

T.W.I.T.T. NEWSLETTER



CAN YOU NAME THIS FLYING WING? Photo contributed by one of our new members, Gerry Geske of Superior, Montana. It looks like a Lippisch style, but I didn't have time to research all our files. Let us know your answer.

T.W.I.T.T.

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



The number to the right of your name indicates the last issue of your current subscription, e.g., **9504** means this is your last issue unless renewed.

Next TWITT meeting: Saturday, **April 20, 1995**, beginning at 1330 hrs at hanger A-4, Gillespie Field, El Cajon, CA (first hanger row on Joe Crosson Drive - East side of Gillespie).

TWITT



**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
 Vice Pres: Bob Chase (818) 336-5485
 Secretary: Phillip Burgers (619) 563-5465
 Treasurer: Bob Fronius (619) 224-1497

Editor: Andy Kecskes

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: NBKP63A@prodigy.com

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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, east side of Gillespie).

TABLE OF CONTENTS

President's Corner	1
This Month's Program	2
Meeting Minutes	2
Letters to the Editor	5
Available Plans/Reference Material	9
Model Wings	10

PRESIDENT'S CORNER



I've decided I need to get a better tracking system for some of the mail and messages I receive between newsletters. I'm not sure if I let some people know answers to questions sent via the mail or E-Mail.

The first goes to Jim Martyn who asked if Dan Armstrong or Danny Howell had E-Mail addresses. Since I have trashed most of my earlier outbound E-Mail messages I can't find where I passed on the information from Chuck McGill, which is no on both of them. They have indicated they will be on the net at some time in the future, but no date was given.

The second item was a word of advice from Chuck about designing E-Mail addresses. I mistakenly published his address as ...@win.com when in fact it is rwr-usn@wln.com. Therefore he recommends getting one that does not include an l (that's a small L) since it obviously can be viewed at an i. I apologize for the error.

By the way, don't think that your local post office has fallen down on the job this month. The newsletter is about a week or so late due to conflicts in my business and personal schedules. Fortunately, this is a non-meeting month so you are just getting the information a little later. It should be back on time with the next issue.

Just in case anyone used the E-Mail address for Glenn Sembroski published in the February newsletter (versus the correct one in the March NL) it is: sembroski@purvsb.physics.purdue.edu I apologize for making the initial error.

Speaking of the internet, I haven't received any new mail from other users. Hopefully I will be getting more going with this in the next several months as more time becomes available for such activities. I will keep you informed of my progress. In the mean time don't hesitate to E-Mail me with your comments and views.

I hope all of you builders are finding the spring weather more to your liking and is letting your glues and resins dry faster.

Andy

MAY 20, 1995 PROGRAM

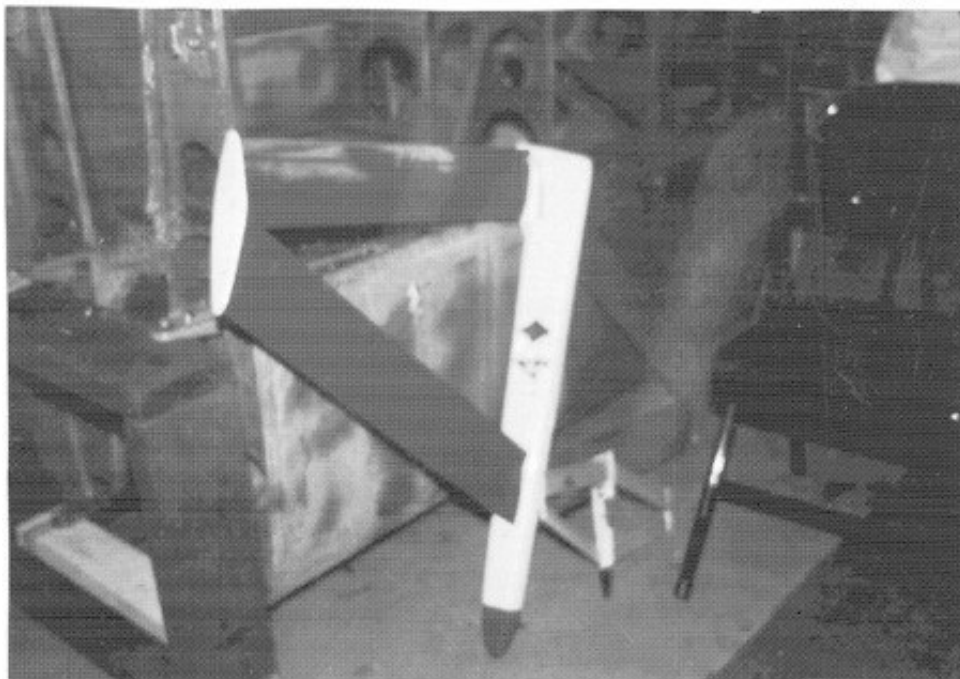
As of the publication date, we still did not have a program lined up for the May meeting. Bob is searching for an appropriate subject and speaker, but if anyone out there knows of someone in the San Diego or Los Angeles area who would be willing to come and talk to us about some aspect of flying wings or related aerodynamics, please give Bob a call at either the hanger (during the day) or at home (in the evening).

