No. 290 AUGUST 2010

T.W.I.T.T. NEWSLETTER

This was an interesting image from the web site listed as the source. It appears to have links to many other types of flying wings. Take a look.
http://www.century-of-flight.net/Aviation%20history/flying%20wings/soviet_wings.htm

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

The number after your name indicates the ending year and month of your current subscription, i.e., **1008** means this is your last issue unless renewed.

Next TWITT meeting: Saturday, September 18, 2010, beginning at 1:30 pm at hanger A-4, Gillespie Field, El Cajon, CA (first hanger row on Joe Crosson Drive – Southeast side of Gillespie).

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.

T.W.I.T.T. Officers:

President: Andy Kecskes **(619) 589-1898**
Treasurer:
Editor: Andy Kecskes
Archivist: Gavin Slater

The **T.W.I.T.T.** office is located at:
Hanger A-4, Gillespie Field, El Cajon, California.
Mailing address: P.O. Box 20430
El Cajon, CA 92021

(619) 447-0460 (Evenings – Pacific Time)
E-Mail: twitt@pobox.com
Internet: http://www.twitt.org
Members only section: ID – **20issues10**
Password – **twittmbr**

Subscription Rates:
$20 per year (US)
$30 per year (Foreign)
$23 per year US electronic
$33 per year foreign electronic

Information Packages: $3.00 ($4 foreign) (includes one newsletter)

Single Issues of Newsletter: $1.50 each (US) PP
Multiple Back Issues of the newsletter: $1.00 ea + bulk postage

Foreign mailings: $0.75 each plus postage

Wt/#Issues	FRG	AUSTRALIA	AFRICA
1oz/1	1.75	1.75	1.00
12oz/12	11.00	12.00	8.00
24oz/24	20.00	22.00	15.00
36oz/36	30.00	32.00	22.00
48oz/48	40.00	42.00	30.00
60oz/60	50.00	53.00	37.00

Meetings are held on the third Saturday of every other month (beginning with January), 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).

TABLE OF CONTENTS

PRESIDENT'S CORNER

This issue contains the next to last part of the Northrop lecture, with the final part coming next month. I hope everyone has been enjoying it even though it is coming in pieces. The last part will be looking into the future as best as possible at that time by Jack Northrop.

The month of July was another very slow month for any activity on the Nurflugel bulletin board. I find it interesting that not even the European members have much to say about what is going on in the world of flying wings. They have sort of been the leaders most of the time, with much less activity here in the US in terms of developing ideas or any type of construction. It is possible that everything has been said about the subject and we are at an impasse on coming up with any new theories or designs!!

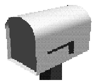
I hope everyone is having a great summer of building and flying. I am making progress on my 1-26 project, but it is still slow going like most at this stage.

Don't forget the Experimental Soaring Association (EDA) Western Workshop will be this coming Labor Day weekend at Mountain Valley Airport in Tehachapi, CA. There are lots of great lectures scheduled this year and you can see a complete listing at:

http://www.esoaring.com/calendar2010.html

This is a great event each year and you get a chance to meet a lot of people who have diverse interests in everything aviation oriented. If you can't come for both days, try to come on one of the days that fits your schedule and topics of interest.

Andy



LETTERS TO THE EDITOR

July 23, 2010

Greetings:

I have been a long time flying wing enthusiast. I go back to the days of Richard Millers Conduit Condor, Icarus II, and reading about Al Backstrom's flying planks in Soaring magazine.

I wondered if Al Backstrom is still living, and if he has contact information. Perhaps Email.

Somehow I missed any representation of Backstroms planks on your TWITT website.

Thanks,

Max Perrault

(ed. – Since Al if still with us and a member of TWITT I forwarded his e-mail address to Max. Haven't heard anything back, but hopefully they have made a connection and both are enjoying an exchange on Al's designs.

There is so much stuff on the web site I don't recall what we have on Al's flying wings. I will have to go back through it and the material we have on hand and see what can be added.)

July 26, 2010

Andy:

Most comprehensive Horton Site I've ever seen!!

"Rudy Opitz, and my Hungarian flight instructor Dezso gyorgyfalvi at Mississippi State, Flight evaluation of the Horton-IV Flying Wing"

http://www.nurflugel.com/Nurflugel/Horten_Nurflugels/ho_iv/Falvy_Pics/falvy_pics.html

Alex Kozloff
<avkozloff@roadrunner.com>

(ed. – Alex received the caption and link from a friend and passed it along to us. If you haven't visited Doug Bullard's Nurflugel web site lately, you might want to take a few minutes and rummage through it again. It appears he has added a lot of new material, at least since I last viewed it. I noticed he had some pictures of captured Hortens on trailers, but from the looks of them they were something the military threw together to transport them since they lacked the hard shell cover and gull wing front section.)

August 2, 2010

We are sending the press release to you and we would kindly ask you to forward the information to the person in charge of this matter.

