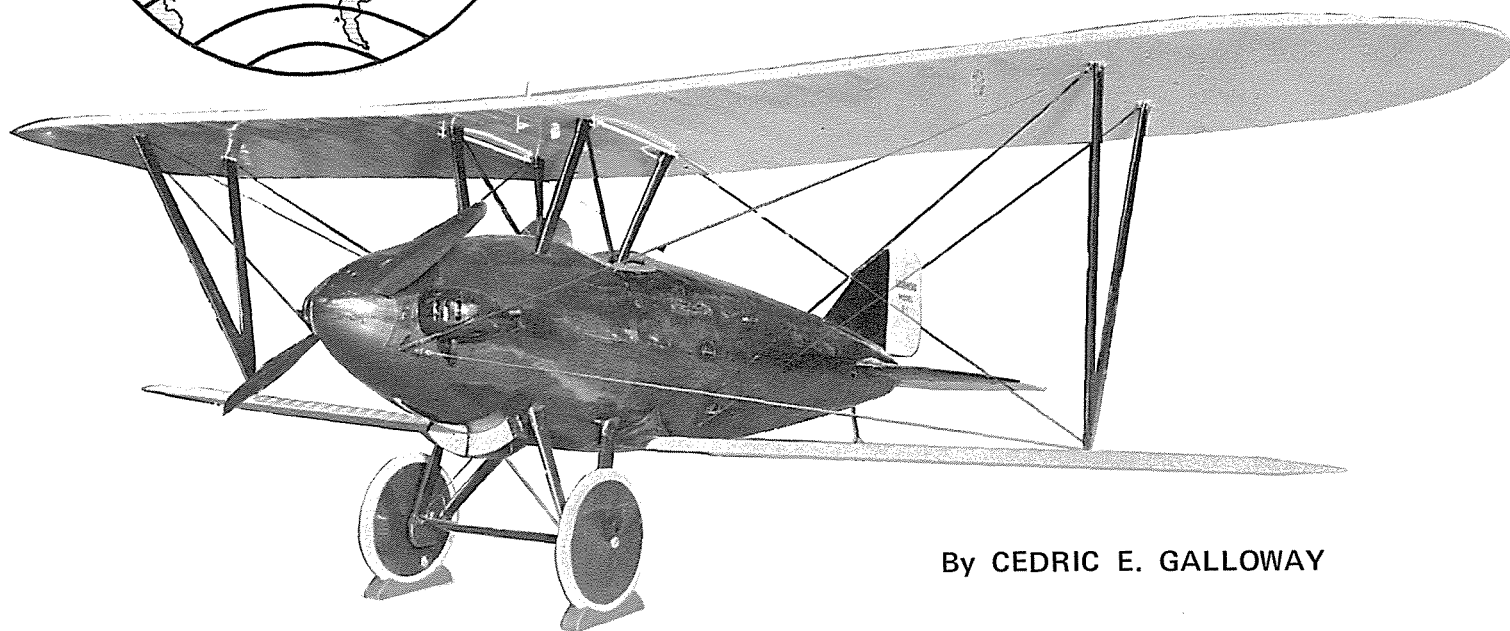




LOUGHEAD

SPORT BIPLANE



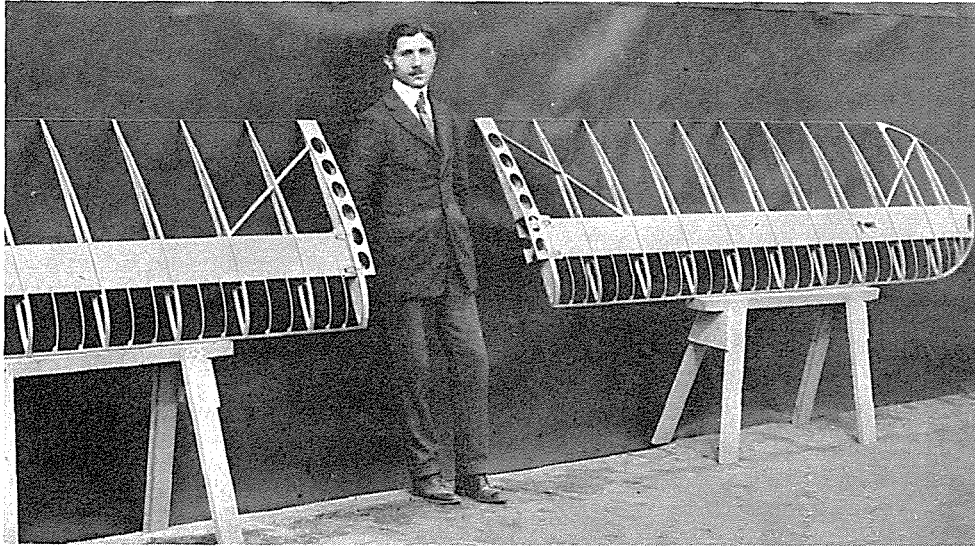
By CEDRIC E. GALLOWAY

The Loughead S-1 was an exciting aircraft for its day. It was small, reliable, and economical, "The poor man's airplane," as Lieutenant — later General — H.H. Arnold described it at the San Francisco Air Show in 1919.

In 1916 the Loughead brothers established the Loughead Aircraft Manufacturing Company in the rear of a garage near the Santa Barbara waterfront. Their finances were meager, but they were ambitious. Berton R. Rodman, Santa Barbara financier and machine shop owner, was elected president, Allen Loughead first vice president, and his brother Malcolm secretary and treasurer. Norman S. Hall became advertising and sales promotion manager, and

Anthony Stadlman was factory superintendent. Stadlman, a mechanic and a good practical engineer, first worked with Allen in the maintenance of the Curtiss pusher that Loughead flew during his barnstorming days in Illinois.

In midsummer 1916 a 21-year-old garage mechanic and architectural draftsman became a frequent visitor at the factory on State Street. He knew the Lougheads by reputation. He had seen their Model G at the Panama Pacific Exposition the year before. And he wanted a job — anything at all, so long as it was connected with aircraft. The young man was the farsighted John K. Northrop, later one of the most talented designers in aviation history.



Workmen support the half-skinned monocoque fuselage, lightly constructed of wood. (Photo—Lockheed LA-2669)

Below left — The structure was cleverly designed to fold without changing the rigging appreciably for convenience in setting up. (Lockheed M-1454)

Below right — a portion of the horizontal stabilizer was folded back to clear the wingtip. (Stadlman).

The Loughheads hired Northrop and put him to work helping to shape the hull of their new airplane, called the F-1. A self-taught engineer, Northrop understood stress analysis. He designed and stressed the wings of the F-1 flying boat, world's largest seaplane at that time.

It was built to carry 10 persons, including pilot and co-pilot, and was of wood and fabric construction, with engine cowlings and fittings of metal. The upper wing spanned 74 feet, and the 47 foot lower wing carried pontoons beneath each tip. Two 160 hp. Hall-Scott engines hung between the wings on either side of the hull. It was 35 feet long, with a gross weight of 7300 pounds and a useful load of 3100 pounds. Throughout it showed evidence of practical design and careful workmanship.