MINUTES OF THE MARCH 18, 1994 MEETING



Andy opened the meeting by thanking everyone in the larger than normal crowd for coming. After running down the program for the day, which was rather full, he asked for visitors to introduce

themselves and tell us what brought them to the meeting.



ABOVE: Paul Stahlhuth's joined wing R/C model and the hand-launch test model.

We were pleased to welcome Phil and Mary Barnes from San Pedro, a Northrop engineer (he was also picking up a full set of newsletter back issues). Phil is currently working on a paper on how to describe airfoils using equations instead of coordinates which he thinks will be published in an upcoming issue

of SoarTech. He learned about TWITT from Ferdi Gale's book. Jim Roberts was introduced by Ralph Wilcox who explained Jim has been involved in the development of many west coast experimental aircraft. Craig and Nancy Roberts down from Kent, WA (both looking for jobs in sunny southern CA) and, Anna and Gerti Inga from Chino.

Paul Stahlhuth shared his new joined wing designed with the group, explaining what problems he ran into trying this concept. Although it was stable and flyable, he found that using a symmetrical airfoil was not the way to go for an aerobatic glider. The wing loading was too high due to the increased weight of making it strong enough to survive the inevitable crashes. The elevators are on the forward wing and the ailerons on the trailing edge of the aft wing.

He has taken the lessons learned from this one and is building a new one with a 5' wing span. It will have a smaller front wing and a larger aft wing and be lighter. The airfoils will essentially be a Clark-Y with the forward wing having a little more camber than the aft. He mentioned he got a lot of good material from the Wolkovitch article published in the Journal of Aircraft (copies of which are available from the TWITT library). Chris Tuffli also mentioned there was a recent article in Aviation and Aerospace Weekly on a similar shaped joined wing configuration.

Bob Chase announced that the 29th Annual Flying Wing Contest would be held at Taft, CA, on May 27, 1995. This used to be the Northrop contest, but has changed due to the decrease in corporate sponsorship. Last year's contest produced some very nice models, so it might make for a nice day trip for those members living the Los Angeles basin and high desert. (I have included the announcement flyer later in the newsletter.)

Bruce Carmichael said he had gotten a letter from a German exchange student who is trying to get a project going at his college to build an aircraft similar to the SWIFT, but better. This would be a first for the college, so he obviously has a long road ahead.

Andy pointed out the latest TWITT donation from Randy Bergum of a 14' RC model built to test the Culver Twist theory and a prototype model for a full size aircraft. Bob and June had gone up with a Honda Accord and two dogs to pick this thing up several weeks ago. Everything just barely fit, and all were frazzled by the time they got home.

It has been flown, but received some damage that must be fixed before it is again flyable. If anyone is interested in pursuing the repairs and trying to get it to fly properly, we would be glad to loan them the aircraft for that



ABOVE: Bruce Carmichael and Ed Lockhart examining a sample of the porous film which allows resin to flow to the felt absorber.

purpose. Of course, we would expect an article on the what, where, when and hows of the flight tests.

Andy then showed a brief section of a video tape on the Lancair 320 which **Budd Love** is considering purchasing and building. He was looking for some input from anyone in the group that had information about the aircraft. He still hasn't made his final decision (he is still waiting for his medical certificate) but seems convinced this will be the way to go.

Budd also thanked TWITT for the flowers we sent to the church for his late wife's memorial service. Unfortunately, the service was on the same day as the January meeting and we were unable to attend in person (which we regret).

Andy then showed a short video on the X-4 Bantam experimental twin jet flying wing (see Karl Sanders comment in the letters section). From there we viewed a video brought in by **Brian Evans** (our principal speaker for the day) which showed the construction techniques used in building the Concept 70 sailplane some years ago (1972). Brian narrated the tape as a prelude to his primary presentation, but did note that some of the techniques used then are no longer necessary or efficient with today's technology. *(ed. -I will only hit the highlights of this part of the program since they are associated with the video and would be to cumbersome to fully explain to achieve the correct context.)*

Brian explained that the gelcoat layer initially put in the mold provided a hard outer surface on the sailplane. He later commented that this is not always necessary since the

resin coat can usually be properly finished at a lot less weight penalty.

He talked briefly about the use of pre-preg cloth, which he felt often resulted in a heavier structure than a properly prepared resin and cloth lay-up job.

One of the things they did during construction was use the molds as part of the assembly fixtures to eliminate the need for separate structures. The halves of each part are left in the molds until they are joined into the final part. The molds are then removed using rubber mallets to break them away from the gelcoat layer.