We are happy to inform you that - on the occasion of the 200th Anniversary of Berblinger`s first attempt to fly - the town of Ulm will be organising another international aviation contest in 2011. The technical part of the flight competition for the Berblinger Prize will take place on April 15, 2011 during the AERO Global Show for General Aviation in Friedrichshafen.

Enclosed you will find our latest press release regarding the Berblinger Flight Competition 2011. We would like to ask you to publish the information given in the enclosed press release.

Since 1988, the town of Ulm has been awarding the Berblinger Prize, one of the highest value prizes in the field of general aviation. The prize is synonymous with environmentally sustainable technological development and research at the highest level. For more details on the Berblinger Flight Competition also visit our website at www.berblinger.ulm.de.

Please do not hesitate to contact us for further information. Many thanks in advance for your assistance.

Yours faithfully

Verena Bader
Hauptabteilung Kultur, Stadt Ulm
Frauenstraße 19
89073 Ulm
Telefon (0731) 161-4723
Telefax (0731) 161-1631

(ed. – I have included the announcement material later in this issue. So if you live in the area or are planning a trip to Europe in 2011, you might want to consider making this a stop on your itinerary.)

Press Release June 23, 2010

Berblinger-Prize 2011:
Ulm's Flight Competition is to take place at the AERO Global Show for General Aviation in Friedrichshafen

The town of Ulm and the trade fair organization "Friedrichshafen Messe" have joined forces to stage the Berblinger Flight Competition 2011. The technical part of the flight competition for the Berblinger Prize will take place on April 15, 2011 during the AERO Global Show for General Aviation in Friedrichshafen. The prize is valued at 100,000 €.

In 2011 the town of Ulm will be celebrating the 200th anniversary of Albrecht Ludwig Berblinger's attempt to fly. In May 1811, Berblinger, known locally as „The Tailor of Ulm", attempted to fly across the Danube in a hang-glider he had designed and constructed himself. This visionary, boffin and inventor failed – not because of any shortcomings in his construction but owing to a lack of knowledge of the thermics above the surface of the cold river. In professional circles, Albrecht L. Berblinger has long been regarded as an aviation pioneer. Since 1988, the town of Ulm has been awarding the Berblinger Prize, one of the highest value prizes in the field of general aviation, as a tribute to his work.

The prize is synonymous with environmentally sustainable technological development and research at the highest level. "This approach is eminently suited to the purpose and the international nature of the AERO", said Ivo Gönner, Senior Mayor of Ulm. "This show offers ideal conditions for the competitors and indeed for the competition itself: the event attracts an international forum of specialists, specialist press coverage and aviation enthusiasts from the entire region. The infrastructure is excellent."

Since 2008 AERO has placed particular emphasis on "E-flight" which is continually being expanded. The "E" stands for "Electrical, Ecological, Evolutionary".

Alternative propulsion technologies are presented here not only at the prototype stage but also as models ready for serial production. "With this event we will be forming an "aviation link" between Ulm and Friedrichshafen. We are looking forward to the competition, which fits in very well with our exhibition concept", said AERO project manager Roland Bosch with regard to the cooperation with Ulm.

The aim of the Berblinger Flight Competition 2011 is to promote and demonstrate flight concepts using innovative technologies based on the latest research, knowledge and developments in the field of aviation. The search for the winner(s) will concentrate on practicable, one- or two-seater, person-carrying aircraft using innovative technology and design and/or propulsion. Particular emphasis will be placed on environmental sustainability, economy and safety.

Construction teams working with innovative and environmentally sustainable technologies are invited from all over the world to take part in the competition. An independent jury made up of experts from the aviation and space industry, representatives from universities and research institutes and representatives of the town of Ulm will judge the entries.

The Berblinger Flight Competition 2011 is open to teams from all over the world. Information on the Berblinger Flight Competition and the registration forms are available on the Internet at **www.berblinger.ulm.de**. **Entries** can be submitted until **December 31, 2010**. **Please note: The closing date for final registration** has been brought forward to **March 15, 2011** due to the early date set for the event.

The Senior Mayor of Ulm, Ivo Gönner, will present the Berblinger Prize /the Berblinger Prizes in a special ceremony on Sunday April 17, 2011 in Ulm Town Hall. It is envisaged that all the aircraft taking part in the competition will be exhibited at the same time either in the Market Place or in the Minster Square in Ulm.

Flight Competition for the Berblinger Prize 2011

Venue: Friedrichhafen / Messe Airport

Date: The competition will take place on Fri., April 15, 2011
(alternative date in case of bad weather: Sat., April 16, 2011)
(at the AERO, Friedrichshafen)
Prize-giving ceremony on Sun., April 17, 2011 at 11.00 h
(Town Hall Ulm)

Closing date for preliminary registration including the most important technical details: Fri., December 31, 2010

Closing date for final registration with submission of all documentation: Tue., March 15, 2011

Contact addresses for press representatives:

Stadt Ulm, Hauptabteilung Kultur
Iris Mann
Frauenstr. 19, 89073 Ulm
Tel.: +49 -(0)731/161-4701
Fax: +49 -(0)731/161-1631
E-Mail: i.mann@ulm.de
www.berblinger-ulm.de
www.ulm.de

AERO Friedrichshafen
Wolfgang Köhle
Press Spokesman
Member of the Management
MESSE FRIEDRICHSHAFEN GMBH
Presseabteilung
PO Box 20 80, 88010 Friedrichshafen, Germany
Neue Messe 1, 88046 Friedrichshafen, Germany
Tel.: +49 -(0)7541-708-309
Fax: +49 -(0)7541-708-2309
E-Mail: wolfgang.koehle@messe-fn.de
http://aero-expo.com/

(ed. – The following is the next installment of the technical paper from the 1940's that were sent to us by Steve Torpey in Bakersfield. My thanks to Steve.)

