

Louisiana Aerospace Catalyst Experiences for Students (La ACES)

Aerospace Workforce Development
Supplement to NGT5-40115

submitted to

Office of Education
National Space Grant College and Fellowship Program
Code NH
NASA Headquarters
Washington, DC 20546

by

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Certification of Compliance with Applicable Executive Orders and U.S. Code

By signing and submitting the proposal identified in this Cover Sheet/Proposal Summary in response to the NASA request for a proposal under the National Space Grant College and Fellowship Program, the Authorizing Official of the proposing institution, as identified below:

- 1. certifies that the statements made in this proposal are true and complete to the best of his/her knowledge;*
- 2. agrees to accept the obligations to comply with NASA award terms and conditions if an award is made as a result of this proposal;*
- 3. provides certification to the following that have been reviewed on the following NASA website (http://genesis.gsfc.nasa.gov/grants/grants.htm#Grant_Forms): (i) Certification for Debarment, Suspension, and other Responsibility Matters; (ii) Certification Regarding Lobbying, (iii) Assurance for Nondiscrimination Compliance.*

James L. Bates, Director
Office of Sponsored Programs
Louisiana State University and A & M College
330 Thomas Boyd Hall
Baton Rouge, LA 70803

6 November 2003

Concurrence

The development of the La ACES concept began two years ago and culminated in the presentation of the results from the pilot project at the LaSPACE Council meeting on 29 September 2003. The council members were impressed with the results and gave their approval to the next phase, i.e. extending the opportunity to student teams from other schools in the consortium. They discussed the coordination issue and the resources needed for the teams. They empowered the LaSPACE office to work out the details and produce a Louisiana proposal. Minutes of the meeting were distributed by e-mail with a request for additional comments. This proposal was developed and sent to all affiliates for concurrence in the submission. Responses, such as those reproduced below, were received via e-mail. In addition, e-mails from organizations supporting the project have been received.

Gary, For our last Workforce Development project you supported us with a tour for the students of your place. one I need a **quick answer** about. JPW ----- From: "Willett, Gary L" <Gary.L.Willett@maf.nasa.gov> [Yes no problem,](#)

From: Danny RJ Ball <dball@master.nsbf.nasa.gov> Subject: Re: La Aces Workforce proposal
John, We're enthusiastic about this and will support it in any way possible. When we get closer to the time when we need to take action, perhaps we could meet in either Baton Rouge or Palestine to get things going. You can count on us.
Danny Ball, NASA National Scientific Balloon Facility

I concur with the La ACES proposal.
Prof. Keith A. Gonthier
Louisiana State University

I concur with the La ACES proposal.
Fahmida Chowdhury,
University of Louisiana at Lafayette

I concur with the LA ACES proposal.
Andrea Benjamin
Baton Rouge Community College

I concur with the La ACES proposal.
S. T. Hsieh, Tulane University

Matthew F. Ware of Grambling State University concurs in the submission of La ACES.

I concur with the La ACES proposal.
Zeno D. "Dick" Greenwood, LaSPACE Coordinator
Louisiana Tech University

I concur with the La ACES proposal.
Gayle Glusman, Director
Challenger Learning Center, Louisiana Arts and Science Museum

I concur with the LA ACES proposal.
Jim Gershey,
Louisiana Board of Regents

I concur with the La ACES proposal.
Dr. Virginia Eaton
The University of Louisiana-Monroe

I concur with the La ACES proposal.
Michael A. Stubblefield
Southern University - Baton Rouge

Concepcion Rodriguez of Southern University – Shreveport concurs in the submission of La ACES.

I concur with the La ACES proposal.
Cliff Fenton, Nicholls State University

I concur with the La ACES proposal.
Ann Wilson, Science Program Coordinator
Louisiana Department of Education

I concur with the La ACES proposal.
Trey Goodman, Highland Road Park Observatory
Recreation and Park Commission for the Parish of East Baton Rouge

Creston King of Loyola University concurs in the submission of La ACES.

