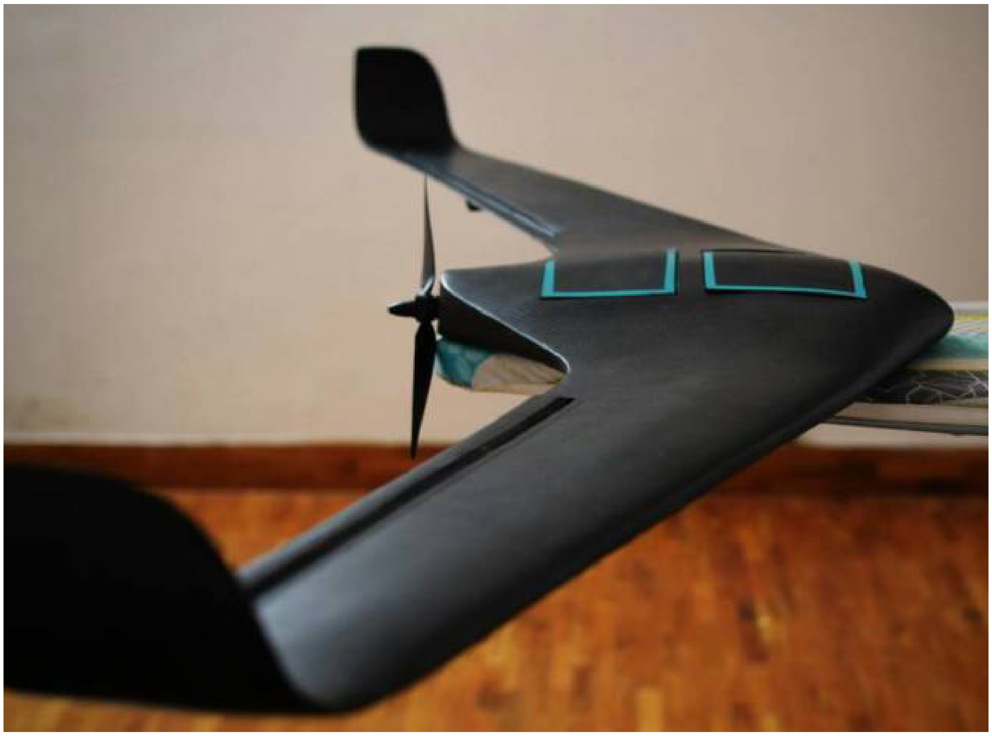
No. 385 SEPTEMBER 2018

T.W.I.T.T. NEWSLETTER



Designed for aerial photography/ surveying. Carbon fiber flying wing, quite durable. Had an excellent vendor work on this (manufacturing here is much cheaper in India).

Source: https://diydrones.com/profiles/blogs/cf-flying-wing

T.W.I.T.T.
The Wing Is The Thing
P.O. Box 20430
El Cajon, CA 92021

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THE WING IS THE THING (T.W.I.T.T.)

T.W.I.T.T. is a non-profit organization whose membership seeks to promote the research and development of flying wings and other tailless aircraft by providing a forum for the exchange of ideas and experiences on an international basis. T.W.I.T.T. is affiliated with The Hunsaker Foundation, which is dedicated to furthering education and research in a variety of disciplines.

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Gatherings are held on the third Saturday of every odd numbered month, at 1:30 PM, at Hanger A-4, Gillespie Field, El Cajon, California (first row of hangers on the south end of Joe Crosson Drive (#1720), east side of Gillespie or Skid Row for those flying in).

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PRESIDENT'S CORNER

Not a lot to say this month so this will be mostly white space. I was hoping a couple of our new members would write and let us know what types of projects they are working on to see if it corresponded to any thing our other members might be interested in. Maybe next month.

Andy

LETTERS TO THE EDITOR

The following information came to me in March from Larry Nicholson and I set it aside for a future issue then forgot I it. This is the first of several reproductions he sent along so will get done in the next few issues. The source for this month is: Faulconer, Thomas, Introduction to Aircraft Design, New York and London: McGraw-Hill Book Co. Inc., 1942. pp. 69-73.

(e. - My thanks to Larry for passing this along to the membership for improving their knowledge of aircraft design.)

CONTROL-SURFACE DESIGN 69

pitching moments and controls the plane in entry to or recovery from a dive.

3. The *elevators* control dive and climb.

4. The fixed vertical tail surfaces to which the rudder attaches are the *fins*. They produce most of the directional stability and act like the keel of a boat.

5. The *rudders* produce control around the axis of yaw and thus direct turning or directional control.

Surfaces Aft of Rear Spar of the Wing.—The *ailerons* are hinged portions of the trailing edge of the wing, usually near the tip. They are balanced statically and dynamically about their hinge lines.

The ailerons produce roll by increasing the camber of the wing section on one side of the ship and decreasing it on the other. A by-product of roll is yaw. The aileron in increasing the effective wing camber also increases the drag on that side and thus causes the ship to turn. The frise nose balance adds corrective yaw by "venting" the air flow about the aileron and making the drag on each side equal.