"The Development of All-Wing Aircraft"
by J. K. Northrop

Royal Aeronautical Society Journal (Vol. 51, #438)
June 1947 (RFD# 117122)

CHARACTERISTICS AT HIGH LIFT

The pitching instability of a swept wing at high lift coefficients is by now a somewhat familiar phenomenon. The complete mechanisms involved, however, are still somewhat obscure. There are apparently two opposing effects, which are of prime importance. They are the tendency for sweepback to increase the relative tip loading and also (by creating a span-wise pressure gradient) to promote boundary layer flow toward the tip. On a plain swept-back wing the latter effect apparently nullifies the former, so that there occurs in the tip portion of the wing, a gradual decrease in effective section lift-curve slope with a resulting progressive decrease in stability. This effect is indicated in Fig. 17, which also shows that the tip,

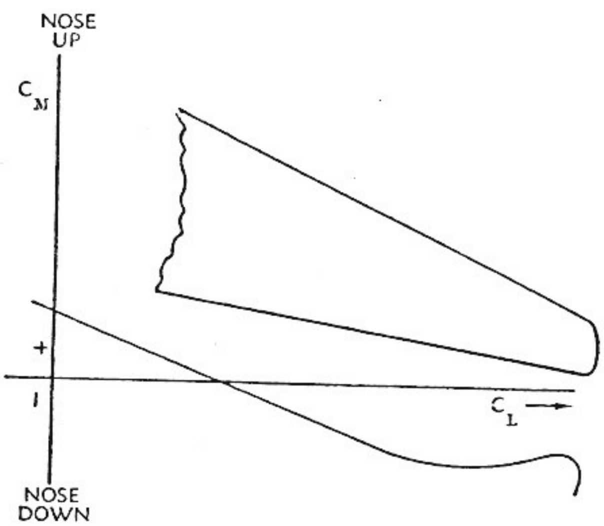


Fig. 17.
Pitching characteristics at high lift of a plain swept-back wing.

under these circumstances never completely stalls, as evidenced by the stable pitching moments occurring at the maximum lift coefficient. On the other hand, as illustrated in Fig. 18, the addition of end plates will prevent to a large extent the effects of span-wise flow, thereby straightening the pitching moment curve but producing the normally-expected tip stall, as evidenced by the strongly unstable moments in the vicinity of the maximum lift coefficient. Thus, any modification to the basic wing, which affects the span-wise flow will have a noticeable effect on the pitching behavior at high lift coefficients.

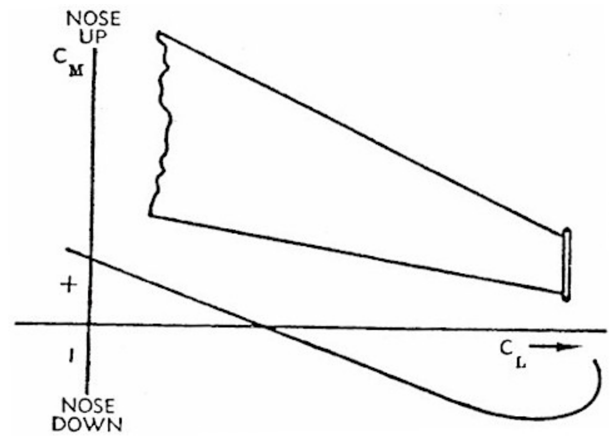


Fig. 18.
Pitching characteristics at high lift of a swept-back wing with end plates.

In the case of the XB-35 the propeller shaft housings act to inhibit span-wise flow and straighten out the moment curve below the stall as in the case of the end plate; but in order to obtain stability at the stall, a tip-slot is provided to increase the stalling angle of the tip sections. These effects are illustrated in Fig. 19, which also shows that by raising the trim flap in the outer 25 percent span and lowering the main flap in the inner 35 percent span, the stability characteristics are noticeably affected, presumably because of a decrease in span-wise pressure gradient and therefore in boundary layer flow.

Recent investigations have indicated that the problem of static longitudinal instability near the stall for plain swept-back wings depends not only on sweep but also on aspect ratio and it now appears that for a given sweepback the magnitude of the unstable break in the moment curve decreases with decreasing aspect ratio, eventually vanishing.

