



Wright Brothers 1903 Flyer

The Wright Brothers' 1903 aircraft was the first heavier-than-air, self-propelled, maneuverable, piloted aircraft. It was, in short, the first airplane.

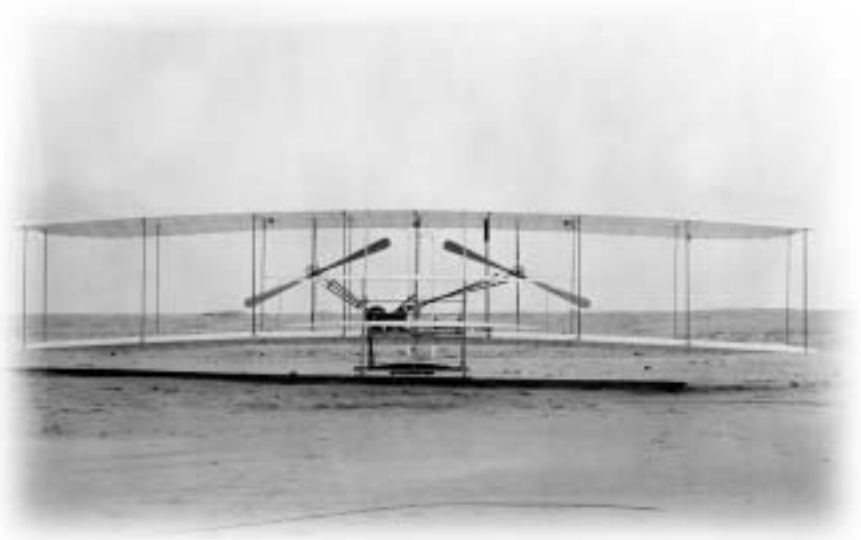
The forces acting on this aircraft were identical to the forces that act on any modern aircraft. The various parts of the aircraft were designed and perfected by 3 years of flight testing of unpowered kites and gliders and from wind tunnel testing. The Wrights used a moving elevator at the front of the aircraft to control pitch (an up or down movement of the nose). From the glider flights of 1901, the brothers identified the need for a rudder at the rear of the aircraft to control yaw (a side-to-side movement of the nose) and to allow coordinated turns. Control of roll (an up-and-down movement of the wing tips) was provided by wing-warping, which meant twisting the wing tips to increase or decrease lift on the outer sections of the wing.

The brothers began large-scale testing of their ideas with a combination kite and glider in 1900. The ideas tested on this aircraft were further refined on the glider of 1901, verified by the Wrights' wind tunnel data, and finally confirmed on the very successful 1902 Glider.

The 1903 aircraft (shown below) was similar to the 1902 craft, but now with a longer 40-foot wingspan, a 6-foot chord, 5 feet between the wings, and twin rudders and elevators. The biggest difference between the 1902 and 1903 aircraft was the addition of the propulsion system. The 1903 aircraft used twin pusher propellers located behind the wings. They were made to rotate in opposite directions, so that the rotational forces would cancel each other out. The Wright Brothers used gasoline to turn the propellers. Since no one could provide them with a lightweight motor of adequate horsepower, they built their own 4-cylinder, 12-horsepower motor. To put this into perspective, the motor of a modern lawn mower can easily achieve 6 horsepower.

The motor was placed on the lower wing next to the pilot and connected to the propellers with bicycle chains. A small gasoline tank was mounted on one of the wing struts. With the pilot and motor, the 1903 craft weighed a little over 700 pounds. This aircraft was first successfully flown on December 17, 1903, at Kitty Hawk, NC, on four flights from about 100 to over 800 feet.

Each of the four flights was marked by an instability in pitch; the nose, and consequently the entire aircraft, would slowly bounce up and down. On the last flight, hard contact with the ground broke the front elevator support, damaged the engine, and ended the season's flying. The brothers were encouraged, but realized that there was still more work to do before a truly operational aircraft could be developed. They continued to perfect their design through 1904 and 1905.





Wright Brothers 1903 Flyer Model Instructions

Designed by

Roger Storm, NASA Glenn Research Center

Materials

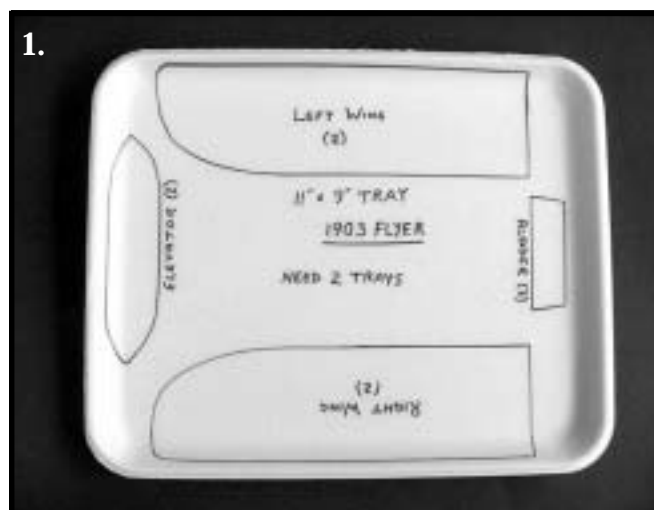
- Two to three clean Styrofoam meat trays, at least 9 inches (23 centimeters) by 11 inches (28 centimeters), preferably white
- 40 to 50 toothpicks
- 30-inch piece of 1/8- by 1/8-inch (.3 centimeter) piece of balsa wood
- Two craft sticks or wooden ice cream sticks
- Low-temperature glue gun
- Scissors
- Hobby knife, razor utility knife, or single-edge razor blade (adult help here)
- Cardboard or board to cut on
- Ultrafine-tip black marker
- Ruler
- Emery board
- Manila file folder
- Clear plastic sheet, such as a transparency sheet for an overhead projector
- Small plastic toy army soldiers, about 2 inches (5 centimeters) tall (optional)

