No. 173 NOVEMBER 2000

T.W.I.T.T. NEWSLETTER

Jeff Byard's Genesis 2 outside his hanger at Tehachapi, CA. Jeff will be our speaker in November and will have this sailplane there as part of the program. Photo by Andy Kecskes.

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., **0011** means this is your last issue unless renewed.

Next TWITT meeting: Saturday, November 18, 2000, 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.

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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).

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PRESIDENT'S CORNER

I hope everyone enjoyed last month's issue. I know some of you really like lots of pictures, especially when they are related to the material or show an unusual flying wing. You will get more of it this month with the continuation of Al Bowers presentation on the BWB. For those of you with internet access, once this issue is on the streets I plan on putting this on the website where you can see the slides in color with all the wording. I hope everyone likes this in terms of seeing the slides as they were shown by Al.

I want to thank those people who have contributed material for this month's newsletter. This is always helpful when it comes to publishing time since I don't have to go rummaging around the internet looking for appropriate, non-copyright material to fill in the spaces. As I have asked in the past, please let us know what you are doing with your favorite project. Whatever you submit doesn't need to be lengthy or elaborate, just something simple that explains what you are trying to accomplish and your results. Pictures and/or drawings are nice if you have them, but are not always necessary.

Although not involved in flying wings, some of our older members may remember George Tweed. He passed away from a heart attack on October 16th at his son's home in Nevada City. Over the years he had built a number of gliders with the GT designation, a few of which still survive. His garage was a veritable factory for building sailplanes. He also competed in the 1973 cross-country sailplane derby. He served as a director for the SSA and taught soaring with AGCSC, the San Diego glider club. George worked for General Dynamics and Cubic Corporation over the years and even ran his own tug boat company for a while. He will be missed.

Andy

NOVEMBER 18, 2000 PROGRAM

We are pleased to announce our program for November will feature **Jeff Byard** and his Genesis 2 sailplane. Jeff will have the glider at the hanger and, after a short presentation on the aircraft and its development, of which he was a small part of, will go through the assembly process. This will allow him to show us some of the many unique features that have been designed into the aircraft.

So if you are looking for a hands-on experience and want to see some actual flying wing hardware, make sure to mark your calendar and come on down to the hanger on Saturday.

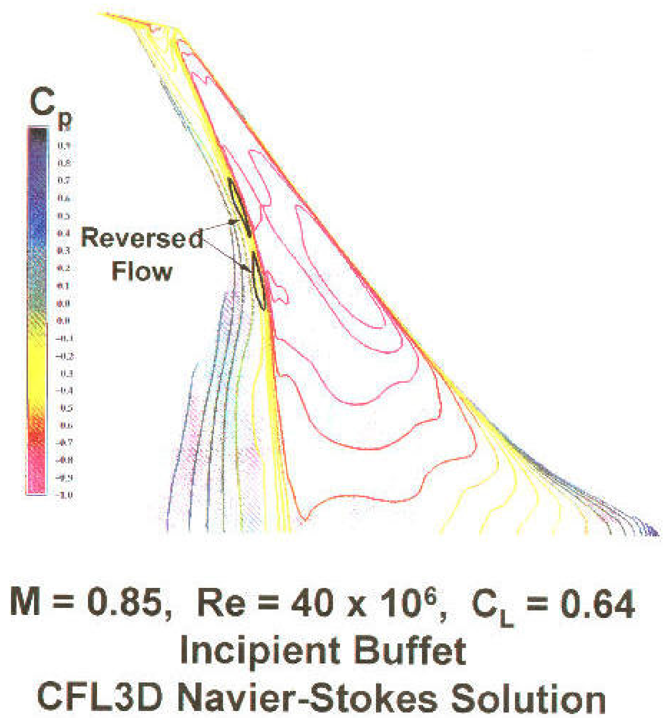
(Photo: By Bill Bartel, courtesy of www.glider.com from his coverage of the 2000 SSA Convention in Albuquerque, New Mexico, March 16-18, 2000.)

Jeff is a Captain flying for US Air Captain. He is quite active in the Vintage Sailplane Association, owning and flying a TG-2, Baby Bowlus, Slingsby T-21 side-by-side open cockpit glider, Slingsby T-38 primary and a Standard Austria. His hanger at Tehachapi is the centerpiece for the annual SHA Western Workshop with its many homebuilders making their presentations.

