No. 217 JULY 2004

T.W.I.T.T. NEWSLETTER

Eric du Trieu de Terdonck holding what looks like an electric powered model of the Northrop N-9M. I think this is from a model shop in Bad Oeynhausen, Germany that he wrote about back in June 2001. For more on the N-9M, see Dr. Hallion's article beginning on page 7.

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., **0407** means this is your last issue unless renewed.

Next TWITT meeting: Saturday, July 17, 2004, 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).

TWITT

THE WING IS THE THING

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
Secretary: Phillip Burgers (619) 279-7901
Treasurer: Bob Fronius (619) 224-1497
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) 596-2518 (10am-5:30pm, PST)
(619) 224-1497 (after 7pm, PST)
E-Mail: twitt@pobox.com
Internet: http://www.twitt.org
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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).

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PRESIDENT'S CORNER

Where does the time go? It is nearly meeting time again and I am happy that we have a speaker for you this month. I hope you have your calendar marked and will be there to hear John Seelig's presentation on construction techniques used in building his LP-49.

This issues finishes the NACA paper on the Cornelius XFG-1 Glider, and does the next installment in the Dr. Richard P. Hallion's article on the history of flying wings from 1986. It will take at least two more issues to get this piece done without it taking a majority of the newsletter in any one month.

Well, I finally got to do some work on the website I had talked about for many, many months. I have gone through the various link pages and eliminated those that no longer take the user to a valid page. Although it reduced the number of items available, I am searching the Internet looking for new ones to replace them, or find new links to previous pages. This should be a continuous project over the next couple of months, so come back from time to time and check for updates. I will put the little green icon and/or a date that an update was done on the home page link to help you determine what to look at when you open it.

It is soapbox time again, since I haven't received many letters or e-mails with something to share with the membership. I appreciate the short notes with your renewals, but I could sure use something more substantial in terms of projects, including pictures, or articles on some aspect of flying wing design. I am sure many of you have questions about design or construction elements, so send them in so we can get responses from other members to help you along. This way everyone learns new things they can apply to their project, which in turn may generate more questions. This is your organization, so make the most of it.

Andy

JULY 17, 2004 PROGRAM

The program this month will feature **John Seelig** who will be doing a presentation on construction techniques he used in building a Laister LP-49 sailplane. Since this is a homebuilt effort, his trial and errors should be of interest to our members as they look into doing their own projects.

To continue with John's background from last month, he became Vice-President of G.M. Robertson Corporation, designers and builders of projects for the U.S. Naval Civil Engineering Corps. Following resignation from the firm I entered consulting for numerous engineering contractors engaged principally in Naval CEC and US Army Corps of Engineers projects. In all, 21 years in Engineering and Construction. In 1996 he completed his last Navy project. He was mechanical, civil project manager under consulting contract for the Fire Fighting Training Facility, Fleet Training Center, Naval Station 32 St., San Diego. (Project cost 30 Million. "It was fun while it lasted - Contracts are a bit like women. It's great when it starts. It's great when it's over... It's that stuff in between that can be the pits, but that is what building anything right is all about".)

The LP-49 won 1st Place at the 1986 EAA Friendly Fly In and SHA 1987. The LP is based here at Warner Springs. He flew commercially for Sky Sailing on weekends beginning in 1989. Having left the engineering business he began Flight Instructing for Sky Sailing four years ago. He is currently building a Schreder HP-18 and flying the friendly skies...students in tow..."Guess I'll never learn."

LETTERS TO THE EDITOR

June 15, 2004

Hi Guys,

Just discovered your site! Seems like it contains a wealth of knowledge!

I am currently working in Papua New Guinea. If I send you a cheque (U.S. $20) from my bank in Ft. Smith, AR, would you be able to send the newsletter to an address there AND make it possible for me to access your site from over here (We have to bulk ship magazines/newsletter to prevent problems).

Let me know what I can do to facilitate things from this side of the Pacific.

Yours for safe flying,

John Relyea
<j-m.relyea@sil.org.pg>

(ed. – Since this message we have worked out the details and John is now a new member. We hope he enjoys the information in the coming newsletters when they finally reach him out in the Pacific, and that he finds time to continue working his way through the website, especially as I get it updated.)

