

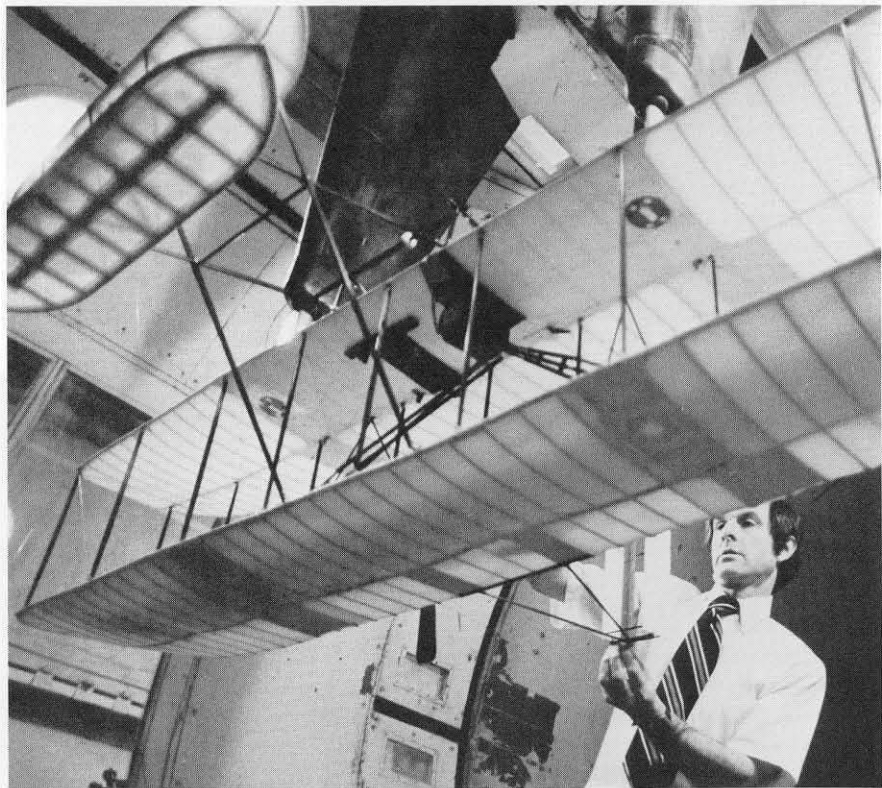
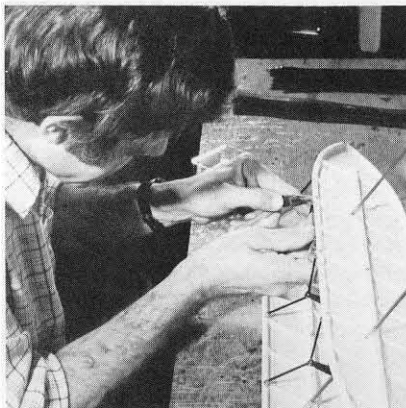
# The Wright Way to Fly

THE Wright brothers' 1903 success, which launched the aviation age, derived largely from their careful attention to the experimental, as well as the theoretical, details of aircraft control. And it was in part their own great desire to fly that inspired Orville and Wilbur Wright to such care. Flying it yourself is an extra incentive to doing it right.

Sometime in the summer of 1983 Fred Culick, professor of applied physics and jet propulsion, will take off in a replica of the 1903 Wright "Flyer," built by the Los Angeles section of the American Institute of Aeronautics and Astronautics. It too, we can be sure, will be done right.

Culick is a private pilot and has long been interested in the history of aircraft, in addition to his research in fluid mechanics, solid propellant rocketry, lasers, and applied aerodynamics. And he's an active member of the AIAA. A group of Los Angeles members conceived the Wright Flyer project in 1978 to replace its replica built in 1953 for the 50th anniversary of the historic flight at Kitty Hawk. That one was destroyed in the 1978 fire at the San Diego Aerospace Museum. (The original 1903 plane, after flying a total of 98 seconds in its career, now resides at the Smithsonian Institution.) With the insurance from the fire, the local section of AIAA decided to try again. But this time it would go itself one better and make not only an exact replica, but one that would really fly. Besides being a lot of fun, the project would demand a thorough study of the aerodynamic principles and engineering innovations the Wrights worked out and promote a truer appreciation of the scale of their achievement.

