No. 163 JANUARY 2000

T.W.I.T.T. NEWSLETTER

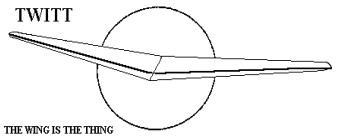
Scott Winton's "Facet Opal" wing that set numerous world records. Photo courtesy of Mike Muller in Australia. See page 6 for Terry Baxter's comments on this aircraft and how it may be influencing his design decisions.

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

HAPPY NEW YEAR

The number after your name indicates the ending year and month of your current subscription, i.e., **0001** means this is your last issue unless renewed.

Next TWITT meeting: Saturday, January 15, 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

There seemed to be a lot to cram into the newsletter this month, for a change. We have the last part of Bob Hoey's presentation on R/C bird models now looking at how simulated tip feathers affected performance and handling. We have the first installment of the design proposal by Terry Baxter of Australia which has many interesting aspects and questions. Then there is the annual membership roster which, hopefully, I have sorted better than last time so it will be easier to use.

The January meeting looks like it will be a lot of fun. We will have some free-flight foam flying wing gliders for everyone to take a hand at making fly better. I am sure that without us even planning it, some type of contest will ensue trying to see who can get the most distance or make the most loops. We can thank Jay Sadowski for these airplanes. He is the distributor and sent us a case of each to play with and pass the word around about them. If you are interested in something like this for your kids, or would like to buy some as handouts at your business, you can see Jay's ad in our "shortened" classified section this month.

It seems I forgot to put in a Y2K disclosure before the end of the year, so better late than never. This is to let you know we experienced no significant Y2K problems during the new year change over and all equipment and people continue to work in their near flawless manor. Our television, video and overhead projectors have shown no signs of any "bugs" and the audience chairs have proven to be just as immune to any electronic failures. We have also done a lot of testing on the Bats & Birds and found them to be "bug-free" so feel they will operate normally during the January and subsequent meetings.

I would like to wish everyone a belated Happy New Year. I hope everyone got through it with the minimum of hangover and most of all didn't have to work through the weekend on some Y2K related problem. We are looking forward to another year of helping keep everyone informed on new and old developments in the flying wing arena.

Mark your calendar today for the March meeting since it will feature Al Backstrom. See next page.

Andy

JANUARY 15, 1999 PROGRAM

Our program for January will feature **Doug Fronius**, Vice President of Advanced Development at the Ryan Aeronautical Center of Northrop Grumman, who will brief us on some of the unique projects they are currently working on. Then Doug will cover the Minature Air Launch Decoy (MALD) program in more detail, which incorporates a small turbo-jet to deploy these decoys in front of fighter aircraft to confuse ground radar. The turbo-jet engine develops 55 pounds of thrust out of an 8-pound package and he will be bringing along one for all to drool over (they are probably a little pricey for most of us). He will also bring along one of the decoys so you can get an idea of it's true size and configuration.

After Doug's presentation we will be showing the short video of the Northrop flying wing's history done by Clete Roberts back in the early 1980s. This footage includes one-on-one interviews with Jack Northrop where he relates why the Air Force contract was canceled and the existing airplanes ordered destroyed.

For those of you who have seen this Northrop footage before, we have some new toys for you to play with. Jay Sadowski of Creature Gliders & Co. shipped us two cases of Bats and Birds, which are foam, free-flight flying wing models. These fly pretty well right out the wrapping, but I am sure you guys will find ways to make them perform even better. Jay is interested in hearing back from us on how our members liked them and I am sure any suggestions for improvements would be appreciated.

MARCH 18, 2000 PROGRAM

We are extremely pleased to announce that our **March program will feature Al Backstrom**. He will be re-creating his 1998 Flying Wing Symposium presentation on his flying plank series of gliders. We will have more details in the next newsletter, but you need to **mark your calendar now** for this date so you don't miss this one.

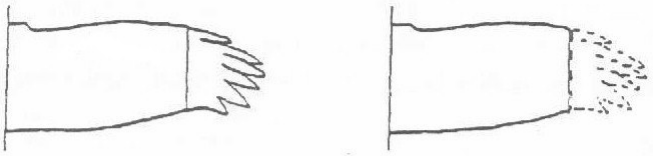
MINUTES OF THE NOVEMBER 20, 1999 MEETING *PART 2*

(ed. - This is a continuation of Bob Hoey's presentation on radio controlled (R/C) bird models being used to explore the control and performance parameters of birds.)