General Instructions

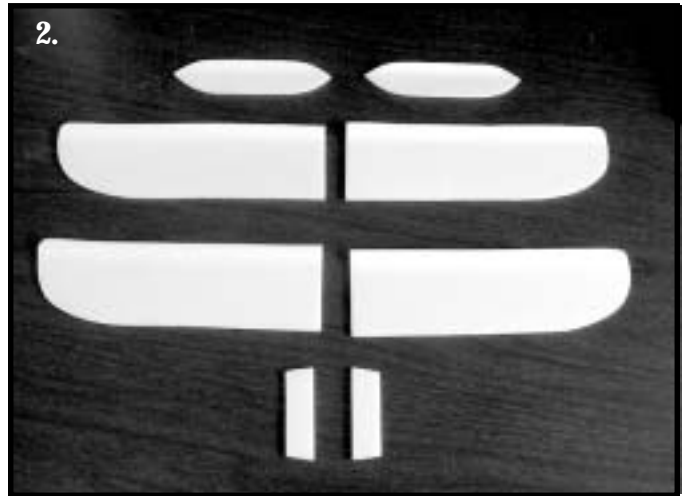
- Use scissors to cut out all three templates on the heavy lines of the 1903 Flyer template (found in the back of this book).
- Do all hobby knife or razor blade cutting on the board or cardboard to protect your working surface.
- The finished model is for display only; it is not meant to fly.

Procedure

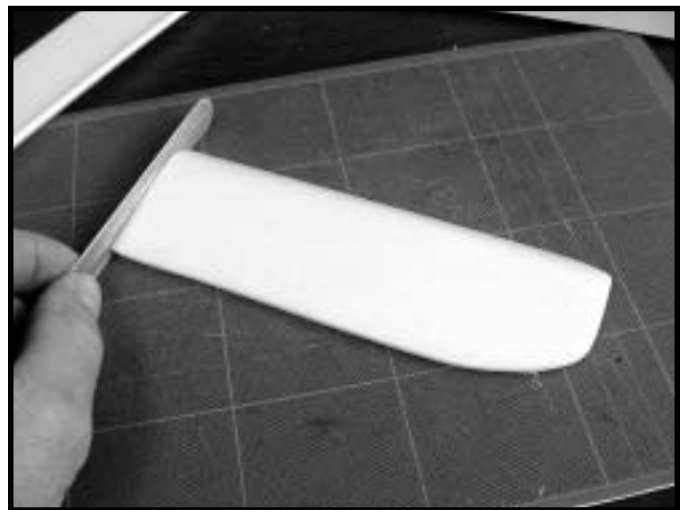
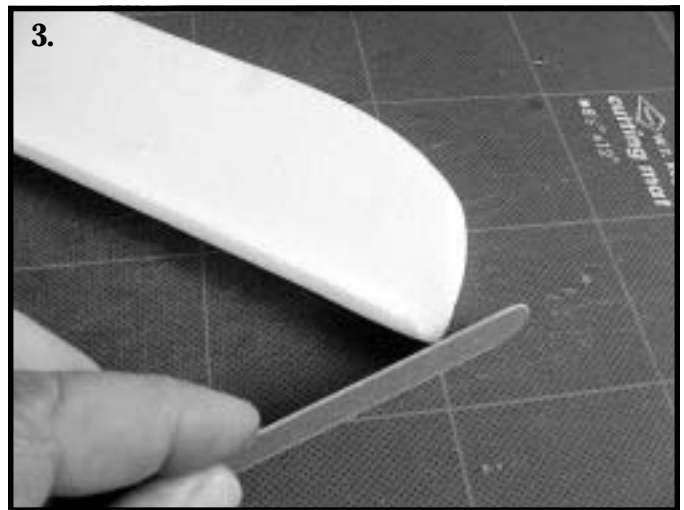
1. Carefully trace the wing and elevator shapes on the inside of the two Styrofoam trays as shown. Be sure the front edges of the wings go about two-thirds of the way up the curved sides of the tray. Check the bottom of the tray and avoid any logo found there. Cut out the wings and elevator with the hobby knife or scissors. Use the emery board to smooth the cut edges and sand off the pen lines.