The various parts were made of a foam and glass sandwich which allowed for the reduction in the number of ribs in the wings and bulkheads in the fuselage. The structure is just as strong, but weighs less.

Brian mentioned there are two types of suction. One is a perimeter bleed which draws off excessive resin at the edges of the mold. The other is vertical bleed where a piece of felt is placed on top of the a film with small holes that allows the resin to be absorbed by the felt. (The felt is sandwiched between the porous sheet and the outer plastic layer that creates the final vacuum seal.)

Lay-up of the cloth was done in such a way that the tip had one layer and the root had about 27 layers. These layers were tapered out towards the tip, but done properly it develops good strength without an excess in weight.

Brian spent a few minutes telling the group about some of the things he has done over the years and who he had worked for to obtain the knowledge he has of composite structures. He has had a varied career working with sheet metal, wood and glass structures, and composites. He also used the time to explain a little more about the Concept 70 aircraft and some of the troubles it had when the wingspan was reduced from 18 meters to 15 meters.

Brian then got into showing us how to make small parts using the vacuum bagging system. The diagram below tries to show how the various layers of plastic bagging film go over the mold. They consist of a bottom layer which goes directly on the mold to provide a separating mechanism after the resin hardens.

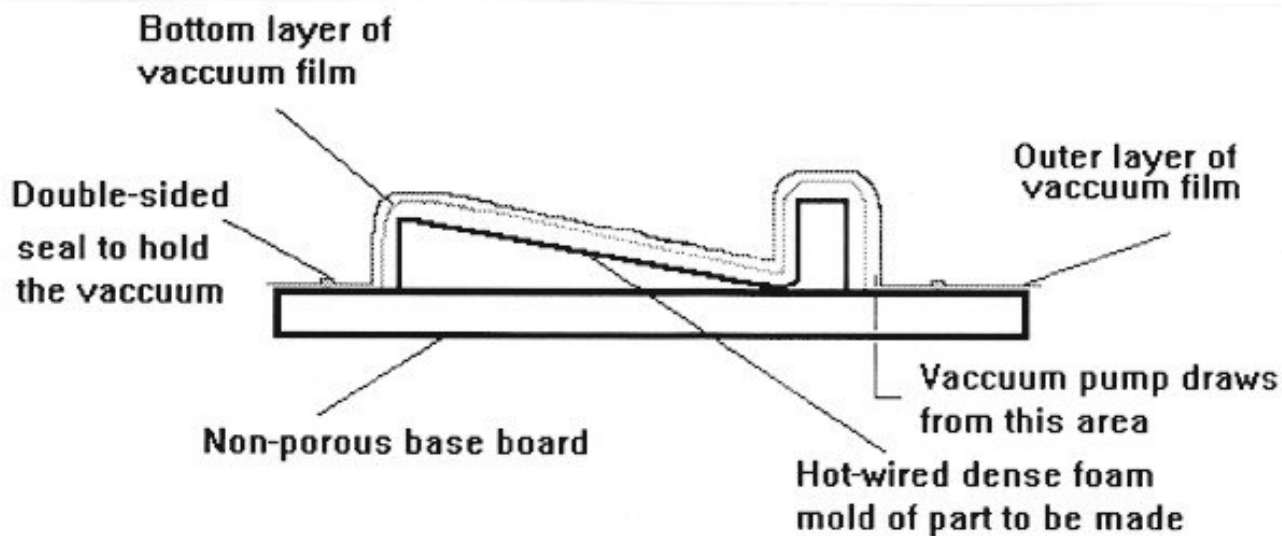
The mold is made from homogenous high density blue foam and a hot-wire system. This produces a fairly smooth starting surface that can be sanded to a final finish. (If there are some of you out there that don't know how to hot-wire foam let us know and maybe we can put together a small demonstration at one of the upcoming meetings. Or perhaps someone can send us a good article on how to setup and use

and hot-wire cutter.)

To work effectively the bottom layer needs to be drawn down on the mold so that it can be smoothed of any wrinkles. This will require two sources of constant suction (two lines from a single pump) since the bottom layer needs to stay as tightly as possible on the mold. If you mold is very smooth and you can get the bagging film to stay in place without wrinkles, then sucking it down may not be necessary. This membrane will also allow you to put down some type of surface coat, if you desire, before putting in the cloth and resin.

strength since the micro-balloons displace the heavier resin in the holes.

He talked briefly about the difference between a perimeter and a vertical bleed. In perimeter bleed the resin is forced off to the sides of the mold which then requires squeegeeing it out of the way and getting rid of it. The vertical system note above works much better since it provides a more even absorption of the resin and results in a more consistent thickness across the surface. The vertical method also works with pre-preg cloths.



Glass cloth goes in between the bottom and outer layers of film

ABOVE: Diagram of how Brian constructs his system for vacuum bagging small parts.

The resin and cloth are applied over the bottom layer and then the top bagging layer (with any resin absorbing system you desire put in place) placed over the whole thing and sealed for the vacuum. It would be good idea to get as much of the top layer in place before doing the lay-up, especially if you have a short hardening time resin.