After a short break for everyone to stretch and have some coffee and donuts, the group returned to their seats so Bob could continue with the more recent phases of their project.

One of the things that led to further aerodynamic studies was birds not having drag flaps which was one of the control methods being used on the models. Bob resumed with a short video of the gliders during the early tests. He commented that the Turkey Vulture has a really nice glide but it rocks around a lot laterally because there is too much dihedral, but of course the real birds to it also. The frequency of the rocking is slower than that of a real Turkey Vulture, but he thinks this is due to the model wing being heavier than the birds and could be resolved with a lighter structure. This model was controlled by a drag flap on the bottom of the wing like the Raven, but they were also experimenting with various lateral control devices that would simulate wing twist. Besides the bottom drag flap they also tried a top wing spoiler, which when coupled with a stable airplane and the dihedral effect produced the necessary control.

CALCULATED EFFECTS OF NO-LIFT, NO-DRAG WING TIPS



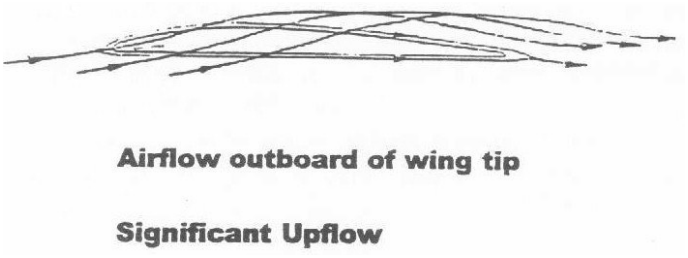
	Normal Wing	No-Lift, No-Drag Tips
Area	400 sq. in	322 sq. in.
Span	50 in.	34.8 in.
Aspect Ratio	6.2	3.76
Angle of Attack	12 deg.	12 deg.
Velocity	18.5 ft./sec	22.7 ft./sec
Drag Coefficient	0.0948	0.0914

As part of their experiments they tried standard ailerons, differential ailerons, leading edge flaps and strip ailerons all the way to the tip. None of these methods ever gave them the twist effect they were looking for.

They also tried an electric motor on the nose of one model to eliminate the mothership. The first few flights were still dropped from the mothership with gradual powered attempts made after separation. In high speed powered flight it had a large lateral oscillation, but if you got a little too slow with power on it would have a tendency to do a snap into a spin as we saw on one of his video clips. Pulling the power off was effective in recovery and it became a docile glider again. (Phil Burgers commented that's why birds don't have electric motors, to which Bob replied that now we know why airplanes with motors need vertical tails. Notice he didn't say at the end of the fuselage, so Bob must like flying wings.)

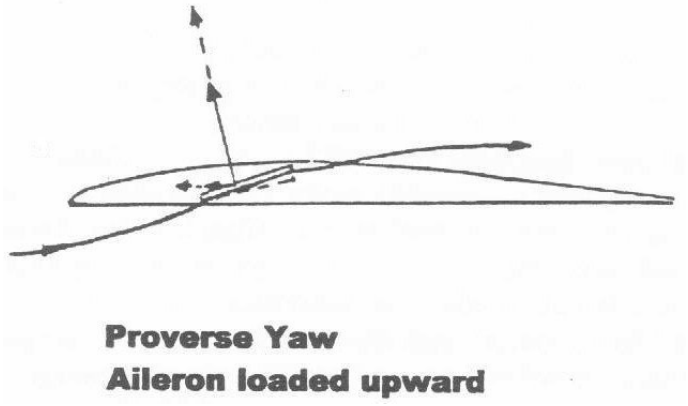
The tests with various aileron configurations kept giving them different levels of adverse yaw which was what they were trying to get away from. So they tried up to about 6 degrees of tip washout to keep the tip from lifting. This took care of the adverse yaw during turns, but what Bob observed was the tips weren't loaded in level flight like those of a bird. A bird's tip feathers have a very definite upsweep to them so he knew they were heavily loaded.