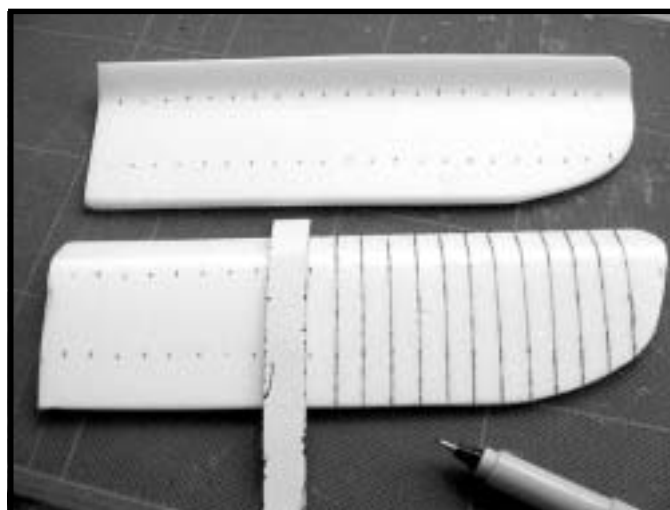
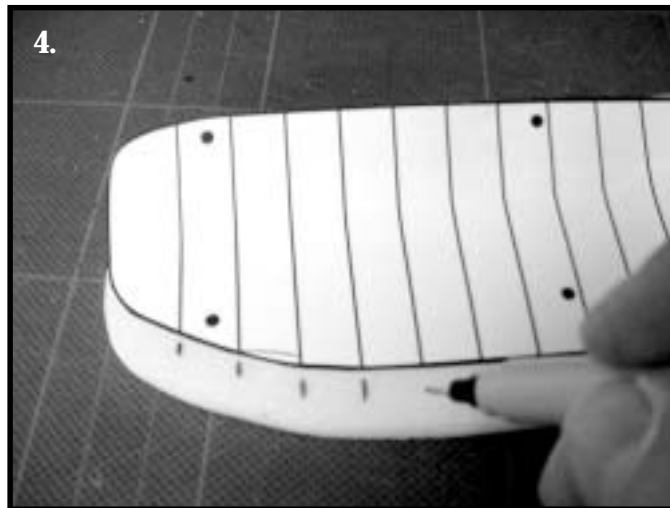
2. When finished you should have these parts, as shown.



3. Using the emery board, make sure that the two halves of the upper and lower wings are flat where they will be joined, as shown at the lower right.



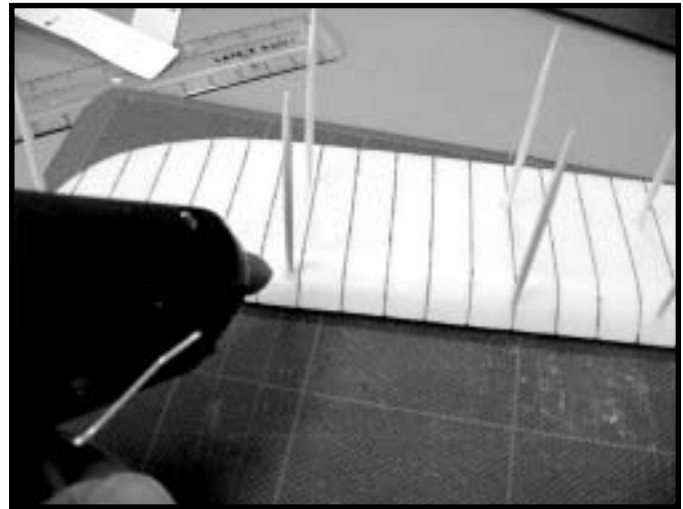
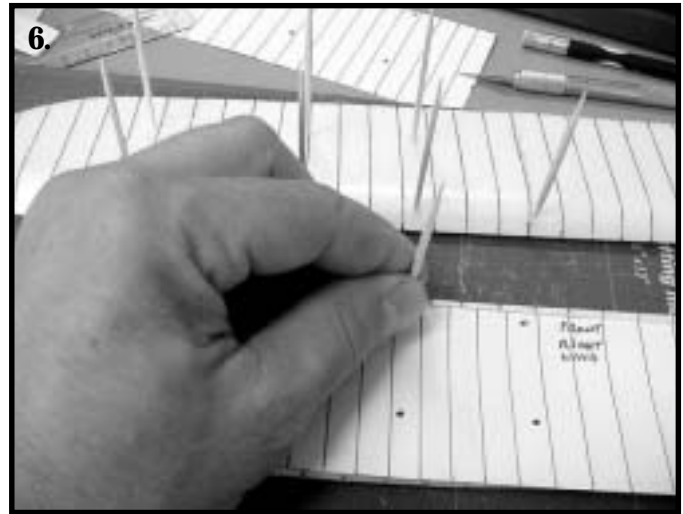
4. Using the templates as a guide, mark the locations of the rib lines on the tops and bottoms of the wind and elevator sections with the ultra-fine tip black marker. Make two sets of marks, one on each edge. Connect the marks to make the rib lines. Make a rib template from a manila folder to draw the rib lines (so the end of the template can be bent to conform to the rounded shape of the Styrofoam).



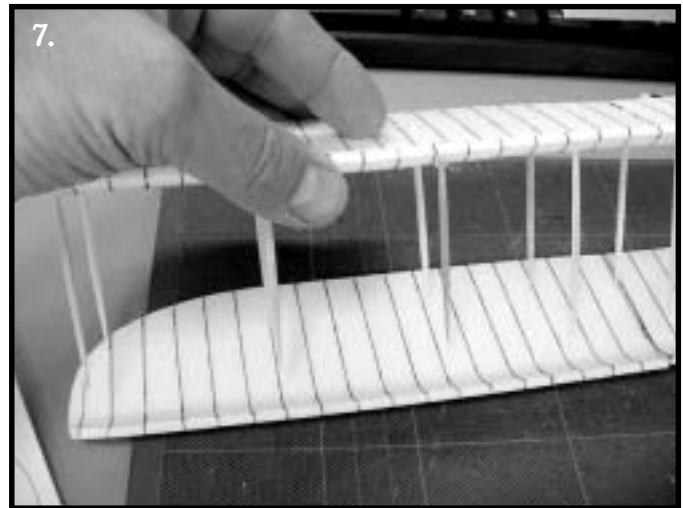
5. Place glue on the flat edge of the upper and lower wing halves and join each wing as shown.



