

Curriculum Enhancement Through Space Science Research

Progress Report

Principal Investigator: Dr. Donald K. Walter

Period of Performance: March 1, 2002 – February 28, 2003

**South Carolina State University
300 College Avenue
Orangeburg, South Carolina 29117**

NCC 5 – 454

**Progress Report for Year 3 and Renewal for Year 4
of the NASA PAIR Project at South Carolina State University
(NCC 5 – 454)**

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Progress Report for Year 3 and Renewal for Year 4 of the NASA PAIR Project at South Carolina State University (NCC 5 – 454)

January 1, 2003

The following report is submitted as a Progress Report for Year 3 and as a Renewal Request for Year 4 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 follows that of the Year 1 annual report with minor adjustments. The items listed below are taken from a template supplied by MURED to the PAIR Group 2 schools for their Year 1 annual report. More information about the SCSU program is available at: <http://physics.scsu.edu/pair/>.

EXECUTIVE SUMMARY

The SCSU CESSR project has completed a highly successful Year 3 of a four-year program. PAIR has made a significant and lasting impact on the curriculum in the three collaborating departments of Physical Sciences, Mathematics and Computer Science and Industrial and Electrical Engineering Technology. Coursework for majors outside of the technical fields has also been enhanced including physical science courses that are a part of the required curriculum for SCSU education majors and introductory computer science courses that are required for all majors. Some of the highlights of the Year 3 PAIR project at SCSU include:

- 7 refereed faculty or faculty/student publications
- 3 non-refereed faculty publications
- 3 faculty proposals submitted
- 10 faculty conference or seminar presentations
- 16 student conference or seminar presentations
- 209 MSET majors enrolled in courses impacted by the project
- 435 non-MSET majors enrolled in courses impacted by the project
- 13 faculty members were funded by SCSU PAIR
- SCSU students and faculty participated in the national PAIR Summit
- A SCSU student won a "Meritorious Presentation" award at the PAIR Summit
- A new partnership has been formed with a local community college
- A new partnership has been formed with Dr. Ronald Oliverson at the Goddard Space Flight Center (GSFC)
- Existing partnerships with scientists at NASA, a majority university and a research institute have been strengthened

Numerous other accomplishments by students and faculty are described below.

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 3 by facilitating activities at an MI (SCSU) that

related to NASA's old mission to "communicate scientific knowledge of the universe" and that part of its new mission "... To inspire the next generation of explorers as only NASA can." In this case, the students at SCSU are a part of that next generation of explorers.

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 3 are clearly related to the goals and objectives of the Space Science Enterprise, in particular to "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." Training and use of the LabVIEW software package as well as applications related to radio astronomy, database management, robotics and remote control of instrumentation over the web are examples of the type of experiences these students have gained which make them more competitive. Oral and poster presentations by students at national as well as local meetings and conferences further enhanced the capabilities of SCSU students.

The SCSU PAIR partnering center is the 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 3 included optical spectroscopy of extragalactic supernova remnants, radio astronomy, robotic control of a radio telescope, remote web management of a radio telescope, the study of RS CVn variable stars, construction of CCD cameras and mapping of neutral hydrogen emission at 1.4 GHz across the plane of the Milky Way galaxy.

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 3 project activities have supported this mission. During Year 3, as in Years 1 and 2, four teams of students conducted yearlong research projects under the direction of a faculty mentor. In Year 3, as in Year 2, all four teams were integrated into one large project with each faculty-student team being responsible for one component of the large project. This proved to be a more efficient means for managing the project as well as developing a stronger sense of teamwork among the PAIR students and faculty. Furthermore, the overlap in subject matter between some of the groups led to cooperative learning and implementation of the project as one group's expertise could easily be shared with other groups.

The specific group project in Year 3 was to continue what was begun in Year 2 on the upgrade of a 4.6-meter radio telescope (a.k.a. Smiley) at the Pisgah Astronomical Research Institute (PARI) with the intention of making the telescope remotely accessible and manageable over the Internet in real time. PARI is a close and very active partner with SCSU in implementing CESSR. PARI is the site of a former NASA satellite tracking facility near Rosman,

North Carolina, and is a nonprofit organization that owns and operates the facility that includes two 26-meter radio telescopes, the 4.6-meter radio telescope and several other radio and microwave receivers as well as one 0.2-meter optical telescope. The four SCSU teams implemented the following projects which were components of the overall group project of upgrading Smiley: (1) design and configure a database for installation on a server which will be a repository for Smiley's observations and will be accessible to the K-12 community; (2) design and implement the LabVIEW interface to remotely control (robotically) the telescope; and, (3) design and implement the LabVIEW-based telescope control user interface which will be accessible over the Internet. The fourth team, the so-called "science team" had smaller, multiple team projects which included: (4) install a web-assessable commercial weather station at SCSU and then assist in the installation of a similar weather station at PARI; (5) test and install a commercial lightning detection system at PARI; (6) develop a LabVIEW VI which reads information from the spectrometer on a radio telescope and displays it to a local monitor; and, (7) study and observe RS CVn stars at radio and optical wavelengths. Finally, a project started in Year 2 that has been carried over into Year 3 but is now being funded under the SCSU MU-SPIN project is (8) the optical detection of supernova remnants (SNRs) in a nearby galaxy.

Project 4 is completed (see <http://physics.scsu.edu/weather/>). Projects 2, 3 and 5, and 7 have completed the development phase and are now in the testing or implementation phase. Projects 1 and 6 are still in the development phase.