Dihedral produces lateral stability by making the lift on the low wing greater than that on the high wing and thus righting the ship.

The movement of one surface produces an effect on the other two surfaces by changing the air flow about it and changing its attitude with respect to the relative air streams. Thus, due to dihedral, the rudder produces roll by advancing one wing faster than the other and thus increasing its lift.

Roll will produce turn with a fixed rudder, for the air flow will be faster over one side of the rudder than the other. Thus, reversal of controls in steep turns may become necessary in order to maintain stability.

The need for light control forces is obvious. Many schemes for reducing required forces are in use.

Aerodynamic balance is achieved by the use of aerodynamic forces on a part of the surface ahead of the hinge line to counteract those acting aft.

Balancing tabs are small hinged surfaces attached to the control surface to act as corrective or differential forces to correct for trim, and for directional discrepancies.

Servo-tabs are tabs connected by cams or levers to the primary control to give percentage corrections. They are sometimes connected by a differential control to give a balancing effect as well.

Power boosters are sometimes connected to lighten the control forces.

Trim tabs (usually mounted on piano hinges) produce fine adjustment of the control surface so that no force is required on controls. They are used in place of the primary controls on long flights where only minor deviations in direction, climb, etc., are required.

The adjustment is in the cockpit; thus, the pilot may make corrections as required in flight. The system must be rigid so that small amplitude vibrations may not be set up and amplified in the primary control. The system must be irreversible also, so that aerodynamic force will not tend to change its setting or adjustment.

Mass balance is used in structures in which the surface mass cannot be distributed about the hinge line sufficiently. Static balance is obtained in these cases by adding weights at one end of the structure. Dynamic balance must also be achieved so that flutter will not occur.

The axes of vibration, product of inertia, method of accomplishing complete dynamic and static balance, are all vital factors in reducing control forces.

For the airplane to move efficiently in flight, it must have less wing surface than that required for take-off. Thus, various types of flaps have been developed. Those which increase the lift by a change in the effective airfoil camber only are called *plain flaps*. Plain flaps are located from the side of the fuselage outboard to the inboard end of the aileron and, in fact, are similar to the aileron except in operation. They are connected so that they depress together on both sides. As they are lowered, they produce lift by increasing the camber, but they do not add to the total wing area. This type of flap produces drag with increases in lift and is usually employed on smaller airplanes in which the drag is not too important. The plain flap also produces a large diving moment by placing the center of drag below the chord plane, a condition requiring correction by the elevators.

Fowler flaps are a more efficient type in terms of the ratio of increased lift over increase in drag. The Fowler flap is much more complex than a plain flap, but with careful design the weight penalty is usually cut to a justifiable minimum. It is also more effective, for it increases the area of the wing while adding to the camber and effective chord length. It produces the change in camber less abruptly than the plain flap does. With proper arrangement, it does not disturb the balance due to down-wash striking tail. This is a function of empennage location as much as anything else, and the ship should be designed from the first with the flap in mind.

Other flaps are modifications of the above, as a rule. The *split flap* is a hinged type in which only the lower trailing-edge surface is hinged downward. The *zap flap* is a "ventilated" split flap.

Flaps of the Fowler and other extensible types are of airfoil section. Thus, they add lift with a minimum increase in drag.

Trailing-edge structures are often built as detachable units of lighter construction than the main wing panel. They take none of the wing bending loads. Over the aileron the trailing-edge section merely acts as supporting structure for its hinges and fairing for the aileron leading edge. The trailing edge over the flap has the same function as at the aileron, modified by the type of flap.

DESIGN PROBLEMS

From the foregoing, it may be seen that the design problems are numerous and complex.

Fins and Stabilizer.—The construction of the fins and stabilizer must be extremely rigid so that no vibration will be imparted through the hinges to the rudder or elevator.

The *loads* imposed on them are as follows:

1. Beam bending, due to the loads acting normal to their axes.
2. Chord bending, due to drag forces parallel to the time of flight.
3. Torsion, due to slip-stream differential forces from one side to the other.
4. Fin loads on the stabilizer for twin vertical surfaces, where the fins are mounted at the stabilizer tips. These add bending moments to the stabilizer and add to the chord bending.
5. Shaking forces, due to fuselage flexibility and whipping action.

Many *types of construction* are employed to gain the required strength. Stressed skin monospar types with and without stringers are used. Those with stringers require a lighter spar. Either type can be designed very efficiently. Stressed-skin two-spar types, with and without stringers, are usually of the "box-spar" type in which the two spars and upper and lower skins form a beam of high sectional qualities. Various multispar types have been used in which the number of bulkheads or ribs usually varies inversely as the number of spars.