MINUTES OF THE SEPTEMBER 16, 2000 MEETING

(ed. – We now continue with the presentation by Al Bowers on the joint NASA/Boeing Blended Wing Body (BWB) concept test vehicle that is currently under development at the Dryden Research Center.)

Another set of challenges that came up early on were just the aerodynamics. This is still looking at an 800 passenger, big BWB aircraft with three engines sucking in air from the upper surface boundary layer. After running computation fluid dynamics to predict what the flow would be, they found two areas of reverse flow. One was where the lift coefficient was very high, right at the sharp break in the trailing edge and right over the control surfaces. The other problem is putting people inside the airfoil, which now has to be thicker than people are tall. This gives you a very thick, transonic airfoil, which sets up new challenges to overcome the various shock waves and resulting wave drag. All these are bad things that need to be addressed and viable solutions found before continuing.



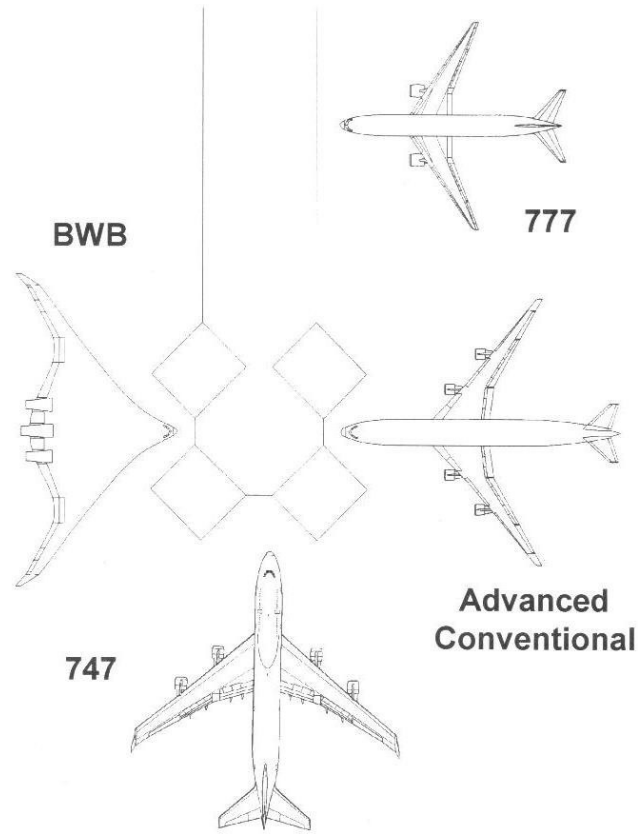
Ride quality is another issue that needs to be looked at. When you put all the control surfaces in close together in one location fore and aft, the whole aircraft is affected by turbulence at one time. So given the same level of technology in control feedback systems as currently used on conventional aircraft with control surfaces spread out over the wing and tail surfaces, the ride quality of the BWB, or a flying wing, will be worse. New feedback technologies need to be developed for the improving ride quality without letting things get so sloppy that the pilot can't control the airplane.

Along with the digital fly-by-wire comes the all electric subsystems; everything is electronic onboard the aircraft. This is a very common in the military in aircraft like the Air Force's F-16, but is just now starting to become more prevalent in commercial aircraft. Doug Fronius asked if this meant no hydraulics and Al commented that there were still hydraulic actuators being controlled electrically at the site of the control surface. Doug noted that the next generation of military aircraft coming along will truly be all-electric with no hydraulic subsystems. Although there are some supporting subsystems on commercial aircraft at the present time, both Doug and Al indicated all-electric main systems were probably a long way off.

Dominique Viellard asked about the thickness of the boundary layer. Al said he wasn't sure about the numbers, but did estimate it could be a couple of feet thick at the rear of the centerbody section of the wing. The chord at this point is close to 160', so Al wouldn't be surprised if the it reached these larger thicknesses.