Project #8 is ongoing and involves collaboration with a radio astronomer from the University of South Carolina, Dr. Christina Lacey. Lacey provided longslit, optical spectra of select positions in the spiral galaxy NGC 6946. After initial work by a Year 2 PAIR team, one student member of that team (Guy Mentor) was part of a team of MU-SPIN-funded students in the summer of 2002 that carried out the research. The students used the IRAF software package to measure emission lines in hydrogen-alpha (656.3 nanometers) and singly ionized sulfur lines (671.7 and 673.1 nanometers). The ratio of the fluxes of the sum of the sulfur lines and hydrogen-alpha line are used to determine if emission objects in the galaxy are supernova remnants (ratio > 0.4) or HII regions (ratio < 0.4). Out of 24 objects examined so far, three have been found to be SNRs. The optical results will be used to confirm the radio results from observations obtained by Lacey. During the academic year 2002-03, Guy Mentor and the PAIR PI (Donald Walter) are continuing to examine the data with the expectation that the results will be submitted in 2003 to a peer-review journal.

INTRINSIC MERIT

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) that is in-line with the objectives stated in the original NRA. These objectives are as follows:

1. Integrate current science and technology concepts, practices and teaching strategies into the MSET curriculum at SCSU. (This was modified in Year 3 from Year 2 in that the term "cutting edge" was replaced with "current". The SCSU PAIR Advisory Board pointed out that much of what is being done in the SCSU, while current, is strictly-speaking, not cutting-edge.)

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 that 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 3 as evidenced by the examples given under Items 4, 5, 9, 14 and 15.

Item 4: Impact on faculty and staff

Refereed Publications resulting from the MURED PAIR project at SCSU:

Kelvin, R. Aaron, Noreen L. Foster, Dannielle P. Hazel, and A. M. Hasanul Basher, "Closed-Loop Position Control System Using LabVIEW," Proceedings of the IEEE SECoN 2002, Columbia, SC, April 5-7, 2002, pp. 283-286.

Nikunja Swain, "System Modeling using Virtual Instruments" Proceedings of the IEEE SECoN 2002, Columbia, SC, April 5-7, 2002, pp. 121-126.

Dezra Hinkson, Claude Marshall & Shaun Robinson, "Design and Development of a User Interface to Remotely Control a Radio Telescope Using Virtual Instruments" Proceedings of the IEEE SECoN 2002, Columbia, SC, April 5-7, 2002, pp.279-282.

Nikunja Swain, "Design and Analysis of Digital Filters Using Virtual Instruments" , Proceedings of the 6th World Conference on Systemics, Cybernetics and Informatics (SCI 2002), July 2002.

Nikunja K. Swain, James A. Anderson, Ajit Singh, Mrutyunjaya Swain, Marvin Fulton, Joseph Garrett & Omaria Tucker. "Study of Joint Time Frequency Analysis Using Virtual Instruments", Proceedings of the ASEE 2003, Nashville, TN, June 2003

Nikunja K. Swain, James A. Anderson, Mrutyunjaya Swain, Ajit Singh, & Raghu B. Korrapati , "IPAR – A Visual Basic Program to Study IP Addressing and Routing" Proceedings of the IEEE SECoN 2003, Jamaica, WI, April 2003 (submitted)

Nikunja K. Swain, James A. Anderson, Ajit Singh, Mrutyunjaya Swain, Marvin Fulton, Joseph Garrett, & Omaria Tucker, "Remote Data Acquisition, Control, and Analysis using LabVIEW Front Panel and Real Time Engine", IEEE SECoN 2003, Jamaica, WI, April (submitted)

Non-refereed Publications resulting from the MURED PAIR project at SCSU:

Brown, James, "Easy Radio Astronomy For Everyone", *Mercury Magazine*, 2003, in press

Brown, James, "A Year Of Radio Jove Solar Observations", *Journal of the Society of Amateur Radio Astronomers*, January/February 2002, pp 5–14

Non-refereed Conference Proceedings resulting from the MURED PAIR project at SCSU:

Jafar Sadighi, Khalid Ibnouchir, "Creating An Online Database", *Proceedings of the South Carolina Academy of Science 2002 Annual Meeting*, Aiken, SC, April 2002

Submitted Proposals resulting from the MURED PAIR project at SCSU:

Lead institution: SCSU
SCSU PI/Col: James Payne (PAIR Project Director) (Proposal PI)
Submitted to: DOE SROO Department of Energy Savannah River Operations Office
Amount Requested: \$250,000 Project Duration: 1 year (start December 1, 2002)
Status: Funded

Lead institution: SCSU
SCSU PI/Col: James Arrington (Proposal PI)
James Payne (PAIR Project Director) (Proposal Col)
Linda Payne (PAIR Col)(Proposal Col)
Other SCSU faculty (Proposal Col)
Submitted to: NSF under the HBCU-UP Program
Amount Requested: \$2.39 million Project Duration: 5 years (start August 2003)
Status: Pending

Lead Institution: Pisgah Astronomical Research Institute
SCSU PI/Col: James Payne (PAIR Project Director) (Proposal Col)
Submitted to: NSF under the REU Program
Amount Requested: \$163,317 Project Duration: 3 years (start June 2003)
Status: Pending

Resource Development in Radio Astronomy and the Radio Jove Project

James Brown, SCSU Planetarium Director, continues to do an extraordinary job of enhancing SCSU's involvement in radio astronomy. This includes installation of a new radio telescope at 1.4 GHz with which Brown is mapping the galactic emission from neutral hydrogen. An engineering technology major used this data to complete an advanced physics lab in which he mapped the rotational curve of the galaxy.