I concur with the La ACES proposal.
Roy Keller, Director, Louisiana Technology Transfer Office

Hi John, I enjoyed talking with you yesterday. KSC will be pleased to again work with the LASGC on your workforce development project. We will identify a KSC engineer (or other) to provide limited reviewing and advising on your project management course. ---- Mike Freeman

Ken Holladay, institutional representative of the University of New Orleans, concurs in the submission of La ACES

Louisiana Aerospace Catalyst Experiences for Students (La ACES)

Abstract

The Louisiana Aerospace Catalyst Experiences for Students (La ACES) project, successfully piloted during the 2002-2003 academic year, will be extended to student teams from institutions across Louisiana. The Louisiana ACES program is designed to transfer knowledge on the design, development and operation of student-built balloon payloads developed under the first Workforce Initiative to institutions and students with diverse backgrounds. There are four main phases to La ACES: 1) Development of an informal “Student Ballooning Course”, based upon ACES pilot material and designed to be disseminated to La ACES participants, 2) La ACES Leader training workshop to familiarize LaSPACE institutions with the ACES program as well as the “Student Ballooning Course” material and to solicit student team proposals from the institutions; 3) Design, development, fabrication of students payloads following the ACES model; and 4) Flight operations and final report. Collaborators on the project include NASA Kennedy Space Center (KSC), NASA Wallops (WFF) and the National Scientific Balloon Facility (NSBF), plus Lockheed-Martin Michoud (LM).

I. Introduction

NASA Administrator Sean O’Keefe has drawn attention to the Workforce problem facing NASA, and many of its contractors, over the next decade. This follows the Walker Report, which stated that the “future of the U.S. Aerospace industry depends on the ability of the industry to attract, develop and retain a properly skilled professional, scientific, engineering and production workforce” (Commission on the Future of the U.S. Aerospace Industry). Declining enrollments in science, math and aerospace related engineering programs are well documented and are seen at colleges and universities across the state of Louisiana. Further, Louisiana continues to suffer a “brain drain” where bright students and young professionals seek better opportunities in other states. Currently, LM-Michoud is projecting the need for several hundred new employees to complete its part of the ‘Shuttle Return to Flight’ program. What is required are motivated students with experiences that prepare them for the workplace. During the 2002-2003 academic year we were able to involve ~15 undergraduate students in the design, development, fabrication and operation of their own balloon experiment under the Aerospace Catalysts Experiences for Students (ACES) program. Here we plan to extend the highly successful ACES project to institutions across the state of Louisiana.

Louisiana Aerospace Catalyst Experiences for Students (La ACES), will build upon the ACES pilot program and extend the project to multiple institutions across the state. In particular, we plan to develop an informal “Student Ballooning Course” with the assistance of our collaborators, prepare and hold a “La ACES Leader Training Workshop,” select and fund four “Student Team Payload Proposals” from LaSPACE institutions, monitor and assist in the student payload development and perform flight operations with the assistance of the NASA National Scientific Balloon Facility (NSBF). The La ACES methodology will serve as a model for involving undergraduates at other institutions and be directly applicable to similar student involvement programs across the Southeast.

II. Results from the ACES Pilot Program

A pilot version of ACES was funded by LaSPACE during the 2002-2003 academic year (<http://laspace.lsu.edu/aces>). The long-term goals of ACES are to 1) attract new students to aerospace related science and engineering programs, 2) provide students with a background to develop and manage modern aerospace projects, 3) give students practical experience with sensors, electronics and “spacecraft” systems, and 4) assist in retaining these students by exciting their imagination and fostering their innate curiosity.

The pilot program involved undergraduate student participants from Southern University (SU) and Louisiana State University (LSU), both located in Baton Rouge. These students were grouped into four teams of 3 to 4 students each and were exposed to the aerospace project development life cycle using the design, fabrication, testing and operation of small payloads (i.e. < 1 kilogram) launched on a sounding balloon as a ‘spacecraft simulation’. They were required to produce reports, establish schedules / milestones and undergo reviews similar to the kinds of metrics used to track NASA projects. At the end of the academic year, following their Flight Readiness Review, the group traveled to NSBF in Palestine, Texas (Figure 1), where their payloads were launched, operated during flight, recovered and the data analyzed. During this trip the group also toured the NSBF facility, the Raven Balloon Plant



Figure 1: The 2002-2003 ACES student group at NSBF



Figure 2: The ACES-01 launch

where the large (~30 million cubic feet) scientific balloons are made and the NASA Johnson Space Center.