WING TIP VORTICES (3-DIMENSIONAL)



Bob then read an article by Carl Horst that explained the tip feathers were not really part of the wing, but rather part of the flapping mechanism. Their primary purpose is to produce thrust and not lift. So during level flight these tip feathers are trying to either continue producing thrust or else create as little drag as possible and leave lift generation to the inner portion of the wing. This got Bob thinking about the 3-dimensional air flow around the wing tip, so just outboard of the tip you have a tremendous upflow of air. So he thought if a blade could be stuck out into this upflow and adjusted to the right angle then it could generate a lift force or thrust. This would then give them proverse yaw which is what they were looking for to make the models turn better.

OUTBOARD WING TIP AILERON

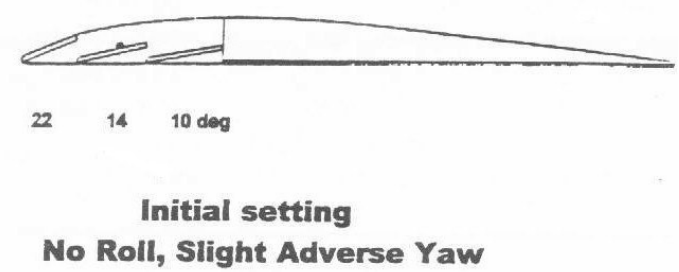


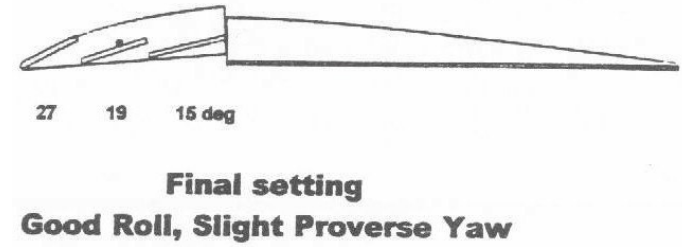
Bob noted that some people had said they were trying to get something for nothing, sort of like a perpetual motion machine. However, he retorts with the fact that the blade (or a feather) is simply using the energy resulting from the production of lift by the main portion of the wing. He also noted that wave surfers have used this technique for years by picking just the right portion of the wave and then riding it for long periods of time. (The wave is the vortex and the surfboard is the feather in this case.)

The next phase of the project was to put a set of four ground adjustable "feathers" out on the tip and go through a series of tests to determine the optimum settings. Well, as luck you have it they had a slight accident on the second flight when the model bird hit the mothership upon launch. This knocked off the "tip feathers" (about 12% of the wing span) from one side and tumbled the glider for a few seconds. It recovered into level flight and Bob found it was flying relatively normally except for a slight yaw. He tried turns in both directions and found it handled almost the same as without the tip. Obviously the existing tip feathers were not causing any drag and were creating the desired results of proverse yaw. In this one flight they had accomplished what all their planned tests would have been designed for, so they eliminated them and moved on to the next phase.

This phase was to install a set of in-flight moveable "feathers" on the tip to replace the ailerons. The leading

3-FEATHER WING TIP AILERONS





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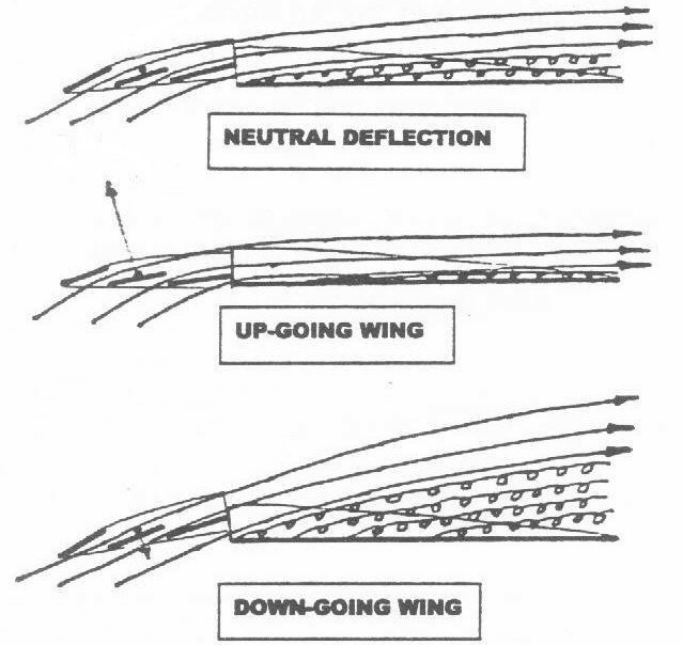
edge outboard of the flat tip was fitted with a moveable section with 3 feathers attached. Aft of these moving feathers were the same flat, stationary feathers from the early test model. The 3 feathers were initially set at 22, 14 and 10 degrees negative pitch. With the newer type of radio control equipment the feathers could be moved like normal ailerons and the unit biased up or down to increase or decrease the washout while in flight. The flights with these initial settings produced no roll and a slight amount of adverse yaw.