Brown continues to monitor the sun at two frequencies, 20 MHz and 145 MHz, and maintains an extensive database of these observations at <http://www.draco.scsu.edu/>. This web server is funded by the SCSU PAIR project. His site is one of only five such sites linked from the NASA Radio Jove web page at: <http://radiojove.gsfc.nasa.gov/>. Brown is also a national "Master Helper" in the Radio Jove program and provides assistance to others in the use of their Jove equipment.

Brown has implemented other radio astronomy projects in Year 3. These included: (1) he engineered, constructed and put online the dual frequency radio telescope; (2) he installed and implemented data streaming via the Internet for classroom or individual use worldwide. This allows individuals to observe his data in real time as it is collected; (3) he participated in worldwide, coordinated observations of Jovian radio bursts; and (4) he produced a resource videotape on solar radio bursts which was submitted to Radio JOVE for distribution as part of their educational program.

Faculty members funded

A total of 13 faculty members were funded in Year 3 by the SCSU PAIR project. Ten of those faculty members received salary money as well as additional funds for travel and/or equipment. Three faculty members did not receive salary money from PAIR but did receive funds for travel, training and/or equipment.

Faculty Appointments resulting from the SCSU PAIR Project

Dr. James Payne was appointed to the Board of Directors of the Pisgah Astronomical Research Institute.

Mr. James Brown was appointed Master Helper for the State of South Carolina for the NASA Radio Jove Program.

New Partnerships

A new partnership has begun with the recent appointment of Dr. Ronald Oliverson as the Technical Monitor for SCSU PAIR Project. Dr. Oliverson is an astronomer at GSFC and he is serving as a student mentor by providing hands-on observing experience for a SCSU student at the McMath Solar Telescope at Kitt Peak Observatory in Arizona in March of 2003.

Project Director James Payne has developed a new partnership for SCSU with the local community college. Orangeburg-Calhoun Technical College (OC Tech) will be the site of the construction of a new, 1.4 GHz radio telescope in Year 4 of the PAIR project. SCSU and OC Tech will operate the telescope on-site and over the Internet. It will be a duplicate of the one on the campus of SCSU (see above) and the LabVIEW VIs developed for Smiley will be modified as needed for this telescope. The OC Tech partnership has also included LabVIEW training provided by SCSU for one OC Tech faculty member with others to be trained in the future. OC Tech will also serve as a backup site for SCSU astronomers for remote access to an optical telescope at Kitt Peak in Arizona.

Continuing Partnerships

The relationship with Dr. James Thieman, radio astronomer at GSFC, continues to be a strong one. He serves as the Chairman of the SCSU PAIR Advisory Board, serves as a point of contact for our involvement with Radio Jove and assists in placing students from SCSU and other minority institutions in summer positions at GSFC.

Dr. Christina Lacey, a radio astronomer at the University of South Carolina, continues to be a partner to the SCSU PAIR project. In addition to providing technical advice to the student teams, she and Dr. Walter have developed a faculty research collaboration with an ongoing research project to be published in 2003.

The partnership with PARI continues to be the cornerstone of our student research projects and provides additional opportunities to our faculty.

*Participation in Local/State/Regional/National Workshops/Conferences/Seminars
(faculty and student presentations)*

Faculty Conference Presentations

“Partnering with NASA at South Carolina State University”; Walter, D.

Faculty oral presentation at the NASA PAIR Summit; Leesburg, VA; November 2002

“PAIR Student Research at South Carolina State University”; Walter, D.

Faculty oral presentation at the NASA PAIR Summit; Leesburg, VA; November 2002

“Dual Frequency Jupiter/Solar Radio Telescope”, Brown, J;

Faculty oral presentation at the Society of Amateur Radio Astronomers 21st annual conference; Green Bank, WV; July 2002

“A Comprehensive Approach to K-16 Education Utilizing the Space Sciences”; Walter, D. et al.;

Faculty poster at NASA OSS E/PO Conference; Chicago, IL; June 2002

“System Modeling using Virtual Instruments”; Swain, N.

Faculty oral presentation at the IEEE SECoN 2002; Columbia, SC; April 2002

Faculty Seminar Presentations

“The Use of Information Technology in Undergraduate Research”; Walter, D.

Faculty oral & poster presentation to the faculty and administration at SCSU; Orangeburg, SC; October 2002

“Use of LabVIEW to Enhance Undergraduate Technology Education”, Swain, N;

Faculty oral & poster presentation to the faculty and administration at SCSU; Orangeburg, SC; October 2002

“Graphical Programming (Virtual Instruments) in Science, Math, Engineering & Technology Education”, Swain, N.; Faculty oral presentation to faculty and students attending the SCSU Computer Science & Industrial and Electrical Engineering Technology Seminar Series; Orangeburg, SC; September 2002

“The Use of Information Technology in Undergraduate Research”; Walter, D.

Faculty oral & poster presentation to the faculty and administration at SCSU; Orangeburg, SC; April 2002

“Use of LabVIEW to Enhance Undergraduate Technology Education”, Swain, N;

Faculty oral & poster presentation to the faculty and administration at SCSU; Orangeburg, SC; April 2002

Student Conference Presentations

“Creation of a Radio Astronomy Database Using ColdFusion”; Beharry, K. et. al.;

Student poster presentation at the NASA PAIR Summit; Leesburg, VA; November 2002

“A Search for Extragalactic HII Regions and Supernova Remnants”; Mentor, G. et. al.;

Student poster presentation at the NASA PAIR Summit; Leesburg, VA; November 2002

“Internet Access and Control of a Radio Telescope”; Cohen, K. et. al.;
Student poster presentation at the NASA PAIR Summit; Leesburg, VA; November 2002