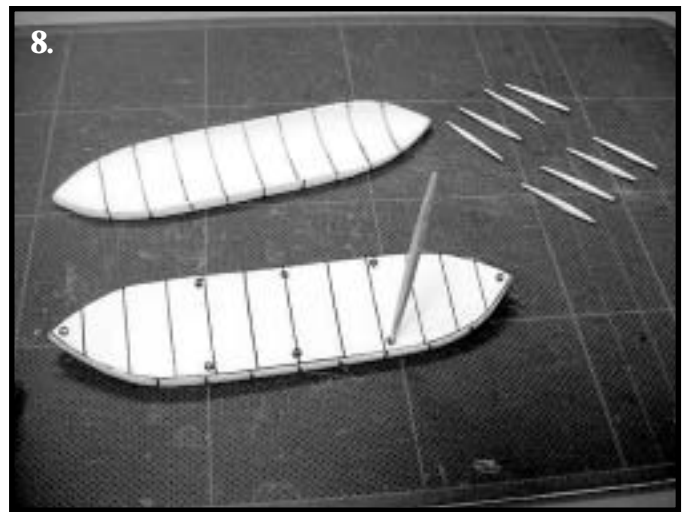
6. Use the wing template and a sharp toothpick to mark the holes for the spars on the top surface of the lower wing. Note that the front edges of the wings curve down. Dip toothpicks into glue and set them upright in the lower wing. Try not to push them all the way through the wing. Be sure they are straight and let them dry.



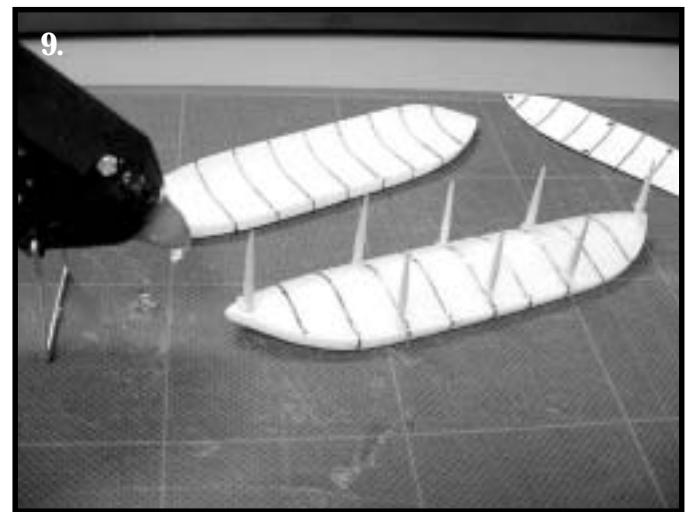
7. Now turn the lower wing upside down and insert the spars into the underside of the upper wing, doing the back row (away from the curved edge) first. Be sure each is vertical and add a little glue to hold each in place. Now tip the wing forward and insert the front row of spars, working from one end to the other. Again, try not to push them all the way through the wing. It takes some effort to get each in the right place and vertical. Add a dab of glue at the top of each spar to help secure it to the upper wing.



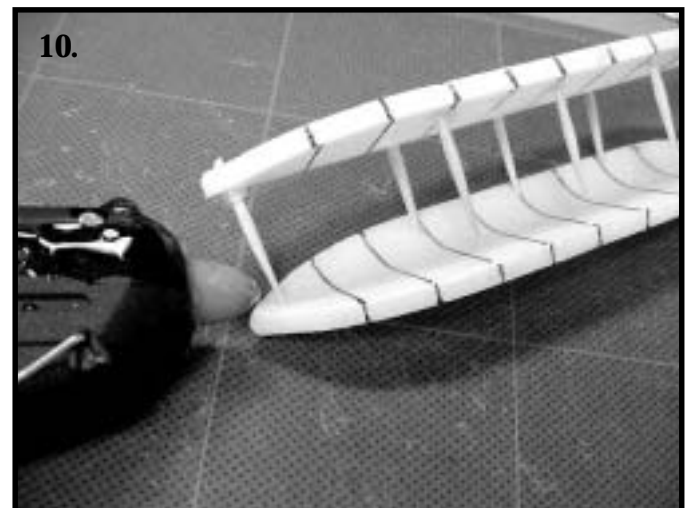
8. For spars for the elevator, cut eight toothpick sections, each 1 inch (2.5 centimeters) in length, and sharpen the cut ends. Mark the locations for these spars on the upper surface of the lower elevator using the template, just as you did with the wings.



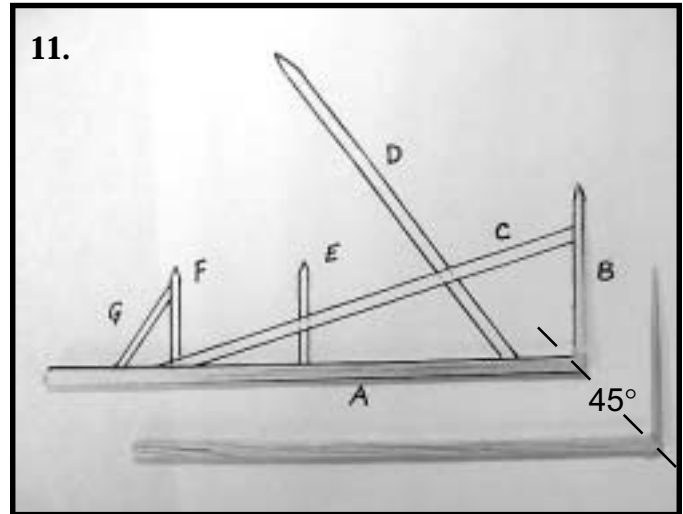
9. Set the eight short spars into the top surface of the lower elevator and add a bit of glue to each at the base, as shown.