LATERAL CONTROL
PRELIMINARY ANALYSIS



The next set of flights tipped the feathers down to 27, 19 and 15 degrees. Roll control was much improved and they had a slight amount of proverse yaw. By going further negative with the feathers the amount of proverse yaw caused abrupt movements of the nose and they suspect they were stalling the front feather. Bob thought they might have some flutter problems with this arrangement, but it hasn't materialized yet at the slow speeds they have been flying. They also noticed some improvement in the overall performance of the glider at the 27 degree settings.

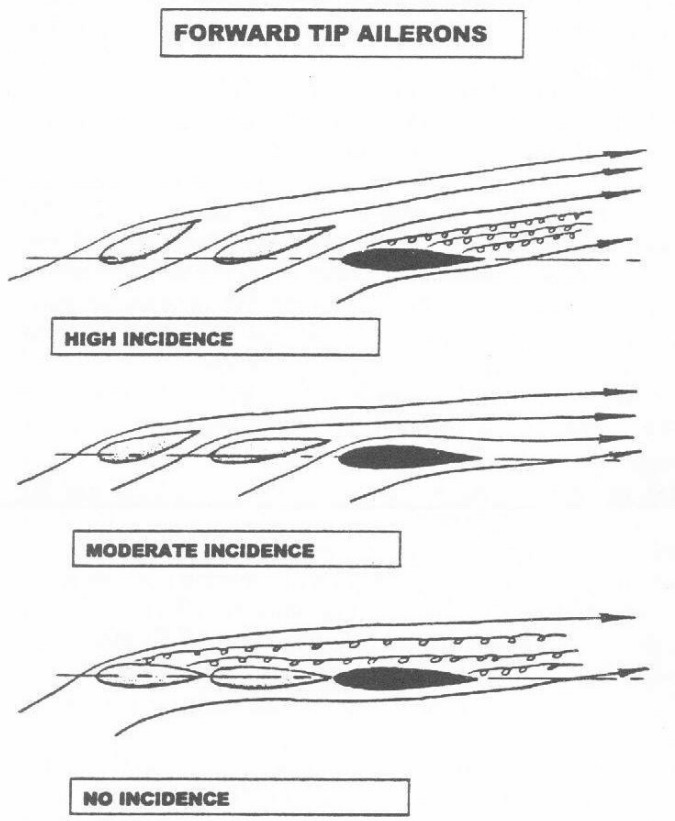
On the seagull model rather than put individual feathers at the tip, they simply cut the tip off and rigged it to pivot around an axis parallel to the wing span. The radio mixer also allowed this arrangement to be moved differentially and bias the tips up or down to modify the amount of washout. This configuration change made a significant difference in the controllability of the glider once the optimum biased angle was found (about an 1/8 of an inch washout measured at the trailing edge).

They found that all three gliders had a "sweet spot" associated with this biased washout. It didn't take long once in flight to find this angle since there was a noticeable difference in performance and controllability.

Last summer Bob asked the NASA Dryden folks at Edwards AFB if he could use their water tunnel to analyze the flow around the feathers. They used a half span model (which was shown on page 2 of last months newsletter) of the Raven wing. The results were very interesting the first time around and NASA has set up some time for them to go back into the tunnel in the near future.

The water tunnel's dye marker flow wasn't quite as smooth through the simulated feathers as they would have liked. It kind of had some clumps in it, but they still were able to see some of the separation on the rear part of the main wing. They weren't sure if it was real since the tunnel was operating at much lower Reynolds numbers than the actual glider. The flow around a blank wing tip showed the strong upflow and merge with the vortex. Without the tip there is a very narrow, strong core vortex shown staying developed well behind the wing after forming just inboard of the tip.