“Space Science Applications to the SCSU PAIR Project”; Arnette, R.;
Student poster presentation at the NASA PAIR Summit; Leesburg, VA; November 2002

“Closed-loop Position Control System using LabVIEW”, Hazel, D., et. al;
Student oral presentation at the South Carolina Academy of Science
Aiken, SC; April 2002

“Temperature Control for the Smiley Radio Telescope”, Cayton, L., et. al;
Student poster presentation at the South Carolina Academy of Science
Aiken, SC; April 2002

“Applications of LabVIEW in the Educational Field”, Robinson, S. et. al;
Student oral presentation at the South Carolina Academy of Science
Aiken, SC; April 2002

“Creating An Online Database”, Ibnouchir, K. et. al;
Student oral presentation at the South Carolina Academy of Science
Aiken, SC; April 2002

“Design and Development of a User Interface to Remotely Control a Radio Telescope Using
Virtual Instruments”; Hinkson, D. et. al.;
Student oral presentation at the IEEE SECoN 2002, Columbia, SC, April 2002.

“Closed-Loop Position Control System Using LabVIEW,”; Aaron, K. et. al.;
Student oral presentation at the IEEE SECoN 2002, Columbia, SC, April 2002.

“Database Management - A Web-based Link to the Stars”; Burns, K. et al.;
Student oral presentation at Tennessee State University Student Research Day;
Nashville, TN; April 2002

“A Closed-Loop Control System for the PARI 4.6-meter Radio Telescope”; Forster, N. et. al;
Student oral presentation at Tennessee State University Student Research Day;
Nashville, TN; April 2002

Student Seminar Presentations

“Creation of a Radio Astronomy Database Using ColdFusion”; Beharry, K. et. al.;
Student poster presentation at the SCSU Student Research Day;
Orangeburg, SC; November 2002

“A Search for Extragalactic HII Regions and Supernova Remnants”; Mentor, G.;
Student oral presentation at the SCSU Student Research Day;
Orangeburg, SC; November 2002

“Internet Access and Control of a Radio Telescope”; Cohen, K. et. al.;
Student poster presentation at the SCSU Student Research Day;
Orangeburg, SC; November 2002

“Space Science Applications to the SCSU PAIR Project”; Arnette, R.;
Student poster presentation at the SCSU Student Research Day;
Orangeburg, SC; November 2002

Student Award

Guy Mentor won a “Meritorious Presentation” award at the NASA PAIR Summit in Leesburg, VA, for his poster “A Search for Extragalactic HII Regions and Supernova Remnants”. His award was part of the competition among 20 posters presented by students from 10 PAIR schools (2 posters per school). The awards included a first and second place poster and six meritorious posters.

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

A new course incorporating the concepts of data mining was developed and offered during Year 3 with partial funding from PAIR. This cross-departmental offering in the fall of 2002 was under Physics 498 and Computer Science 499, special topics courses. The course was team taught by Dr. Walter in the Department of Physical Sciences and Dr. Zografski in the Department of Mathematics and Computer Science. The title of the course was “Scientific Knowledge Discovery in Astronomical Image Databases”. Data mining techniques and software were introduced as was the MAST Database at the Space Telescope Science Institute website and astronomical image processing techniques.

The PAIR project was responsible for the creation of a new, two-semester, 1-credit course entitled “Interdisciplinary Research Seminar in Space Science” (ETS 468-469) during Year 1 off the project. This course was first offered in Year 1 with an enrollment of 17 students each semester, in Year 2 with an enrollment of 12 each semester and in Year 3 with an enrollment of 13 each semester. Members of the interdisciplinary student research teams are required to enroll in the course and continue their research projects that 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 each student giving a total of four presentations including one to K-12 students, another to their peers at SCSU and at least one presentation at a state, regional or national meeting.

Two lab exercises for the Advanced Physics Laboratory course (P 407) were developed under the PAIR project and used during Year 3. These were mentioned earlier and include: (1) the reconfiguration of a simple “eyeball” camera that was in turn attached to a small telescope and observations of the planets were made. Students were exposed to CCD technology as well as astronomical image processing; and (2) a student used the 21-centimeter emission data obtained with the SCSU 1.4GHz telescope to map the rotational curve of the galaxy.

Computer Science faculty members used commercial software funded by PAIR to enhance the teaching of computer programming and to develop a ColdFusion-based automated testing program.

LabVIEW has been integrated into several physics and electrical engineering technology courses including the physics Advanced Laboratory (P 407) course and electrical engineering technology courses (EET 475, Computer-Aided Design of Electrical Systems; EET 460, Senior Project; EET 443, PLC and Virtual Instrumentation; EET 392, Introduction to PLC and Virtual Instrumentation; EET 383, Digital and Microprocessor Laboratory) as well as others. PAIR is directly responsible for this result, either for incorporating LabVIEW into the course for the first time, or for dramatically increasing its use where it already existed.

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 that 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 3 and the cumulative milestones and projections for Years 1-4.

Stage 2: Occurred in the fall (October) by which time student and faculty training had been completed and the team and group projects were well underway.

Stage 3: Occurred at the end of the fall term (December) and addressed a number of issues related to the advisory board visit in January 2003, the student research teams and their presentations in November 2002 and issues upcoming in the spring and summer of 2003.

Stage 4: Occurred in the spring (March). Year 3 issues were reviewed and plans were made for the Year 4 student teams and summer research projects.

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 3 described below involves some projections to May 14, 2003.

