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The 
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Design and Construction of the 
World’s Largest Paper Airplane

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It was late in the afternoon on March 25 in the NASA Langley hangar when a local high school student, standing on a 10-foot-high platform, raised a giant paper airplane high above his shoulders. He paused a few moments to concentrate on the right glide angle, then took a few quick steps and launched the "White Pelican" with a big push of both hands and watched it glide to a new world record for the largest paper airplane. This was the culmination of a one-year educational project involving 37 participants in various capacities.

Project Organization

It all started in 1987 at a brainstorming session between advisors of the Virginia Air and Space Center (VASC) and the VASC exhibit designers. The 30-million-dollar Virginia Air and Space Center and Hampton Roads Visitor Center was slated to open its doors in Olde Downtown Hampton, Virginia, on April 5, 1992. The Center’s theme “From the Sea to the Stars” would signify the integration of the abundant history of Hampton Roads, starting some 400 years ago, with the area’s rich aerospace legacy in the modern era. The Center would be designated the official NASA Langley Visitor Center and would include a teacher resource and classrooms. The nine-story-high main gallery would house more than ten air- and spacecraft and a 300-seat IMAX theater. In those early days of 1987 several of the exhibits were still on the drawing board. Looking for a vehicle to illustrate the basic principles of aerodynamics to the public, a suggestion was made to design a World’s Largest Paper Airplane Exhibit displaying a 10-foot folded paper airplane in the Center. In the late summer of 1990 one of the VASC’s advisors, NASA’s Head of Public Affairs, A. Gary Price, proposed the concept to then-AIAA Hampton Roads Section Chairman Dr. Ferdinand W. Grosveld, who conceived the idea to have the section support high school students from
the Hampton City School System in an attempt to break the record for the World's Largest Paper Airplane for inclusion in the Guinness Book of Records. He consulted with VASC Director Ralph Johnston to devise and coordinate an educational project that would stimulate the students' interest in aeronautical engineering and perhaps motivate them to pursue a career in engineering or science. Edgar G. Waggoner, Head of the Subsonic Aerodynamics Branch, and Mohammed A. Takallu, a Lockheed staff engineer and at that time President of Virginia Soaring, Inc., agreed to be members of the AIAA Hampton Roads Section organizing committee. At meetings in early 1991 with the VASC, Hampton City Schools, and the participating high schools, a one-year itinerary was planned that included lectures, field trips, soaring glider rides, and the design and construction of the prototypes and final designs. Wilmer H. Reed, W. Hewitt Phillips, Dr. Richard T. Whitcomb, Jim A. Penland, and Donald A. Baals (who later had to resign due to personal circumstances) were asked to be advisors for the students, and they enthusiastically accepted. This group of legendary NASA retirees and model airplane enthusiasts provided vast experience and enormous knowledge to the project.

School Participants

The teachers from the four Hampton high schools (Bethel, Hampton, Kecoughtan, and Phoebus) selected a total of 18 outstanding senior students to participate in the project. Bethel High School was represented by Benita Brown as the educator and students Russell Bascomb, Brian and Sean Harley, Caroline Hill, and Greg Selby. Betty Long represented Hampton High School with students Tony Bordeaux, Phillip Check, Kumaravel Jagasivamani, Kevin Kelley, Richard Mack, and Ben Spencer. Kecoughtan High School students Amy Nichols, William Perry, and Becky Richey were guided by teachers Mark Christman, Donald Johnston, and Debra Mortimer. James Sherrad was the Phoebus High School teacher who secured the enthusiastic support of students Ian Bilyj, Jon Davis, Kristin Wallio, and Michael Whitlock. Math/Science Coordinator Joyce A. R. Weeks of Hampton City Schools, with the assistance of Susan Booth and Susan McBurney, hosted the project and provided a work area suitable for building the contender airplanes.