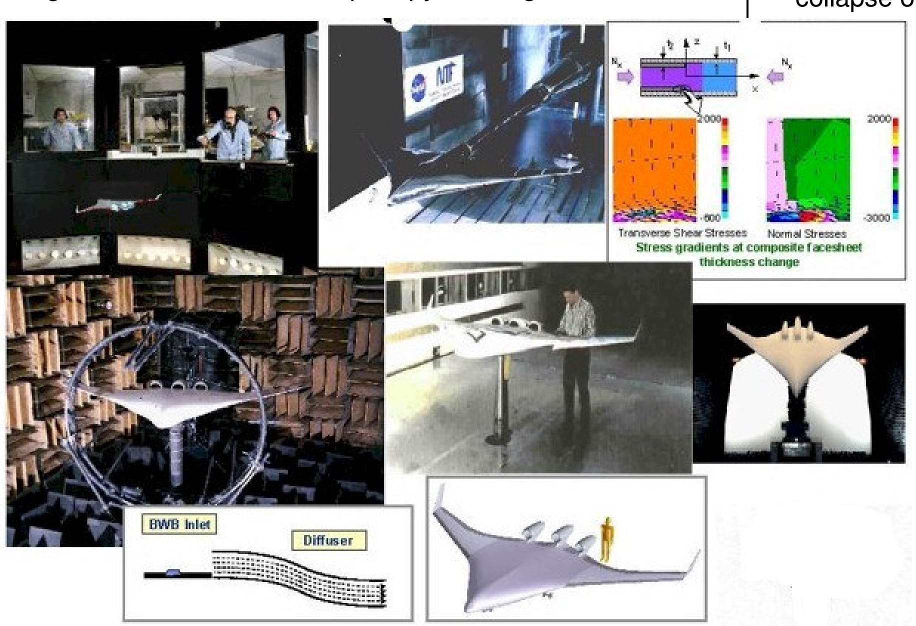
Ralph Wilcox asked about what the wing loading would be for this type of wing. Al commented that when you go to a flying wing you need to bring the numbers back down from what you would have for a conventional aircraft. So instead of having the 105-120 numbers for things like the Boeing 7X7 series, you need something like 95-105. This is easier to do on the BWB since you have so much more wing area.

Gavin Slater asked about the problems associated with boundary layer ingestion (BLI) on the three engines at the back of the aircraft. Engines don't like to see a lot of distortion at the compressor face and, this will become even worse at high angles of attack. The boundary layer will get much thicker and it presents many problems in designing ducts or making changes to the engines themselves. *(ed. – This problem has led to a different engine configuration as shown below. The engines have been moved up on pylons to get them out of the boundary layer flow at all times.)*



Al moved on to the infrastructure problems noted earlier (above). The ICAO wants to stay with the 80m (262 ft.) wingspan separation between terminal gates, so this becomes an intractable problem. The 800 passenger version was also a double-decker which presented another set of problems with the existing gate structures. The two decks also raised concerns over passenger safety in a crash situation where the upper deck could collapse onto the lower one. The last issue was how to you handle 800 passengers for several airplanes at a time in terminals not designed to handle that volume of humanity.

SO, this all had the engineers at Langley pulling their hair out. The upper left segment of the slide in the left column shows a 1% spin tunnel model at Langley. They tried a couple of different models and the one that is going to be flight tested showed high yaw rates. There also appears to be an auto-rotation tumble mode that was observed in the tunnel tests. The lower left segment shows a model in the acoustics chamber being tested of radiation's from things like the radio antennas. The other pictures on the slide show some of the various models that were put through further tunnel testing leading up to changes in the configuration that will be flight tested.



Al then laid some background on the changes that were being made for the upcoming flight test model. The top picture below are of the models Ilan Kroo and his graduate students at Stanford University built and flew as proof of concept vehicles (see below). The top one is a 6' R/C model flown with fairly stable static margins. There were two versions, one with gas power for longer flights and one with electric power (cleaner and quieter). The lower picture below is the 17' version with a true closed loop control system using a MacIntosh laptop computer as the processor for this system. This was a twin engine, gas powered model with multiple control surfaces, each one controlled by an electric actuator designed and built by the students. Ilan also designed the internal instrumentation systems.

The large number of control surfaces presented their own unique troubles. Since any one control deflecting upward will cause the aircraft pitch up the question became one of how best to control the mixture of movements. They had to determine whether there were any pitfalls like airflow separation as the controls moved in differing amounts. Some of these questions are being answered through wind tunnel tests.