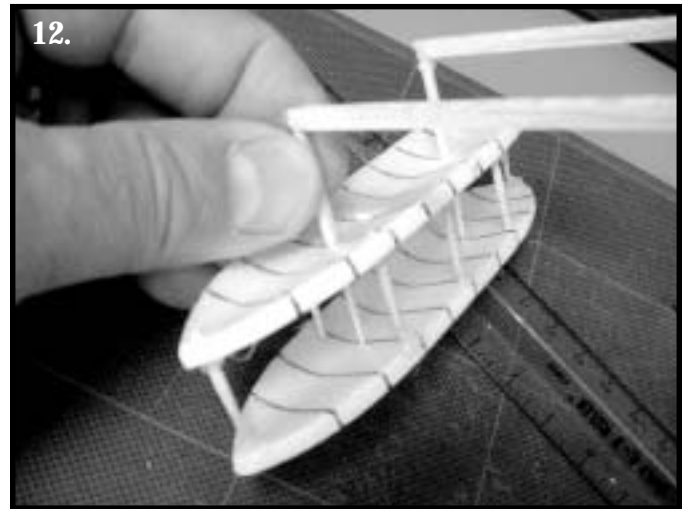
10. Turn the lower elevator assembly over and insert the spars into the underside of the upper elevator, doing the back row first and then the front, trying not to go all the way through the Styrofoam. Anchor with glue.



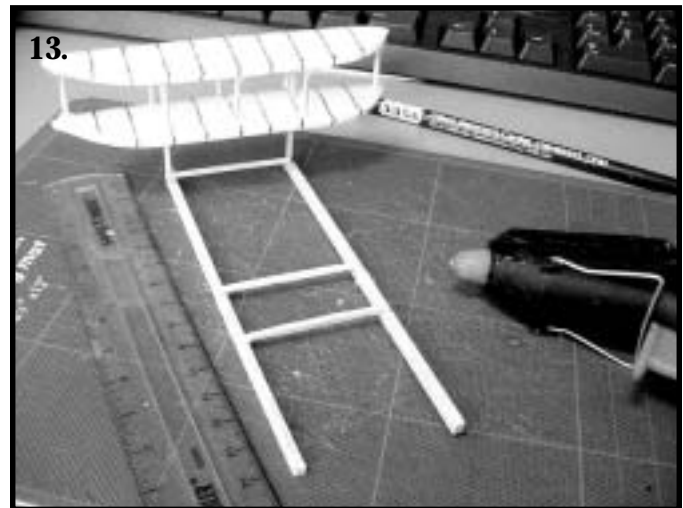
11. Cut a 5.5-inch (14-centimeter) piece of the balsa wood for section A of the skid (from the skid template) and lay it on the template. Cut the right end to form a 45-degree angle at the very end. Cut a toothpick for section B to a length of 1.8 inches (4.5 centimeters), also cutting the end of it at a 45-degree angle. Glue the 45-degree ends of the toothpick and the balsa wood piece together to form a 90-degree angle, as shown. Make a second skid by repeating the process.



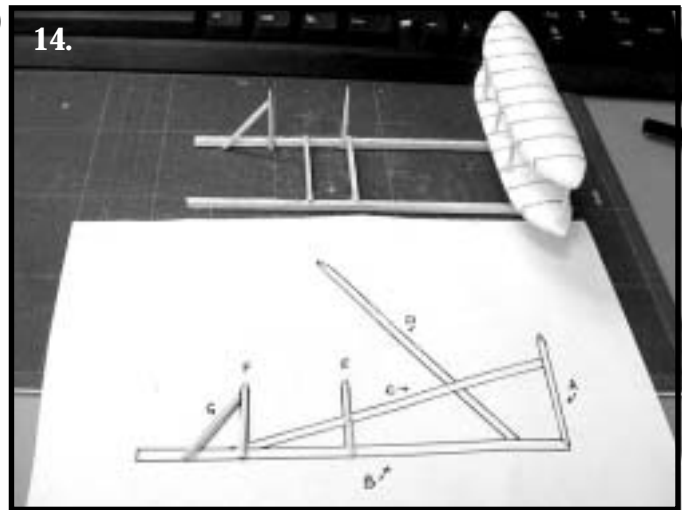
12. Turn the elevator assembly over and poke two holes through the lower elevator, midway between the front and rear spars of each of the spar pairs that are next to the center pair of spars (near the third rib mark from either end). Push the top of the skid assembly through the hole just made, add a bit of glue, and then stick the skid into the upper elevator. Repeat with the second skid as shown.



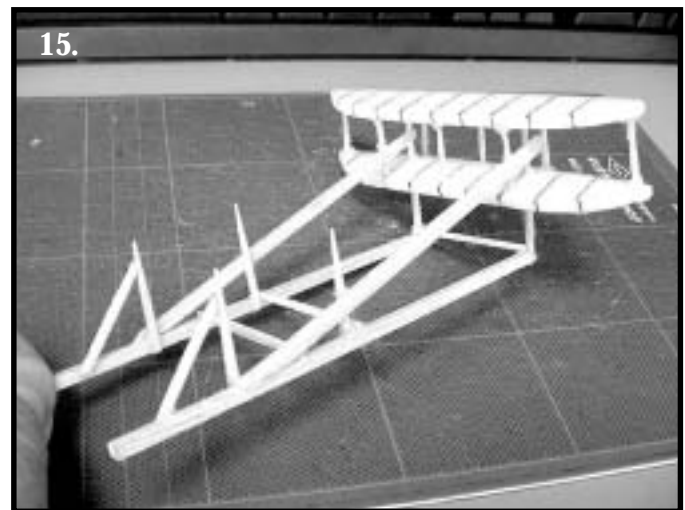
13. Cut the pointed ends off of three toothpicks so that they are 1.8 inches (4.5 centimeters) in length and place them as cross-braces across the skids as shown, one at the right angle of the skid, one at 2.8 inches (7 centimeters) from the right angle, and one at 3.5 inches (9 centimeters).