The possibility of controlling the stalled portions of the wing, as outlined, means that trailing edge flap controls can be laid out to maintain their effectiveness at very high angles of attack. Since a certain portion of this flap must be used to provide high lift and roll control, the amount available for longitudinal trim is limited, so that for the XB-35, for example, the total available nose-up pitching moment coefficient is .15 as compared to .30 for a conventional aeroplane. This

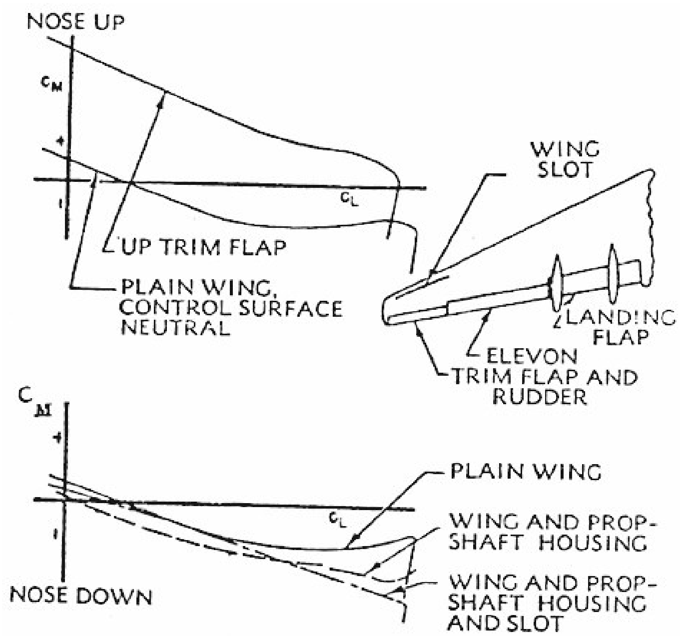


Fig. 19.
Effect of various devices and control surface deflection on XB-35.

limited control plus the fact that the main wing flaps apparently cannot be made self-trimming and impose a diving moment in the landing condition reduces the available C.G. range in percent of the m.a.c. as compared with conventional aeroplanes. The XB-35 has a C.G. range of only 5 percent or 6 percent as compared with conventional values in the order of 10 percent or 12 percent. This comparison is somewhat misleading, however, because the all-wing aeroplane may have a greater comparative m.a.c. in view of its somewhat lighter wing loading. It is also much easier to arrange weight empty and useful load items span-wise within close m.a.c. limits than in conventional types.

Where manual control of the elevator is employed the stick-free stability and control of all-wing aircraft are impaired by separation of the flow from the upper surface of the wing near the trailing edge, causing up floating tendencies at higher lift coefficients. If not corrected these up-floating tendencies lead to stick-free instability and, in some cases, to serious control-force reversal at high lift coefficient. Aerodynamic design refinements devised and tested by us to date have not provided a satisfactory solution to the up floating tendency. For small aeroplanes these undesirable forces can sometimes be tolerated, but for large aircraft the only solution found so far has been the employment of irreversible full power-driven control surfaces.

LATERAL STABILITY DERIVATIVES.

It is when considering the lateral stability and control factors that the difference between the all-wing and conventional aeroplanes becomes most apparent. Figure 20 compares the XB-35 factors with those of a conventional aeroplane. It is reassuring to state that despite the large differences apparent, the dynamic lateral behavior of the XB-35 type is quite satisfactory, as will be discussed later.

Definite requirements for the weathercock stability $C_{l\beta}$, depend to a large extent on the aeroplane's purpose, but positive weathercock stability is always required. The swept-back wing has inherent directional stability, which increases with increasing lift coefficient; but this is not considered sufficient for satisfactory flight characteristics under all circumstances and must be supplemented by some additional device. The wing-tip fin has been favored by some since it gives the largest yawing lever arm and provides a suitable rudder location. However, as previously pointed out, wing-tip fins may be unsatisfactory at the stall. For the XB-35 configuration, effective fin area is provided in large measure by the side force derivative of the pusher propellers.

Derivative (per radian)		XB-35 $C_L = 0.3$	XB-35 $C_L = 0.6$	Conventional $C_L \sim$ Cruise
$C_{n\beta}$	Weathercock Stability	0.020	0.026	0.060
$C_{l\beta}$	Effective Dihedral	– 0.029	– 0.057	– 0.070
$C_{y\beta}$	Sideforce	– 0.050	– 0.075	– 0.600
C_{nr}	Damping in Yaw	– 0.007	– 0.010	– 0.080
C_{np}	Yaw Due to Rolling	– 0.011	– 0.022	– 0.050
C_{lr}	Roll Due to Yawing	0.06	0.12	0.15
C_{lp}	Damping in Roll	– 0.44	– 0.44	– 0.45

Fig. 20.
Comparison of lateral stability derivatives for XB-35 and conventional aircraft.

RUDDER DEVELOPMENT.

Rudders for all-wing aircraft are perhaps the chief control difficulty. Unless large fins are used a conventional rudder cannot be employed. If large fins and rudders are used, an objectionable adverse side force due to rudder is inherent, since the rudder moment arm is small and the side force comparatively great.