Along with a hands-on experience of their genius, the project has already stimulated respect for the Wright brothers' nerves. Although the 1903 Flyer repre-



*Fred Culick assembles the canard (above, left) and a wing (right) of a 1/6-scale model of the Wright brothers' "Flyer." In the lower picture he readies the finished model for tests in Caltech's 10-foot wind tunnel.*

sented the peak of aeronautic technology at that time (and not paralleled by anyone else for several years thereafter), flying it was still an exceedingly dangerous thing to do. This was dramatically demonstrated by Culick's 1/6-scale model, which he tested in the GALCIT 10-foot wind tunnel in December 1979, in the project's early stages. Culick built the model himself with some help from Caltech's machine shop and a small grant from NASA. The model was very similar to the original plane, constructed of spruce and plywood, covered with doped fabric, and with external structural members of aluminum and steel. The propellers were driven by a 1/25 horsepower electric motor.

Wind tunnel data, the first such data obtained on the original Flyer, convinced Culick that "there is no possibility of making that configuration fly as a stable machine." And since Culick and the other pilots have little desire to risk their necks to re-experience *all* the aspects of the Wright brothers' achievement, the replica will have some subtle modifications and "design assistance" from subsequent aeronautic knowledge. The challenge will be to make it stable with as minimal (and invisible) changes as possible. The modern emphasis on safety won't detract from the triumph of the first man-carrying, powered flight on December 17, 1903, and the years of scientific research that led up to it.

Culick's own interest in the Wright brothers was aroused when he saw the AIAA's first replica in the San Diego Museum not long before the fire. He began to wonder just why they built it the way they did, and he is now considered an authority on their work and on early aeronautics generally. His study of their letters and diaries has firmly discredited the myth that Orville and Wilbur Wright were simple bicycle mechanics who just happened onto inventing the airplane. They were serious scientists, theorists as well as experimenters, who were years ahead of anyone else in aeronautics.

They began experimenting in earnest in 1899, working out their ideas first in gliders flown free and restrained as kites on the North Carolina coast, where winds were favorable at the time of year they could get away from their Dayton, Ohio, shop. The Wright brothers were well acquainted with the prevailing theories of the time; their own research, however — measurement of lift and drag with their gliders and in their own wind tunnel — led them to reject a number of these

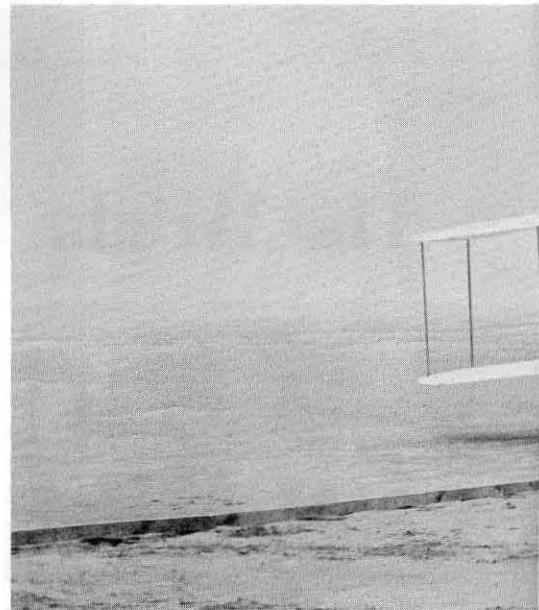
theories and to embark on some radically different innovations. For example, they did not accept as final the then popular solution of dihedral (wing tips slanted upward) to the problem of lateral stability. Wilbur Wright's observations of buzzards who regained their balance in flight by a torsion of their wing tips led to the invention of wing warping used in all their gliders and in the 1903 Flyer. The predecessor of ailerons in modern aircraft, wing warping not only enabled the Wrights to stabilize the plane in a straight path but also to turn it. They controlled the flexing of the wings, which actually drooped downward rather than upward, by wires attached to a hip cradle (to leave the pilot's hands free).

Previously the tail had been considered the means of steering a plane, like the rudder of a boat. But a plane turns by rotating around its longitudinal axis, which the Wrights accomplished by wing warping. The Flyer's double vertical tail moved only when the wings were flexed, and its true function was its contribution to control of yawing motions about the aircraft's vertical axis.

The oddest feature of the 1903 airplane, and one that ultimately did not survive, was the forward horizontal surface called a canard. This configuration contributed to longitudinal stability, and, although it later proved to work better aft of the wing, the forward position enabled the pilot to see it in the event something went wrong — a decided advantage in 1903. Previous fatal accidents with a rear horizontal surface were a persuasive argument for the front position.

The Wrights designed and built their own 15-horsepower engine, since none could be obtained to their specifications from commercial sources. They also had to design and build their propellers and in the process developed the basis of modern propeller theory, which is credited to others since they never published their work. In this, as in all stages of the Flyer, the Wrights were a complete research, development, and manufacturing team in themselves.