14. Cut two toothpicks to a 1.2-inch (3-centimeter) length. Glue them to the skid as shown on the template at points E and F, pointed ends up. Now measure and cut another toothpick as the rear brace (section G) and glue it in place. Repeat for the second skid.



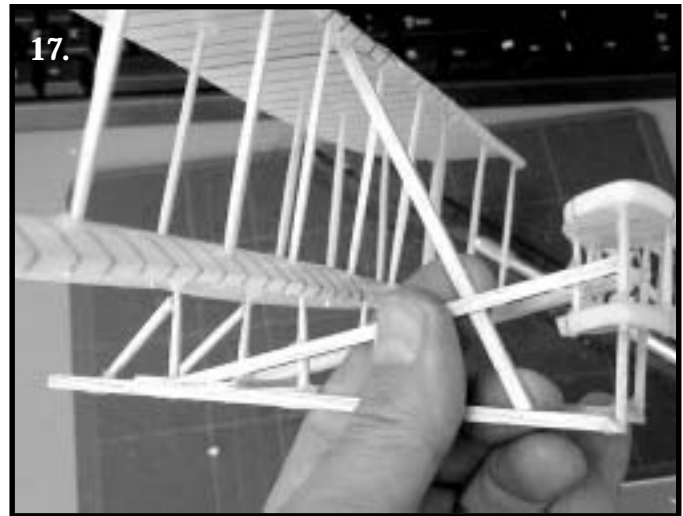
15. Now cut two balsa braces (section C) to go from the rear skid support up to the elevator support. Glue them in place as shown.



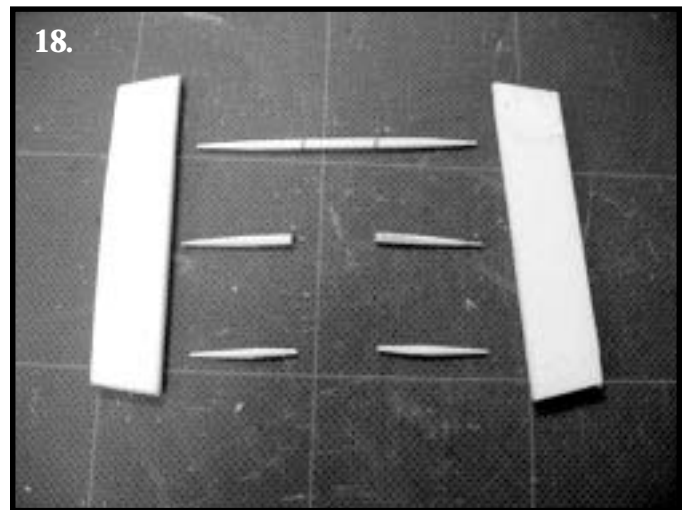
16. Turn the wing assembly over and press the skid assembly into the center of the lower wing as shown. Be sure the elevator projects out from the curved edge of the wing. Try to keep the toothpicks from going through the Styrofoam. Add some glue to each support.



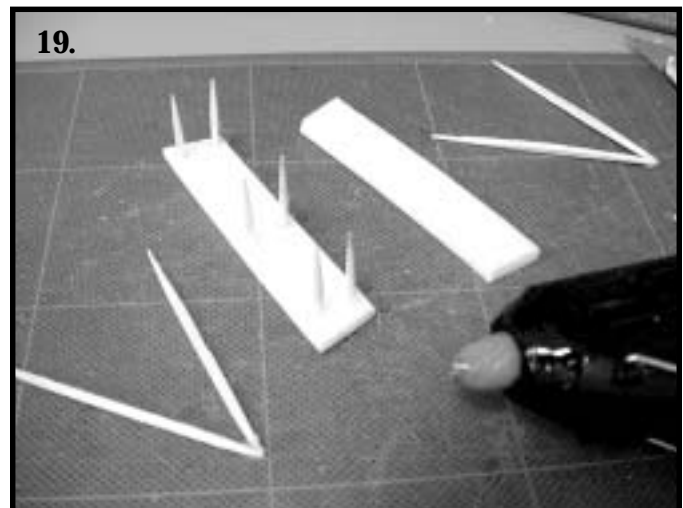
17. Cut two 4-inch (10-centimeter) pieces of balsa for section D and sharpen one end of each. Glue one end under the leading edge of the upper wing between the center and next-to-center spar, and then glue the other end to the bottom skid. Repeat on the other side of the skid.



