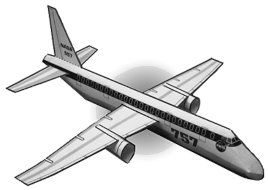
National Aeronautics and
Space Administration

Educational Product	
Teachers and Students	Grades 5-12



757 Glider Kit

A Boeing 757-200 (B-757) was acquired in 1994 by the National Aeronautics and Space Administration (NASA) for aeronautical research. Given the call sign NASA 557, this aircraft is used for conducting research on increasing aircraft safety, operating efficiency, and compatibility with future air traffic management systems, benefiting the U.S. aviation industry and commercial airline customers. Part of the Transport Research Facilities (TRF) project, this twin-engine commercial aircraft was modified extensively to create a "flying laboratory." Most of the seats were removed to make room for a large test area capable of carrying over 5100 kg (10,700 lb) of experiment equipment. It is outfitted with electronics for extremely precise instrumentation and data gathering capabilities, and a flexible interior configuration allows future upgrades to be incorporated. The B-757 is continuing the work begun by NASA's Boeing 737-100, which has been in service for over 20 years. The B-757 retains the experimental approach of the B-737, but offers newer technology and improved capability. "Airborne Trailblazer" by Lane Wallace is an excellent history of NASA's B-737 research aircraft. <see: http://www.dfrc.nasa.gov/History/Publications/SP-4216/>
One of the basic working philosophies of the TRF project is the concept of "simulation to flight." The main objective is to develop technical or operational concepts (e.g., electronic cockpit displays, flight management systems, airborne windshear detection sensors) and take them from ground-based simulation testing to flight testing in an easy and straightforward manner. The TRF project includes the B-757 aircraft as well as several ground-based simulators and a Research Systems Integration Laboratory (RSIL). Increasing the effectiveness of conducting experiments from simulation to flight will better meet the needs for bringing advances in safety, operations, and capacity into the ever-changing national airspace system. The NASA 557 will be maintained and flown by NASA's Langley Research Center (LARC) in Hampton, VA. Listed below are some experiments that have used the NASA 557.

ELECTROMAGNETIC EFFECTS (EME)
The NASA 557 was used to conduct several experiments to determine the effects of High Intensity Radiated Fields on aircraft electronics, which is important research for aircraft safety and navigation systems. A database was produced for use in validating advanced analytical tools. NASA, the Navy, and the Air Force conducted static tests at LARC to characterize the electromagnetic environment in and around a large transport aircraft. Flight tests were conducted in the vicinity of radar transmitters at Wallops Flight Center in Virginia, and in close proximity to radio transmitters in North Carolina. Data collected during both types of tests are being analyzed. The results will be used to improve the reliability of digital electronics and to reduce their certification costs for use on civil transports.

GLOBAL POSITIONING SYSTEM (GPS) USE FOR ALL-WEATHER LANDINGS
The aviation industry is investigating the use of differential GPS concepts for precision landings in bad weather to improve the safety and reliability of air travel. The GPS is a constellation of 24 satellites used to determine aircraft position anywhere on or near the Earth. When a ground-based GPS receiver is used to provide a "differential" correction signal, an aircraft's position can be determined within a foot or two. Boeing partnered with NASA to examine GPS Landing System concepts and evaluate their accuracy, integrity, and continuity of function in automatic landings of airplanes. The team tested several prototype GPS Landing System concepts using NASA 557 during 226 automatic approaches and landings. The data obtained is being used to validate GPS Landing System simulations and to define system certification requirements.

SUBSONIC AIRCRAFT: CONTRAIL AND CLOUD EFFECTS SPECIAL STUDY (SUCCESS)
NASA is studying the environmental impact of aircraft emissions upon the atmosphere. The SUCCESS project began as an investigation into the radiative properties of cirrus clouds, how cirrus clouds are formed, and the effects of subsonic aircraft on cloud formation (subsonic means slower than the speed of sound, which is 330 m/sec [1,088 ft/sec] at 0°C [32°F] at sea level). NASA 557 was used to generate engine exhaust for the experiment. High-sulfur fuel was used in the engine of one wing, and low-sulfur fuel was used in the engine of the other wing. A NASA DC-8 aircraft followed the B-757, taking data on the sulfuric acid and soot content of jet engine exhaust by measuring gas and particle samples emitted from the engines, while a NASA ER-2 aircraft took infra-red images from above. Research on this project is still in progress. <For photos and other information on the SUCCESS project, start with: http://cloud1.arc.nasa.gov/espo/success/aircraft.html>