June 19, 2004

Hi Henry—(Whittle – June Letters)

The test results of the X-4 are discussed in "On The Frontier: Experimental Flight at NASA Dryden". It describes the high-speed pitch instability of the X-4 and the modifications they (NACA) tried to make it safe to go faster than 0.92M. Ultimately they were unsuccessful. This may be what destroyed the DH-108.

This PDF may cover everything relative to the X-4 in "On The Frontier"
http://naca.larc.nasa.gov/reports/1950/naca-rm-a50i01/

In "Tailless Aircraft in Theory and Practice" the authors say there are two phenomena. The normal short period pitch oscillation (alpha-oscillation) and something peculiar to flying wings they call "pecking". I'm not clear on the distinction but I think they're saying that "pecking" is a flutter mode in which the alpha-oscillation frequency gets close to the spar bending frequency. Interestingly they relate the alpha oscillation to sweep angle, saying that it almost never occurs in planes with sweep angles greater than 20 degrees (I assume that means it's well damped by the greater sweep).

Both books are a bit pricey and only a small part of "On The Frontier" is specific to flying wings. You should be able to get them both through interlibrary loan.

Norman Masters
<nmasters@acsol.net>

(ed. – This seems like an appropriate answer to include from Norm, since there is more in Dr. Hallion's article on page 7 that talks about the X-4 and some of its shortcomings.)

June 27, 2004

TWITT:

First, I have your address and will be sending a check for dues for TWITT.

Next, all my life I have had a great interest in flying wing aircraft. I have restored different types of airplanes and am know ready to do a flying wing. I need a powered type because most of my flying is done by myself.

My question. Is there a powered flying wing out there in plan or kit form? Also, would you send me a phone number where I could talk with someone about your organization. Also, the best time to call.

Thank you and I look forward to your reply.

John D. Patten
JPPatten@aol.com

(ed. – I sent John the contact information for Richard Avalon for the Mitchell wings, the B-10 and U-2, since those are the only powered wings I know of where you can currently get kits or plans. If anyone has other information on kits, plans, fully built flying wings that might be of interest, please pass it along to John so he has more choices. If you do send him some information, please make sure to include TWITT as an addressee in any e-mail so we can add it to our information base.)

NACA LANGLEY MEMORAIL AERONATUICAL LABORATORY MEMORANDUM REPORT

For the Air Technical Service Command, Army Air Forces MR No. L5K21

FREE-SPINNING, LONGITUDINAL-TRIM, AND TUMBLING TESTS OF 1/17.8 SCALE MODELS OF THE CORNELIUS XFG-1 GLIDER

By Ralph W. Stone, Jr., and Lee T. Daughtridge, Jr.

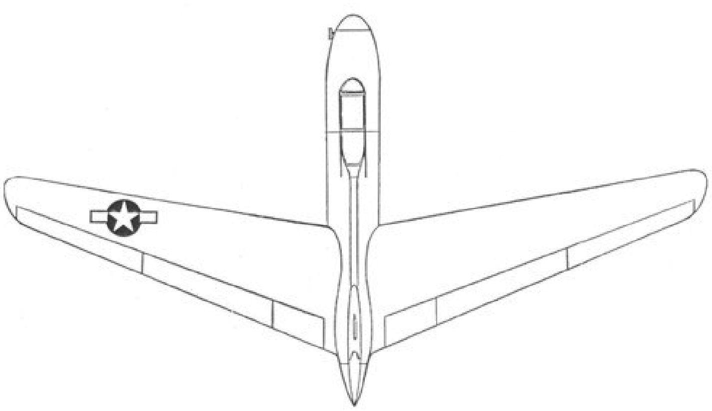
(ed. – This is the last part of this article started last month.)

Mass Variations – These results are somewhat similar to those obtained with the model in the normal minimum flying weight condition. After being launched in a spinning attitude, the model usually went into a flat stalled attitude, oscillatory about all three axes sometimes with rotation about the vertical spinning axis and sometimes with little or no rotation about the vertical axis. The rotation was stopped by rapid rudder reversal, but the model remained in a stalled glide when the elevators were up or neutral. Results of longitudinal-trim tests indicated that movement of the elevator to the full-down position (20º) after rotation had ceased would have undoubtedly pitched the model into a steep dive.

