THE DOUGLAS *WEILANDCRAFT* VENTURE

By Bruce Cunningham

During the late 1950s and early '60s many aircraft companies, still recovering from the sudden close of production at the end of WWII, searched for new or different products to submit to the buying public and military organizations. The Douglas Aircraft Company could see the end of the aircraft production line at its Santa Monica plant with the DC-7 airliner phasing out as the Boeing 707 came into view. The plant remained active for several years, designing and producing missiles and related equipment, after which the missile production activity was moved to the new Douglas Space Center in Huntington Beach, California. The last Navy airplane was delivered from the El Segundo plant in 1961 and soon thereafter Douglas moved out and the plant reverted to its owner, the U.S. Air Force.

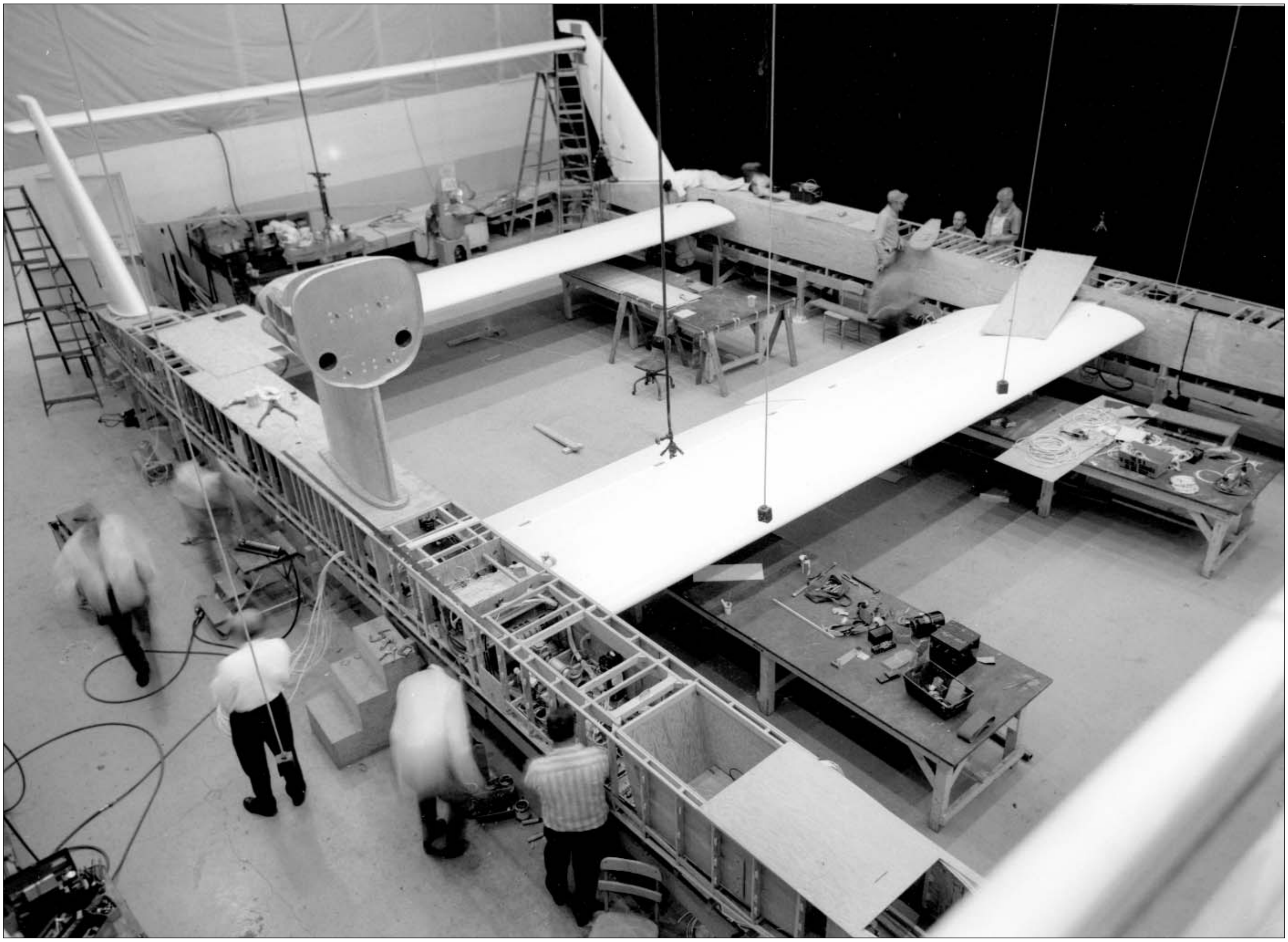
The Douglas Long Beach plant continued to produce aircraft for the Air Force. The C-124 *Loadmaster* was replaced in production by the C-133 *Cargomaster*, powered by four turboprop engines, of which only 50 were produced, were the last propeller-driven aircraft produced at the Long Beach plant. The B-66 *Destroyer* delivered from Long Beach and the A-4 *Skyhawk*, manufactured at Long Beach and assembled and flown at the Douglas Palmdale location, phased out in the late 1950s and early '60s.