The 50 or so volunteers (Culick was one of the first) in the modern Flyer project are a somewhat larger team but are also learning by doing every step themselves. They are divided into teams for the various technical tasks — aerodynamics and control, propulsion, construction, structures, and testing. In addition to being the first pilot, Culick is also the chief project engineer and coordinates all the technical work. Howard Marx of

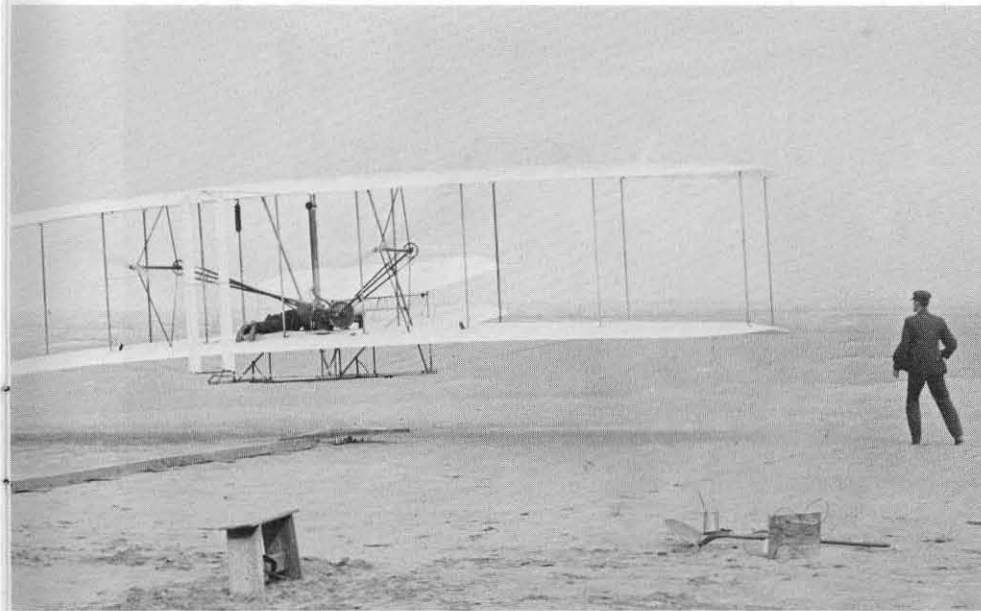


Northrop Corporation originated the whole Flyer idea and was the first project manager, a position now held by Jack Cherne of TRW Inc. Roger Schaufele (MS '52) of McDonnell Douglas Corporation, chairman of the program's advisory board, is one of several Caltech graduates involved.

Bits and pieces of the plane have been built in members' living rooms and garages over the past year, and it is now being assembled in a corner of a Northrop factory in Los Angeles, to be finished by early summer. Actually, two full-size replicas of the Wright plane will be made; the first one, which will be an exact copy externally, will not fly but will be tested in a full-scale wind tunnel. The results will be compared with the analysis of data from the 1/6-scale model. Only the functioning Flyer will need modifications for safety, stability, and structural soundness.

Some of the aerodynamic modifications are ones the Wrights themselves employed in later planes. For example, the canard, the front horizontal surface, will be slightly larger and a bit farther forward. The most important change will be in the shape of the wing section. The airfoil of the 1903 plane was highly cambered, even though the camber had already been reduced from that of earlier wings after the Wrights' discovery in testing that too much curve in the airfoil caused the aircraft to pitch. The replica's wings will have the camber cut down still further, and the trailing edge will turn up slightly, making a much more stable configuration.

A 35-horsepower "Revmaster" engine (a Volkswagen engine modified for air-



*At the left, with Orville Wright as pilot and Wilbur running alongside, the Flyer makes one of four flights on December 17, 1903. The flight covered 120 feet at an average speed of 7 miles per hour over the ground.*

*Below, Harlan "Bud" Gurney (left), a veteran of barnstorming days with Lindbergh in the 1920s and now a retired United Airlines pilot, heads construction of the full-size Flyer replica. Here he holds the finished canard framework with Koonwah Lim, retired from McDonnell Douglas.*

*Bottom, an aft view of the 1/16-scale model in the wind tunnel illustrates wing warping, invented by the Wrights to turn the plane. A system of wires flexes the outer trailing edges of the wings upward on the left and downward on the right.*

craft) will power the modern Flyer, and wing warping will be controlled with a stick instead of a hip cradle. Design engineers are creating a welded steel tube structure to protect the pilot in hard landings; the plane may or may not have a supplementary wheeled landing gear added. Fittings for struts and skids will be designed to improve structural integrity, and more durable synthetic fabric will replace the original cotton.

But when Culick takes off in the reincarnated Flyer, these changes will be invisible to all but the most knowledgeable. The flight will be the culmination of the five-year undertaking, and the large crew of workers on the project (not least the pilot) will be eager to see if the replica works. But the real accomplishment lies in the re-creation itself — the actual documentation of a piece of technical history.

□ -J.D.