Prototype Designs

In the preliminary phase of the project, George Washington University graduate students visited each of the four high schools to introduce them to the world of aeronautics as part of the students' AIAA Hampton Roads Section outreach program. Hewitt Phillips lectured the students on aeronautical design, giving specific emphasis to the construction of model airplanes. The students of each of the high schools were to conceive and build a 6-foot paper airplane during the summer and early fall, which resulted in several original designs. Students from one of the schools originated an innovative honeycomb construction of a wing in which the honeycomb core was cut out of folded paper. Other students designed a reinforced grip that made it easier to launch the air-

Hampton High School students Tony Bordeaux and Kumaravel Jagasivamani prepare the 28-foot paper airplane for its record flight while advisor Dr. Richard T. Whitcomb looks on.

High school students Becky Richey and Kristin Wallio work on the 30.5-foot record-breaking airplane while being advised by Wilmer H. Reed III.
plane with less chance of damage during the launch and landing. This design featured fuselage beams several feet apart to more evenly distribute the gravitational and lift forces. The four school designs were test-flown and criticized by the advisors. This resulted in an optimized design to be built by students from the four schools together.

Field Trips

The teachers of the schools played an active role in motivating the students and provided substantial input to the project. They accompanied the students on several field trips to have them learn more about aeronautics and gain insight into real-life design procedures. The students and the teacher/advisors were taken on a field trip to the National Air and Space Museum in Washington, D.C., where they learned about the history of airplane design and watched an IMAX movie. On a field trip to NASA Langley Research Center, the students were introduced to the uses of the many NASA research aircraft stationed at Langley. The fundamental principles of wind-tunnel testing were explained on a tour through the 14- by 22-foot subsonic wind tunnel, where a transport airplane was being readied for testing. During an interactive 3-D graphics design exercise, they were able to view their own paper airplane at various angles of flight attitude on a high-resolution monitor. The tour at Langley was concluded with a visit to NASA's flight simulation facility, where the students had an opportunity to practice their pilot skills and crash a few aircraft. They participated in Career Day at Langley, where they stole the show by presenting an 18-foot paper airplane to their high school peers and explaining some of the principles that were used in the design. The students were given a lecture to prepare them for demonstration glider rides by showing the techniques and procedures to be exercised when flying an airplane without propulsion, somewhat like a trimmed paper airplane in free flight. On a beautiful Saturday in late February 1992, they were able to put into practice what they had learned. They took the controls of a glider airplane at the Emporia, Virginia, airport, where pilots of Virginia Soaring, Inc., took them for a ride. Towed to an altitude of over 1000 feet, they soared over the Virginia countryside experiencing the beauty of free flight. Watching the hawks, they took full advantage of thermal updrafts as indicated by the birds.

Final Designs

With only a few more months left before the scheduled date of the record attempt the project focused more on building the actual airplanes. The advisors demonstrated the technique of rolling paper tubes and tapering the spars towards the tip to save weight. A balancing device was constructed to measure the strength of the tubes under a static load. The students received instruction in calculating the wing's area, its center of gravity, and its aspect ratio. The advisors explained how bonded surfaces are affected by normal and shearing loads. A low-speed wind tunnel, built by AIAA Hampton Roads Section members as a prototype for a permanent exhibit in the Virginia Air and Space Center, was used to show the students how the angle of attack of a model paper airplane changes the lift experienced by the plane.

By that time, it was learned that the world record in the 1990 Guinness Book of Records was broken by a group of students from Pendleton High School in Indiana, who constructed a 16.4-foot airplane that flew over 86 feet. The team of students and advisors then decided to build two planes, each with a wingspan of 24 feet, which could be increased to 28 feet by insertion of a 4-foot center panel. It was felt that two planes were needed in case one crashed or was damaged before or during the record attempts. To ease in transportation, the

Kecoughtan High School student William Perry prepares to launch the 28-foot paper airplane for its world-record-breaking flight.
planes were constructed in 6-foot sections and all parts were interchangeable. The sections were easy to assemble by joining the tapered tubular spars. The working sessions took place after school hours in the Hampton City Schools administration building, where the project participants were comforted by the staff with soft drinks, pizza, and popcorn.