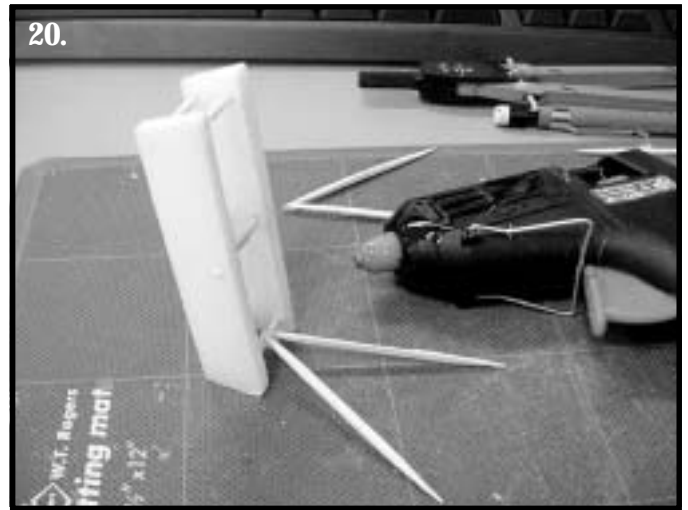
18. Six .8-inch (2-centimeter) rudder braces are needed. Cut them from three toothpicks as shown and sharpen the cut ends.



19. Dip the braces in glue, insert them into the rudder as shown here, and then turn the assembly over and insert the braces into the other rudder. Add more glue for support. To attach the rudder to the flyer, make two sets of V-shaped braces by gluing together two toothpicks as shown. The distance between the two legs of the V should be 1.5 inches (3.8 centimeters).



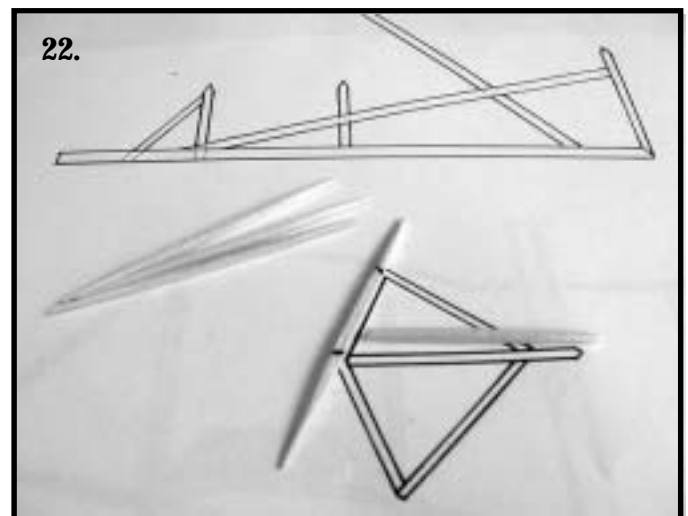
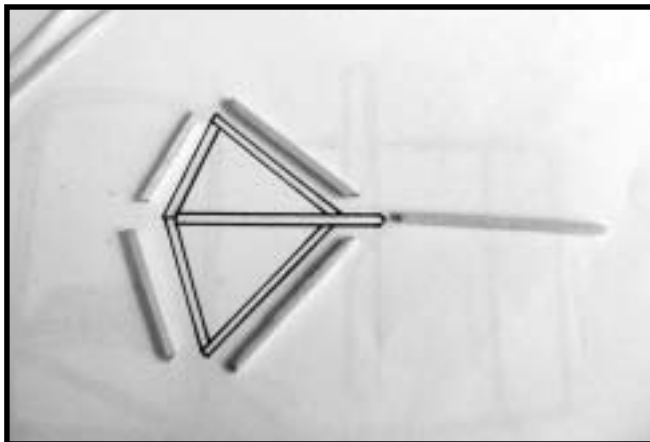
20. Glue the V-shaped braces to the rudders as shown. Once the glue is set, turn the rudder assembly over and glue on the other brace.



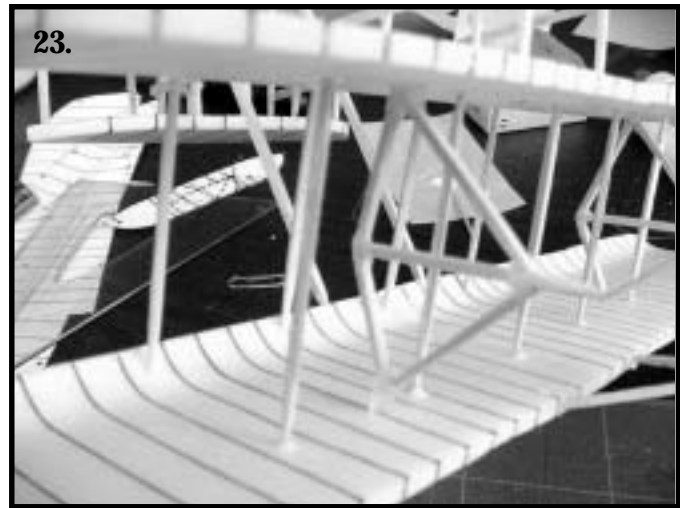
21. Stick the upper brace ends into the rear edge of the upper wing as shown and add a spot of glue. (If the wing is thin, glue the brace under the wing.) Now glue the ends of the lower brace to the rear of the skid so that the rudder is vertical.



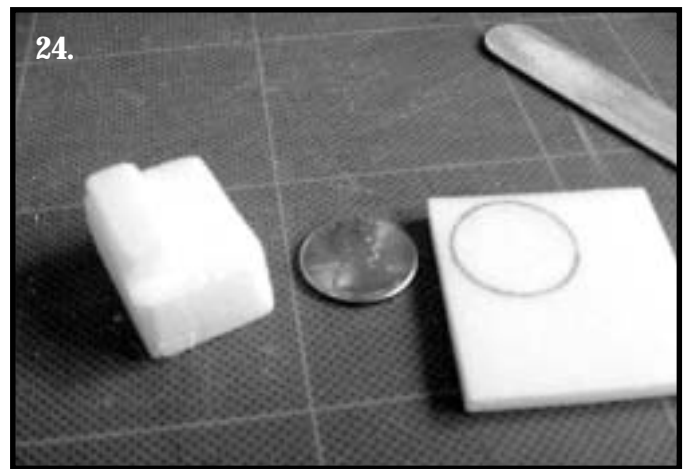
22. To make the propeller supports, use the template to mark and cut five toothpicks for each. Try to keep the assembly flat as it is glued.