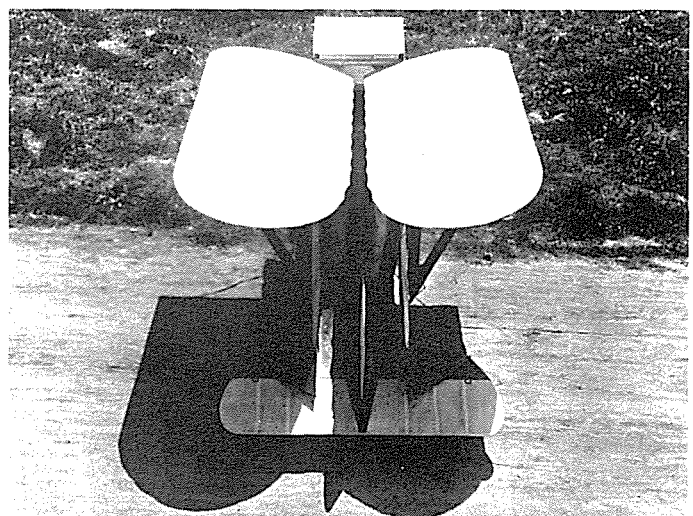
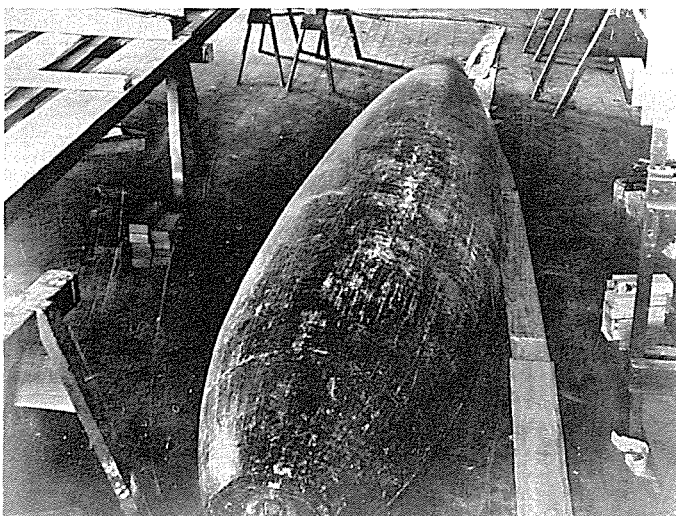
By early 1917 it seemed that the U.S. might be on the verge of entering the European War. The Loughheads offered to place their factory and "personal services as trained pilots" at the government's disposal "in the event of trouble with any other foreign power." Well, after the U.S. declared war on Germany and the Central Powers, the Navy displayed an interest in the Loughhead F-1 and arranged for it to be flown to North Island Naval Base for testing.

On its trial flight on 28 March 1918, Allen Loughhead took the F-1 around a circular course that demonstrated inherent stability although there was too much area in the counterbalanced ailerons. This problem was quickly solved, and a few days later he flew it to North Island.

Navy engineering officers began a series of flight and structural tests that spanned three months which convinced them the Loughheads knew how to build an airplane, but procurement was ruled out because of a design standardization policy. The government was concentrating production of specified aircraft types, and the chosen seaplane design was the Curtiss HS2L. Accordingly, the Loughhead's first military contract was to construct two seaplanes patterned after the Curtiss design.

At War's end, (and Navy contract completed) the Loughhead brothers continued to fly their F-1; they carried passengers, gave flying lessons, and rented it to several movie studios as a camera plane, and eventually they sold it to a group that planned to use it in charter service to Catalina Island. But the syndicate ran out of money before the venture started. Finally the F-1, abandoned on the beach, served as an attraction for curious children until it fell apart.