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 Years 1–3. The most significant changes to the original proposal that have occurred include: (1) a single, group project (Smiley) was implemented with separate components for each team in Years 2 and 3. (2) the space science foundation for the project has shifted its emphasis from optical to radio astronomy; (3) old partners (A Tech, and Western Kentucky University) were replaced with new ones (OC Tec, PARI, Dr. Christina Lacey at the University of South Carolina, Dr. Ronald Oliverson at GSFC); (4) adjustments to management of the student teams were made largely in Year 2 and somewhat in Year 3 to accommodate concerns expressed by earlier student teams. This has resulted in more frequent communication between the PI and students and the PI and faculty mentors; and, (5) Dr. James Payne was appointed Program Director in Year 2 with primary responsibility of coordinating faculty activities and the student research team and group projects. This has resulted in a far greater coordination among all participants, better communication among faculty members, reduction of duplication of effort and has enabled all four teams to work together as a single group.

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 has taken the form of a web site (<http://physics.scsu.edu/pair/>), a brochure, an activity booklet and an astrophysics recruiting poster. These items are distributed to a wide range of individuals including NASA officials, SCSU administrators, the SCSU office of public relations, SCSU students and high school students attending college recruitment events. Finally, dissemination included a large number of faculty and student publications and presentations both on the campus of SCSU, in the state of South Carolina and nationally. Those conferences are described in detail under *Item 4: Impact on faculty and staff* and are summarized here:

- 7 refereed faculty or faculty/student publications
- 3 non-refereed faculty publications
- 3 faculty proposals submitted

- 10 faculty conference or seminar presentations
- 16 student conference or seminar presentations

Item 9: Tabular Representation of Outcomes/Milestones for Year 3

Project Outcomes	Metric for Success	Actual Achievement
LabVIEW introduced in courses	None predicted	EET 374, EET 450
New Lab Exercises Created	2 new ones	RLC project in EET 475, Radio Astronomy lab in P 407
New/Revitalized courses	PSC 203 (astronomy)	P 498/CS 499 Data Mining
New courses impacted by different/new educational techniques/methodology	None predicted	P 250 (Inquiry-based teaching) P 253 (Inquiry-based teaching)
Enhancement of CS	None predicted	ColdFusion application to simultaneous group testing
Partnering with 2-year colleges	Distance Learning of LabVIEW	On-site LabVIEW and radio telescope project at 2-yr school
K-12 presentations	All 13 PAIR students involved in presentations	All 13 students involved in presentations to 200 visiting high school science students
Student professional presentations at conferences	3	19 individual or team presentations (poster or oral)
Student presentation to peers at SCSU	4 team or individual presentations (all 13 students involved)	4 team or individual presentations (13 Year 3 students and 1 Year 2 student involved)
Number of students trained	12	13
Number of faculty trained	20 total for Years 1-3	14 total for Years 1-3
Number of faculty funded	Not an original metric, but 5 were in the original budget to receive salary	13 in Year 3 (10 received salaries and 3 received other support)
MSET Majors Impacted	140	209
Non-MSET Majors Impacted	365	435

Comments/Issues to Address in Item 9 Table

Most of the annual metrics for Year 3 included in the original SCSU proposal have been met or exceeded except for total faculty training in Years 1-3. The original proposal predicted 20 faculty members would be trained by this time while only 14 have actually been trained. Some modifications have occurred to the predictions in the original proposal. For example, the revitalization of the PSC 203, Introductory Astronomy course did not take place in Year 3. Instead, the cross-departmental course on data mining, P 498/CS 499, was introduced. The revitalization of the astronomy course has been delayed until future years because SCSU now has a new faculty member in astronomy. The PAIR PI (an astronomer) and this new faculty member (Dr. Jennifer Cash) are preparing to submit an astronomy minor to the SCSU Educational Policies Committee. This new minor will include revitalizing the PSC 203 course.

Item 10: Partners and outcomes from formally established partnerships

Partnering under the SCSU PAIR project has been highly successful throughout the three years of the project. New partners were added in Year 3 and existing partnerships were strengthened. For details see: *Item 4: Impact on faculty and staff*, the sections entitled *New Partnerships* and *Continuing Partnerships*.

MANAGEMENT APPROACH

Item 11: Implementation steps for achieving milestones.

Currently the PI, in consultation with the Co-PI, the Program Director, the Co-Is and the faculty mentors 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. For example, the K-12 outreach goal was suspended in Year 2 in order to more fully concentrate on university goals; but in Year 3 it has been reactivated.

CESSR received valuable feedback from its PAIR Advisory Board in Year 2 when the Board pointed to the need to increase the number of faculty and students impacted by the project. In response to their recommendations, in Year 3 CESSR has increased the number of salaried faculty members from six to ten and has provided travel, training and/or equipment to three other faculty members. The total number of students impacted has **increased from 188 in Year 2 to 644 in Year 3** after several large-enrollment classes for non-majors were targeted by the project. Furthermore, in response to the Board's recommendation for greater on-campus dissemination of information about the project, PAIR students participated in the first-ever SCSU Student Research Day in November 2002.

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 or exceeding most annual milestones. Additionally, Item 4 provides details of the faculty success resulting from the project, comments under Item 13 show the success of the program from the student perspective and Items 14 and 15 enumerate the impact on human resources, specifically the involvement of underrepresented students and a **PAIR retention rate of 98%**.

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

The PAIR project has had a significant impact on SCSU as evidenced by the large number of faculty publications and presentations (Item 4), student presentations (Item 4) and student involvement through coursework (Item 14). The NASA Radio Jove program has been impacted by the SCSU PAIR project through a major contribution by the school to its monitoring program. New coursework (ETS 468/469) and other curriculum developments (expanded use of LabVIEW in MSET courses) as well as future developments (an astronomy concentration and a minor) all have had or will have a lasting effect on the institution.