Center of Gravity Movements – When the center of gravity location was 5% of the mean aerodynamic chord rearward of normal, the spin and recovery characteristics were similar to those with normal center of gravity positions, except that when the elevators were only 10º down, the model remained in a stalled glide after rudder reversal. The longitudinal-trim tests indicated that the model would recover from this stalled glide if the elevators were moved 20º down.

When the center of gravity was moved 5º of the mean aerodynamic chord forward of normal the spins were oscillatory and relatively steep when the elevators were neutral or down, but recoveries by rudder reversal were unsatisfactory. The steep attitude of these spins apparently made the rudder ineffective because of shielding of the rudder by the wings and for this reason it is not considered advisable to spin the glider with the center of gravity forward of normal. Recovery may be effected in this loading by holding the elevators full up, reversing the rudder to stop rotation, and after the rotation has stopped, fully reversing the elevator to dive out of the stalled glide.

Inverted Spins – For inverted spins, the designations of the control configurations are different from those used for erect spins. "Controls together" means that when the right rudder pedal is forward the stick is to the pilot's right, and "controls crossed" means that when the right rudder pedal is forward the stick is to the pilot's left. When the controls are together in an inverted spin, the ailerons oppose the rolling motion; when the controls are crossed, the ailerons aid the rolling motion. The model would spin only with the controls crossed and the stick forward for the developed spin. Rapid full rudder reversal stopped the spinning rotation; the model, however, remained in a flat inverted position. Movement of the stick full back would pitch the glider from this flat inverted glide, but results indicate that care should be exercised to avoid entering an erect spin when the stick is moved full back. For the other control configurations, the model motion was very oscillatory and the model went into an inverted glide or dive with stick forward and into an erect position with stick neutral and back even though the rudder was held full with the spin.



In general, the spin tests fully loaded were quite similar to those of the model in the minimum flying weight condition for both erect and inverted spins.

Spin Recovery Parachute Tests – The results of tests to determine the optimum size of, and towline length for, spin recovery tail parachutes indicate that a 4.5' (flat circular) tail parachute with a 27' towline will produce satisfactory recoveries for the minimum flying weight condition. A 7.5' diameter tail parachute with 27' towline will be satisfactory for the fully loaded condition. These results are based on tests with silk parachutes having a drag coefficient of approximately 0.7.

Longitudinal-Trim Tests – The results of the longitudinal-trim tests appear to be in good agreement with the results of the spin tests. When the center of gravity was at the normal location (14º MAC) the model trimmed only at positive angles of attack when the elevators were full up and only at negative angles of attack when the elevators were don 10º. However, when the elevators were only 7.5º down, the model trimmed at both negative and positive angles of attack, and from the results it appeared that a down-elevator setting of 10º was barely enough to prevent trim conditions at a positive angle of attack. Trim in the normal flight range of angles of attack could not be obtained with the elevators neutral. Brief force tests in the Langley free-flight tunnel indicated that the spin-tunnel model would trim in the normal flight range of angles of attack only with small down-elevator settings. The free-flight tunnel tests showed an earlier stall and an upward shift of the pitching-moment curves in the positive direction, and indicated that small elevator-down deflections were needed for trim in the normal flight range. Additional longitudinal-trim tests with small elevator-down settings showed the tendency to trim in the normal flight range for the spin-tunnel model.

The position of the spoilers and disposition of the landing gear had no effect on the general trimming characteristics of the model with the center of gravity located at 14º of the mean aerodynamic chord.

When the center of gravity was located at 19º of the mean aerodynamic chord and the landing gear was off, the results indicate that more than 20º of down-elevator is necessary in order to prevent the model from trimming at relatively large positive angles of attack for this condition. Otherwise, the results of the trim tests with the center of gravity moved rearward of normal were very similar to those with the center of gravity at the normal location.

Tumbling Tests: Minimum Flying Weight Condition – The model that was released without initial rotation from a nose-up position to simulate a whip-stall condition. It did not tumble for any control configuration, but executed a series of extreme oscillations in pitch during which the mode would pitch through almost ±180º measured from the nose-down attitude. An attempt was made, by means of the film records of these tests, to determine if these oscillations damped out. No damping effect could be observed in the short distance the model had to fall before hitting the safety net (approximately 12 feet).