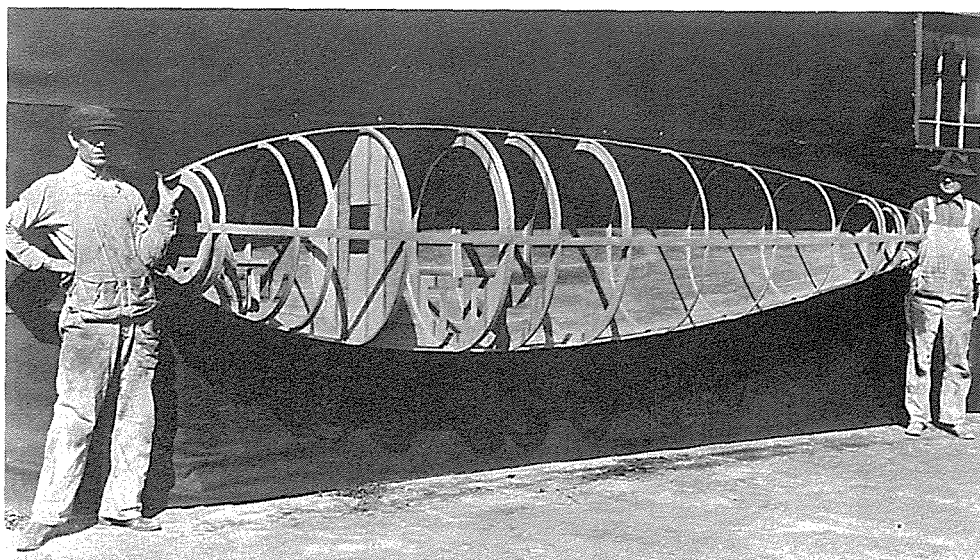
The Loughhead company was reorganized in 1919 with Allen as president, John K. Northrop engineer, and Tony Stadlman as superintendent of construction, and launched upon the design for a "dream plane" for the hundreds of pilots returning from World War 1. Originally Allen envisioned the S-1 as a two-place, tandem type, believing this would be more readily marketable, but his associates held out for the single-place design. It had to be a small, personal airplane; the main feature was the folding wings, so that it could fit into the home garage. John K. Northrop designed the airplane and ran the stress analysis.



Anthony Stadlman with the prototype lower wings, of wooden single box spar and rib construction. (Photo—Stadlman)

Below left — the concrete male mold for the fuselage left half. (Lockheed LA-2667)

Below right — The wingfolding geometry was designed to fit in an automobile garage of 10 x 20 ft. dimensions. (Lockheed A-2668)



Tony Stadlman engineered the tooling and production facilities, and in the process he developed and patented the method of making the preformed plywood shell to form an aerodynamically smooth monocoque fuselage. A concrete form was built, the size and shape of the 20 foot fuselage. From this a left hand and a right hand mold were made. Opposite molds were necessary as the center line of the fuselage was not symmetrical in that the center line connecting the oval cross sections curved downward in the area of the wings and upward again at nose and tail.

The fuselage halves were produced by applying thin strips of spruce veneer in three layers, alternately laid and well swabbed with casein glue, to the inside of the molds. The resulting plywood half shell was set in position by clamping a cover on the mold and inflating a rubber bag within it, and kept under 20 pounds per square inch pressure for twenty four hours. This process produced a wooden shell of uniform thickness of 1/8th inch, which is stronger for its weight than any other type of fuselage construction yet developed. The process pioneered the smooth stressed-skin monocoque fuselage, later used in the Vega and other Lockheed Aircraft Company designs.

As published in their 1920 brochure we can get some idea as to how far advanced this Sport Biplane was in its design and construction for that era.² The fuselage was constructed of spruce rings and bulkheads covered by the plywood skin. At points of attachment of landing gear, wings, struts, and tail surfaces, the loads were evenly