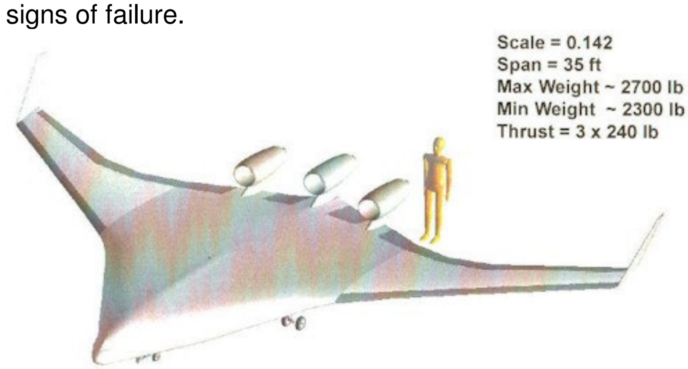
Andy asked Al what caused the phenomenon on the model where the control surfaces appeared to be flopping around during ground taxi. Al indicated the controls were responding to the inputs from onboard sensors being activated by bumps in the taxiway. Due to the low airspeed associated with taxiing, the control deflections to correct the sensed conditions were large and therefore drove the surfaces to their stops. The electric actuators are very fast, so it appears the surfaces are just really loose on the hinges. Al noted this occurs on current fly-by-wire aircraft in the military as they taxi, you just have to look closely to see it.

As Al continued, he noted one of the big questions revolves around something they call "behavior quantification"; how does the aircraft behave, what does it do. They have problems with stall, the aeroelastic properties cause dive problems during the pull out, and a mach buffet with an "ugly" tuck. Then there is the issue of engine out performance since it doesn't have real strong directional stability. If you loose an engine, what is the V_{mca} really going to be? The last issue is stability margin in terms of pitch, lateral and overall directional control.

Up to this point everything that he had been talking about revolved around the 800 passenger version that was studied under a NASA contract that ended in 1996. At that time the Douglas division of McDonnell/Douglas picked up the study and continue it on their own money. These studies resulted in design you see below, which was frozen sometime late last year. The Douglas division of Boeing then continued the project and have further refined the design, which no longer looks like this drawing. However, this is the design version NASA is continuing with for wind tunnel testing and construction of the remotely piloted vehicle (RPV). It is 14.2% scale with a 35' wing span. The flight control systems are being designed at the Dryden facility, but the actual construction and installation of the boxes is being done at Langley. Boeing is also providing engineering support for the vehicle.

One of the first things you notice on this design is the engines having been raised out of the boundary layer flow. This was the fastest and easiest way to solve the inlet and compressor problems trying to deal with the turbulent flow off the rear of the wing, especially in high angle of attack flight. Since this was going to be one of the hardest problems to solve and may not have been economically feasible, the simpler approach was taken.

Although hard to see in the drawing, the control surfaces are spread out differently. There are now 16 control surfaces instead of 22, but it still have the split elevons in the last four outboard elevons, with the outermost two being ganged together. It is all electric with no hydraulics on board, using control actuators taken from an air-launched munitions program. These actuators are designed to work for 90 seconds, yet the test vehicle is being designed to last for 100 hours, so there was another problem than needed to be worked out. It turned out that the actuators were way over designed for the munitions application and probably would last much longer in the less demanding environment of the BWB. The model was also being built in such a manner that the actuators could be easily removed if they showed signs of failure.



The next problem they had to overcome is which digital controller would drive which control surfaces. To maintain a minimum level of redundancy, each controller must drive actuators at different parts of the wing so the failure of one controller will not bring the aircraft down. A little later there was a discussion between Al and Doug about the software NASA is using so the digital controllers know which one takes the lead. The main problem is how the entire system determines when the lead controller is actually having a problem and needs to be relieved by a secondary unit. This got a little deep on the technology side, so not much more will be covered here.