FLIGHT CHECK: Check out the following NASA and Boeing sites and related aeronautic sites on the Internet:

http://www.aero.hq.nasa.gov/hpcontent/edu.html
This site links to education materials from each NASA Aeronautics Center, other interesting locations, and to NASA Aeronautics' main homepage.

http://www.boeing.com/757.html
http://quest.arc.nasa.gov
http://www.db.erau.edu/www_virtual_lib/aviation.html
http://observe.ivv.nasa.gov
http://www.nasm.edu/GALLERIES/GAL109/
http://www.hq.nasa.gov/office/codef/education/index.html

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FOCUS: The glider challenges focus on the **Science as Inquiry** standards. Students are given the opportunity to use scientific methods and develop the ability to think and act in ways associated with research design and inquiry, including asking questions, planning and conducting investigations, using appropriate tools and techniques to gather data, thinking critically and logically about relationships between evidence and explanations, constructing and analyzing alternative explanations, and communicating scientific arguments and results.

CHALLENGES: The challenges investigate design parameters of the glider -- wing, tail, and nose. The aerodynamic forces of lift, drag, and weight are explored. Each glider challenge calls for students to develop abilities to identify and state a problem, design a solution, implement a solution, and evaluate the solution. Extensions to the challenges are offered for further mathematic and scientific explorations and investigations.

GLIDER CHALLENGE EVENTS

DIRECTIONS: Divide class into flight squadrons (3 to 4 students per squadron). Have each student construct a 757 glider and write their name on the wing. Present glider challenges to squadrons. Explain to students the object of each event and how it is scored. Extra points can be obtained by completing a glider extension activity. Students should be encouraged to conduct some experimentation (i.e., add weight; reshape wing or tail) on their gliders in order to maximize the performance for the different objectives of each challenge. Rotate squadrons through the challenges keeping score on a squadron's scoresheet. Debrief afterwards to discuss glider designs, experimentations, and outcomes.

CHALLENGE #1 -- Spot Landing

Set-up: Tape off a large circle, 7 meters in diameter. Create a bull's-eye ring with 3 circles, equally spaced from each other, inside the circle (5, 3, and 1 meter). Label circles (A, B, C, D) with A being the center ring. Give a point value to each circle with A being the largest point value and D being the smallest point value. Indicate the launching zone with another piece of masking tape 4 meters from the edge of outer circle. *(You may wish to try a glider unmodified to see how far it can go and use the distance as a baseline for making adjustments.)*

Playing rules: Object is to make modifications to the glider to improve its performance with the goal of launching the glider towards the circle and touching down inside circle A (the bull's-eye).

Scoring: Points are determined by the spot the glider first "touches down" in the target area, not where it finally comes to rest. After each squadron member has landed their glider and determined the point score, the squadron's combined points are entered on the score sheet.

Extensions: (1) Find the average for the squadron and enter on score sheet. (2) Try to land with a "downwind" -- a three-speed fan (using low, medium or high speed) located directly behind the launch zone. Discuss the performance changes. With a given windspeed (low, medium or high), calculate the increased distance needed to land. (3) Repeat Extension 2, but instead have the glider land "upwind." After completing Extensions 2 and 3 answer the question: Which way would pilots rather land an airplane, downwind or upwind? Why?

CHALLENGE #2 -- Launch and Land

Materials needed: 1 standard rubber band (10 cm) per student, 1 balance scale (metric) per squadron, 1 meter stick, paper clips

Set-up: Establish a launch zone on a tabletop. Tape the meter stick to the edge of the table. Have students hook one end of rubber band to the glider's nose, at Tab D, and the other end to the front of the meter stick. Have students pull glider back to the 20 cm mark on the meter stick and release. Measure distance from launch table to touch down point.

Playing rules: Object is to manipulate glider's weight and, operating under "powered" flight, achieve the greatest distance from the launch zone.

Scoring: Add together each squadron member's distance from launch zone to touch down.

Extensions: (1) Find the mean, median, and mode for the squadron. (2) Vary the length which the rubber band is pulled back on the meter stick (e.g., 10 cm, 25 cm, 40 cm) while holding the glider's weight constant. Conduct several trials at each length. What impact does this have on performance? (3) Vary the glider's weight (number of paper clips) on different parts of the plane, wing, nose, tail, or body. Using constant thrust, conduct several trials, recording weight, weight location, and distance flown. What impact does weight have on performance? (4) Determine the weight to thrust ratio for your glider's best performance. Compare with other squadrons. What can you conclude about glider performance?