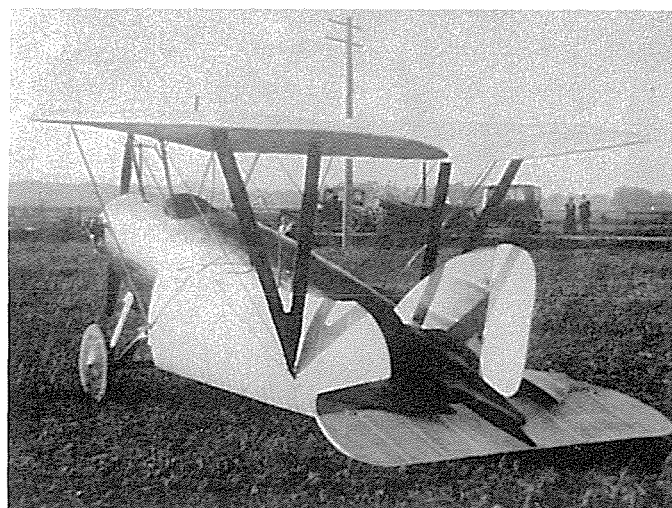
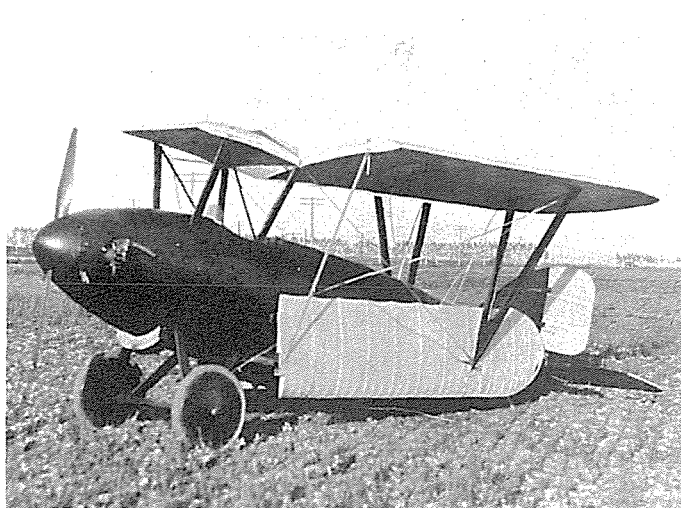
distributed over adjacent areas through reinforcing blocks and plates.