The payloads developed by the students included the “Temperature – Infrared – Camera (TIC)” experiment that measured infrared radiation and temperature as a function of altitude and returned some stunning images taken during flight. The “Flux Reliant on Environmental Density (FRED)” experiment measured the cosmic ray intensity and clearly showed the Pfozter maximum. The “Student Made Ultraviolet Radiation Detector (StuMURD),” a collaboration between SU and LSU students, measured the transmission of ultraviolet radiation through the atmosphere as a function of altitude. Finally, the “Ozone Measuring Equipment at Given Altitudes (OMEGA)” payload was developed to study the

concentration of ozone in the atmosphere as a function of altitude. Three of these four payloads received final flight approval (OMEGA suffered a major failure the day before launch) and were launched from the NSBF facility on May 21, 2003 at 12:20 UTC (Figure 2). The balloon climbed to an altitude of 98,179 feet prior to balloon burst at 14:09 UTC (Figure 3) and Figure 4 shows an image returned by the TIC payload from an altitude of ~60,000 feet. Following burst the payload descent was slowed by a parachute to a final landing at 14:44 UTC approximately 60 miles from the launch site. Figure 5 shows the recovery of the StuMURD payload.

After payload recovery the teams returned to the NSBF where they began the process of downloading and analyzing their data (Figure 6). Figure 7 shows the cosmic ray data returned by the FRED experiment. Here the FRED team included the flight profile information (i.e. Figure 3) to relate their data to altitude plus performed an error analysis to correctly assess their uncertainties. The resulting plot shows the typical peak in intensity at about 60,000 feet and good agreement between the datasets collected during ascent and descent.



Figure 5: Recovery of the joint SU, LSU StuMURD

The ACES pilot achieved the metrics outlined in the original proposal. Thirteen students plus three instructors were dedicated to the program throughout the academic year. We successfully implemented the program, tested our methodology and developed a number of resources that will prove useful in the La ACES effort (see <http://laspace.lsu.edu/aces/Presentations.html>). We are tracking our students and find that most are remaining in a science field; several have attended REU or science conferences during the summer. An ACES presentation will be given at the January 2004 AAPT meeting. We presented results of the ACES pilot project to the LaSPACE Council and developed a plan for extending the program.

III. Expanding ACES Across Louisiana

Louisiana ACES is a project that will capitalize on the experience, materials and methodology developed during the ACES pilot to involve undergraduates from across the state in the development and operation of small student built balloon payloads. Based upon what we learned during the pilot we will build a “Student Ballooning Course” and train Leaders from LaSPACE institutions on how to implement this program at their site. These Leaders will submit a “Student Team Proposal” and 4 of these will be selected for funding. During the academic year the students will be exposed to the aerospace project development life cycle using "Learn," "Do" and "Experience" methodology tested during the ACES pilot. They will be required to produce reports, establish schedules / milestones and undergo reviews similar to the kinds of metrics used to track NASA projects. Their progress will be monitored throughout the year and successful payloads will be flown from the NASA NSBF. Student teams will be encouraged to present their results at appropriate American Association of Physics Teachers, Society of Physics Students, or Louisiana Association of Science Teachers conferences.

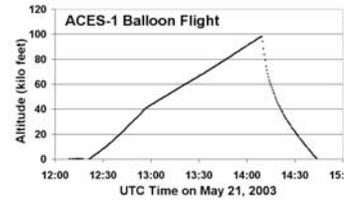


Figure 3: Altitude versus time for the ACES-01 flight.



Figure 4: ACES-01 view from ~60,000 feet.



Figure 6: ACES-01 post-recovery data analysis.

