities supported by this program.

The project has remained aligned with these objectives in Year 1 as evidenced by the examples given under Items 4 and 5.

#### Item 4: Impact on faculty and staff

The CESSR PI and five Co-Is have received new training in astrophysics, LabVIEW, UNIX and innovative teaching techniques which use the metacognitive tools the Concept Map and Vee Diagram. The CESSR Co-I for Outreach received additional training in the use of the StarLAB portable planetarium. She now uses PAIR research students to conduct outreach sessions for K-12 students using StarLAB. PAIR partially funded the PI to attend a workshop on advanced network applications which will assist in a planned proposal to NSF to dramatically expand the SCSU MSET Internet bandwidth and increase participation in NASA and NSF

research and educational initiatives in astrophysics. Four of the CESSR faculty members have attended national meetings to present PAIR-related activities.

Faculty members at SCSU who are not part of the CESSR project have also benefited from PAIR. One faculty member in the Electrical Engineering Technology Area (EET) received PAIR LabVIEW training for future curriculum development in EET courses. A physics faculty member is revising a solar laboratory exercise which will use NASA SOHO and other web resources as part of the exercise. Three SCSU faculty members who are not part of PAIR attended the workshop at Tennessee State University in which the PAIR team was trained to use the Concept Map and Vee Diagram. These non-PAIR faculty members will be using the training during summer 2001 research projects with students funded under other NASA programs at SCSU (e.g. the MU-SPIN NRTS project).

A significant impact of PAIR has been on the involvement of the SCSU planetarium and its director in PAIR-related activities. The planetarium is located in a museum/planetarium building on campus and has been part of the Arts and Humanities school for the past twenty years. At times this has made it difficult for the Physical Science department to carry out collaborative efforts with the planetarium. The SCSU PAIR Co-PI is the Dean of the School of Engineering Technology and Sciences (SETS). During the past year, he has successfully convinced the University administration to transfer the planetarium and its director to the SETS. The PAIR project and its heavy involvement with the planetarium provided additional leverage in convincing the University administration that such a transfer was necessary. With the planetarium director now a faculty member in SETS, he has been able to devote more time to teaching physical science courses and to participating in the PAIR project.

The planetarium director has been a major benefactor and contributor to the PAIR project at SCSU even though he is not a Co-I. In May 2000, he received funding from PAIR to attend an NSF short course on radio astronomy at the National Radio Astronomy Observatory (NRAO) in Greenbank, West Virginia. During the summer of 2001 he will attend an advanced radio astronomy course at the NRAO VLA facility in Socorro, New Mexico. He has been heavily involved in bringing the NASA Radio Jove project to SCSU, including working with our NASA contact at the Goddard Spaceflight Center, Dr. James Thieman while monitoring both solar and Jovian radio bursts. In Year 2 he will assist CESSR in installing and using a commercially available 1.4 GHz radio telescope to observe galactic and extragalactic sources of radio emission from hydrogen.

#### Item 5: Integration of NASA-related research into the MSET curriculum

The PAIR project is responsible for the creation of a new, two-semester, 1-credit course entitled "Interdisciplinary Research Seminar in Space Science" (ETS 468-469) which was approved by the SCSU Board of Trustees and is now part of the curriculum. This course was first offered in Year 1 with an enrollment of 17 students each semester. Members of the interdisciplinary student research teams are required to enroll in the course and continue their research projects which were begun during the summer prior to the academic year. During the two semesters in which the course is offered, the cumulative requirements for each student team includes giving three presentations to K-12 groups, one presentation to their campus peers and one presentation at a professional meeting at the state, regional or national level.

A new laboratory experiment was developed under CESSR for the Advanced Physics Laboratory course (P 407), a course which is required for all physics majors. In this new exercise, the student learns about the operation of a CCD through reading assignments, builds a simple CCD camera using an inexpensive computer "eyeball" camera and then takes astronomical images with the CCD camera they designed while attached to an 8-inch telescope. The student concludes their multi-week project by carrying out basic astronomical image processing of CCD images using PC-based software. While the telescope and computer

hardware were already in-hand, PAIR funded the purchase of the CCD camera components and the image processing software.

Several astronomical lab exercises were developed for the non-MSET majors course, Space/Earth Science Laboratory (PSC 153). These exercises included student assignments which required accessing NASA web sites (e.g. the JPL images) to answer questions. Feedback from students indicated that they found the web-based exercises to be for more stimulating than traditional work.