The use of pure drag rudders is feasible on the all-wing type because it is not necessary from a performance standpoint to fly at zero yaw. Thus in the case of an engine failure equilibrium conditions involving a yaw angle and the resultant corrective yawing moment do not involve appreciable side forces and associated bank angles, nor noticeable drag increases. Thus the rudder is used only rarely for trim and its drag is therefore unimportant.

Of the many types of drag rudder investigated, a simple double-split trailing-edge flap at the wing tip has been found to have the most satisfactory all-round characteristics. This arrangement permits the simplest construction and allows combination of trim flap and rudder in the same portion of the trailing edge. One disadvantage of this type is its comparatively low effectiveness at low angles of rudder deflection, which may be remedied by the employment of a non-linear pedal-to-rudder linkage in the case of power-operated rudders.

EFFECTIVE DIHEDRAL.

Considering now the effective dihedral $C_{l\beta}$ it is apparent that sweepback is the essential difference between the all-wing and conventional aeroplanes—a difference that will disappear as flight speeds increase and it becomes necessary to employ the desirable high-speed characteristics of swept wings in conventional tailed configurations. For swept-back wines $C_{l\beta}$ increases quite rapidly with lift coefficient which gives difficulty only when its value becomes too large. It is unimportant for either flight ease or for dynamic stability and control characteristics when it is near zero. Flight ease may indicate that a slightly positive effective dihedral is desirable while dynamic considerations point toward a slightly negative dihedral. Our practice has been to retain positive effective dihedral over the complete flight range.

ROLL CONTROL.

The rolling control for all-wing aeroplanes is essentially normal. When elevons are used rather than separated aileron and elevator control, certain variations from conventional craft appear, in that, with the upward elevator deflection required for longitudinal trim, the adverse yaw ordinarily due to aileron deflection disappears. On the other hand, if large up-deflections are required for longitudinal trim, the up-going elevon used as aileron loses effectiveness rapidly, thus reducing the available roll control at high lift coefficients. This is particularly undesirable when considering the increased dihedral effects of swept wings at high lift coefficient.

SIDE FORCE EFFECTS.

All-wing aeroplanes, particularly those without fins, have a very low cross-wind derivative; thus a low side force results from side-slipping motion. Some cross-wind force is probably important for precision flight, such as tight formation flying, bombing runs, gun training, maneuvers, or pursuit. This importance arises because with low side force it becomes difficult to judge when sideslip is taking place, as the angle of bank necessary to sustain a steady side-slipping motion is small. This lack of side force has been one of the first objections of pilots and others when viewing the XB-35. After flying in the N9M or XB-35 the objection is removed, except for some of the specific cases mentioned above. For the correction of the lack of sideslip sense, a sideslip meter may be provided for the pilot or automatic pilot, and for very long-range aircraft there is a valuable compensating advantage in being able to fly under conditions of asymmetrical power without appreciable increase in drag.

DYNAMIC LONGITUDINAL STABILITY.

The free longitudinal motions of any aeroplane fall into two modes. The first of these is the short-period oscillation. It is highly damped for conventional aeroplanes and also for all-wing aeroplanes in spite of the relatively low pitch-damping, C_{mq}. This somewhat surprising result is due to a coupled motion such that the vertical damping, Z_w, comes into play absorbing the energy from the oscillation. Also, low moment of inertia in pitch makes the small existing C_{mq} more effective than a similar value would be in conventional types. In tests on the N9M aeroplane this short-period oscillation was too rapidly damped to obtain a quantitative check. The combination of low static stability in pitch, as previously described, and low moment of inertia in pitch results in periods of oscillation for all-wing aeroplanes that are comparable to those of conventional types.

The second mode of longitudinal motion is a long-period oscillation commonly called the phugoid. This is a lightly damped motion even for conventional aeroplanes, and seems slightly less damped for all-wing aeroplanes, because of the fact that they have relatively low drag, and drag is the chief means of energy absorption in this mode. N9M tests indicate that calculation is slightly optimistic in this matter, but still this phugoid motion is sufficiently damped so as to give no serious difficulties. Being a slow motion, it is easily controlled.

To date the criteria for the description of aeroplane dynamic stabilities are vague. In the past it has been thought that consideration of damping rates and periods of oscillatory motion were adequate, but it has become evident that some further criteria are necessary. Consideration of the angular response of aeroplanes to various unit disturbances may supply this need.

DYNAMIC LONGITUDINAL RESPONSE

The criterion of response is probably the only category in which the flying wing is importantly different from the conventional aeroplane for longitudinal motion. The action of the two types in an abrupt vertical gust is especially interesting, two factors combining to reduce the accelerations experienced by all-wing aeroplanes. These factors are the relatively larger wing chord and shorter effective tail length of the all-wing type. The first characteristic increases the time for the transient lift to build up and is the more important in reducing accelerations. The second decreases the time interval between the disturbing impulse at the lift surface and the correcting impulse at the effective tail, so that the aeroplane tends to pitch into the gust. This latter characteristic is a matter of concern to pilots, since a disturbance in the air is likely to leave them farther from trim attitude, consequently requiring more active pilot control in rough air. It is believed, however, that automatic control will effectively eliminate this difficulty.
The response of the all-wing aeroplane to elevator deflection seems entirely adequate. It errs, if at all, on the side of over-sensitivity because of low C_{mq} and low moment of inertia in pitch. Fig 21 illustrates this effect.