INCIDENCE BIAS
PRELIMINARY ANALYSIS



When they ran the dye marker flow across the original flat feather arrangement used on the early models it showed complete separation right at the leading edge. Then the 3-feather arrangement using the 27 degree setting showed smooth flow until the third feather then they got separation over the rear stationary ones. This is because the third feather is at about 15 degrees and the flow has to transition to zero degrees which it just can't do. As they continued to experiment they found that reducing the angle of attack of the three leading feathers helped reduce the rear feather separation, however, as noted earlier these settings weren't very good for actual flight since they were too high or low. Later tuft testing on the models revealed some of the same results.

After an analysis of the tunnel testing and performance with and without the tip feathers they came to the following conclusions. At neutral deflection the front three feathers are getting a little bit of positive or zero lift and, the rear feathers have a little bit of separation. During a turn, on the up-going wing the front feathers produce more lift, and probably a little thrust, with a reduction in the separation on the rear feathers. This gives proverse yaw which what was being looked for. The down-going wing increases the angle of attack producing negative lift and a lot of separation on the rear feathers. This gives the down-going wing more

drag which in turn is more proverse yaw. BUT, Bob thinks that the birds wouldn't accept this kind of thing.

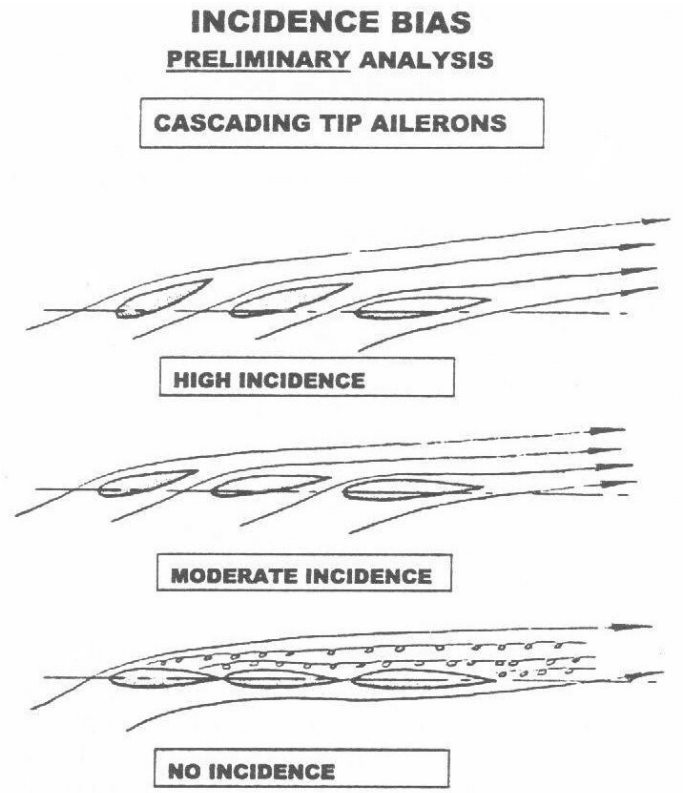
Bob then took an old Flight Streak and fitted it with a 3-tier set of airfoil shaped tip ailerons that could be individually controlled in relation to each other. If the front "feather" moved 10 degrees the second feather would only move about 5 degrees. At first they only moved the front two, but worked into moving all three with the rear feather moving even less than the second one. These experiments found the same thing as with the Raven feathers. At zero incidence the model would not turn and this was assumed to be due to the separation seen in earlier flight tests. However, at high and moderate incidence angles the airplane flew relatively well. What did occur as they moved the rear feather was the re-introduction of adverse yaw. They are still playing with the settings and gearing of the feathers, so testing goes on with this aircraft.

One of the funnier things Bob tried to do with the Flight Streak was fly it inverted to see if the controls were reversed as he suspected they would be. However, using the tip feathers as ailerons wouldn't roll it past the 90 degree point, so he had to use the strip ailerons to get it on it's back. It was commented that birds don't fly inverted, which Bob acknowledged, but he did find the controls were reversed. Bob Chase noted that when he was stationed in Greenland, Ravens used to try and imitate the victory rolls being done by the real airplanes. However, according to Bob they never made it, usually just ending up flailing around and falling out of the air.