The PAIR Co-I in computer science has modified the course CS 411, Database Management System Design, to include a study of how to store and retrieve non-textual data (images) based on his new PAIR experience using astrophysical CCD images. Additionally, he is using the metacognitive Concept Map and supporting commercial software package (funded by PAIR) to teach students enrolled in his programming classes how to design and develop a computer program.

Several courses in physics (P 407) and electrical engineering technology (ET 443, PLC and Virtual Instrumentation; EET 392, Introduction to PLC and Virtual Instrumentation; EET 383, Digital and Microprocessor Laboratory) are now using LabVIEW as part of the coursework, either for the first time or to a far greater extent than prior to the PAIR-funded training for students and faculty.

### *Program Evaluation*

#### Item 6: Outline Implementation of the Program Evaluation Plan

The plan for evaluating the success of the program has been implemented in four separate stages corresponding to time periods which were defined by the academic calendar.

Stage 1: Occurred at the beginning of the summer term (May) and involved an overview by the Steering Committee of the various milestones and projections required in Year 1 and the cumulative milestones and projections for Years 1-4.

Stage 2: Occurred near the end of the summer term (August) by which time most student and faculty training had been completed. Changes were made in plans for the student outreach portion of the project to allow the project to take advantage of visits by large groups of K-12 students to the SCSU campus in the fall of 2000, thus freeing travel funds needed for outreach to be used elsewhere.

Stage 3: Occurred at the end of the fall term (December) and addressed a number of issues related to the student research teams and their presentations during the spring term.

Stage 4: To occur in the middle of the spring term (March) to determine if any final adjustments in procedure are needed to achieve Year 1 milestones by May 14, 2001.

It should be noted that while the funding period for the SCSU PAIR project is March 1 to February 28, the evaluation plan assumes a period beginning on May 15 of one year and ending on May 14 of the next year since student and faculty commitments and subsequent achievement of milestones are tied to the academic calendar. Therefore, the assessment and evaluation for Year 1 described below involves some projections to May 14, 2001.

#### Item 7: Formative Development of the Project in Response to the Program Evaluation Plan

The project, its goals, milestones and assessment have largely remained the same during Year 1. Adjustments have been made due to changing circumstances to the extent that the manner in which certain milestones were achieved has been modified. For example, the change in the outreach presentations by the student research teams has been to accommodate several large groups of students visiting SCSU rather than have the teams go out to individual schools. Another example is that the type of training using innovative teaching methods was modified from the original plan to take advantage of a workshop offered by our NASA MU-SPIN

NRTS partner, Tennessee State University. The PAIR PI and Co-Is went to Nashville to train in the use of the metacognitive tools already being implemented at that school under the direction of Dr. Marino Alveraz.

Item 8: Dissemination of “best practices” information

The dissemination of such information within the project has been carried out through quarterly meetings of the Steering Committee and semi-monthly email exchanges. Unscheduled face-to-face discussions and phone conversations among members of the Steering Committee occur one or more times per week since the committee members interact with each other through various other committees and activities such as shared teaching responsibilities.

Dissemination of the information beyond the project will take the form of the annual report and web postings once the project web page is complete. Additionally, an annual summary of the recommendations of the Advisory Committee and other “best practices” information will be disseminated as a web posting as well as sending hard copies to appropriate individuals. If possible and appropriate, this will be incorporated into the MURED Annual Uniform Outcomes Report in the narrative section.

Item 9: Tabular Representation of Outcomes/Milestones for Year 1

The original proposal by SCSU called for an assessment of the project (page 14) based on a number of criteria including specific annual milestones, annual and four year totals for enrollment in impacted classes, annual and four year totals for the number of individuals trained as well as the number of presentations given. In the following table, those outcomes and metrics are evaluated.

<b>Project Outcomes</b>	<b>Metric for Success</b>	<b>Actual Achievement</b>
PAIR Advisory Board created, review of project provided	13-15 members from varied backgrounds	100 % (projected by May 2001)
Student research teams formed, projects completed	3 teams, 3 completed projects	4 teams, 4 completed projects
New advanced research course tied to space science	ETS 468-469 approved by Board of Trustees and offered	100%
New lab exercises created	2 in MSET courses	1 in physics, 4 in physical science
Incorporates NASA resources in non-MSET course	PSC 152 (lecture)	Deferred to PSC 153 (lab course)
A-Tech low-light video system	Purchase & begin observing	100%
Impacted MSET class enrollment	154	151
Impacted non-MSET class enrollment	365	39
Faculty members trained	5	11
Students trained	12	17
Presentations to K-16	12	12
K-12 students view PAIR undergrad presentations	225	343
Student professional presentations	3	4

### **Comments/Issues to Address in Item 9 Table**

All annual metrics included in the original SCSU proposal have been met or exceeded except for the enrollment in non-MSET classes which are impacted by the project. The reason for this is: (1) the new lab exercises for the courses were not ready during the summer 2000 session, hence an entire group was not impacted even though they were included in the original projections; (2) due to a change in the curriculum for non-MSET majors, there will be far fewer students taking PSC 152 & 153 (lecture and lab) than in the past; and (3) the PSC 152, lecture course in Earth/Space Science, has not implemented new space science resources. This needs to be rectified in the future. It is anticipated that once all PSC 152 & 153 sections are using new space science resources that the annual totals will increase, however the four-year goals can no longer be met due to the curriculum change noted. This metric will have to be reevaluated.