If you are building a foam sandwich part it is probably best to do the outer skin and foam core in one setting and then add the inner skin in a second go around. It can be done all in one step, but Brian indicated you have to be pretty good at it since the foam doesn't take the mold's shape until after application of the top bagging film is sucked down.

The question was asked about whether you needed to punch holes in the foam core to allow for the resin to bleed through. Brian indicated this was dependent on the type of foam you used and its porosity. He has used a simple tool of nails driven through a board to make holes in the foam many at a time.

In the case where you were using a more porous foam, he suggested preparing the surface with a mixture of resin and micro-balloons in a paste form to fill in the holes. This will produce a lighter structure without sacrificing

The base board must be of a non-porous type and sufficiently thick to remain straight and true during the vacuum process. A good model building board with a layer of formica over it will provide the necessary stiffness and sealing capability under the bagging film.

The seal he used was a layer of double sticky tape that has enough thickness (about like chewing gum) for molding it into the plastic and around the vacuum fitting. This type of tape is available at most supply stores. It can be quite messy to handle once the project is completed, but it works better than just plain double sided adhesive tapes.

Brian recommended using a venturi type of vacuum generator since it must be held for long periods of time. It takes about 23-25 inches to do the job correctly. You should probably experiment with the pump and suction system before starting on a wet lay-up to make sure there are no problems with over heating, there are no holes in the plastic, etc.

Once the resin has properly set, the entire thing can be dismantled and the plastic films removed from the part. If everything went well and all the wrinkles were removed, it should be an easy task to put a good finish on the outer surface. For small imperfections, a mixture of resin and micro-balloons will work well to smooth out the surface.

There was some general discussion on how

to join the top and bottom of the main spar to the inner surfaces of a wing panel. Brian indicated that this is done by bonding the spar to one of the surfaces during its lay-up process. Then a layer of resin and micro-balloons or other filler is applied to the top of the spar before the other surface is mated. Once the two pieces are pressed together the filler spreads out into any gaps that may be present due to an uneven surface on either part.

This can work well or can have problems depending on how good the dry fit is before doing the final joining. Air pockets can form that won't allow the filler resin to attach to the skin's inner surface producing isolated areas of some weakness. However, he noted that one glider wing he saw had such a condition, but it didn't seem to affect its airworthiness since it had been in operation for a number of years under strenuous flying conditions. This is an area of concern on the part of the FAA for composite homebuilts and glass imports, but the only way to be sure is to use an ultrasound type devise to analyze each joint.

There was some discussion about the requirement to have two layers of cloth over the exterior of joints which requires a lot of hand sanding to blend the edges. It is interesting that the Lancair film showed the surfaces were prepared with premolded indentations to accept these two layers and end up with a flush surface requiring only minor filling.

The question was asked about whether you could just build a single piece D-tube so there were no joints along the leading edge. Brian indicated this was possible and there were several methods for accomplishing the job. He also noted there are several examples of existing aircraft with this type of construction.

After Brian's presentation, Andy conducted the day's raffle. The first prize was won by Jorge Paullada who chose the small socket set, and the second prize of a pliers set was taken away by Bob Chase. Bob also commented that out of the several programs we have had on this subject, he felt this was one of the most understandable, which means Brian reached his audience very well. With that final piece of business out of the way, Andy adjourned the meeting.

On my questions to get information on some unknown tailless aircraft I received a reply only from Mr. Krauss and a lot of copies from his summary of tailless aircraft. I am finished with the documentation of 230 different types for the planned book Tailless Aircraft of the World. (In Germany we had discussed about the difference between only-wing aircraft Horten types, Northrop types and tailless aircraft all types.)

Included was an unknown type for me, the MDD A-17 who was first published in February in the British magazine Air Force Monthly. Did anyone see the type over in the USA? Is it the designation right? Maybe this was the type from which is spoken in the report of the North Sea eyewitnesses.

For my book I am looking for some reports from the world of tailless aircraft of 12 co-authors including a report on the development of Jack Northrop's aircraft by Dr. R.P. Hallion (Air Force Historian's office), but I think it would be very interesting to get a report of the experiences from tailless aircraft homebuilders in the USA too. Maybe you know a person who will write about these for publishing in the book (approximately two sheets). Of course the author will get an exemplar of the book. I am very grateful to be asked into the circle of TWITT members.

Thank you very much in advance.