For all conditions tested, the model continued to tumble in a positive (nose up) direction when the elevators were up and in the negative (nose down) direction when the elevators were down. The model stopped tumbling, however, when the elevators were set against the pitching motion. With the elevators neutral, the model continued to tumble in either direction when the landing gear was on and the spoilers were retracted when the center of gravity was normal or 5% of the mean aerodynamic chord rearward of normal. For the normal center of gravity location, when the landing gear was on and the spoilers were extended, the model would tumble in the negative direction with the elevators neutral. Similarly, the model would tumble in the negative direction with neutral elevator when the landing gear was off and the spoilers were closed. When the center of gravity was 5% of the mean aerodynamic chord forward of normal, however, the model would not tumble with elevators neutral.

Fully Loaded Condition – For the tests of tumbling in the fully loaded condition, the model was given initial rotation about the wing axis. The model stopped tumbling when the elevators were set against the rotation, but generally, continued to tumble for other elevator positions. The results obtained were generally similar to those obtained with the model in the minimum flying weight condition (with pilot and landing gear).

CONCLUSIONS

Based on the results of tests of 1/17.8 scale models of the XFG-1 glider, the following conclusions regarding the spin and recovery and tumbling characteristics of the glider at a test altitude of 15,000 feet have been made:

1. The motion of the glider in a spin will be oscillatory about all three axes. The rotation can be terminated satisfactorily by reversing the rudder, but the elevator must also be moved to a down position of 20º to insure nosing down from the stalled attitude. Care should be exercised by the pilot, however, in order to avoid entering an inverted spin.

2. Extending the spoilers will decrease the oscillations and cause the glider to stop rotating when the elevators are up or neutral even if the rudder is held full with the spin.

3. Jettisoning the landing gear or moving the center of gravity 5% of the mean aerodynamic chord forward or rearward of normal will have an adverse effect on recovery characteristics.

4. Increasing the wing dihedral or varying the mass distribution moderately will have no appreciable effect on the spin and recovery characteristics.

5. The glider will spin inverted only when the stick is forward. The rotation can be stopped satisfactorily by reversing the rudder, but the stick must be moved back to insure nosing out of the stalled inverted position. Care should be taken to avoid entering an erect spin when the stick is moved full back.

6. A 4.5' diameter silk parachute with a 27' towline for the minimum flying weight condition, and a 7.5' diameter silk parachute with a 27' towline for the fully loaded condition will give satisfactory recoveries by parachute action alone.

7. The glider will tumble, but the tumbling motion can be stopped by deflecting the elevators against the rotation.

Langley Memorial Aeronautical Laboratory
National Advisory Committee for Aeronautics
Langley Field, VA

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1. Zimmerman, G.H.: Preliminary Tests in the NACA Free-Spinning Wing Tunnel. NACA Rep. No. 557, 1936.

2. Seidman, Oscar, and Neihouse, A.I.: Comparison of Free-Spinning Wind Tunnel Results with Corresponding Full-Scale Spin Results. NACA MR, Dec. 7, 1938.

A SYNOPSIS OF FLYING WING DEVELOPMENT, 1908 - 1953

By Dr. Richard P. Hallion
Air Force Chief Historian

History Office
Air Force Flight Test Center
Edwards AFB, CA 93523-3000
January 9, 1986

(Reprinted with the permission of Dr. Richard P. Hallion, June 3, 2004)

It is curious why the Komet, a markedly unsuccessful aircraft, should have had such great (though brief) postwar influence upon aircraft designers. In part it may have been psychological – a tendency of the victors to credit the vanquished with greater technical perspicuity and acumen than they, in fact, had possessed. In the immediate post-1945 climate, anything that seemed to have been of interest to the Nazi regime took on immediate technical significance to Allied Intelligence teams, and many designers pursued some of the wilder ideas to stem from the conjurer's shop mentality that had afflicted Nazi R&D. The Komet proved no exception to this rule. Great Britain developed the DeHavilland D.H. 108 Swallow, a tailless aircraft bearing a marked similarity to the Komet. In September 1946, it broke up during a divergent longitudinal pitch at approximately Mach 0.87, killing its test pilot. Two other Swallows faired equally badly, one in a similar craft, and one in a low-speed spin. One of the few fortunate surviving test pilots judged the craft with typically British understatement as "rather malignant." (1)

ABOVE: De Halliland D.H. 108 Swallow. Does look like a larger version of the Me 163 Komet from this angle.

