When Charles Lindbergh and the Spirit of St. Louis completed the first nonstop flight from New York to Paris in 1927, it became the most heralded flight in history. The hearts and minds of the world were captured as reports of a successful flight inspired a new age of aviation (Fig 1). Yet, only three months earlier, the aircraft had been only a dream. It may have remained so, if not for Ryan Airlines and a design engineer named Donald A. Hall.

The proposed plane had been named the Spirit of St. Louis, the pilot was to be Charles A. Lindbergh, and sufficient funds had been raised. The only thing missing was the airplane itself. A manufacturer was to be chosen from those who responded to a telegram listing specifications, with the added stipulation that the plane must be finished in sixty days. However, one by one, each replied, and it quickly became clear that no one was willing to accept the risk of this flight. Eventually, one company was found willing to accept such a huge risk: Ryan Airlines.

Ryan Airlines

In San Diego, a young Benjamin F. Mahoney had just purchased the remaining portion of his partner’s share in Ryan Airlines, a small aircraft manufacturing company. From its beginning, the company had ferried passengers between Los Angeles and San Diego, along with constructing aircraft for regular airmail services along the California coast. A shrewd businessman, Mahoney was convinced that aviation had huge potential for profit and expansion.

In January 1927, he hired a young design engineer by the name of Donald A. Hall from Douglas Aircraft in Santa Monica. Hall had graduated from the Pratt Institute in New York City, and began his career as a junior draftsman with Curtiss Aircraft in 1919. He demonstrated a strong talent for design, and moved to other aircraft companies over the next several years, each time winning positions of greater responsibility. However, he realized that the experience of a pilot would be invaluable in aircraft design, so he enrolled in the Army Air Corps fighter training school at Brooks Field, Texas, in 1926. There he learned the critical lessons about aircraft from a pilot’s perspective, as opposed to just an engineer’s. On February 3, 1927, three days after Hall joined Ryan Airlines as their Chief Engineer, the telegram arrived from St. Louis.

The Orteig prize

In 1919, New York hotel owner Raymond Orteig had offered a prize of $25,000 for the first person to fly nonstop across the Atlantic from New York to Paris. Charles Lindbergh, a mail pilot and barnstormer in St. Louis, had been pioneering airmail routes across the country. Practical and hardworking, he had saved his money, dreaming of how aviation could grow, and what that future would be. Not content to only dream, Lindbergh decided to try for the Orteig prize, and somehow convinced nine St. Louis businessmen to support him. They agreed to provide him with $15,000. The next step was finding an airplane that could make it across the ocean.

A new design

"After intensive preliminary design analyses of aerodynamics, structures, and weights of various configurations of the proposed airplane, it was concluded that a redesign of the production model three-seater, open-cockpit, Ryan M-2 could not make the 3600 mile flight between New York and Paris with ample reserve fuel, and that a new design development was necessary." Donald A. Hall, Sr., 1953.

With these words, Donald Hall committed to the design
of a new aircraft, designed for a single purpose and a single flight: the Ryan NYP, “New York to Paris,” with a range of 4000 miles. However, he would incorporate as much as possible of the proven designs of the Ryan M-2 model.

When Lindbergh arrived at the factory, the proposed plane was still nothing more than a concept. Lindbergh specified that a Wright Whirlwind J-5C engine and an Earth Inductor Compass would be required. Beyond that, he insisted that the most important factor was efficiency in flight, followed by safety in a crash landing, and then the comfort of the pilot. However, much of the aircraft had yet to be designed. Furthermore, the new requirements made it clear that the final model would have little in common with the Ryan M-2.

During the following three days, Hall developed a new design based on Lindbergh’s specific requirements. These constraints were the starting point, and Hall worked backwards from Lindbergh’s vision to a design they both approved. Since delivery had to be within 60 days from construction beginning on the 28th of February, Hall could not incorporate major design features that had not been already well proven in actual service.

A unique cockpit

Hall and Lindbergh agreed that the cockpit would be placed behind the fuel tanks for safety, and that it would be enclosed within the fuselage for streamlining and added efficiency. This allowed the nearly 425 gallons of fuel to be placed over the plane’s center of gravity. However, this placement also eliminated all forward visibility, and forced the pilot to fly the majority of the flight by instruments alone, relying mainly on his principle navigational tool, the Earth Inductor Compass. This complete blindness was mitigated somewhat by the addition of two windows on the left and right sides of the cockpit. In addition, a periscope was installed to aid visibility during the early stages of the flight.

Wing construction

Hall had already determined that the wing (319 sq. ft.) needed to be lengthened to 46 ft. for good takeoff characteristics and improved range. The wing chord did not have to be changed (7 ft.), and this allowed the M-2 wing rib (Clark-Y airfoil) to be incorporated. However, all other parts in the wing had to be newly designed because of the higher structural load. The larger wing also meant that the tail had to be moved aft by 24 inches.