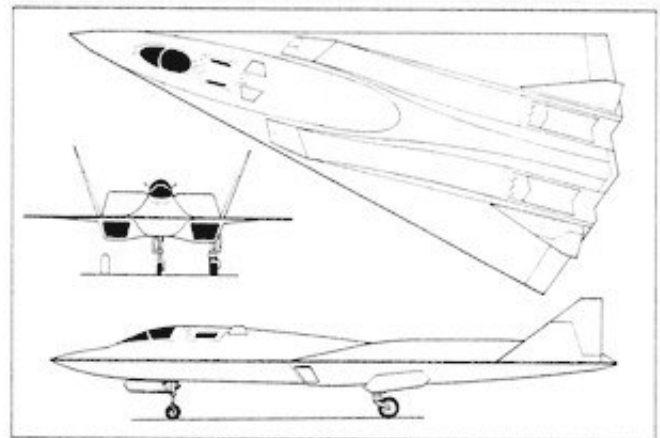
Sincerely yours,

Rudolf Storck

(ed. - We were glad to hear that you received some response to your request. Perhaps one of our other members will recognize the MDD A-17 designation as something different from the canceled A-12 Navy flying wing replacement for the A-6 Intruder.

I have included the 3-view outline you sent along of the "black" aircraft. I presume it was in a British publication in response to the many "sightings" of unusual aircraft in the UK and North Sea area.

We wish you continued success in getting your book completed and published.)



ABOVE: This may be the Northrop TR-3A stealth reconnaissance aircraft that had supposedly been seen over Exmoor, England.

LETTERS TO THE EDITOR

3/7/95

TWITT:

Thank you very much for your publishing of my letter in the TWITT Newsletter of January.



2/24/95

TWITT:

Read in February issue about Charles Fauvel and his publications. I am sorry, but I don't know exactly where I could get these references. I met Charles Fauvel many times about twenty years ago before his death in a bad weather accident in Italy with his SIPA 903 small plane. He was appreciated by everybody for the quality of his advice and the efficiency of his gliders and airplanes.

I shall send you something if I find, anyway.

Best regards to all of you,

Alain Mirouze

(ed. - I don't know if Serge sent these to you or not, but he did send us copies of the two articles by Fauvel that are entirely in French. They are titled: "Le problème de Pavion sans queue et la solution alle volante Fauvel" by Charles Fauvel. These have been added to the TWITT library for any of you out there who are interested in reading French in your spare time.

If you do not have these and would be willing to do a general translation (not word for word) for us to publish over a period of time, I will be glad to send you copies. Please let me know if you are interested.)

2/19/95

TWITT:

Regarding some comments as regards the last few issues of TWITT: the Ultralight Soaring News mentioned in TWITT, comments on the powered ultralight sailplane issue, and an article on the Carbon Dragon by Gary Osoba in the Vol. 1, Issue #2 (Nov/Dec '94). In such ultralights as the Carbon Dragon, the dreams of Richard Miller from back in the 1960's and 70's have almost been implemented. The Complete Book of Hang Gliding by D.S. Halacy, Jr., Hawthorn Books, Inc., 1975, in Chapter 9 "Toward the Human-Powered Airplane" mention is made of Richard Miller's dream ultralight "Thistledown". Miller suggested pedal power for reducing ultralight sink rate. The chapter also mentions pedal powered take off. A further use I can think of is physical conditioning exercise during long XC flights. This chapter 9 would be of valuable for those interested in pedal powered ultralights.

On the cover of #103 January '95 TWITT Newsletter the Burgess-Dunne hydroplane is shown; it's an interesting looking aircraft. The February '95 (#104) on page 11 shows those intriguing low aspect ratio flying wings. J.G. Evens 11/1/94 proposed design is somewhat reminiscent of some zanonina seed aircraft designs.

Barns and barnstorming are often mentioned in the history of aviation; and Glenn

Sembroski, the sky surfing internet physicist, makes mention about his plans for a Jerry Blumenthal Rattler; so he might appreciate the chorus of a traditional song, Old Rattler that goes as follows: Ho! Rattler Ho!, Ho! Rattler Ho! Call Ol' Rattler from the barn! Ho! Rattler Ho!.

I'm interested in the remarks about internet. It sounds quite difficult and complex. Chuck McGill, Editor Emeritus, in a newsletter once wrote something about "clicking the mouse". This internet lore is very recondite and esoteric and if newsletter editor stalwarts such as yourself and Chuck have difficulties with it I doubt very much if I'll ever get to set foot on the information super highway. I'll have to be content with taking the off the super information highway road less traveled.

Best of internet sky surfing on the information super highway from information roads less traveled.

Longhand,

Edwin Sward

(ed. - Thanks for the comments. Personally, I find all the different types of aircraft that come through the newsletter to be fascinating, but not being an aviation historian I don't see the significance of some of it.

As for the new wave of electronic communications, you don't have to worry about be left behind, since the newsletter will continue to go out by "snail mail" for a long time yet. There may be a time when those who desire to get it via the internet will be able too, but the printed word will probably never end.)

3/7/95

TWITT:

Among the many catalogs that I get on a regular basis is one from Tower Hobbies. They carry a full range of flying model airplanes, and I happened to notice that on one page of the catalog there were no less than six different flying wing models.

I have included a copy of that page if anyone is interested in a source for flying wing models. There are probably some other tailless kits available in other parts of the catalog.