Bob Hoey went on to say that the version of the Raven he had with him today has been flown with a tip configuration where the second feather is at about 10 degrees, the third at about 5 degrees and the rear one is at zero. He plotted the cascade to maintain a linear relationship in the angle and gap between the feathers at the back. The glide with these settings is markedly better than previous configurations, acting like a glider with an aspect ratio of 12-13 rather than like the AR 6 that it is. Aileron effectiveness is reduced over the previous settings, since he thinks they are now only getting induced thrust versus having the additive effects of thrust and flow separation. In other words they have a more efficient rear end section and they are going to check this out in the water tunnel shortly. The problem was overcome with an increase aileron throw and the glider flew fine.

Phil Burgers commented that one of the difficulties the team was having related to the fact they had 3-dimensional flow versus 2-dimensional as with other types of lift devices like fowler flaps. Phil also suggested that the water tunnel probe with the colored dye be placed as close the leading edge as possible to improve the Reynolds numbers of the flow and perhaps give better results.

INCIDENCE BIAS
PRELIMINARY ANALYSIS



Henry Jex mentioned that Clarence Come had written a book which included an analysis of the effects of cascaded tip feathers. There were some advantages to the configuration if the cascade effect was properly designed and suggested Bob get a hold of a copy since it was directly related to his project. Henry went on to tell the group how a bird goes about controlling its feathers in response to a question from Gavin Slater on whether each feather can be separately controlled. It was quite fascinating, but he admitted some of the information was third hand so it might not all be exactly correct.

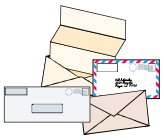
Ed Lockhart asked a question about the relationship between the amount of upwash due to high degrees of twist in the Horten wings and what Bob was finding with the feathers. Bob felt there wasn't a good comparison since he was working essentially with a straight wing and that putting sweep into it would change everything. Phil mentioned that Horten had several aircraft that used fully pivoting tips similar to Bob's Seagull model. He also added another technique for the water tunnel where more attention is paid to the vortex wake. If the wake is diffused it could give him information about whether he is using more energy to produce thrust or just having a mess due to separation problems.

As Bob's formal presentation wound down, there were some more questions and comments from the audience. However, at one point while Henry Jex was gesturing his way through a explanation of bird feather manipulation, Andy came up to officially close the meeting. This was mainly because he was rapidly running out of video tape

since the program had gone on so long due to everyone being so enthralled with the subject.

In between sessions by Bob, we had a short door prize raffle with items contributed by XZX. They were some fun type things and the winners had their choice as they won.

NOTE: As noted above, we video taped Bob's presentation so those of you who have a real interest in this area could see the whole thing rather than rely on a written transcription. We were able to get a copy of Bob's videos he showed during the presentation and have added them to the end of the tape so you can see them normally rather then as a video of a television screen. The package also contains a full set of the slides he used so you can see them more clearly and/or make annotations on them as you view the presentation. This entire package is available from TWITT for the price of $10.00 (postage paid in US dollars) and $15.00 for foreign orders (postage paid in US dollars).



LETTERS TO THE EDITOR

11/18/99

TWITT:

Having come across No. 149 TWITT Newsletter 1998, I wish to become a member and request lots of information.

The first thing I am doing at the moment is resurrecting a Mk III Scout, the original minimum aircraft ultralight, which was designed and built in Australia in the late 1960s. The Mk I which was the beginning was powered by the Australian Victa Motor Mower engine, bicycle chain drive and sprockets about 3:1 reduction. I am donating this to the Darwin Aviation Museum and modifying it to a Sea-Scout, tri retractable landing gear and converting it to a bi-plane, combining many modifications that the resourceful Australians carried out.