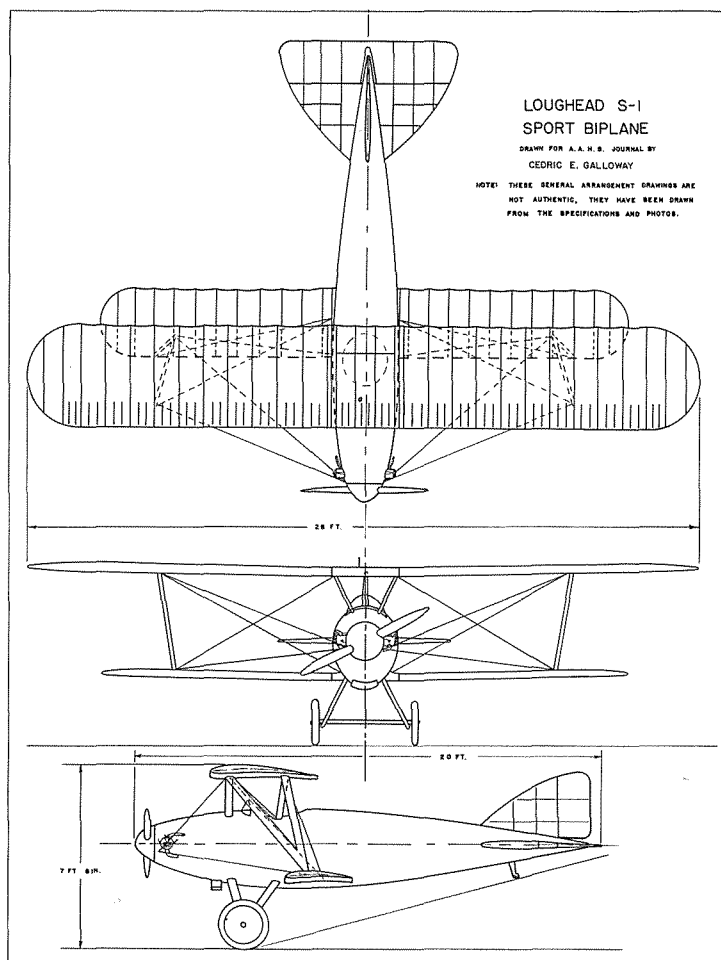
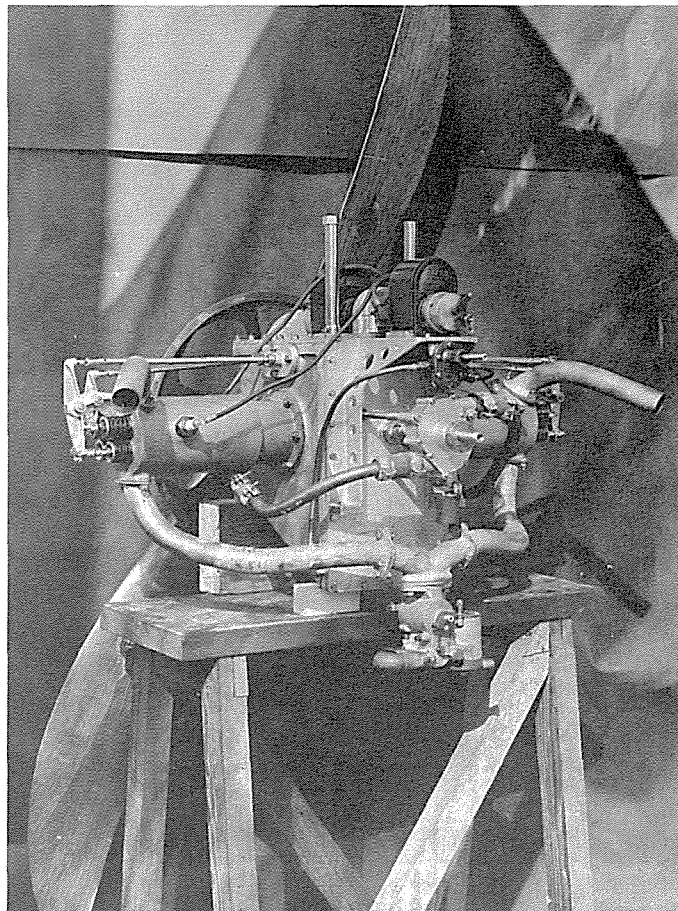
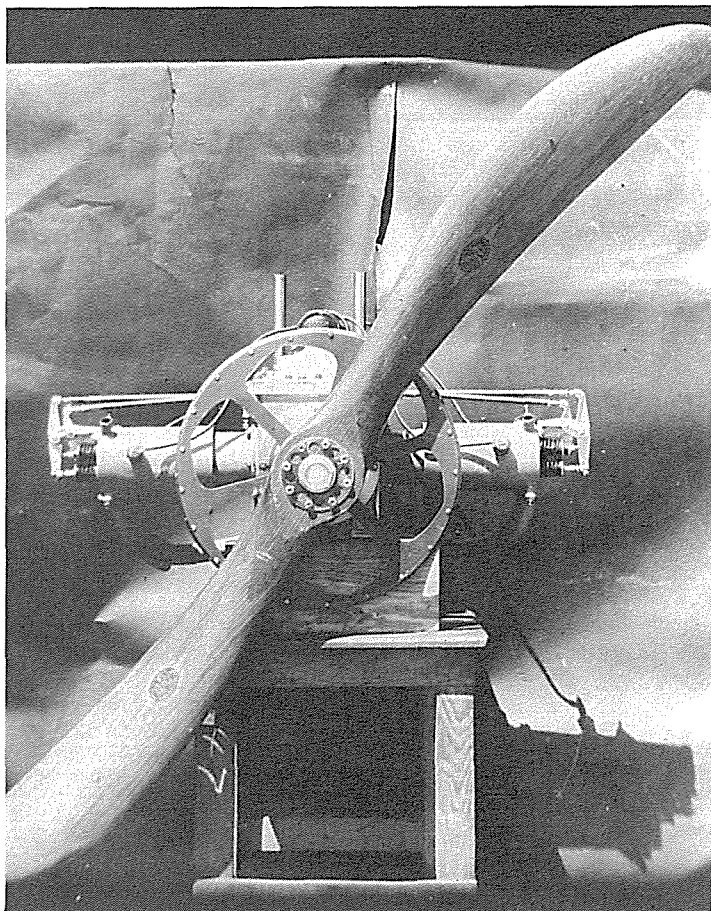
It was, however, the construction of the wings and tail that gave the Loughhead Sport Plane its potential for the "poor man's airplane market (although that was never realized). The entire concept was built around the need to fold the wings in order to fit the airplane into the family garage, a concept as real today as in 1919. Indeed, the design features of the S-1 are strikingly practical for today's homebuilt airplane buff.