The impact of PAIR on students who are members of the Year 3 research teams is evident in the following quotes:

Senior computer science major Kerra Nesbit is making plans for graduate school and stated that, "Working in the NASA PAIR program has furthered my goals and helped me gain some valuable "hands-on" experience needed for my future career. This opportunity has helped me expand my knowledge of computer software and different computer languages as well as meet more people, and work in a different environment and new atmosphere."

Erika J. Terry is a junior in professional biology with a career goal to obtain a Ph.D. in genetics. She feels that "The NASA PAIR project has afforded me an experience that may never had occurred with my major. I am able to work with students and faculty members outside of my field of study such as engineering, computer science, and physics. I have learned

a lot about the field of robotics. Also, I was introduced to the LabVIEW software package and gained skills that will prove to be profitable in the future. The NASA PAIR project has enforced teamwork and given me an educational opportunity that I would not trade for anything.”

Computer science major Rafael Arnette has found that “The NASA PAIR project has really expanded my horizons in the field of astronomy and has allowed me to incorporate my computer programming skills with the various other disciplines to accomplish a common goal.”

Junior Omaria Tucker is majoring in professional mathematics and feels, “The PAIR project has been very substantial to my educational experience. It has made such a great impact, because it has given me experience in working with teams on one common scientific goal. I have also learned two new software programs that have given me more experience in computer programming. I have also learned more information about NASA and its different Space Centers and the job opportunities that it can provide to minorities.”

HUMAN RESOURCE DEVELOPMENT

Item 14: Project involvement of underrepresented students

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

MSET Majors

PAIR course	Course Title	Semester	Black Male	Black Female
CS 499	Special Topics in Comp. Science	Fall 02	5	1
EET 374	Electrical Machines	Sum 02	15	1
EET 383	Digital & Microprocessor Lab	Fall 02	9	
EET 392	Intro. to PLC & Virtual Instruments	Fall 02	8	
EET 392	Intro. to PLC & Virtual Instruments	Spr 03	13	3
EET 443	PLC & Virtual Instruments Lab	Fall 02	12	4
EET 443	PLC & Virtual Instruments Lab	Spr 03	12	2
EET 450	Intro. to Electric Power Systems	Sum 02	18	2
EET 475	Computer Design of Elec. Sys.	Fall 02	20	2
EET 475	Computer Design of Elec. Sys.	Spr 03	15	5
ETS 468	Research Seminar in Space Sci.	Fall 02	7	5
ETS 469	Research Seminar in Space Sci.	Spr 03	7	5
P 250	General Physics I w/ Algebra	Spr 03	7	10
P 253	General Physics II Lab	Spr 03	5	6
P 407	Advanced Lab	Fall 02	4	
P 498	Special Topics	Spr 02		1
P 498	Special Topics	Fall 02	1	1
P 499	Special Topics	Spr 03	3	
TOTAL		Year 3	161	48

Non-MSET Majors

PAIR course	Course Title	Semester	Black Male	Black Female
CS 150	Computer Technology	Fall 02	42	58
CS 150	Computer Technology	Spr 03	40	60
CS 151	Computer Concepts	Fall 02	33	42
CS 151	Computer Concepts	Spr 03	35	40
PSC 151	Physical Science Lab	Fall 02	22	28
PSC 153	Foundations Earth/Space Science	Spr 02	13	22
TOTAL		Year 3	185	250

Item 15: Measuring MSET student retention

The retention rate stands at 98%. A total of 42 students, 17 from Year 1, 12 from Year 2, and 13 from Year 3, have participated as members of the student research teams. Forty-one of the 42 students (98%) have either graduated as MSET majors or are still students in an MSET field. One student completed their year of work in the SCSU PAIR project, but transferred to a junior college in another state and did not graduate from SCSU.

PROPOSED COST

Item 16: Explain any significant budget changes

The amount of funding for faculty salaries and benefits in Year 3 was approximately \$17,000 higher than in the original proposal for Year 3 (\$119,000 versus \$102,000); and, therefore, the indirect costs were about \$6,000 higher (\$50,000 versus \$44,000). This was made possible because the PI and PD were able to obtain almost \$51,000 in cost share contributions for faculty salaries and benefits from SCSU and leveraged funds from other NASA and NSF grants to pay for student stipends and travel. This in turn allowed the project to significantly increase the number of faculty members funded and thereby enhance the impact of PAIR on the faculty and students.

The overall amount of money spent on equipment was only \$1,000 less than projected in the original budget (\$31,000 instead of \$32,000). However, the original budget proposed purchasing a few high-cost items such as a \$16,000 National Instruments PXI workstation and a \$7,500 HP Scope and Interface. Instead, several new, inexpensive PCs were purchased along with DAQ and controller cards to upgrade existing PCs which enabled the project to configure 12 machines to carry out what the single PXI would have been capable of doing. Also, with the shift to radio astronomy, the original planned Year 3 purchase of an optical telescope with solar filters was replaced with purchases for the SCSU radio telescopes and related equipment and supplies.

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

Funds in Year 3 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, especially with the additional support for student stipends (\$31,200) and travel (\$4,000) from other NASA and NSF grants at SCSU. 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. Furthermore, expenditures of almost \$30,000 for equipment and software made it possible for SCSU to become involved with projects which normally could not be funded (e.g. the installation of a new radio telescope).