Event Scoresheet

Squadron Members:

1. ____________________
2. ____________________
3. ____________________
4. ____________________

	Score
Event #1 - *Precision Landing*	______
Event #2 - *Launch and Land*	______
Event #3 - *Student Determined*	______
Total Score	______

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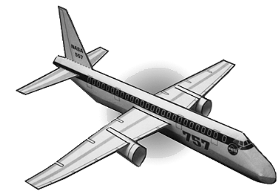

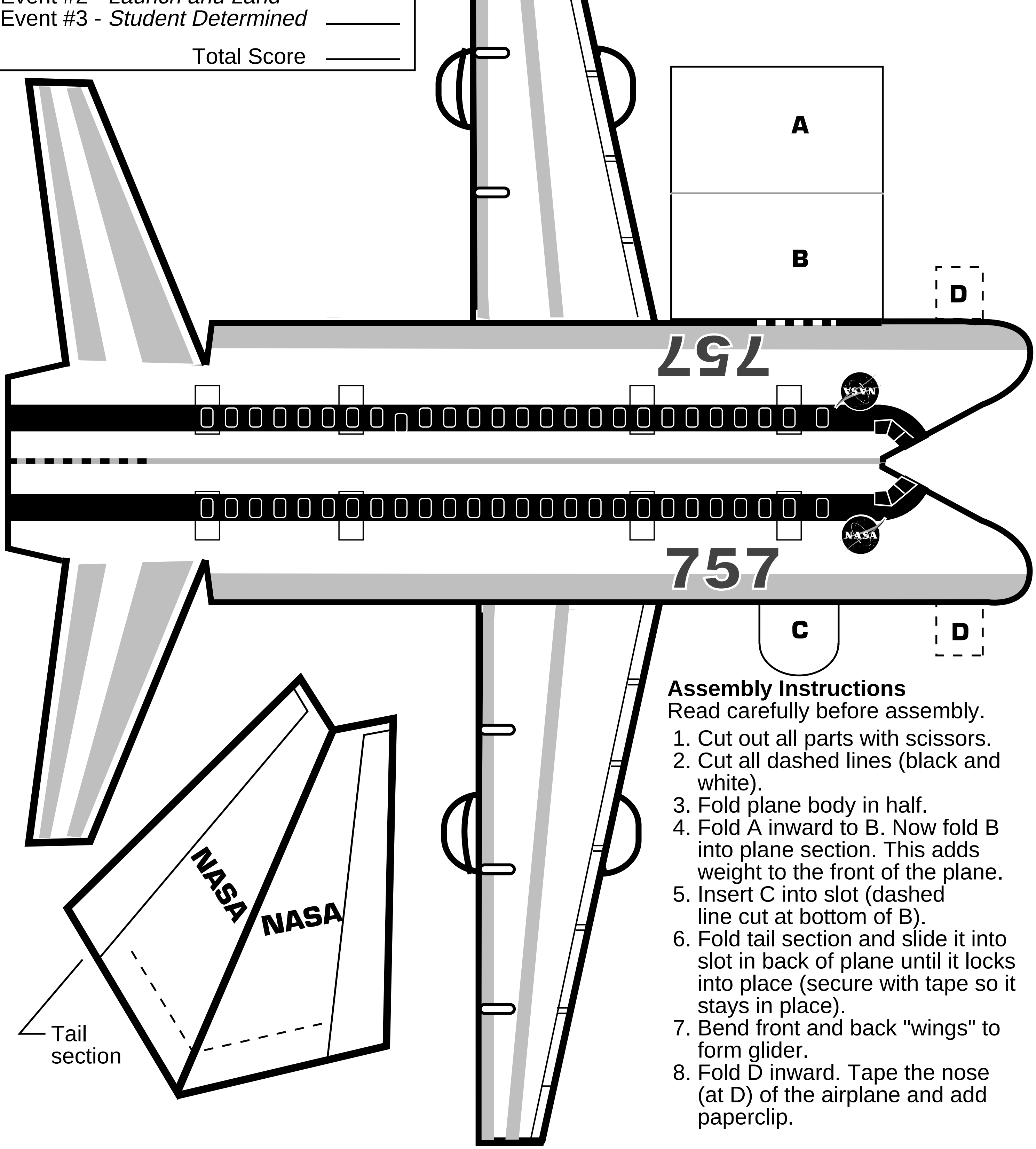

Assembly Instructions

Read carefully before assembly.

1. Cut out all parts with scissors.
2. Cut all dashed lines (black and white).
3. Fold plane body in half.
4. Fold A inward to B. Now fold B into plane section. This adds weight to the front of the plane.
5. Insert C into slot (dashed line cut at bottom of B).
6. Fold tail section and slide it into slot in back of plane until it locks into place (secure with tape so it stays in place).
7. Bend front and back "wings" to form glider.
8. Fold D inward. Tape the nose (at D) of the airplane and add paperclip.

YOU ARE NOW READY TO FLY YOUR 757!