With FAA certification of the DC-8 four-engine turbojet-powered transport taking place in late August 1959, the future for the company began to show promise. As with most forward looking companies, Douglas was searching the market place for potential requirements for new products in the aviation related field.

Air cushion vehicle studies had been conducted by companies within the United States as well as in other countries, including the United Kingdom, Poland, Sweden and Russia. All were of the same general description in that the supporting medium was a cushion of air generated by fans contained within the confines of the vehicle. Hydrofoil craft also were looked at by Douglas, but research in this area was discontinued when the company was approached by a Swiss inventor, Carl Weiland, who proposed that the company build and produce his latest design, the *Weilandcraft*.

Mr. Weiland had previously designed and built two flying machines that operated on the principle of ground effect created by vertically directed airflow from engine-driven

The Weilandcraft *being "rolled-out" at the Douglas Long Beach plant. (Douglas photo from the author's collection)*



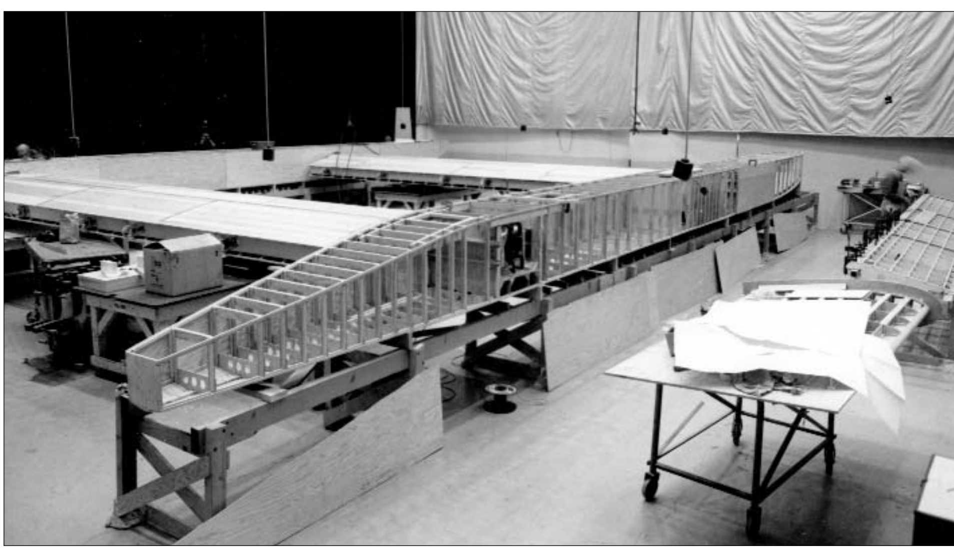
The Weilandcraft *undergoing construction in the Douglas mockup department. (Douglas photo from the author's collection)*

propellers. The first craft designed by Mr. Weiland in 1959 met an untimely end during a storm on Lake Zurich. Mr. Weiland's second machine, built by an American boat manufacturer, included four seats in an open cockpit and was propelled by a single reciprocating engine driving the propeller. A second engine provided the air cushion that supported the craft. This craft was first tested near the company with unknown results.

Mr. Weiland's proposal to Douglas officials involved a catamaran type craft with tandem wings separating the two hulls. This vehicle was to be designed specifically for flight within the ground effect regime, carrying heavy, outsized cargo long distances over water at speeds, possibly in the 100 knot speed range.

The craft was to takeoff from water, climb to the maximum altitude of ground effect for flight to its destination. Mr. Weiland felt that once the craft reached a stabilized level flight altitude, there would be little for the pilot to do, as ground effect would maintain the craft in a longitudinal and lateral level attitude.

Trim of the craft was to be provided by the restoring effect of the ground effect. Flaps were provided which were not primary pitch controllers but trim controls. The flaps were set



Another view showing details of the wood construction used in the Weilandcraft. *(Douglas photo from the author's collection)*

Remains of the Weilandcraft *after departing stable conditions during flight testing. (Douglas photo from the author's collection)*

to a position symmetrically for the takeoff run and returned to the faired position for cruise flight. Supposedly when the craft lifted off the water with a longitudinally level or slight nose up or down position, power was to be reduced for stabilization. In the cruise mode, additional power would cause an increase in altitude with the same attitude longitudinally. If the nose came up or down with a small change in angle of attack the wing would lose or gain lift and settle to the original trim position and be stable longitudinally. Pitch control was present by the inherent ground effect moment. If the craft was wing down or not level laterally or longitudinally, the respective flaps would be energized only to change the trim. Power was to be used for altitude control: pitch control was by the inherent restoring moment generated by the wings in ground effect.