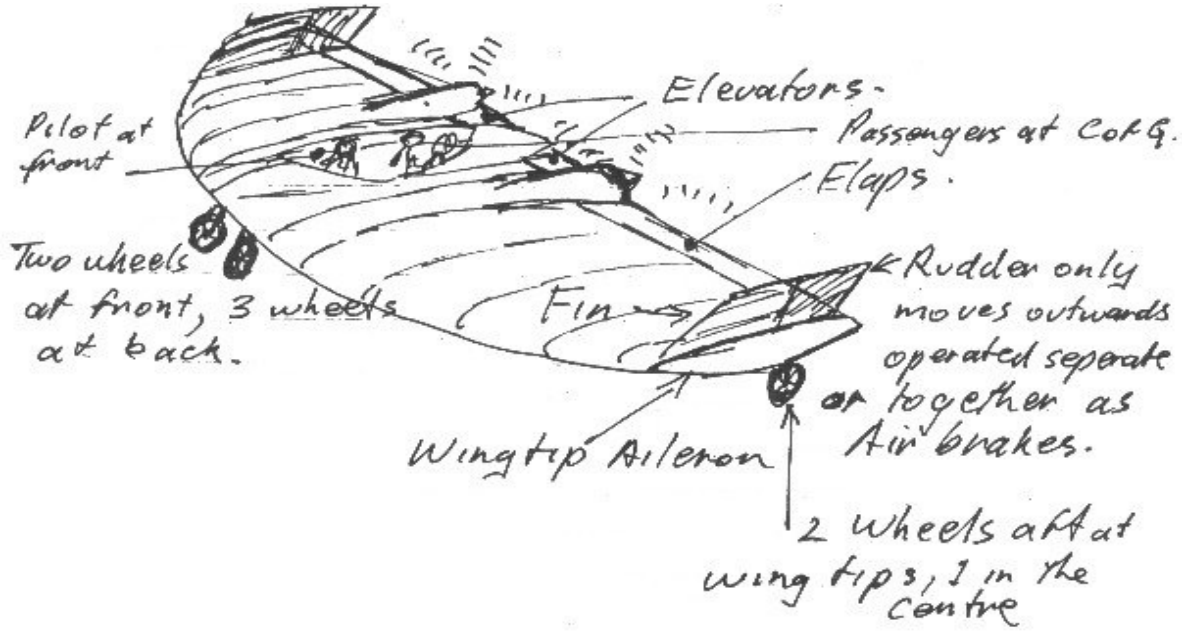
I believe these were the first ultralights with camping gear tied on the floats that crossed water to land on islands off Australia's coast, early 1970s.

I am a senior citizen, hold a degree in horticulture and am a qualified lepidopterist, breeding butterflies and operating the Darwin Butterfly Sanctuary. I am a member of the Australian Society of WW I Aero Historians and am trying to procure the original plans to build a "Sopwith Pup" before I die. If any of your members have any information I would appreciate it.

I am a member of the Top End Ultralight Club and training in a "Drifter", a "Thruster" and other aircraft, as I need an ultralight license even to fly the minimum aircraft "Scout" in Australia; not like in America where no license is required if certain rules are adhered to.

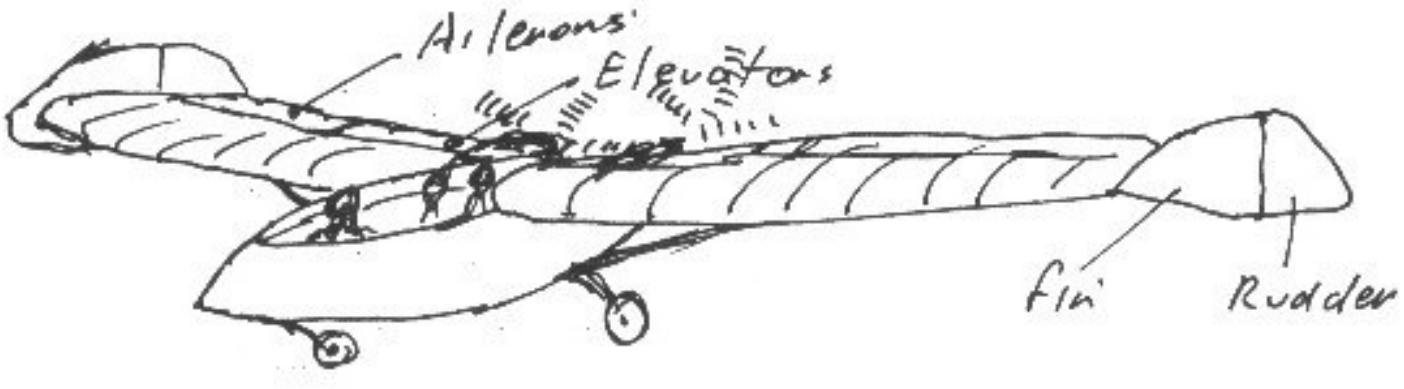
I am building an ornothropter as a hang-glider combing 3-axis control and weight shift controls with a trike attachment with power. Instead of flapping wings I have designed a wing warp operated by hand levers to flap the wings to varying angles of attack. I discovered this idea from the "Ornothroptera Priamus" the large Birdwing Butterfly I have been breeding for years and, watching the Pacific Gulls hovering at the cliffs of Darwin's waterfront. I have studied Leonardo Da Vinci's plans and have simplified his designs to use modern materials and ideas. *(ed. - Terry included a little more on this concept, but I am going to push ahead in his letter to get to some of the material concerning his ideas for the designs shown on last month's cover.)*