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 and consultants. While other grants typically provide funding for items of equipment that cost a few thousands of dollars, the PAIR grant has allowed SCSU to purchase more costly pieces of equipment. The purchase in Year 3 of such items as \$10,000 for National Instruments equipment upgrades and DAQ cards, the \$5,000 for the new server for the radio astronomy web site and the \$5,000 for the weather stations, radio telescope and lightning detectors were possible only because of the PAIR grant. Without these items, the PAIR project would be unable to accomplish any significant upgrade to its student and faculty research capabilities. These and other equipment items will have a lasting impact on the ability of SCSU's MSET departments to carry out student and faculty research projects. The \$27,485 for consulting in Year 3 is a bit misleading since about 25% of it is for standard services such as equipment setup and installation as well as commercial training.

Item 19: Commitment of Resources by the Institution

In Year 3 a total of **\$50, 900** was leveraged by the PAIR grant at SCSU. This included:

- \$13,700 in salaries, benefits and indirect costs saved on the PAIR project because SCSU provided the PI with 15% reassignment time to the project during the academic year as a voluntary cost share.
- \$31,200 was provided for PAIR student stipends through the NASA MU-SPIN grant (NCC 5-534) and the NSF AMP grant.
- \$4,000 in student travel from Tennessee State's URC grant (NCCW-0085).
- \$2,000 in communication & other costs provided by the MU-SPIN grant (NCC 5-534).

In Year 4 a total of **\$32,706** is projected to be leveraged by the PAIR grant at SCSU, including:

- \$13,706 in salaries, benefits and indirect costs saved on the PAIR project because SCSU will provide the PI with 15% reassignment time to the project during the academic year as a voluntary cost share.
- \$12,000 in student stipends from the NSF AMP grant.
- \$5,000 in student travel from Tennessee State's URC grant (NCCW-0085).
- \$2,000 in communication & other costs provided by the MU-SPIN grant (NCC 5-534).

Two computer labs in the science building and the computer science building have 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.

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

The SCSU PAIR project is in the process of implementing the following items that will institutionalize the project after the end of funding.

1. An astronomy minor and concentration is being developed as an option in the physics area. During the spring of 2003 it will be presented to the Educational Policies committee for consideration.
2. New courses or new sections of courses which focus on PAIR-related topics
 - a. A new, two-semester course "Interdisciplinary Research Seminar in Space Science" was accepted by the University during Year 1 and has been taught for three full years. This is required of all PAIR students.
 - b. A new cross-departmental offering on data mining has been developed. This has been offered once to date as a team-teaching effort between the departments of Physical Sciences and Mathematics and Computer Science.

3. The SCSU PAIR project is providing funding for the recently awarded NASA NOVA Project at SCSU. Partial salary for NOVA PI, Mr. Frank Robinson, is being provided during the summer of 2003. Robinson and his colleagues (including PAIR PD Dr. Jim Payne and PAIR Advisory Board member Dr. Albert Hayward) will modify the existing physical science course that is required for science education majors. They will enhance pre-service teachers' understanding and teaching of science through such techniques as inquiry-based learning. More details including the entire SCSU NOVA proposal can be found at <http://physics.scsu.edu/nova/>. This project will have a significant and lasting impact on the way education majors at SCSU learn physical science and in turn how those future in-service teachers teach the subject matter.
4. Institutionalization of undergraduate research:
 - a. After years of discussion, the first annual SCSU Student Research Day was held on November 20, 2002. Dr. Judith Salley, the Chairman of the Biological Sciences Department and Director of the South Carolina AMP program, was responsible for implementation of the activity. However, the PAIR PI and PD supported Dr. Salley in this effort by requiring all PAIR students to participate as well as recruiting non-PAIR students to participate. The PAIR PI and PD have held numerous discussions with Dr. Salley and others over the years regarding this activity and it is reasonable to state that the NASA PAIR Project at SCSU has helped establish and institutionalize this activity.
 - b. A proposal requesting \$2.39 million for undergraduate and faculty research has been submitted to the NSF HBCU-UP program. The PAIR PD and one of the PAIR CoIs (Dr. Linda Payne) are CoIs on the NSF proposal and made significant contributions to its writing. The successful student research experiences under the PAIR project served as a model for this proposal. Regardless of whether or not this proposal is funded this year, the PAIR student research model will serve to strengthen and institutionalize undergraduate research at SCSU.
5. Development of a series of new or revised laboratory exercises for MSET courses for non-majors as well as advanced courses for majors is an ongoing project. Numerous laboratory exercises have been developed and continue to be tested in physical science, EET and advanced physics courses. Additionally, modified teaching techniques in computer science are now a part of the coursework at the introductory level.
6. The SCSU PAIR project is providing funding to introduce the field of astrobiology into the SCSU curriculum and research programs. A consultant with curriculum development experience in astrobiology will confer with SCSU faculty members and offer insight on how to implement such a program. This portion of the SCSU PAIR project has the potential to have a long-term impact on the institution since NASA's contribution to this field is projected to grow significantly over the next 20 years. Additionally, the Department of Biological Sciences at SCSU has approximately 200 majors and those students have not been heavily involved in NASA programs in the past. Astrobiology offers an excellent opportunity to get those students and faculty members interested in the NASA space science program.