A. Program Implementation

During the first phase of La ACES we will incorporate what we have learned during the ACES pilot into a “Student Ballooning Course”. This course will be targeted at an intermediate level and structured for informal implementation. In particular, the course structure will include two sessions each week for 13 to 14 weeks during Fall semester and a similar amount of time during the Spring. The Fall semester will focus on developing basic skills while the Spring semester will concentrate on payload design, development, fabrication, integration, test and flight preparation. Each two hour session will be divided between a lecture / discussion period and an activity period.

Students will be encouraged to work on their projects beyond the two weekly sessions. Development of the course will involve generating a number of components including: **Course Syllabus:** a brief summary of the course including content, primary topics to be covered, date and times of sessions, requirements, evaluation procedure and schedule. **Session Work Plan:** a listing of the actual material to be covered in each session including topics, basic concepts, discussion points and planned activities. **Lectures:** cover a particular topic, will be developed in PowerPoint format and include animations, videos and online material where necessary to add interest or clearly explain a concept. **Activity Instructions:** step-by-step instructions for each activity including materials, setup, execution and investigation of results. An additional instructors sheet will include discussion points, expected results and references to the topic covered by the activity. **Materials List:** all components and quantities needed for the course including tools, instruction aids, and expendables. **Background References:** papers, texts, and online sources that can be used as background for the instructor and/or as additional material for participants. **Evaluation Forms:** a survey to be filled out by the participant to provide a qualitative evaluation of the course.

The course will be split into five units to cover the most important topics needed by the students for the successful development of their balloon payload. These topics include the following: **Science:** include background on the space environment and history, atmospheric science, remote sensing, cosmic rays and other topics that students can use to focus their payload development effort. **Project Management:** provides practical information on project life cycle, budgeting, work breakdown structure, task allocation, management and preparation for preliminary design (PDR), critical design (CDR) and flight readiness reviews (FRR). **Electronics:** provides experience in circuit construction and soldering, sensor interfacing and signal conditioning, power supply and battery characteristics, and how to use data storage, DAC and ADC chips. **Programming:** provides practical knowledge on how to program and use a real-time controller like the Parallax Basic Stamp including sensor readout, data storage, timing and payload control. **Balloon Payload Design:** covers topics ranging from the balloon flight profile and environment, mechanical design and construction, thermal calculation and control, payload constraints and flight train interface, pre-launch checkout as well as flight and recovery operations.

The NASA Kennedy Space Center will assist in the development of the Project Management unit, and members of the Baton Rouge Amateur Radio Club as well as faculty and staff of the LSU Department of Physics & Astronomy will help with the Electronics, Programming and Balloon Payload Design units. Once completed all materials will be copied to a dissemination package CD and distributed to interested LaSPACE institutions.

The next phase of the program will focus on involving student teams from institutions across the state. We will organize a “La ACES Leader Training Workshop”, to be held at LSU during late Spring / early Summer 2004. Each LaSPACE institution will be invited to send a representative, who would be responsible for interfacing with La ACES and for leading a student team during the academic year payload development. The workshop will familiarize the participants with the “Student Ballooning Course” material, the payload development methodology, their responsibility as institution leaders, and the format, content and deadlines for their “Student Team Payload Proposal”. These proposals will be due several months after the workshop and will be reviewed by the La ACES management team. At least four proposals will be selected for funding. The maximum funding level is set at \$12,000 and more than 70% of the La ACES direct cost is allocated to support these institution proposals. Subcontracts to the selected institutions will be in place by the beginning of the academic year.

Academic year 2004-2005 will focus on implementing the Student Ballooning Course and payload development at the participating institutions. Progress will be monitored throughout the year using e-mailed reports from the institution leader, copies of the student’s PDR, CDR and FRR reports and presentations and, when feasible,