In practice, the lower wings pivoted about the single spar attached to the lower ends of V-struts and at the fuselage, while the upper wings swung about a connecting point at the rear spar where the outer wings joined the center section, and there was a portion of the stabilizer that hinged up out of the way to provide clearance for the wing tips as they folded against the fuselage. The center section had an ingenious rear portion that folded up out of the way to allow the upper wings to pivot. The whole could be folded into an arrangement requiring no more than garage space of 10 feet by 20 feet.

The upper wing was built in three sections. The center section contained a 7 gallon fuel tank between the spars, and the section aft of the rear spar could be raised when the pilot entered or left the cockpit. Simple latches held this section in place during flight.

The lower wing was similar in plan-form to the upper, but a





The claims for the S-1 in the brochure of 1920 were modest:

Top speed	70 mph
Landing speed	25 mph
Rate of climb	700 ft. per min.
Service ceiling	12,000 ft.
Weight, empty	375 pounds
Weight, loaded	600 pounds
Fuel consumption	50 miles per gallon
Safety factor	Over 6:1

Likewise, the engine which Loughead called the XL-1, was modestly described. It was to use a 5 ft. 6 inch diameter propeller with a pitch of 42 inches, and although several were tried, including a Paragon make, the final and most successful was of Tony Stadman's own make. The brochure specifications were:

Bore	3-5/8 inches
Stroke	4-1/2 inches
Normal brake horsepower	25
Propeller speed	1800 rpm
Lubrication	Two high-pressure gear pumps, 50 psi to main and connecting rod bearings
Ignition	Dual, independent Bosch magnetos and dual spark plugs.
Fuel consumption	One gallon per hour
Oil consumption	One-half pint per hour

Above — two views of the Loughead XL-1 engine which developed 25 horsepower at 1,800 rpm in test runs with the Paragon propeller, later replaced with one made by Tony Stadman. At left, the basic three-view, reconstructed by the author from specifications and photos.

single deep box spar served to brace the wing in all directions. It was pivoted at the fuselage and at the lower end of the "V" interplane strut, and therefore served as the aileron and as air brake. Through a most novel arrangement of the control system, the entire wing was used for lateral control. Through connection to a hand lever it was possible to rotate it, increasing its angle of attack, to act as the air brake. The pivot point was just forward of the center of pressure of the wing, so there was little effort required in its operation. The wings were braced by five streamlined wires on each side, three flying, one landing, and one drift.

The horizontal and vertical stabilizers were internally braced, and both elevators and rudder were constructed about a steel tube as the main member to which the control levers and wires were fastened inside the fuselage. By removing the quick-detachable aluminum tail cone, the control cable turnbuckles were readily accessible for inspection and adjustment. The entire set of control rods and cables were enclosed within the fuselage, and the S-1 was among the first airplanes to have this feature.

John K. Northrop originally intended the S-1 to use the English-designed and built Green engine, but the Green Company went bankrupt before an engine could be delivered. This forced the Loughheads and Northrop and Stadlman to reassess their investment. With confidence, they decided to design and build an appropriate engine of their own.³

Both Loughhead brothers were good auto mechanics before they became involved in aviation. Allen listed the specifications desired and they set to work. Tony designed the two cylinders which were made of grey iron castings with Monel metal water jackets. The components were locally made in Santa Barbara except for the magnetos and radiator, and represented a further example of the original thinking that went into the S-1. The result was a two-cylinder horizontally opposed, four-cycle, water-cooled, valve-in-head engine which the S-2 brochure listed as 25 brake horsepower.