Budget Request Summary

From: March 1, 2003 to: February 28, 2004

	Project Total	Request to NASA	Contributions from Institution	Others
I. Direct Labor				
a. Salaries, wages	105,215	97,645	7,570	0
b. Fringe Benefits	24,130	21,931	2,199	0
2. Other Direct Costs				
a. Subcontracts	0	0	0	0
b. Consultants	27,485	27,485	0	0
c. Equipment	29,000	29,000	0	0
d. Supplies	5,783	5,783	0	0
e. Travel	15,981	10,981	0	5,000
f. Communication Costs (telephone, postage, printing)	4,000	2,000	0	2,000
g. Other (Student stipends, etc)	66,400	54,400	0	12,000
3. Indirect Costs (52%)	54,712	50,775	3,937	0
4. Other Applicable Costs	0	0	0	0
5. Total Estimated Costs	332,706	300,000	13,706	19,000
6. Deduct Carryover Funds	XXXXX	0	XXXXX	XXXXX
7. Cost to NASA	XXXXX	300,000	XXXXX	XXXXX

SCSU Year 4 Budget Narrative

Year 4 Direct Labor: \$119,576:(AY-Academic Year, Sum-Summer)

Person	Period	Time	Rate	Salary	Ben. Rate	Benefits
Walter	AY	10%	50466 /9mo	5047	29.05%	1466
Walter	Sum	4 wks	50466/9mo	5607	20.15%	1130
Payne	AY	25%	57272/9mo	14318	29.05%	4159
Payne	Sum	8 wks	57272/9mo	12727	20.15%	2564
Basher	Sum	max 6 wks	60905/9mo	10151	20.15%	2045
Swain	Sum	max 6 wks	54347/9mo	9058	20.15%	1825
Sadighi	Sum	max 6 wks	34544/9mo	5757	20.15%	1160
F. Robinson	Sum	misc.	4290	4290	20.15%	865
J. Brown	12 mo	misc.	7000	7000	19.65%	1376
C. Lacey	12 mo	misc	2000	2000	19.65%	393
Adm. Assist.	52 wks	25%	29160/12mo	7290	29.05%	2118
6 Fac Mentor	AY	misc	2400/mentor	14400	19.65%	2830
TOTAL				97645		21931

Faculty salary rates in AY 2003/04 assume no salary increase from the previous year. A total of 25% time commitment by Walter is made each semester during AY, 15% each semester will be cost shared by SCSU during AY (see below). The total commitment for the summer of 2003 for Basher, Sadighi and Swain is not fully defined at this time; therefore, a maximum commitment is shown.

Fringe Benefits Detailed by element:

Percentage Rate	29.05%	20.15%	19.65%
Social Security	6.20%	6.20%	6.20%
Medicare	1.45%	1.45%	1.45%
State Retirement	9.95%	9.95%	9.95%
Pre-retire Death Ben.	0.15%	0.15%	0.15%
Workman's Comp.	1.90%	1.90%	1.90%
Unemployment Comp.	0.50%	0.50%	-0-
Health & Dental Ins.	8.90%	-0-	-0-

Year 4 Equipment: \$29,000:

- \$15,000 for upgrade of planetarium equipment.
Specific items to be replaced will be prioritized based on age (some in excess of 10 years) and their importance to overall operation.
- \$6,000 to National Instruments
(2 control cards x \$500 + LabVIEW site license \$1000 + 1 ENET to RS 232 card \$750 + 1 DAQ card for laptop \$1000 + 2 motion controllers x \$500 + 3 motion controller interfaces x \$150 + 1 motion assistant \$800).
- \$1,000 for DVD recorders (2x\$500).
- \$6,000 for PCs for instrument control (3x\$2,000).
- \$1,000 for a robotics kit.

Year 4 Other: \$54,400: Student stipends (Note below, an additional \$12,000 in student stipends for PAIR from other sources – leveraged funds.)

Year 4 IDC: \$50,775: Rate of 52% on salaries only. U.S. Dept Health & Human Services, June Talbert, (202) 401-2808. Period: After July 1999 until amended.

Year 4 Consultants: \$27,485: Rates based on negotiated rates

Item	Quantity	Time	Cost/Item	Total Cost
UNIX training & support Dr. Patrick Shopbell Caltech: Pasadena,	1	5 days	\$453/day	\$2265
Web, Computer & Videoconferencing support CSC; Hampton, VA	10 hrs	52 wks	\$36/hr	\$18720
Astrobiology Curriculum Development Dr. Arthur Bowman, Hampton University	1	Misc	\$2000	\$2000
Microcraft Corp of North Carolina (training)	1 week	40 hr	\$4500	\$4500

Year 4 Travel: \$10,981: Costs based on recent experience & existing per diem

Person	Air	#day	Lodge	Food	Ground	#people	TOTAL
P I+ Co-PI + PD to NASA meeting	\$550	3	\$125/day	\$32/day	\$50	3	3213
Faculty to conference	550	4	100	32	50	3	3384
Students			See other	Funds	below		0
Overnight at PARI		1	75	32		20	2140
Van Rental							2244

PI +Co-PI + PD travel to NASA meeting. Faculty & student travel to present papers. Van rental from Whatley Toyota, Orangeburg, SC for observing sessions, outreach and to present papers at state and regional meetings \$561/month x 4 months = \$2,244.

Year 4 Supplies: \$5,783: Miscellaneous software, electronic, computer and other supplies based on Year 1-3 experience. (e.g. web cameras, electronic components, printer toner, CDs, DVDs, cabling, hardware for the radio telescopes, etc.)

Year 4 Communications Costs: \$2,000 based on Year 1-3 experience: phone, postage & delivery service \$500; printing costs, \$1,500 for brochures, posters, etc. from Kinko's, 1111 Greene St. Columbia, SC.

Year 4 Institutional Cost Share: \$13,706 which includes 15% of Walter's salary for AY 2003-04 (\$7,570) plus accompanying benefits (\$2,199) and indirect costs (\$3,937).

Year 4 Leveraged Funds from other Sources: \$19,000 is projected and includes \$12,000 from the NSF AMP program for student stipends, \$5,000 in travel and \$2,000 in additional communication costs from other NASA grants to SCSU.