In the United States, Northrop produced a specialized tailless configuration demonstrator, the X-4. Though its test program was much better managed than that of the Swallow, the X-4 possessed equally poor behavior, having persistent yawing and rolling motions above Mach 0.76 accompanied by greatly reduced elevon effectiveness. At Mach 0.88 the X-4 had undamped oscillations abut all three axes; particularly objectionable were longitudinal porpoising "roller coaster" or "washboard road" motions that approached unsafe load values above Mach 0.9, and which obviously rendered the X-4 configuration unsuited for combat aircraft design at that time. (2)

The Me 163B-1, D.H. 108 and X-4 all represented an attempt to take the traditional tailless swept-wing planform dating back to 1908 and adapt it to the transonic aerodynamic environment of the 1940's. Thus, it represented an evolutionary attempt to use the swept-wing not merely for stability and control (the traditional reason for using such a planform) but also to delay drag rise and shock formation over the wing – the latter point a new concern of significance to aerodynamics only after the late 1930's and the aerodynamic studies of Adolf Busemann in Germany and Robert T. Jones in the United States.

ABOVE: Northrop X-4 flying wing demonstrator.

The resulting tailless configurations that such thinking produced – the Komet, Swallow and X-4 – possessed no virtues and a multitude of vices. They were operating in a speed regime (Mach 0.8+) that was new to the swept-wing tailless experience, and though they generally had acceptable low-speed (i.e. subsonic) characteristics, their transonic characteristics were not merely mission-inhibiting but were outright dangerous. Thought the stability augmentation systems of the 1950's (inspired by the needs of the so-called "Century Series" jet fighters) could have resolved many of their problems, the early tailless jet aircraft would have offered so few advantages over their more conventional contemporaries even had their characteristics been improved as to not merit the intensive "fix" effort that would have been required to make them a success. For the time being, the world belonged to the conventional swept-wing aircraft such as the North American F-86 Sabre family and the more suitable delta wing, first demonstrated by Convair's XF-92A (1948) before being applied to the F-102/F-106 family in the early and mid-1950's. (3)

One other German effort of the Second World War deserves brief mention: the Horten IX V2 jet fighter-bomber, which would have been placed in quantity production for the Luftwaffe as the Gotha Go 229 had the war continued. This was indeed a true flying wing, with no vertical surfaces or discernable fuselage, and possessed an aerodynamic cleanliness and elegance that surpassed even that of Northrop's later XB-35 and YB-49. A derivative of the Horten sailplane experience, the Ho IX was of mixed wood and metal construction, with two turbo-jet engines buried in the wing roots and exiting above the wing. With an armament of four 30-mm cannon, the plane could have proven a dangerous opponent. Interestingly, writing after the war, Reimar Horten recollected that:

“The wood construction had some additional benefits; for example, the aircraft was almost invisible on radar. The wood panels even diffused the returns from the top mounted engines sufficiently to make radar gun sights useless. A second advantage was the minimal damage a 20-mm shell would do when it exploded inside the wing. A hole would be made, and a few ribs damaged, but the aircraft could still fly. A similar explosion inside the metal wing of a (Bf 109) would deform the wing so that the aircraft could not fly.” (4)

ABOVE: Horten Ho IX V2 (Gotha Go 229) in the approximate condition as it currently sits in the Smithsonian awaiting restoration (time period unknown).