The S-1 was testflown at Redwood City, California by Gilbert C. Budwig. (later inspection chief of the U.S. Department of Commerce, Aviation division). Following is his report on the test flight:

"Horizontal flying speed of sixty miles per hour with the motor throttled to sixteen hundred revolutions per minute. Due to the newness of the motor, I did not run it wide open long enough for a test of the speed with full power. A speed of fifty-two miles per hour in horizontal flight with a motor speed of fifteen hundred revolutions per minute. I find it possible to fly at the low speed of thirty miles per hour with absolute safety. The machine climbs close to four hundred feet per minute and this is not its maximum climb by any means. At no time in the flight did the machine feel loggy or have any tendency to settle. The machine has a gliding angle of ten to one, and a landing speed of 25 miles per hour. The machine came to a stop in twenty feet, this without the use of the air brake. The lower wing action, taking the place of ailerons, is sure and positive, and not too sensitive, although the machine is under perfect control even at very low speeds."

The S-1 proved every bit as good as it looked, and handled well in the air. Loughhead embarked on an extensive advertising campaign, stating that, "Since the S-1 is only 20 ft. long, it could be transported and exhibited practically anywhere." It was described as "small, reliable and economical," only 2 cents per mile. It was "within the reach of every automobile owner."

Although the S-1 was advanced for its time and despite favorable publicity, no sale prospects developed. There was a postwar slump in aviation; hundreds of war surplus Curtiss JN-4's were available. These sold, new — still in the crates — for \$400 or even less. It became painfully apparent that not enough automobile owners would look to the S-1 as a substitute for their earth bound transportation. The S-1 cost nearly \$30,000 to develop, but not one single airplane was sold. Rodman, who correctly foresaw no commercial market for it, resigned as president and in 1921 the Loughhead Aircraft Manufacturing Company suspended operations and was liquidated.

Tony Stadlman, an Early Bird, resides today in San Francisco. Of the S-1 he recalled this anecdote:⁴

"The S-1 was trucked up to the Santa Clara County Fair to be put on display. They were scheduled to make a demonstration flight. The air was very turbulent and gusty, but Gil Budwig took it off despite my opposition. It barely cleared the fence in the high wind and after a short time it was landed. The Fair management had agreed to buy the plane and give it as a prize at this county fair in San Jose, but because the performance was so poor they told the Loughheads that they couldn't live up to their contract and they would impound the plane on the basis of a fraud. Budwig, standing by, hopped it again out of the area and the Loughheads outfoxed them by picking the plane up in their truck in a nearby field and cleared for home."

The future was to bring success and fame far exceeding Allen Loughhead's early dreams. Six years after the S-1, Allen Loughhead, Ken Jay, John K. Northrop, and Anthony Stadlman founded a new company, the Scottish surname changed to its phonetic equivalent — Lockheed. Malcolm had left the group to manufacture four-wheel brakes for Chrysler Company, having invented the new Lockheed Hydraulic brake system. In January 1927, this team designed and built the first Lockheed Vega. The rest is another history. As Shop Superintendant, Tony Stadlman stayed with Lockheed for many years, and developed the tooling that helped to build those sleek beautiful airplanes that set one record after another in the Golden Age of Aviation. It took a Lockheed to beat a Lockheed.

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ACKNOWLEDGEMENTS.

Thanks are due to the following persons for their aid in Research Project 6916, in addition to Mr. Anthony Stadlman, (Early Bird and A.A.H.S. Member): Mr. John K. Northrop; Messrs. Brewster C. Reynolds, John W. Underwood, and Willis L. Nye of the A.A.H.S.; David D. Hatfield (Northrop Institute of Technology); Eric Miller (also A.A.H.S.), Kenneth Aymar and Bill Krecek of Lockheed Aircraft Co.; Curtis Olson (Aero Spacelines) and Walker A. Tompkins (historian, *Santa Barbara News Press*).

ABOUT THE AUTHOR

Cedric E. Galloway, a member of A.A.H.S. almost since its founding, is also a longtime employee of Lockheed Aircraft Co. and began his research with Tony Stadlman into the S-1 Sportplane last year as Research Project 6916. His previous article, the "Braley Beezebug," was in Volume 6 (Summer 1961, p. 120).