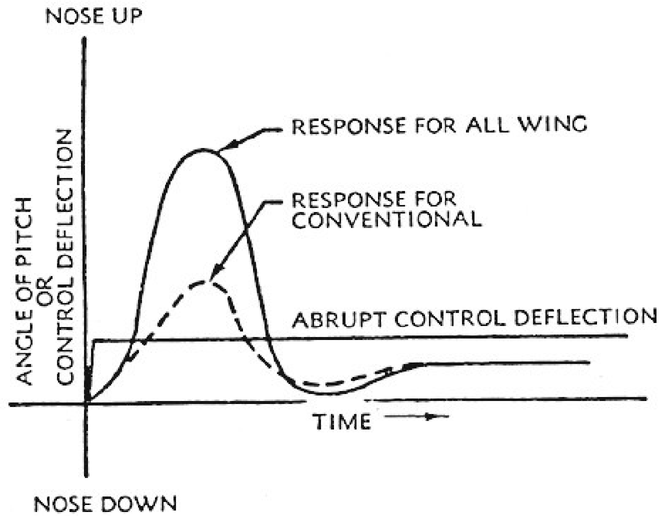


Fig. 21
Response of all-wing and conventional aeroplanes in elevator control.

As is seen from the curves, an abrupt control movement giving the same final change in trim speed for a conventional and a comparable all-wing aeroplane results in a larger initial swing in pitch for the all-wing.

DYNAMIC LATERAL STABILITY.

As with longitudinal motion, there are two characteristic modes that are of interest laterally. The first of these is the spiral motion, which is usually divergent on modern aeroplanes, thus uncontrolled flight results in a tightening spiral. This slight instability seems favored by pilots. All-wing aeroplanes have readily acceptable characteristics in this mode requiring from 15 to 20 seconds to double amplitude. In general, any time greater than five seconds to double amplitude is considered acceptable.

The second mode, the "Dutch Roll" oscillation, is more critical for all-wing aeroplanes, particularly at low speed, high weight and high altitude. All-wing aero-planes seem comparatively bad in this respect because of the combination of relatively large effective dihedral and low weathercock stability and, for the conditions noted above as critical, are likely to approach neutral damping in the Dutch Roll mode. However, analytical determinations of this motion, using calculated damping derivatives, indicated less satisfactory characteristics than were obtained in actual flight tests. Because of a relatively low weathercock stability, the Dutch Roll is of a rather long period, in the order of ten seconds for the XB-35. It is usually assumed that for periods of such length, it is not important to have a high rate of damping since control would seem easily "inside" the motion. However, there may be particular instances where this is not true. For instance, in an all-wing aeroplane in which the rudder is particularly weak, the time of response to rudder control may be of the same order as the period of Dutch Roll motion. This would make directional control extremely difficult in a condition, such as landing, where the roll controls are not usable for changing heading. It is notable that for the very low weathercock stability commonly encountered in all-wing aeroplanes, the conventional solution of increasing weathercock stability to offset increased dihedral does not hold. Increasing C_{nr}, leaves the damping essentially untouched, but reduces the period and increases the number of cycles required to damp.

Another factor contributing, to the relative lack of damping of all-wing aeroplanes in Dutch Roll motion is the low value of the damping coefficient in yaw, C_{nr}. This appears to be inherent in all-wing designs, particularly if the use of fins is abandoned. For special occasions, when particular aeroplane steadiness is required (such as a bombing run), it is probable that the equivalence of such damping in yaw may be supplied by an automatic pilot, or by temporarily increasing the drag at the wing tips. This latter effect can be accomplished on the XB-35 by simultaneously opening both rudders and gives deadbeat damping in yaw.

DYNAMIC LATERAL RESPONSE.

As in the longitudinal motions, the amplitudes of response of an aeroplane in lateral motion are probably as important as the damping rates in determining free-flight characteristics. All-wing aeroplanes seem slightly rougher in turbulent air than conventional aircraft of similar weight. This is due chiefly to the reduced wing loading, but high effective dihedral and low weathercock stability may have an added effect. This is a matter of interest in fixing upon analytical criteria for the description of free-flight qualities. As mentioned above, increasing the weathercock stability for all-wing aeroplanes has a slight effect on the damping rates; however, it affects the amplitudes of response to gusts materially.

Some data from the free-flight tunnel of the National Advisory Committee for Aeronautics indicate that increasing weathercock stability, even for all-wing aeroplanes, materially helps the "flyability" of the aeroplane. Another bit of evidence that is of interest in this connection has to do with the magnitude of the side force derivative, $C_{y\beta}$. Increase of this parameter improves Dutch Roll damping very materially but has virtually no effect on amplitude of response to gusts, according to calculations. Free-flight wind tunnel data again give tentative support to the investigations of response as a criterion by showing little improvement of flight qualities of models with increase of $C_{y\beta}$.