Now to the main reason for joining TWITT. As by the address you can see I live at the top of Australia, but when Cyclone Tracy blew me out of Darwin in 1974, I bought a



farm in Victoria to house my family. The commute between Darwin and Victoria is 4200 km each way over roads that are not always the best. There has to be a better way to make this trip.

In conjunction with a Frenchmen, we have been trying to design a "FACET" similar to Barnaby Wainfan's who I believe is one of your members *(ed. - he is not, but we stay in touch)*. An Australian designed a "FACET OPAL" in which he died and I have repeated dreams about it. My main concern is designing and building a "Long Distance FACET" or flying wing to commute between the top and bottom of Australia so I can manage both of my properties. I believe commuting by plane is safer than the long distance by road and it will be much easier on my wife and little girl than the long ride. So with my family on board it needs to be safe and I have heard it is hard to stall a FACET or flying wing and they just mush down; is this correct?



I have in mind twin engines for safety; small four strokes in-line or opposed or twin small radials. I am no aero engineer, only an old plumber, so need a presentation of different models for selection. I have been playing around with an old 1930's concept where the designer quoted a 4-wheel pusher would probably be the future plane. I have a 5-wheel sketch as below.

In my dreams Scott Winton keeps telling me that the wing should be the cockpit. Scott designed the 'Facet Opal" which he used to break 4 records, including climbing to over 30,000' on 40 hp, before a fatal accident with the aircraft. If you have any photos of the Facit Opal I would appreciate one.

I have been making balsa models and have duplicated the ply sandwich idea with a trangle shape front to a square where the passengers sit to a triangle at the rear with twin pushers and a tri landing gear, conventional 3-axis control. The passengers are recessed into the main spar of the wing putting them at the CG which still allows the plane to fly solo with the pilot up front to balance the weight of the engines aft.

The engines would have to be close together for one engine to still keep the aircraft in flight if one failed. Do you have a concept in your files as a facet or flying wing? Ply/foam fuselage with 18" deep wing at the center to 6" outboard, approximately 20' wing span, 12' chord at the fuselage and as a guess twin 60 hp motors.

As I have built many ply boats I think the ply/foam combination would be the easy way to build as all you need to do is order custom length ply, mark out the shape and cut with a jigsaw. You can then trace it onto another sheet giving you a right and left hand side, then joining them with bulkheads for seats, etc.

(ed. - I will stop at this point now that you have the idea of what Terry is striving for. He has sent a lot of material and I will continue this next month. I also need to leave room for the roster and some pictures.)

Terry Baxter
Darwin Butterfly Sanctuary
79 Mueller Road, Malak
Darwin, Northern Territory 0812
AUSTRALIA

MARSKE WORKSHOP
FEBRUARY 24 - 26, 2000

The Marske organization is again offering a series of workshops and Monarch checkout in February. The courses are for builders and designers in airfoils for flying wings, stress, calculating CG and general discussion of flying wings. Plans for the Pioneer and Monarch will be extensively reviewed. There will be a class project for a hands-on session in fiberglass.

Pilots wishing to be checked out in the Monarch must have a minimum of 10 flights in sailplanes - a current sailplane license with a minimum of 2 hours solo - time in a 1-26 is also recommended. Pilots will have a checkout in a 2-33. Instruction will include auto towing, flying characteristics and ground school. Added cost of this checkout is $100.

Cost all inclusive is $250 or $100 per day (plus the $100 for a Monarch checkout). Pre-registration is required - $125. For more information check their web site at:
http://www.continuo.com/marske/workshop/feb2000/feb2000.htm

You can also contact:

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marske@gte.net