Power will be provided by three Williams turbojet engines from target drones that are designed to operate for about 10 hours. The same issues came up here as with the actuators, plus there was no low idle setting (below 90 lbs.) on the fuel control (the Navy didn't need low idle for in-flight launch so it was not designed in by Williams). The spool up time was also not acceptable since the engine would take 33 seconds from idle to the full thrust of 240 lbs. After long discussion with Williams and a lot of money, NASA got their supply of engines with a 35 lb. idle setting and a much faster response time from idle to full power. Since the test vehicle only needs about 190-200 lbs. per engine, a detent was placed on the pilot's throttle console to limit thrust at 200 lbs. This will make the engines last well beyond the 10 hours. The pilot will have the ability to remove the detent in the event of an engine failure and more power is needed from the remaining engines.

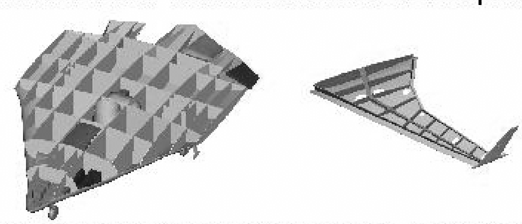
The wing does have slats on the leading edge, however, they do not have actuators so are locked in a fixed position depending on the type of test to be conducted. The original plan called for a ballistic recover chute to save the model, but that has been removed and replaced by triple redundancy in the control software (remember spreading out the control surfaces between controllers) and dual redundancy on hardware. The various antennas will be integrated into the structure to try and keep the surface as clean as possible. There will be a spin recovery chute since plans call for spin testing of this model, along with attempts to make it tumble.

Al mentioned that the weights shown in the slide were dynamically scaled to the commercial, full size version. He gave the example of scaling something down by one half, which results in a piece of hardware that has one quarter of the area, one eighth the volume and one eighth the mass (dynamic scaling). The other scaling factor is moment of inertia. NASA has a very specific set of weights, moments of inertia, area and size targets for this project. The 2,700 lbs. represents the scaled maximum takeoff weight of the full size aircraft. On the other hand, the 2,300 lbs. minimum (empty) weight is well above the truly scaled 1,300 lbs. This is due to the fact you can't always economically scale down things like actuators and other types of hardware, computer systems and other instrumentation. They are not satisfied with the high weight and are trying to get it down below 2,000 lbs., but they are not sure this will happen. The construction is all carbon fiber and Al gave as an example of weight savings the winglet's vertical surfaces. These have a design weight of 7 oz. including all hinges, horns, ribs, etc., and will have to withstand a max speed of 140 knots. Based on what they know now it doesn't look like they will make that weight, but at least it will be the minimum they can make it.

One other thing he wanted to cover on this slide was the relationship between the 14.2% scaling factor and the 35' wing span. If you do the math they don't come out to the 289' of the model he was talking about at the beginning the presentation. That's because this model is for the smaller, 450 passenger, single-deck version that Boeing is working towards. This is still bigger than a current B-747, so many of the earlier noted problems regarding infrastructure still apply.

The next slide shows the molds being built at the Langley facility. The pictures were taken in June and work has now progressed to the point of laying cloth into the molds. However, all of the structural analysis has not be completed so they are not sure how many layers of carbon fiber will be needed. So the engineers are in the catch-up mode trying to get the numbers put together so the technicians can get back to building. The 3% wind tunnel model was nearing completion and it was expected it would go to the tunnel in late September. This model is correct configuration for the skins that are waiting for the final numbers.

3% LSV Wind-Tunnel Model Nears Completion



14.2% LSV Solid Model (Centerbody, Port Wing)

The lower portion of the slide shows the general layout of the test model with fuel tanks and elevons located in the center section. The wings will be separate, which is mainly so the model can be shipped more easily with the plan being to use a large motorhome that doesn't have any interior (just a big box on wheels). Alternate shipping plans include using Air Force C-17 training missions and, as a last resort, paying to ship it on a Super Guppy.

What NASA is doing here is looking at the flight characteristics of the BWB class of vehicles. Although the test model doesn't reflect the latest developments in design changes (as a result of freezing the design for the models purposes), all the test data will be extrapolated to the latest versions using data obtained over the life of the project.

The next slide was a listing of the goals for the ELP (Envelop Limits Program) research, which is where all this is leading too. Things like what happens when you stall it, spin it, tumble it and can it be recovered aerodynamically. Can these modes be prevented aerodynamically using the controls surfaces on the aircraft and, if you can't what will it take in terms of the system software, etc.