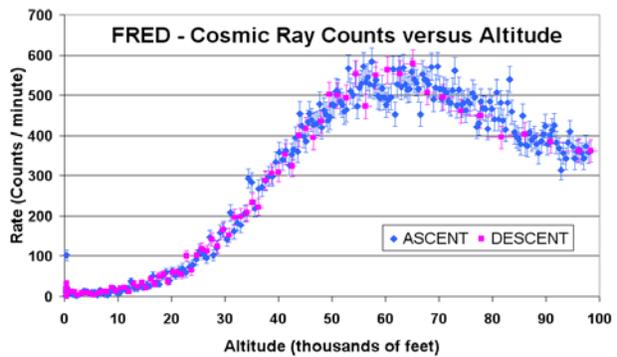


Figure 7: FRED measurements of the galactic cosmic rays

site visits. LSU students and staff with previous ACES experience will be available to address questions and provide mentoring. The ACES website (<http://laspace.lsu.edu/aces/>) will include online access to updated course material, a Frequently Asked Question (FAQ) list and a message forum. La ACES management will monitor this forum and post answers to issues after consultation with collaborators from LM, KSC, NSBF and the Baton Rouge Amateur Radio Club, as appropriate. Also during this period the La ACES team will be preparing for flight operations including interfacing with NSBF, refurbishing the existing flight equipment, ordering flight support material, such as balloons, and preparing for the launch trip.

In the final phase of the project, payload teams will join the La ACES staff at the NSBF for flight operations. This will be an approximately 5-day trip that will include a tour of the NSBF facility as well as the nearby Raven Balloon Plant. This trip will take place close to the spring “wind-turnaround”, during the last half of May, when the high altitude winds are at their slowest velocity. This will minimize drift of the balloon package from the launch site and increase the probability of a successful recovery. The NSBF will provide our group with hanger space, tables, chairs, power, network connection, weather briefings and will assist in payload integration, FAA interfacing and launch operations. Launch preparation including final payload checkout will take about one day. Launch will take place early the next morning and the balloon package will be tracked in real-time for the duration of the flight. Members of the Baton Rouge Amateur Radio Club will provide assistance with the real-time tracking and vehicle communication during the chase. The flight is expected to take 2 to 3 hours. Following recovery the payloads will be returned to NSBF where the students will download their data and begin a preliminary data analysis. Initial results will be presented at the NSBF by the end of the launch trip. These results plus information from the project evaluation will be collected into a final report.

B. Community Involvement

Numerous resources are available in the local area to support development of the “Student Ballooning Course”, mentoring / advice during payload development and flight operation support. Groups that have agreed to participate include: **Lockheed-Martin Space Systems – Michoud Operations:** located in New Orleans, will provide assistance in the course development, answer questions as appropriate as posted on the ACES forum, plus a tour of the shuttle external tank production facility; **Baton Rouge Amateur Radio Club:** local HAM radio organization will provide assistance and lectures on radio telemetry, electronics, ground system, and payload tracking; **Southern University:** part of the largest Historically Black College or University (HBCU) system in the nation, will provide support and mentor students; **Louisiana Office of State Climatology:** Located on the LSU campus, faculty members of this group will assist in the development of science units on atmospheric structure, atmospheric science and remote sensing; **LSU Department of Physics & Astronomy:** Faculty members will help with science units departmental staff will assist with development of the electronics, ballooning and programming units.

C. Goals, Metrics and Outcomes

At the end of this program we expect to have 1) a “Student Ballooning Course” structure that has been field tested and ready for wide dissemination, 2) a group of undergraduate students at institutions across Louisiana that have gained practical experience in the design, development and operation of small aerospace payloads 3) an evaluation of these students based upon their reports, review presentations, attendance and payload performance, 4) expanded the capability in Louisiana to support student built balloon payloads, 5) a self evaluation of the project including “lessons learned”, and 6) constructed a plan to offer the ACES program to Space Grant institutions across the southeast region.

A. Goals	Metrics
A-1.: Attract young students to aerospace related science and engineering programs.	A1.1: Assemble teams at multiple Louisiana institutions.
A-2.: Assist in retaining students in science, engineering and math degree programs by exciting their imagination, having fun, and fostering their innate curiosity.	A-2.1: Track team until graduation/monitor retention in aerospace related fields of study.
A-3.: Provide students with a background on how to develop and manage modern aerospace programs as well as practical experience with sensors, electronics and "spacecraft" systems.	A-3.1: Develop the “Student Ballooning Course”. A-3.2: Train institution leaders in the ACES program A-3.3: Mentor development of student-built payloads
A-4.: Expand program to other institutions.	A-4.1: Support payload proposals from LaSPACE affiliates. A-4.2: Develop a plan for expanding ACES to Space Grant institutions across the Southeast region