In turn, moving the tail changed the location of the center of gravity, and so the engine had to be moved forward by 18 inches.

The I-section spars were made of spruce, comprising four flange members casein-glued to web members. The wood ribs utilized the Warren truss principle. Drag bracing comprised double piano wires, with compression ribs made of reinforced standard ribs with spruce compression members. Relatively small ailerons were located 38 in. inboard of the wing tips, to avoid excessive wing structural loads in the fully loaded condition. The lateral control with these ailerons proved to be ample. The external struts that braced the wing were SAE 1020 mild carbon steel tubes, streamlined with balsa wood.

Fuselage and tail

The final length of the aircraft would be 27 ft. 8 in., and the height would be 9 ft. 10 in. The fuselage was built of SAE 1020 mild carbon steel tubes, welded together to form horizontal and vertical trusses (Fig. 2). In order to carry the heavy fuel and oil load required for the proposed flight, the gross weight was almost double that of the model M-2 weight of 2500 lb. Because of the increase in fuselage structural length, in addition to the increased gross weight, the design eliminated any possibility of using M-2 fuselage parts.

The vertical and horizontal surfaces were made of SAE 1020 mild carbon steel tubes, which formed the structure and ribs. The horizontal stabilizer was adjustable from the cockpit for maintaining longitudinal balance (trim) in flight at any speed or loading condition. Because of time constraints and Lindbergh’s agreement that a slightly unstable plane would aid him during the estimated 40 hours in flight, the M-2 empennage was taken with a minimum of change. It was anticipated that the resulting stability would be ample for the take-off at New York and the flight across the Atlantic, although not for commercial purposes. Ultimately, the design helped Lindbergh remain awake during the 33½ hour flight.

Landing gear

The NYP landing gear design, with its high wheel rise for good shock absorption, was adapted from a suc-
cessful commercial single-engine transport. Its wide tread of 8 ft. 9 in. allowed good ground stability, which was especially important with the longer wing span and doubled gross weight. The split-axle type design used the “trombone” type of shock absorber, which utilized shock absorber cord (bungee cord) of eight individual links in tension to give 6½ in. compression deflection per unit. The dual axles, as well as the tail-skid, were made of chrome molybdenum (SAE 4130) steel tubes heat treated to a strength of 180,000 lb/in², and streamlined with balsa wood.

**Power plant**

The best commercially available engine in 1927 was the Wright Whirlwind J-5C, built by the Wright Aeronautical Corporation of Paterson, N.J. The engine was rated at sea level at 223 BHP (1800 rpm), and maximum power at 237 BHP (1950 rpm). Part of a special series built for the Orteig competitors, it was a “super inspected” nine-cylinder, air-cooled radial engine (Fig. 3). The propeller was made of duralumin, manufactured by the Standard Steel Propeller Co., and was set at 16½ degree pitch.

**Covering and streamlining**

The wing, empennage, fuselage, external struts, axles, and tail-skid were covered in grade-A cotton fabric finished with multiple layers of cellulose acetate dope. This gave the NYP its characteristic silver color.

In relation to standard practices of the period, unusual emphasis was placed on streamlining. As a result, in the lightly loaded condition, the maximum speed possible was about 10 mph higher than the maximum speed of the M-2 with the same engine, while the minimum air speed was about 8 mph lower than that of the M-2. This can be seen in all aspects of the final design, from the airfoil contour to the engine and forward fuselage cowling.

**Materials and fuel system**

The cowling and spinner were made of soft aluminum. The “fish scale” pattern characteristic of all Ryan monoplanes was then added. The fuel and oil tanks were made of terneplate, soft steel, to reduce the danger of leaks developing from vibration. Each of the five fuel tanks was connected to a distribution system in the cockpit, so that fuel could be transferred by hand-pumping from any tank to any other tank. Two independent fuel lines ran from the cockpit distribution system to the engine. In case the engine fuel pump in one line failed, fuel could be hand wobble-pumped from either of the fuselage tanks to one of the wing tanks, whence it could then flow to the engine by gravity.

**Flight instruments**

The Earth Inductor Compass allowed Lindbergh to maintain his great circle route by adjusting the compass every hundred miles. When he passed over the coast of Ireland, he was only five miles off course. This new piece of equipment had a generator powered by the wind (Fig. 4), an indicator in the instrument panel, and a controller dial in the cockpit. The generator and anemometer were mounted on the inside upper portion of the fuselage, just aft of the cockpit.

For more Information: Nova S. Hall is President of Orbital Air Inc., and recently published his book, *Spirit and Creator: The Mysterious Man Behind Lindbergh’s Flight to Paris*. Available in stores nationwide, the book is about his grandfather and the sixty-day construction of the Spirit of St. Louis with over 210 never-before-seen photographs and documents, which were only recently re-discovered after 75 years.