### *Partnering*

Item 10: Partners and outcomes from formally established partnerships

Partnering in Year 1 of the SCSU project has been quite successful, but we do not expect to see its full impact until Year 3 or 4 as these relationships continue to evolve.

Our partnership with Goddard Spaceflight Center (Dr. James Thieman) has been helpful in establishing our NASA Radio Jove program. Additionally, Dr. Thieman assisted us in identifying another NASA scientist, Dr. Theodore Gull, who was interested in partnering with us on what was eventually a successful proposal for the OSS/MURED Minority University Initiative.

Our initial PAIR partnership with the University of the Virgin Islands (UVI) will gain future access to their soon-to-be refurbished observatory. This partnership has expanded under our OSS/MURED project to include recruitment of students from UVI who will attend SCSU as physics majors after receiving their associate degree from UVI.

National Instruments develops and markets the LabVIEW software and they have provided SCSU with free teaching materials for training workshops. Their membership on our Advisory Board will ensure we are aware of the latest use and developments regarding this powerful suite of software.

We have taken advantage of an existing partnership with Tennessee State University under our NASA URC and NASA MU-SPIN grants to further collaborate with them. Our faculty has been trained in the use of their "Explorers of the Universe" program and its metacognitive tools. Furthermore, they are allowing us to set up student and faculty accounts on their servers and to use them for our own classes. The first such use of these resources will take place during the Spring 2001 term.

Our partnership with the Kansas-based A Tech, an astrophysics research company, has resulted in SCSU being the first organization outside of A Tech to own one of their Image Intensified Video Research Systems. During a recent demonstration of the instrument we were most impressed with its capabilities. We plan to collaborate with A Tech and find additional funding to develop astronomical educational videos.

An unexpected partnership has developed during Year1 with the Pisgah Astronomical Research Institute (PARI) in North Carolina. They are at the site of a former NASA satellite tracking facility and the various radio dishes on the grounds are being used for radio astronomy research and education projects. We are working with them to find an appropriate funding source to formalize some of the projects on which we would like to collaborate. In Year 2 of the PAIR project, we intend to focus all four teams on radio astronomy and use the unique capabilities of each team (e.g. robotics, database management) to develop a project in conjunction with the researchers at PARI.

## MANAGEMENT APPROACH

Item 11: Implementation steps for achieving milestones.

Currently the PI, in consultation with the Co-PI and Co-Is, evaluates and enumerates the steps necessary for successful implementation of each milestone as discussed above in Stage 1 under Item 6. This group then monitors the progress toward achieving each milestone as described in Stages 2-4 under Item 6. Adjustments are made at any time to the course of action needed to achieve a milestone when it becomes apparent that such an adjustment is necessary (e.g. the K-12 outreach presentations in Year 1). It is expected that in Years 2 and beyond, CESSR will receive related input from the SCSU PAIR Advisory Board as well as NASA reviewers and the PAIR Project Manager. The Year 1 project milestones are discussed in under Item 9.

Item 12: Evidence of competence in achieving the objects

The table given under Item 9 clearly shows that that project personnel and the partners are capable of achieving the objectives of the project by reaching annual milestones and in all but one case, meeting or exceeding annual quantifiable measures of impact (e.g. enrollment in courses, introduction of new coursework, etc.)

Item 13: Significance/impact on host institution, NASA and/or state's math/science standards

NASA PAIR has achieved a high level of visibility on the SCSU campus in a matter of only a few months compared to longer time periods for other NASA and non-NASA projects. This is in part due to the formal publicity regarding the project including a front-page article in a campus publication and a reference to the project made by the SCSU president during a campus-wide talk. Additionally, the cross-departmental nature of the project has ensured that all the MSET departments are involved and most of them are participating in the project either through training workshops, funding of faculty members from three of the five MSET departments and/or funding of students from all five departments. The high rank of the Co-PI (Dean of SETS) has ensured that the project receives attention at all levels within SETS as well as within the University administration. It is not realistic to expect that the SCSU project would have an impact beyond its own campus after being in operation only 10 months.