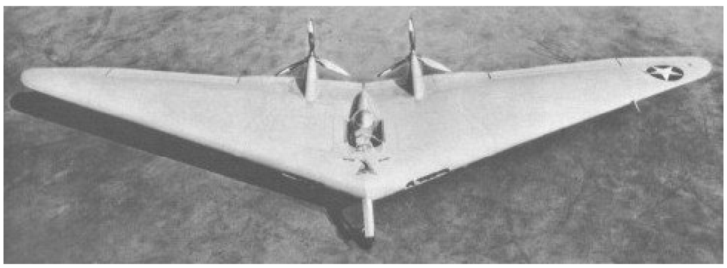
Flight-testing of the prototype Go 229, the Ho IX V2, began in January 1945. According to historian William Green, “handling characteristics exceeded the most sanguine expectations,” and the craft attained a maximum speed of 497 mph (800 km/h). Unfortunately, after only two flight hours, an engine failure forced an emergency single-engine landing; the pilot undershot his approach, and the flying wing crashed and exploded. Despite this setback, plans persisted to place the Go 229 in production, and a fully developed prototype was nearing completion when the war ended. This prototype survived the war and is now in storage in the collections of the Smithsonian Institution’s National Air and Space Museum. (5) It is doubtful the Go 229 would have proven better, say, than its contemporary the Messerschmitt Me 262; the track record of post-World War II tailless aircraft and flying wings prior to the era of stability augmentation is indication enough of the problems it might have been expected to encounter at speeds above 550 mph. What if any contribution it might have made to the development of the high-performance flying wing must forever remain an intriguing speculation; the next stage in flying wing development belonged exclusively to Northrop.

It is the American John K. “Jack” Northrop, however, whose name is most closely associated with the development of the flying wing, for in Northrop’s creations, it came closest to both fulfilling the original conception of a pure lifting surface unencumbered by excrescences marring its shape, and achieving production. Northrop’s importance to aviation history rests not merely upon his accomplishments in flying wing development, but also in the field of aircraft structures.

It was Northrop that reintroduced the wooden monocoque tradition from European aircraft technology into aircraft design with the pace-setting Lockheed Vega of 1927; in 1929, he introduced the techniques of practical all-metal monocoque fuselage construction and the multi-cellular cantilever all-metal wing and empennage with the equally influential Northrop Alpha. That same year, 1929, Northrop undertook the first flight tests of a rudimentary technology demonstrator dubbed the “Flying Wing,” but which, in fact, had a tail group supported by thin booms similar to World War I pusher fighters such as the De Havilland D.H. 2 and the later Lockheed P-38. Nevertheless, the craft lacked a conventional fuselage, though the tractor engine protruded from the leading edge of a fattened, thickened wing center section that housed the fuel and two-man crew. (Originally the craft flew as a pusher.) Not surprising, in terms of its configuration, it utilized conventional ailerons, elevator, and rudder surfaces for control, not yet requiring the coupled elevons that would be required by Northrop’s later pure-wing vehicles. This design bore a marked similarity to a configuration postulated by Czechoslovakian émigré Anthony Stadlman, who worked with Northrop for both the Lockheed and Douglas companies, and, indeed, Stadlman may have been responsible for triggering Northrop’s interest in the all-wing planform. (6)

Northrop’s first Flying Wing (though as described above it was not a true wing) flew at Muroc Dry Lake in 1929-1930, and inspired his efforts at later pure-wing designs resulting in the Northrop family of flying wings (beginning with the N-1M of 1940) as well as some related tailless aircraft having moderate swept-wing layouts coupled to traditional fuselage designs. Northrop also interspersed this interest in the flying wing with more conventional projects such as his later

Gamma transports, a series of attack aircraft, and the famed P-61 Black Widow night-fighter of the Second World War. Northrop's major step in the pure flying wing came with the development of the N-1M demonstrator in 1939-1940. Designed with the close advice and assistance of Theodore von Karman and William Sears of Caltech's GALCIT laboratory (Guggenheim Aeronautical Laboratory of the California Institute of Technology, Pasadena), the N-1M was a sophisticated tricycle-gear pure wing design having elevons and "clamshell" type wingtip drag rudders that also functioned as speed brakes, and two small piston engines driving pusher propellers.



ABOVE: Northrop N-1M "Jeep". Similar lines to the N-9M to the right with the same basic engine placement.