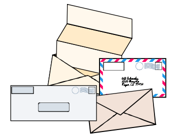
At this point Al took a few minutes to explain a little more about dynamic scaling. If everything goes as planned, the model's scaling will exactly duplicate the aerodynamic forces are work in all phases of flight. So the numbers they get from a wing tip's helix angle as it falls off in a stall will be exactly what the full scale aircraft would see under the same angles of attack. There are a couple of gotcha's here, one being mach number since the model will be nowhere near that of the full size aircraft. For the low speed end this shouldn't be too much of a problem, but they can't do anything about the differences in Reynolds numbers between the vehicles.

For those of you who are concerned with how your government spends its money, Al noted one of the things they are trying to do keep this program under cost control and set an example for future projects. It is a partnership venture between the design engineers at Langley, the flight research group at Dryden and Boeing to do everything right the first time around.

At this point Al went into his summary. The BWB offers potential for substantial economical and environmental benefits. The BWB is a high-risk, high-payoff conceptual platform and it is felt NASA's involvement is appropriate. NASA is now committed to investigating the low-speed stability and control attributes of this confirguration.

Andy thank Al for coming down from the high desert and giving us a unique insight into this fascinating concept aircraft. The raffle was then held so three people could get their hands on their choice of one of the ZingWing rubber-launched, foam flying wings. These fold in half for launch and when reaching the flight apex, unfold and glide down very well based on how the control surfaces have been set. That wrapped up another outstanding meeting.

***We also have a VHS video tape of this presentation available for those of you who would like to see the real thing. The will be accompanied by a complete, printed set of the 18 slides he used so you can clearly see them or make notes as he talks about each one. Also included on the tape is some television coverage of the BWB that shows Ilan Kroo's Stanford team and their flying BWB model. It is priced at $10.00 US for stateside delivery and $12.00 for foreign delivery**.)*



LETTERS TO THE EDITOR

10/16/00

TWITT:

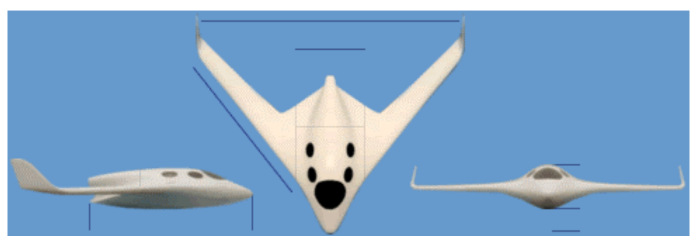
While attending this year's Copperstate 2000 EAA Fly-in this weekend I ran across this company's booth. The company *(Wing Co.)* has been around for a while building wings for Velocity Aircraft for their "Fast-Build" kits. They claim to have the prototype *(Altantica)* flying in January 2001 and have the aircraft on display at Sun 'n Fun next year. The projected price is $51,000 for a heavily prefabricated kit. The central part of the plane can be built, and paid for, first and then the wings can be ordered last for $17,000 in a ready to paint condition. This would be assuming they are still in business by the time you have sunk a ton of money into the center/cockpit body. I thought this might be of interest to our fellow members.

Keep up the great work with the newsletter.

Keep'em flying,

Curtis Clark

(ed. – It is a strange coincidence that I just ran across Wing Co. on the internet the other day and was going to include something about in this or the next newsletter, depending on room. It is as close to being a BWB for the common pilot as I have seen in a while, and one that is available for the well heeled!



The accompanying card contained some of the following information. Five-place, pressurized cabin [90"Lx80"Wx40"H], transatlantic range, stall resistant and impact safe airframe with chute. True 200 hour fuselage. Proprietary pressure molding. Many engine options and modular design. Complies with 51% rule. Phone: 321-253-1975 Fax: 321-253-3868 Address: 1425 General Aviation Dr., Melbourne, FL 32935. www.wingco.com)

10/20/00

TWITT:

Thanks for the minutes of the September 16th meeting, where Al Bowers talks of the complexities of the BWB. From a side view, except for the tail section, it looks like a conventional aircraft. There are many benefits to the BWB and it is important that the BWB design concept is at least as safe, and possibly safer, that a conventional design.