Douglas then spent much time studying this proposal and conducting design studies of aerodynamic effects, stability considerations, power requirements, and market options. As ground-effect aerodynamics was not a sufficiently understood subject nor had it been deeply investigated at this time, it took 18 months for the company to decide to accept Mr. Weiland's proposal and to authorize the design and construction of a prototype. A budget was developed which included the engineering, material, manufacturing, management and flight test expenses.

Once the decision had been made to proceed with the *Weilandcraft* program and design was progressing, construction of the prototype was begun. Wood was to be the primary material for the craft that was to be constructed in the Douglas mockup department by skilled woodworkers. Length of the craft was 52 feet with a beam of 32 feet. Open cockpits were located at the forward end of each hull with only a windshield for protection of the pilot from spray generated by the bows of the hulls. Power was supplied by two 275-hp reciprocating engines mounted on pylons located aft of the forward wing. As an added safety factor, tension cables were installed running from each engine to heavy attachments in the hull aft of the engines.

Vertical fins and rudders were installed on each hull at the extreme aft end. The rudders were manually actuated and were intended as the prime maneuvering control surfaces in flight. The one piece non-controllable horizontal tail section between the vertical fins was to act as a stabilizer and provided no control function. Differential engine powers were the only turn control available when the vehicle was waterborne.

Phase I Test Program

Phase I testing began on February 1, 1963, and included construction of the prototype, proof and vibration tests, transportation to the Salton Sea, and the test program. First launch was planned for September 19, 1963. The test portion of Phase I was to be complete by mid-September at which time the craft was to be returned to Long Beach for update and any required modifications.

The vehicle was fitted with linear tires on each hull. The linear tires were inflatable rubber bags pre-stretched along the entire lower length of each hull for use only during takeoff. Once airborne the tires were to deflate and lie flat against the hull.

The purpose of the Phase I program was:

- Demonstration of the ability to achieve controlled takeoff and surface effect flight.

View showing the details of the aft hydrofoil skis on the destroyed craft. (Douglas photo from the author's collection)

- Determination of stability and control of the craft during takeoff, in surface effect and landing.
- Determination of the feasibility of using this prototype as a passenger carrying demonstrator.

Phase 1 testing consisted of eight days of taxi runs for the purpose of determining hump speed and spray pattern characteristics. (Hump speed being that speed at which both hulls were completely clear of the water with the hydro-skis planning on the water surface.)

The first day of taxi runs proved the linear tires to be deficient and they were removed and replaced with hydro-skis.

During the next two months a total of seven taxi trials were then conducted. As many as 11 runs were made as part of each trial, with the vehicle in various hydro-ski configurations and at maximum speeds varying from 18 knots to 40 knots.

The final report on Phase I testing revealed many areas of concern to the pilot. These included:

- At rest, the flaps were partially under water.
- The wings rested in the water from the ¾ chord position to the trailing edge.
- The hulls developed a longitudinal porpoising action, causing concern for the structural integrity of the hulls.
- On the down cycle of the porpoising there is much spray and water coming over the forward wing.
- The engines developed insufficient power to attain and maintain hump speed without exceeding red lines.
- The hull, wings and flaps were not watertight, increasing the craft's gross weight and possibly negating some of the figures obtained from the tests.
- There was no rudder effectiveness up to 33 knots.