Flight tests of the all-wing glider shown in Fig. 10, in which the vertical fin, located aft on the ship's centre line, was varied in size from approximately 2 to 7 per cent. of the wing area, left the pilot somewhat undecided as to fin requirements except that the larger fin seemed somewhat easier to fly. Presumably, this was, in the light of the foregoing discussion, primarily because of the increased $C_{m\beta}$, the coincidental increase in $C_{y\beta}$ not being effective.

AUTOMATIC PILOT CONTROL.

The application of automatic pilot control to an all-wing aeroplane has certain difficulties, which are associated primarily with the low value of $C_{y\beta}$. In conventional applications the fact that the aeroplane is side slipping is detected by either a lateral acceleration or an angle of bank. In an all-wing aeroplane neither of these indications exists except in an almost undetectable amount. Accordingly, it is necessary, in order to fly the aeroplane at zero sideslip, and therefore in the direction of its centre line, to provide a yaw-vane signal to which the pilot or automatic pilot will respond. This introduces some difficulty in automatic pilot design because for small disturbances the sideslip angle with respect to the wind, and the yaw angle with respect to a set of fixed axes, are nearly equal and opposite for a flying wing. The customary automatic pilot control on azimuth angle therefore tends to oppose the necessary control on sideslip. To avoid this difficulty it is necessary only to reduce the rate of control on sideslip to approximately one-third that on azimuth. This modification to a conventional automatic pilot was flown on the N9M with complete success.

PROBLEMS OF CONFIGURATION--
SWEPT vs. NON-SWEPT WINGS.

Let us now turn to a consideration of the practical limitations in arrangement of the tailless aeroplane. They may be summarized briefly as sweep-forward, sweep-back, and a non-swept wing configuration. The sweep-forward arrangement requires the use of a large fixed load forward of the leading edge at the centre section for proper balancing of the aeroplane. Therefore, a fuselage with some substantial part of the weight empty of the aeroplane disposed therein is required. The swept-forward wing itself is unstable directionally and requires some type of fin for weathercock stability. To this must be added more fin area to stabilize the fuselage. In addition, it may be noted that the moment arm of the fin about the C.G. of the aeroplane is necessarily comparatively small, still further increasing the size of the required fin. If we add to the aerofoil a protruding fuselage and an unusually large vertical tail surface, we have departed from our basic all-wing concept. We have incorporated virtually all the elements of drag found in the conventional aircraft and have not accomplished our intent of improving efficiency. For the above reasons, which could be argued pro and con for hours, our company has done no active design and development work on aeroplanes with swept-forward wings.

An all-wing configuration embodying a straight, or non-swept wing, has been proposed and flown successfully in model sizes. It offers the serious disadvantage that suitable distribution of weight empty and useful load items is difficult and, if proper balance is to be accomplished, most of the structural weight and useful load must be included in the forward 30 percent or 40 percent of the wing, leaving a large volume of space within the wing unusable. Such a configuration results in an unnecessarily large aeroplane to accomplish a given job and for this reason has not been considered seriously.

The swept-back arrangement exemplified by the various aeroplanes previously illustrated and described seems to offer the best configuration for a materialization of our all-wing ideal. It can be balanced satisfactorily within quite wide ranges of sweep-back, utilizing almost all available volume within the wing for storage of useful load items. It seems to fly satisfactorily in many different configurations and the arrangement is such that large payloads can be carried virtually over the C.G., with the weight empty items so distributed as to cause little variation in C.G. position between the fully loaded and empty conditions.

WEIGHT DISTRIBUTION.

As has been pointed out previously, the permissible range of C.G. location is not overly critical in this type of aeroplane. It is, nevertheless, of great advantage to be able to load the aeroplane almost at will, without concern as to how the useful load is disposed and the swept-back configuration lends itself most suitably to such loading.

In the case of the XB-35, the useful load, consisting largely of bombs and fuel, can be readily disposed in suitable position about the C.G. While some fuel is located well forward and other fuel well aft of the desired C.G. location, under normal operating conditions the proper balance is readily maintained. In case of failure of one or more engines, it is necessary to pump the fuel from unused tanks to those supplying the remaining engines, but a simple manifolding system provides this facility.

Based on a great many studies of various types and applications of the all-wing principle, some practical limitations maybe approximately defined. Where very (high specific gravity) payloads are contemplated, such as warheads or similar munitions, quite small units are practical as demonstrated by the all-wing buzz bomb to which reference has been made. Medium-sized units having a span of perhaps 100 ft and a gross weight of 50,000 to 60,000 lbs appear entirely practical for medium bomber, and freighters. Here again the density of the useful load, both in payload and fuel, is comparatively high.