I thought the most exciting part of the newsletter was Play del Rey where Al was test pilot of hang gliders at are 14. At the Dockweiler Beach Reunion were such legends as Richard Miller, Bill Bennett and Joe Faust.

Editor Joe Faust presented some of the most exciting ideas and writings back in those early days of the present age of hang gliding. Maybe it would be possible for you to invite Joe to talk editorial shop talk with you at a future meeting. Faust is a great source of historical information of those now legendary days.

Best regards,

Edwin G. Sward

(ed. – Thanks for the feedback on the meeting and the newsletter. I hope you enjoyed the second half of Al's presentation as you worked your way to the letter's section.

Thanks for the idea on contacting Joe Faust as a possible speaker. Do you happen to have his address and/or phone number so we could get a hold of him? If not, do you have another contact point that might lead us to him?)

10/12/00

Dear Bob & Doug:

Well, finally I've been forced to write a story about the ultralight revolution. Without people like the Fronius' this story would have never been told. It was fun and exciting. I was very happy to have visited with you both at Arvin. Thanks for UFO & believing in my products.

Enclosed are the first 6 episodes of a story now appearing in EAA Experimenter Magazine.

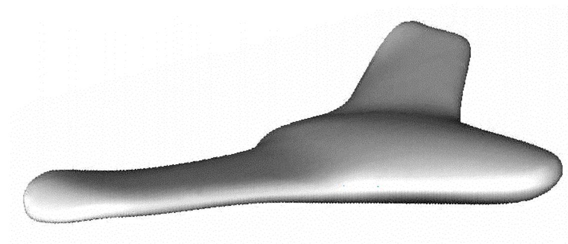
Larry Mauro

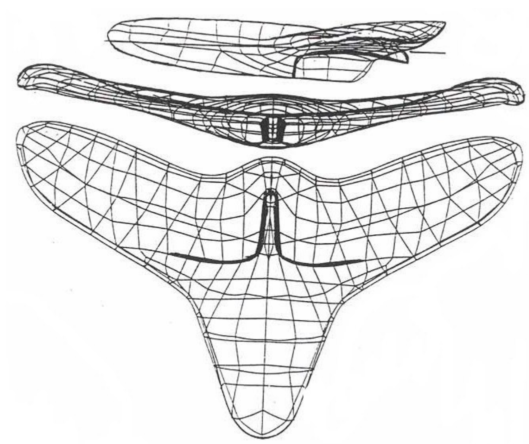
(ed. – I included this letter to let you ultralight fans not familiar with the EAA magazine know that there is something to be looking for.)

BWB MODEL FOR EVERYONE?

This is a computer illustration of a foam casting by Jay Sadowski. Size:7" across. Weight: 2 grams.

Sponsors are needed in order to start production of this excellent hand launched blended wing glider. Should anyone be interested in seeing more of this new type of tailless airplane in the hands of young and old, with a company name and logo on the top, please contact Jay by phone (414-562-6608) or e-mail (creaturegliders@gateway.net).





"DEAF HAWK's" NEW LOCATION

We have learned that Bernie Gross has donated his Marske Pioneer II, "Deaf Hawk", to the Wings of History Air Museum in San Martin, California. Below are a couple of pictures of the Hawk before it was to be raised into the overhead of the museum for permanent display.

THE GOOSE STORY

When you see geese heading south for the winter, flying along in “V” formation, you might consider what science has discovered about why they fly that way.

As each bird flaps its wings, it creates an uplift for the bird immediately following.

By flying in a “V” formation, the whole flock adds at least 71% more flying range than possible if each bird flew on its own.

When a goose falls out of formation, it suddenly feels the drag and resistance of trying to go it alone…and quickly gets back into formation to take advantage of the lifting power of the bird in front.

When the head goose gets tired, it rotates back in the “wing” and another goose files point.

Geese honk from behind to encourage those up front to keep up their speed.

Finally – and this is important – when a goose gets sick or is wounded by gunshot and falls out of formation, two other geese fall out with that goose and follow it down to lend help and protection. They stay with the fallen goose until it is able to fly or until it dies. Only then do they launch out on their own or with another formation to catch up with their group.