Care must be taken in designing so that a careful weight saving in a surface will not mean a penalty in attachment. The stabilizer-to-fuselage connection is usually effected by means of four bolts through spar fittings into fuselage forgings. The fin-to-stabilizer connection can often be made by using integral spar construction and skin attaching strips or angles. Hinge attachments are best when in line with bulkheads to distribute the load out to the skin.

The use of minimum gauges is desirable, but within limits set by practical considerations. With very thin sheet, difficulty in handling in the shop results in poor production and unavoidable damage. The stiffness vs. strength requirements call for very close spacing of the bulkheads when minimum gauges are used, or a great number of stringers.

Elevators, Rudders, and Ailerons.—The construction of elevators, rudders, and ailerons is an entirely separate problem, because of special conditions and requirements.

1. The *loads* imposed on these parts require that they be stiff in bending so that they will not fail at high angles or speeds. Owing to the fact that the control force from the pilot is applied at one point on the surface and must be reacted over its whole length, they must be torsionally stiff. The need for stiffness is obvious; deflections would result in loss of control or in periodic vibration or flutter.

2. Another factor to be considered is *arrangement for proper movement* for ease of control. Locate the hinge line to give the required aerodynamic balance. See that proper clearance exists in all positions of the surface, so that in extreme positions it will work easily and without interference.

Construction.—As usually constructed, the movable control surfaces constitute the lightest exterior construction on the airplane. The *nose section*, or leading edge, of the surface is usually a sheet-bulkhead combination forming a torque box. This section is interrupted by hinge cutouts to accommodate the hinge brackets from the fixed surface. The need for stiffness was described above. Much of the bending is taken by the fixed surface, but being hinged all torsion must be taken by the movable surface.

Aft of the hinge line, the *trailing-edge structure* consists usually of light ribs covered with fabric. A good grade of cotton fabric is still used for lightness, enough ribs being used to maintain the external shape. Owing to "doping," bracing for fabric tension is necessary to avoid collapse of the structure as the fabric tautens.

Trim, Servo-, or *balance tabs* are usually mounted on small beams between ribs, with a control rod or tube running to the fixed surface. The need for lightness is paramount since they are farthest from the hinge line and produce a large moment. The need for stiffness is also great, so that their deflection will not induce flutter.

Mass balance is employed because the light type of construction puts too much weight on the wrong side of the hinge line. The weight must be secure so that it will not magnify any stray vibrations and work loose. Such vibrations may crack the thin skin of the box beam or torque box.

Controls.—The controls that actuate the control surfaces are very specialized in design and involve many considerations. Because flight involves control in three dimensions, flying is more like riding a bicycle than driving a car. Lateral stability must be maintained. There can be no backlash or play in controls because an airplane moves so fast that corrections from one direction to its opposite must be instantaneous. Friction must be minimized so that the control forces at the wheel will not be too large. It is necessary to keep deflections low; thus, reversal of direction can be made quickly, and flutter will not ensue.

The *elevator controls* run from the wheel, or "stick," back to the elevator. They are composed of a torque tube, to the interior of the fuselage, which is an extension of the elevator spar, or torque box. On this the torque-tube horns inside the fuselage act as bell cranks to which the cables from the cockpit

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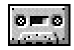
VIDEOS AND AUDIO TAPES



(ed. – These videos are also now available on DVD, at the buyer's choice.)

VHS tape of Al Bowers' September 19, 1998 presentation on "The Horten H X Series: Ultra Light Flying Wing Sailplanes." The package includes Al's 20 pages of slides so you won't have to squint at the TV screen trying to read what he is explaining. This was an excellent presentation covering Horten history and an analysis of bell and elliptical lift distributions.

Cost: $10.00 postage paid
Add: $ 2.00 for foreign postage

VHS tape of July 15, 2000 presentation by Stefanie Brochocki on the design history of the BKB-1 (Brochocki,Kasper,Bodek) as related by her father Stefan. The second part of this program was conducted by Henry Jex on the design and flights of the radio controlled Quetzalcoatlus northropi (pterodactyl) used in the Smithsonian IMAX film. This was an Aerovironment project led by Dr. Paul MacCready.

Cost: $8.00 postage paid
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An Overview of Composite Design Properties, by Alex Kozloff, as presented at the TWITT Meeting 3/19/94. Includes pamphlet of charts and graphs on composite characteristics, and audio cassette tape of Alex's presentation explaining the material.

Cost: $5.00 postage paid
Add: $1.50 for foreign postage

VHS of Robert Hoey's presentation on November 20, 1999, covering his group's experimentation with radio controlled bird models being used to explore the control and performance parameters of birds. Tape comes with a complete set of the overhead slides used in the presentation.

Cost : $10.00 postage paid in US
$15.00 foreign orders

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BLUEPRINTS – Available for the Mitchell Wing Model U-2 Superwing Experimental motor glider and the B-10 Ultralight motor glider. These two aircraft were designed by Don Mitchell and are considered by many to be the finest flying wing airplanes available. The complete drawings, which include instructions, constructions photos and a flight manual cost $140, postage paid. Add $15 for foreign shipping.

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