At this stage, Northrop did not feel confident enough to do away entirely with vertical surfaces for directional stability, so the outer portions of the wing drooped sharply downwards. Eventually, however, Northrop modified the outer portions so that they presented the same planform (i.e.: had the same dihedral angle) as the inner wing sections, thus creating an unbroken wing surface from tip to tip. Nicknamed the "Jeep" the N-1M made its first flight in 1940. Subsequent testing proceeded smoothly, though initially flow separation problems over the trailing edge severely limited elevon effectiveness (the solution was to extend the chord of the elevons so that they functioned within the active flow field around the vehicle).

Not surprisingly, the craft exhibited annoying and persistent Dutch roll oscillatory motions, though in its final configuration, such a motion would damp out of its own accord after excitation by the test pilot via an abrupt rudder kick. During steep turns, the pilot had to initially maintain constant aft stick to overcome pronounced nose-heaviness; as the turn progressed, the stick forces would reverse, the wing would attempt a pitch-up into the turn, and the pilot would have to maintain forward stick pressure as the turn was completed. During approach and landing, the pilot had to maintain aft stick to the flare maneuver, but following flare, elevator stick force reversal required the pilot to maintain forward stick force from flare to touchdown, lest the N-1M climb out after flare (such landing characteristics, incidentally, were similar to those encountered with the Bell SX-1 subsequently, and thus were not necessarily a quirk induced by the Flying Wing's all-wing configuration). (7) Despite some of the mission-limiting performance deficiencies of the N-1M, Northrop test results were encouraging enough that the Army Air Corps supported development of a proposed long-range bomber using the flying wing principle. This emerged as the XB-35/YB-49 discussed in the next section. Northrop's next demonstrator aircraft, the N-9M, served as a flying scale model of this larger craft, and this though it flew in 1942, is discussed with its larger brothers subsequently.

ABOVE: Northrop N-9M. The only flying version of this aircraft is maintained by the Planes of Fame Museum in Chino, CA.

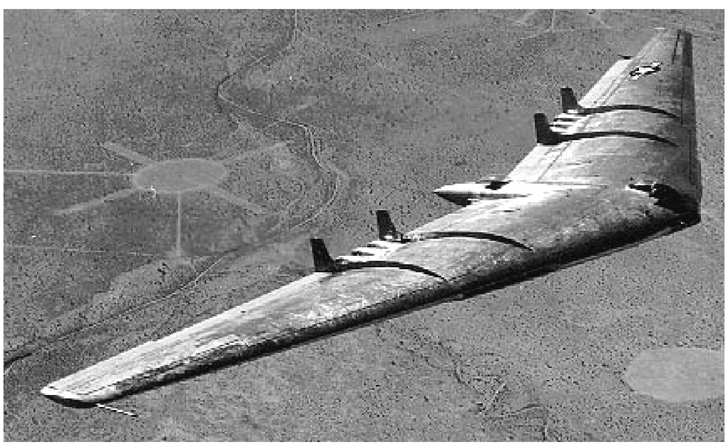
The XB-35/YB-49 Experience

The development of Northrop's massive flying wing bombers, the piston-engined propeller-driven XB-35 and the turbojet-powered YB-49 began in 1941, largely as an outgrowth of Army Air Corps' chief General Henry H. "Hap" Arnold's faith in Northrop's flying wing vision. By August 1942, the XB-35 and its rival, the more conventional but gargantuan Convair XB-36 (being pursued as insurance against the failure of the more radical flying wing) had passed the mockup stage. To validate the anticipated handling characteristics and performance of the large bomber (which spanned 172 feet from tip to tip), Northrop undertook development of a family of flying scale mockups, the N-9M. Eventually, four of these were procured. (8)

The original "Flying Wing" of 1929 (which, as has been discussed, was really a relatively conventional design dominated by a large wing) encouraged two streams of Northrop work. One of these resulted in tailless aircraft having moderate sweepback such as the propeller-driven XP-56 Black Bullet experimental fighter (which had unsatisfactory directional and longitudinal stability, manifested in serious adverse yaw and nose-heavy characteristics, and this did not enter service) and the post war X-4. (A somewhat related effort was the post war Northrop SM-62 Snark surface-to-surface swept-wing tailless long-range cruise missile, which encountered numerous development difficulties that

ABOVE: Northrop XB-35 which looks like the bigger brother to the N-9M, but with four engines and counter-rotating propellers.