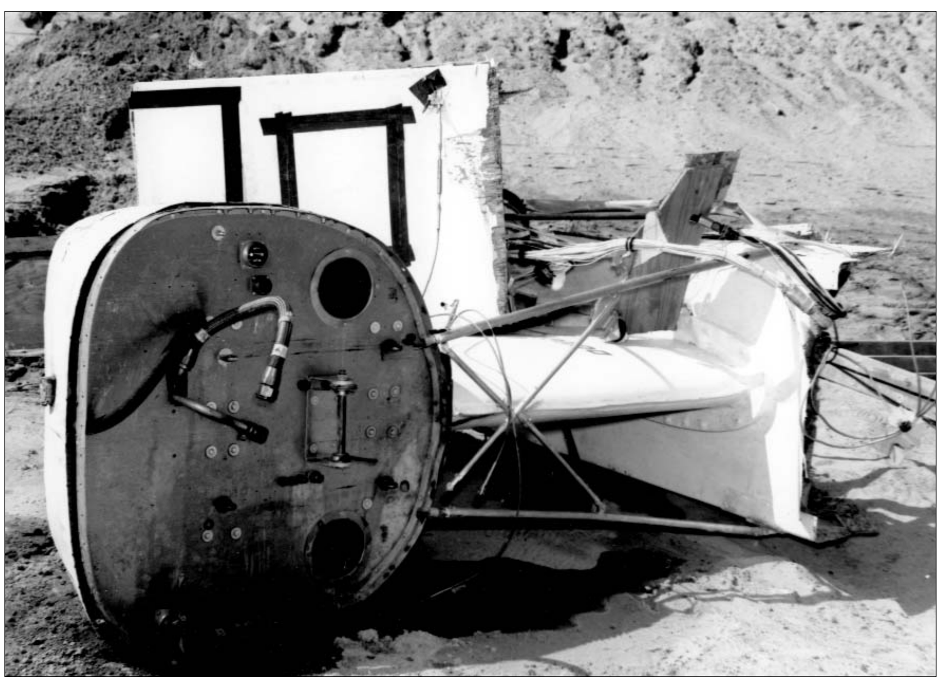
At this point the Phase I testing was terminated and the *Weilandcraft* was disassembled and trucked back to Long Beach. Reports were completed and submitted to management for discussion and decisions and the crews returned to their duties at Long Beach.

Phase II Test Program

The reworked *Weilandcraft* and its crew returned to the Salton Sea in January 1964 to continue the determination of hump speed, spray pattern characteristics, stability and control characteristics and water speed envelope expansion. Modifications to the vehicle included relocation of the aft hydro-skis, change of aft wing incidence, sealing of wing trailing edges and flaps, and the addition of cameras and a tape recorder.

Phase II of the program involved:

- Hump speed determination
- Spray pattern characteristics



Unidentified engine pylon from the recovered pieces of the craft. Salvage operations of usable materials (engines, fitting, etc.) have already begun. (Douglas photo from the author's collection)

Another view of the engine pylon showing details of structural failure resulting from the crash. (Douglas photo from the author's collection)

- Stability and control characteristics
- Water speed envelope expansion
- Controlled flight

Phase II first taxi run was made January 28, 1964, picking up where the program ended the previous September. Hump speed was now determined to be 27 kts and tests were progressing. By trial run #15 the craft was reaching speeds of 72 kts with the hydro-skis just touching the water surface, although there was still no rudder effectiveness even at the 72 kts speed.

For trial run #16 on March 4, 1964, the aircraft had undergone a weight reduction program that reduced the gross weight by about 450 pounds.

During the post-flight meeting the pilot noted that at one point speed was temporarily reduced to 55 knots to better control acceleration of the craft. Power was then gradually increased to approximately 65 knots at which point the front skis left the water symmetrically and almost immediately the aft skis were felt to clear the water. Airspeed was again adjusted in an effort to maintain this condition but the craft continued to rotate nose up until the bows were at least 20 ft. off the water at the maximum angle of attack encountered. Power settings were varied by the pilot but had no effect on the attitude and the craft impacted the water nose high and laterally level.

After the craft was beached in six pieces by the crew it was subsequently stripped of all useful hardware and the remaining plywood was destroyed.

Post Mortem

Douglas aerodynamists were asked to investigate stability and pitch up problems. This resulted in an internal report identified as the D.E. Drake Report C1-250-AERO-64-180 issued May 11, 1964. In this report, it is stated that:

The *Weilandcraft* was conceived as an application of favorable aerodynamic ground effects to provide greatly increased lift-to-drag ratios and sufficient inherent stability that control would not be required. The claim to greatly increase lift-to-drag ratios is valid, but the claim that inherent stability is completely erroneous. Stability and control analyses of the configuration conducted during the last 18 months indicated an altitude instability that is directly comparable to the instability associated with the transonic trim change of transonic airplanes. The results of these analyses contradict the claims of Mr. Weiland and, apparently, the results of small-scale flying model demonstrations. The latter contradiction is not certain because the models reportedly also exhibited the predicted instability on occasions. The analytical results did, however, predict the pitch-up exhibited by the prototype and cannot be disregarded any more.

The configuration, as it is presently conceived, does not possess sufficient stability to replace conventional controls. Ground effect aerodynamics are not sufficiently well developed to be certain that it is possible to design a vehicle with such stability.

Favorable ground effects on lift-to-drag ratio can be realized whether the vehicle possesses sufficient stability to be operated without controls or not.

Post program review and study showed that Mr. Weiland's proposal, while innovative and potentially productive, required further study prior to proceeding with another model. The project was quietly dropped with no probability of future attempts to breathe life into this type craft.