Tower Hobbies address is P.O. Box 9078, Champaign, IL 61826. They also have a toll free number: 1-800-637-6050.

Good flying,

Kevin Renshaw

(ed. - Some of the models available include the Genesis, Klingberg Rocket Wing, Wing Mk II and Sport Wing, and the Global Cutlass.

I didn't include a reprint of the page since the catalog is readily available from Tower. It has been my experience (although some time ago) that their prices were competitive and the mailing time very quick.)

3/11/95

TWITT:

A few days ago I received a brown envelope with the 1936 article by Charles Fauvel from Serge Krauss! Imagine my SURPRISE! I wonder how he got my address. In my thanks letter I added these comments:

"I conclude that the active flight control system and the knowledge of swept wing stall characteristics, are about the only significant new contributions applicable to the tailless/flying wing qualities in six decades. Fauvel always disliked the swept wings favored by his German counterparts. In his article he also discussed some aerodynamic and important design aspects better than by other more recent experts."

Did he send a set of copies to you also? (ed. -

Yes). If not, let me know and I will copy mine and mail/bring them to you. His writings are well worth being translated and are an indispensable complement to Nickel's book!!

In my tailless archives was an article about Fauvel and his designs that appeared in Sport Aviation (EAA) in 1962, with a cutaway by John Wixey. J.W. (Englishman) was an artist at Ryan till about '68. I enclose a copy.

My last item for today concerns a publication in the March issue of Popular Mechanics titled "Titan of Transport" (better know as cargo spanloaders). To make spanloaders economically viable the take-off weights come out in excess of one million pounds!! As is typical for this type of information, it lacks the technical detail necessary for making a conclusive comparison and assessment of the merits of the discussed configurations. These seem to be spruced-up versions of studies made for NASA in the '75-'85 time frame.

I always kept a small file on them, but a few days ago I dug out copies of the "old" contractor summary reports at the NG library. I will try to get hold of newer reports - if available! I am now in the process of leisurely making an active spread-sheet on the MAC using my well proven design charts to fill in gaps, and to find any "bear traps" in the open literature. When it's done you get a copy to publish (in facsimile). Right off the bat, I can predict megaproblems with existing airport cargo facilities. As it stands, the FAA/ICAO will not certify civil transports with fuel and 2000 or more(!) passengers adjacently accommodated in one hull, let alone the structural and control dynamics, and human aspects.

Greetings from us all,

Karl Sanders

P.S. The Northrop X-4 on the newsletter page is NOT a flying wing, BUT a NACA/USAF highspeed flying-qualities tailless research aircraft.

(ed. - Thanks for the article out of Sport Aviation. I think we have parts of it in the library, but not an intact copy of the whole article.

As you can see from the ed. comments to Alain Mirouze's letter we did in fact get a set of the Fauvel articles from Serge. If you can find the time, would you consider giving us some short translations of the more interesting sections of the articles? Perhaps between you and Alain we could pass along some of Fauvel's thoughts on tailless aircraft.)

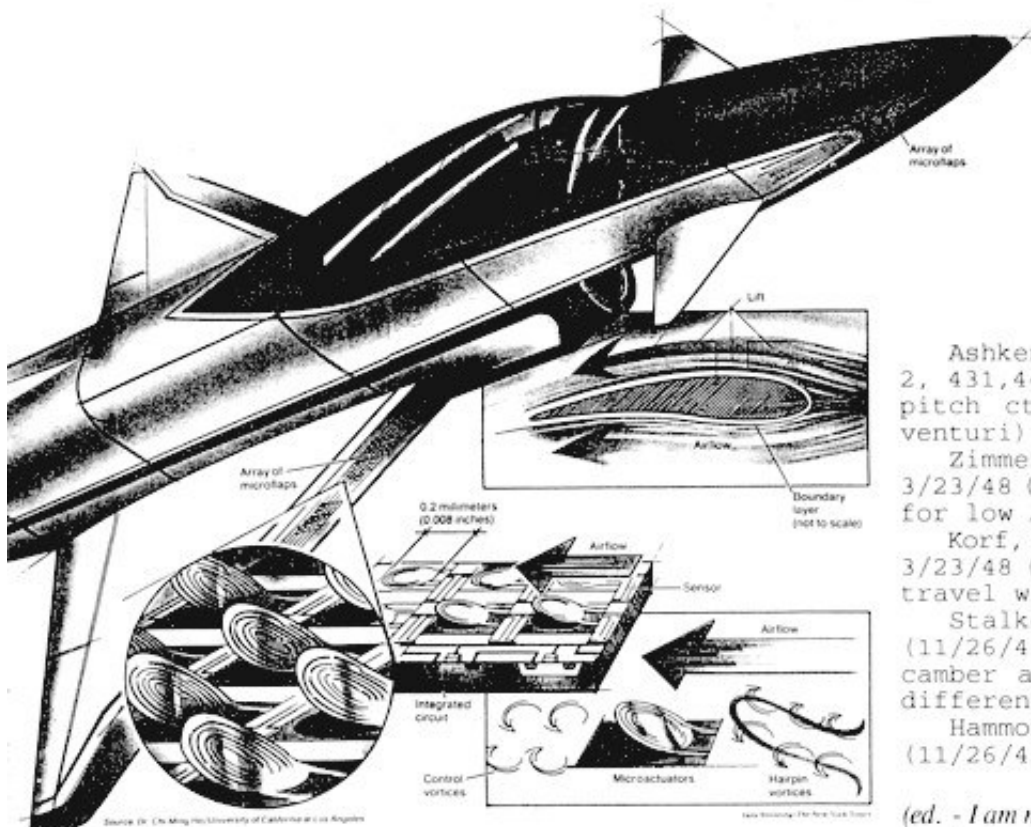
(ed. - Here is some more from the Serge Krauss' long letter which we started last month responding to everyone/thing.)