eventually precluded it from assuming a significant role in America's strategic arsenal.) The second stream was that of the pure flying wing, starting with the N-1M of 1940. The N-1M encouraged no less than three sub-streams of its own involving flying wing designs: pilotless guided missiles powered by pulse-jet engines (the JB-1 and JB-10); piloted test-beds for a proposed



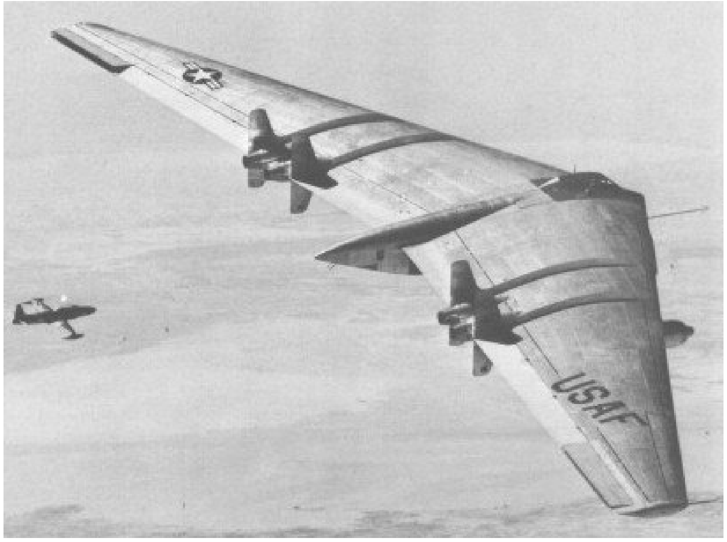
ABOVE: Northrop YB-49, eight engined, turbojet powered flying wing. Much sleeker and efficient than the XB-36 it was competing against.

rocket-powered fighter and eventually a jet-propelled fighter prototype (the MX-324/334 and XP-79B); and the development of a flying wing bomber, including a flying scale demonstrator (the N-9M) and the XB-35/YB-49/YRB-49A.

Of these projects, only the piloted flying wings are of interest to this account. The MX-324/334 family were small gliders conceived as conceptual studies for the proposed rocket-powered XP-79 fighter. A total of three were built, the last being the MX-334 powered by a small rocket engine (in 1944, it gained the distinction of being the first American rocket-propelled aircraft to make a successful flight). One of the MX-324 gliders crashed when entered a stable inverted glide and the pilot, because of his prone position, could not regain control, forcing him to bail out. Although the XP-79 rocket-powered version never reached the construction stage, it did spawn a jet-propelled version, the XP-79B. On its maiden flight, this craft entered a spin from a slow roll and crashed, killing its pilot. Accident investigators believed that the crash was due to a failure of the craft's electrically powered trim system, and not from any inherent flaw in the design itself.

ABOVE: Northrop XP-79B with a prone pilot position.

The four N-9M aircraft exhibited generally satisfactory longitudinal and lateral stability and control characteristics. The first, however, crashed, killing its pilot (despite application of corrective controls and deployment of a spin chute) after entering a steep nose-down right-hand spin. Accident investigators, alarmed that the N-9M might be revealing problems inherent in the larger XB-35 then undergoing development, undertook additional spin tunnel studies, believing that the accident may have been triggered by a departure in an aft CG configuration. However, no corrective design changes or procedure changes were apparently undertaken. As for the XB-35/YB-49/YRB-49A, eventually three propeller-driven B-35's, two jet-powered YB-49's and one jet-powered YRB-49A were built. Of these, both YB-49's were destroyed in accidents: the first apparently due to in-flight structural failure during an abrupt dive pullout following a max gross weight stall (five crewmen were killed); the second succumbed to nosewheel failure during a high-speed taxi test. The remaining B-35's and the YRB-49A were scrapped, as were two of the three surviving N-9M's. Today, only three Northrop flying wings are in existence: the original N-1M, a N-9M currently undergoing restoration, and a test version of one of the Northrop flying wing guided missiles. (9)



ABOVE: Northrop YRB-49B with four turbojet engines in the wing and two in pods beneath the wing. You can just see the split outboard aileron/speed brakes in this shot.

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