Aeroplanes designed to carry people need the largest volume of all. Even individual reclining chair accommodations require a minimum space of perhaps 40 cubic ft. per passenger, which is a density of only about 5 lb. per cubic ft. This is one-half to one-quarter the density of typical air cargo, and only 4 percent or 5 percent of the density of a warhead.

IMMEDIATE APPLICATIONS — ALL-WING AIRCRAFT.

It may be concluded, then, that the all-wing, design is immediately applicable and practical for a number of military and cargo-carrying versions, and that the passenger-carrying aircraft are likely to be of rather large size and, in the immediate future at least, will provide only comfortable seating instead of the more luxurious appurtenances associated with long-range ocean travel.

An aeroplane of the XB-35 configuration and size can carry 50 passengers in comfort in the existing aerofoil envelope with adequate headroom for all, and with vision forward through the leading edge, downward through windows in the floor, and upward if desired. Passenger vision in a flying wing may be more satisfactory than in conventional types if we get used to the idea of forward vision rather than that provided by side windows. The really interesting views are likely to be forward and downward rather than to the side. An aeroplane like the XB-35 will have cargo space for 40,000 to 50,000 lbs. of airfreight at a density of 10 to 15 lbs. per cubic ft., in addition to the necessary crew and space for 50 passengers.

AVAILABLE PLANS & REFERENCE MATERIAL

Coming Soon: <u>Tailless Aircraft Bibliography</u>
Edition 1-g

Edition 1-f, which is sold out, contained over 5600 annotated tailless aircraft and related listings: reports, papers, books, articles, patents, etc. of 1867 - present, listed chronologically and supported by introductory material, 3 Appendices, and other helpful information. Historical overview. Information on sources, location and acquisition of material. Alphabetical listing of 370 creators of tailless and related aircraft, including dates and configurations. More. Only a limited number printed. Not cross referenced: 342 pages. It was spiral bound in plain black vinyl. By far the largest ever of its kind - a unique source of hardcore information.

But don't despair, Edition 1-g is in the works and will be bigger and better than ever. It will also include a very extensive listing of the relevant U.S. patents, which may be the most comprehensive one ever put together. A publication date has not been set yet, so check back here once in a while.

Prices: To Be Announced

Serge Krauss, Jr. skrauss@earthlink.net
3114 Edgehill Road
Cleveland Hts., OH 44118 (216) 321-5743

Books by Bruce Carmichael:
Personal Aircraft Drag Reduction: $30 pp + $17 postage outside USA: Low drag R&D history, laminar aircraft design, 300 mph on 100 hp.
Ultralight & Light Self Launching Sailplanes: $20 pp: 23 ultralights, 16 lights, 18 sustainer engines, 56 self launch engines, history, safety, prop drag reduction, performance.
Collected Sailplane Articles & Soaring Mishaps: $30 pp: 72 articles incl. 6 misadventures, future predictions, ULSP, dynamic soaring, 20 years SHA workshop.
Collected Aircraft Performance Improvements: $30 pp: 14 articles, 7 lectures, Oshkosh Appraisal, AR-5 and VMAX Probe Drag Analysis, fuselage drag & propeller location studies.

Bruce Carmichael brucehcarmichael@aol.com
34795 Camino Capistrano
Capistrano Beach, CA 92624 (949) 496-5191

VIDEOS AND AUDIO TAPES

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

VHS tape containing First Flights "Flying Wings," Discovery Channel's The Wing Will Fly, and ME-163, SWIFT flight footage, Paragliding, and other miscellaneous items (approximately 3½+ hours of material).
Cost: $8.00 postage paid
Add: $2.00 for foreign postage

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 (<u>B</u>rochocki,<u>K</u>asper,<u>B</u>odek) 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
Add: $2.00 for foreign postage

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 Paul MacCready's presentation on March 21,1998, covering his experiences with flying wings and how flying wings occur in nature. Tape includes Aerovironment's "Doing More With Much Less", and the presentations by Rudy Opitz, Dez George-Falvy and Jim Marske at the 1997 Flying Wing Symposiums at Harris Hill, plus some other miscellaneous "stuff".
Cost: $8.00 postage paid in US
Add: $2.00 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

FLYING WING SALES

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.

U.S. Pacific (559) 834-9107
8104 S. Cherry Avenue mitchellwing@earthlink.net
San Bruno, CA 93725 http://home.earthlink.net/~mitchellwing/

COMPANION AVIATION PUBLICATIONS

EXPERIMENTAL SOARING ASSOCIATION

The purpose of ESA is to foster progress in sailplane design and construction,which will produce the highest return in performance and safety for a given investment by the builder. They encourage innovation and builder cooperation as a means of achieving their goal. Membership Dues: (payable in U.S. currency)

United States	$24 /yr	Canada	$40 /yr
So/Cntrl Amer.	$40 /yr	Europe	$45 /yr
Pacific Rim	$50 /yr	U.S. Students	$18 /yr

(includes 4 issues of <u>SAILPLANE BUILDER</u>)

Make checks payable to: Sailplane Homebuilders Association, & mail to Murry Rozansky, Treasurer, 23165 Smith Road, Chatsworth, CA 91311.