Thanks for updating my Tailless Aircraft Bibliography ad. I hope that readers understand that the *p1726X" local to thousands of technical and works drawings for the Ho. 229 and Me 163" is just a small part of the many listings concerning these and a great many other aircraft. I would also like to re-stress that overseas orders must be U.S. funds or collectable from an American-affiliated bank; otherwise American banks reject them or charge a collection fee higher than the value of the check.

Reminder: I have a collection of documents/copies, marked in my bibliography with an "*", and am willing to make copies - again allowing for possible delays due to other work. Whatever copies of this that TWITT wants, it can have.

I enjoyed Phillip Burgers' contribution of 6/94 and agree that stability need not remain the cause of such major tailless performance compromises. Furthermore, while accelerated computer and software development makes access to fly-by-wire stability enhancement seem imminent for homebuilt designers, we should not overlook possible advances in materials themselves and their role in the wing. The enclosed Xerox illustrates a micro-technology with potential for auto-stability and control by influencing the boundary layer. It may also not be too optimistic to extrapolate to skins that change shape in flight (perhaps through a neural network), without need of complex, draggy, hinged surfaces. (ed. - Elsewhere in this issue I have included a reprint of the micro-machines mentioned here along with a little information from the accompanying article.)

It is interesting to look back at earlier attempts at solving such problems and to imagine how these ideas might apply with more advanced technology. Historically and technically interesting tailless control patents from the '40's and '50's address auto stability. Not surprisingly, Northrop (JKN, Sears, Ashkenas, et. al.) is well represented, their patents, among the more thoughtfully and elegantly presented, detailing mechanical and stability considerations. You'll note that Northrop patented the idea discussed in his 1947 lecture (3/4/47 and 10/20/51 below) and mentioned by Phillip Burgers. Cornelius' are clever and well illustrated. Some significant



No. 2, 575,532; 10/20/51 (1/20/45; automatic stabilization and prevention of stick force reversal on tailless acft with c.g. behind aerodynamic center)

Ashkenas, I. (Northrop): No. 2, 549,045; 4/17/51 (1/26/48; tip slot actuated by changes in C_d) and

No. 2, 559,817; 7/10/51 (12/11/44; auto actuated ctrl boost to prevent control reversal)

Ashkenas and Krieger (Northrop): No. 2, 431,449; 11/25/47 (4/24/45; yaw and pitch ctrl by air pressure from tip venturi)

Zimmerman, C.H.: No. 2, 438,309; 3/23/48 (4/11/44; auto-op. ctrl surfaces for low A/R XF5U-1 types)

Korf, W.H. (Lockheed): No. 2, 439,309; 3/23/48 (10/5/42; attempt at stable c.p. travel without down-loading tips)

Stalker, E.: No. 2, 496,565; 2/7/50 (11/26/45; tailless acft w/varied wing camber actuated by chordwise pressure differential)

Hammond, L.: No. 2, 550,806; 5/1/51 (11/26/45; gyro-controlled elevons)

(ed. - I am not sure what type of reference system Serge is using here, but if anyone sees something interesting and would like more information I'm sure we can get it.)

ABOVE: "Tiny Flaps That Control Large Forces"
 - Where the leading edge of plane's wing or nose meets the air flowing past it, a thin boundary layer is created. Eddies and whorls in the boundary layer produce drag-inducing friction. Scientists have developed tiny microelectro-mechanical systems, or MEMS, to control the drag by cancelling the vortices with counter-vortices. The mirco-flaps have sensors that record temperature and pressure; they are raised or lowered by minature mechanisms controlled by a computer. Source: "Micro-Machines Help Solve Intractable Problem of Turbulence," by Malcom W. Browne, The New York Times, Tuesday, January 3, 1995, pp. B5-B8.

early U.S. patents concerning control with increased maximum lift, auto-stability, etc., for tailless aircraft:

- Back, W.E.: No. 2, 191,842; 2/27/40 (3/8/38)
- Gluhareff, M.E.: No. 2, 293,644; 8/18/42 (6/29/39) (variable sweep)
- Ortega, C.: No. 2, 316,885; 4/20/43 (7/3/41)
- Cornelius, G.W.: No. 2, 406,588; 8/27/46 (5/6/44; fwd-swept; auto-stability devices enabling 'efficient' lifting surfaces) and No. 2, 427,189; 3/11/47 (7/27/42; fwd-swept, dynamic pitch stability) and No. 2, 420,932; 5/20/47 (8/11/43; auto-ctl. and compensation via lift sensing gyro.)
- Sears, W.R. (Northrop): No. 2, 416,588 3/4/47; (9/24/42; c.g. behind c.p.) and

Now, with all of this said, let's not forget that stable all-wing or tailless aircraft without artificially enhanced stability remain laudable ideals. I hope most of us enjoy encouraging and participating in efforts to get as close to perfection as possible - regardless of our ultimate expectations.

Thanks also to Karl Sanders for further clarifying the nature of my equations of 3/94, p. 10. I always look forward to Karl's contributions. Omission of "e" (Oswald's, or the subscript) from these equations, or a suitable reminder of their dependence on elliptical lift distribution, was an oversight that occurred while working to compress large topics into a small space; users might just add the subscript "e" to make "A/R", "effective aspect ratio" ('e' is in the legend), or multiply by Oswald's "e" ($A/R_e = A/R * e$) and consider Karl's and Phillip's comments (5/94 p. 8 and 6/94, p. 4). I'm disinclined to change these idealized (even, as Karl aptly says, 'ambiguous') equations further, but would rely on designers to choose "fudge factors" suitable to their own designs. I look forward to reading the AIAA references giving a more useful treatment.

(Reminder: these equations were presented as useful in roughing-out or comparative feasibility studies; coefficients represent only standard conditions and would have been rounded off to a couple digits, but for the need to reclaim the digits in more refined studies. The very least such studies would

require would be re-factoring in the air density.)

Answer to Karl's question (5/94, p. 8): The expression $\sqrt{a_0 a / (a_0 - a)}$ of eqn. 2 results from solving lift-curve-slope equations for aspect ratio, and then substituting the result into the previous expression. (Millikan, Aerodynamics of the Airplane, Wiley, 1941, p. 53, for α in radians, and Diehl, Engineering Aerodynamics, Ronald, 1936, p. 52, for α in degrees.)

(ed. - This will complete all of Serge's replies and comments on past issues. I'm sure that they will probably create some more letter traffic from someone, which is good since we are trying to stimulate your brain cells to learn more about aerodynamics and flying wings.)

ADDITION TO TWITT LIBRARY

Russell Lee, Curator-Aeronautics Department, National Air and Space Museum, Smithsonian Institution has sent us a copy of a microfiched article by the Horten Brothers titled "Zehn Jahre Entwicklung am Nurflügel-Schnellkampfflugzeug" (Ten Years of Development of the High Speed All-Wing Fighters), Berlin, Lilienthal-Gesellschaft für Luftfahrtforschung, Apr. 1943, pp. 71-83 including diagrams. (**This is entirely in German.**) (German and Japanese technical documents on microfilm, Garbor Facility, Bldg. 12, NASM Archives, Real 2630, F144.)

Description of the improvements attained after 10 years of research on all-wing airplanes. According to the author and inventor, the all-wing airplane shows great advantage over a conventional type of airplane provided minor details are considered. The aerodynamic characteristics of the all-wing airplane are superior to the conventional type of airplane.

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Tailless Tale, by Dr. Ing. Ferdinando Gale'

Consists of 268 pages filled with line drawings, tables and a corresponding English text. It is directed towards modelers, but contains information suitable for amateur full size builders. Price is \$38, postage and handling included (also applies to Canada and Mexico).

You might also want to purchase his new book Structural Dimensioning of Radioguided Aeromodels, priced at \$18.00.

On The Wing...the book, by Bill and Bunny Kuhlman (B²) is a compilation of their monthly column that appears in RCSD. Many of the areas have been expanded and it includes coding for several computer programs to determine twist and stability. Priced at US\$28.00.

All these are available from B² Streamlines, P.O. Box 976, Olalla, WA 98359-0976, or (206) 857-7249 after 4pm Pacific Time. Orders shipped elsewhere will be sent surface mail unless an additional \$10 is included to cover air mail postage. Washington residents must add 7.5% sales tax.

VHS VIDEOS AND AUDIO TAPES

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).

Priced at: \$8.00 (postage paid)

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 tape of Alex's presentation explaining the material.

Priced at: \$5.00 (postage paid)
\$6.50 foreign (postage paid)

Audio tapes of presentations by Don Mitchell at the September 1991 SHA Western Workshop, Tehachapi, CA (1 cassette), and his March 1992 presentation at a regular TWITT meeting (2 cassettes).