During the construction phase, a video crew from NASA Headquarters (NASA Select) visited to capture the making of the world’s largest paper airplane, providing the project participants an opportunity to express their feelings about the project. The videotaping, although exciting for the students, interfered somewhat with the timely construction of the contender airplanes, and it was hard work to catch up with the lost time and prepare the two final designs for the record attempt. During that period of increased pressure, some of the students emerged as real leaders and major contributors. This core of students, the AIAA advisors, and the teacher/advisors managed to complete the two designs with still enough time left for some test flights in the Hampton City School’s gymnasium. After adjustments of the fuselage’s center of gravity with the wing’s estimated aerodynamic center, the planes were able to fly some 45 feet when launched from the gym’s floor. This indicated a glide ratio of approximately 7:1, which would result in a gliding distance of more than 100 feet when launched by a 6-foot-tall student from a 10-foot-high platform. This boosted the confidence of the students as well as the advisors that the record could be broken.

Record Attempts

In preparation for the record flight attempts, the research aircraft in the NASA Langley hangar were moved to clear a 90-degree segment with a radius of 150 feet to accommodate the airplane glide. As a precaution, a vintage tennis net was set up to retrieve the airplanes if they unexpectedly veered off their path and flew towards parked aircraft or workbenches. A very sizable crowd showed up to cheer the project participants in their attempt to break the world record.

The record attempt had drawn considerable attention from the media. Local television reporters were on hand to cover the event for their nightly news broadcasts. The NASA Select video crew made a special trip from Washington, D.C., to record the conclusion of this educational project. Interviews were conducted by newscasters from area radio stations and by print reporters. The Associated Press called in to hear if the record-breaking attempt had been successful. The students did not seem to be intimidated by all this attention and candidly responded to questions by the press about themselves and the project.
The participants in the World's Largest Paper Airplane Project with their record-breaking 28-foot and 30.5-foot gliders, which flew distances of 106 feet and 114.75 feet, respectively.

The wings of the two contenders were assembled and taped to their fuselages at previously marked attachment points. A last-minute inspection, some patching up of the planes, and the moment of truth had arrived. The confidence of the students and advisors in the successful completion of this project proved to be justified. Witnessed by authentication officials Ed Kilgore, President of the VASC Board of Directors, and Harry Verstynen, Head of NASA's Aircraft Operations Branch, the 24-foot plane flew a distance of over 103 feet, improving on the world record wingspan of 16.4 feet as listed in the 1992 Guinness Book of Records. The students then broke their own record by gliding the second, 28-foot paper plane more than 106 feet. Prepared for this success but not yet satisfied, the students and advisors extended the wing tips of this airplane to a wingspan of 30 feet and 6 inches. This configuration, weighing only 9.5 pounds, gracefully glided a distance of 114 feet and 9 inches in its third flight before settling down on the concrete floor of the hangar.

Recognition

Project participants were recognized during a Grand Opening Celebration in the VASC on April 13, 1992. The four Hampton high schools received the new student IDEAS award, which is sponsored by the Hampton Roads Section and by the Science and Technology Corporation. This annual award supports and recognizes innovative designs in science and engineering by students and/or teachers from the public school system. The annual plaque was presented to the Hampton City Schools, Bethel, Hampton, Kecoughton, and Phoebus High Schools each received a commemorative plaque along with a stipend of $400 each from Dr. Adarsh Deepak, President of the Science and Technology Corporation, to pursue more innovative projects. The record flight was submitted to the Guinness Book of Records for inclusion in their 1993 edition. The record-breaking plane was hung as a permanent exhibit in the main hall of the Virginia Air and Space Center. The second glider, configured for a 28-foot wingspan, was presented to the Hampton City Schools during the VASC recognition ceremony. The “White Pelican” project had achieved its intended goals as a successful educational project.

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