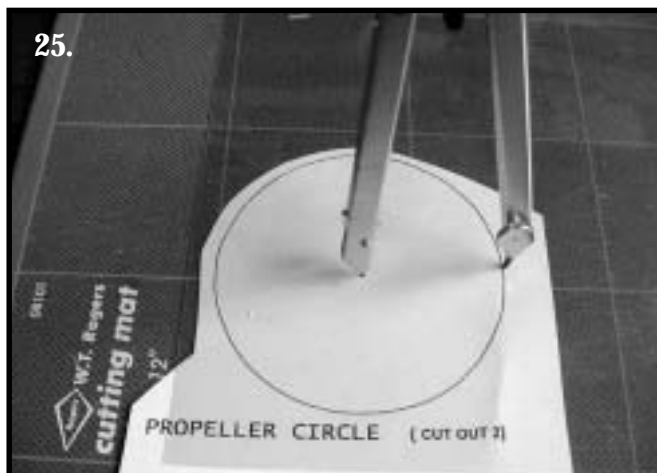
23. When dry, glue each propeller support to the lower wing 2.2 inches (5.5 centimeters) from the center, in line with the back struts. Turn the flyer over and glue to the top wing so that the support is vertical. Extra glue may be added to fill in any gap.

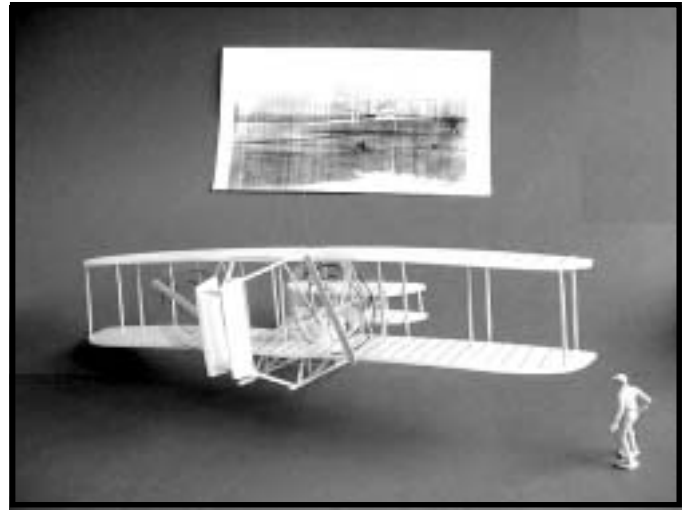
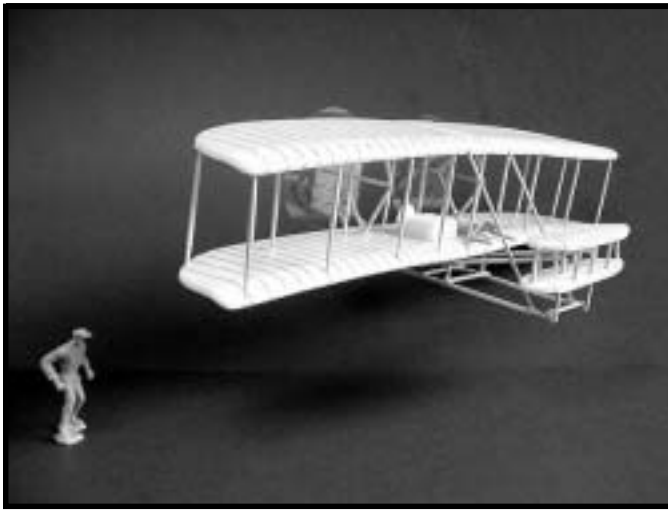


24. Simulate the small engine by gluing two .8- by 1.2-inch (2- by 3-centimeter) pieces of Styrofoam together and then adding a .4- by 1.2-inch (1- by 3-centimeter) piece on top. Trace and cut a circle with a penny or dime, cut out, and then glue on the end of the engine. Glue the engine onto the lower wing just to the right of center.



25. To simulate a turning propeller, trace and cut two 2.8-inch (7.2-centimeter) circles out of stiff clear plastic, such as a piece of a blank transparency sheet for an overhead projector. Draw pieces of smaller circles on the plastic circle with the black marker. Make a small hole in the very center of each circle with a toothpick. Make a propeller blade from a thin craft stick or wooden ice cream stick by cutting a piece the diameter of the plastic circle, rounding the cut edge, and poking a hole in the center. Mount the plastic circle and then the propeller blade on the end of the propeller support and add glue. Make another propeller sheet and blade for the other side.





26. (Optional) You can make the figures of Wilbur and Orville Wright by swapping and gluing parts of plastic army soldiers. To obtain the desired poses, arms and legs can be removed and some from other soldiers glued in their place. Guns and helmets should be trimmed away using a hobby knife and the figure arms and legs can be shaped, swapped, or repositioned to fit and glued on. Five-minute epoxy works best for this. The picture to the right shows how to make a pilot to lay on the wing. The original soldiers on the left were transformed into the figures of Wilbur and Orville Wright on the right.