D. Relationship to NASA

This program builds upon the scientific balloon experience already established at LSU through several NASA supported cosmic ray balloon payloads. During these research programs, dozens of undergraduate student workers obtained a working knowledge of scientific balloon operations. We established relationships between **NASA Wallops Flight Facility (WFF)** and the **NASA National Scientific Balloon Facility (NSBF)**. Danny Ball, NSBF Site Manager, feels that this project will provide students with experiences that are directly applicable to the technical and scientific work supported by WFF and NSBF. As part of their support, Mr. Ball has offered the NSBF in Palestine, TX as a site for the student balloon launches. NSBF staff will also be available to provide the students with a site tour and technical discussions. We have also established relationships with other NASA centers including **Kennedy Space Center**. KSC will support La ACES by providing materials on space systems and NASA career opportunities, as well as assisting in the development of the Project Management course unit.

E. Project Schedule

An overview of the anticipated La ACES timeline is shown in Figure 8. We anticipate starting the program by the beginning of February 2004 and submitting the final report by the end of June 2005. Course development takes place during Spring 2004 along with soliciting LaSPACE affiliate participation and preparing for the Leader training workshop. This workshop is scheduled for May 2004 following which Student Team Proposals will be received and reviewed by August 2004. Implementation of the “Student Ballooning Course” and payload development at the participating institutions will take place during the 2004-2005 academic year.

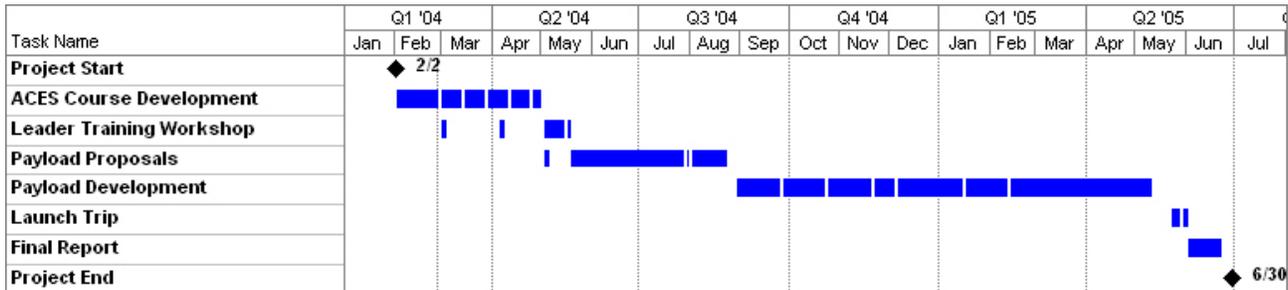


Figure 8: Summary timeline for the La ACES project.

MILESTONES

- Feb. 04** Project start. Draft course syllabus, session work plan, lecture and activity list. Outline content of course units. Establish course development contacts at collaborating organizations.
- Mar. 04** Develop Program Management, Electronics and Programming units. Draft materials list. Distribute Leader Training Workshop announcement and solicit applications.
- Apr. 04** Develop Balloon Payload Design and Science units. Order materials for workshop. Complete course materials.
- May 04** Develop Student Team Payload RFP. Prepare and hold Leader Training Workshop
- June 04** Order long lead items for Student Payloads. Update ACES website with FAQ
- July 04** Payload proposals due. Review and select four proposals for funding
- Aug 04** Award subcontracts to selected proposals. Begin Student Balloon Course.
- Sep – Dec 04** Monitor progress of course implementation. Address issues on ACES forum. Perform site visits when feasible. Distribute and collect semester end student evaluations.
- Jan – Apr 05** Monitor payload development. Review student PDR and CDR reports. Order components. Refurbish balloon vehicle components. Coordinate launch trip plans
- May 05** Perform launch trip. Complete FRR with student payloads. Launch and recover balloon payloads. Download data and analyze. Evaluate student presentations.
- June 05** Complete final report. Establish plans for expanding ACES across southeast region. Project end.