## HUMAN RESOURCE DEVELOPMENT

Item 14: Project involvement of underrepresented students

Course abbreviations include: P (Physics), PSC (Physical Science), CS (Computer Science), EET (Electrical Engineering Technology), ETS (Engineering Technology & Science)

### Non-MSET Majors

PAIR course	Semester	Black Male	Black Female	White Male	White Female	Hispanic Male	Hispanic Female
PSC 153	Fall 00	7	6				
PSC 153	Spr 01	9	9		2		
P 507	Spr 01	1	4		1		
<b>TOTAL</b>	<b>Year 1</b>	<b>17</b>	<b>19</b>		<b>3</b>		

## MSET Majors

PAIR course	Semester	Black Male	Black Female	White Male	White Female	Hispanic Male	Hispanic Female
CS 201	Spr 01	17	9				1
CS 411	Fall 00	25	6			1	
EET383	Fall 00	14	3				
EET 383	Spr 01	4	1				
EET 392	Spr 01	12	4				
EET 443	Fall 00		2				
EET 443	Spr 01	8	2				
EET 460	Fall 00		1				
ETS 468	Fall 00	10	7				
ETS 469	Spr 01	10	7				
P 407	Fall 00	2					
P 410	Spr 01	3	2				
<b>TOTAL</b>	<b>Year 1</b>	<b>105</b>	<b>44</b>			<b>1</b>	<b>1</b>

### Item 15: Measuring MSET student retention

Currently the PAIR project is tracking only those students who are members of the research teams (17 individuals in Year 1) to determine both their retention rate as well as their career choice after graduation. We want to determine what percentage of the students pursue graduate degrees in MSET fields versus what percentage enter the workforce and in what fields.

## PROPOSED COST

### Item 16: Explain any significant budget changes

No significant changes have occurred during Year 1 (see expenditure summary). Five thousand dollars in travel money for a van rental was reallocated for travel for more faculty members to attend the teaching methodologies workshop at Tennessee State University. However, this did not impact the outreach/recruitment plan or the student presentation plan since the required presentations for the K-12 community were largely rescheduled to take advantage of several large groups visiting the campus.

Additional outside funding in the amount of \$10,350 for student stipends was spent on PAIR students. This money came from the PAIR PI's other NASA grants, NASA URC and NASA MU-SPIN. This additional money was used to fund 5 more undergraduates as part of the student research team projects. This allowed the CESSR to take advantage of the large number of highly qualified students who applied to the program.

### Item 17: Ways the budget structure has adequately supported the project implementation

Funds for equipment purchases, faculty salaries and fringe benefits as well as student stipend money have all been adequate to address the needs of implementing the project. Specifically, this budget structure has allowed the University to pursue long-term (12 month) research projects for teams of students, something that has never been done at SCSU and rarely accomplished at other universities.

Item 18: Impact of the largest expenditures other than personnel

If one includes student stipends as a personnel cost, then the largest expenditures, which have had a significant impact on the project, are those for equipment. While other grants typically provide funding for items of equipment which cost a few thousands of dollars, the PAIR grant has allowed SCSU to purchase more costly pieces of equipment. Such items as the low light video imaging system (\$19,500) and the HP Spectrum Analyzer (\$15,000) and Questar long distance microscope (\$14,000) would normally be out of the price range of a typical grant. These and other equipment items will have a significant impact on SCSU's MSET department's ability to carry out student and faculty research projects.

Item 19: Commitment of Resources by the Institution

The University lab technician in the EET Department has been helpful in setting up and configuring the LabVIEW equipment for both training and student projects. Existing LabVIEW hardware and software have been used by the faculty and students. Existing computer labs in the science building, engineering technology building and the computer science building have all been used extensively by the student research teams. Lab space has been set aside for the student research teams in the science building and the engineering technology building. Travel money has been provided for two of the faculty members to attend meetings and present student results. Additionally, the PAIR PI and the physics Co-I have respectively used funds from NASA and DOE(nergy) grants to provide an additional \$10,350 in Year 1 for student stipends.

Item 20: Long-term evidence the project has been institutionalized

One such example of institutionalized change will be when non-PAIR faculty members incorporate the methodologies and resources from the PAIR project into their class work (e.g. the use of Concept Maps). We anticipate this will be true for our physical sciences lab and lecture courses as well as EET and CS courses which are being enhanced and/or modified by the PAIR project. We do not expect to see widespread use of PAIR products (e.g. new lab exercises) until the third or fourth year of the project.

