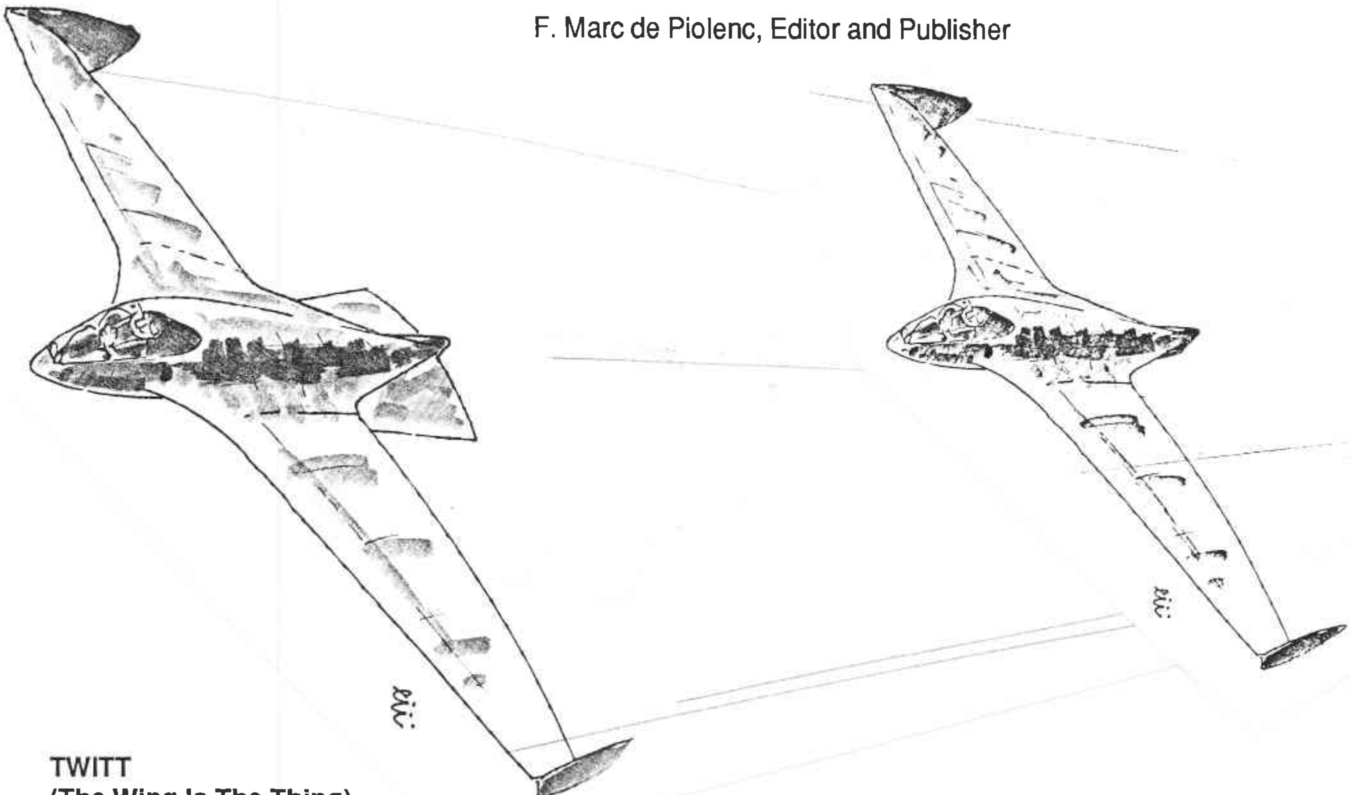
NUMBER 31 JANUARY 1989

TWITT NEWSLETTER

F. Marc de Piolenc, Editor and Publisher



TWITT
(The Wing Is The Thing)
PO Box 20430
El Cajon, CA 92021
USA

The numbers in the upper right corner of your label indicate the last issue of your current subscription, e.g. 8901 means this is your last issue.

NEXT TWITT MEETING: Saturday, 21 January 1989, beginning at 1330 hours. As always, the location is Hangar A-4, Gillespie Field, El Cajon, California, in the first row of hangars on Joe Crosson Drive.

CONTENTS

ABOUT OUR COVER

Our cover shows Ed Leiser's rendition of a flying wing design by Jerry Blumenthal. The very sharp-eyed will notice a minor bobble—Jerry's design is intended to be flown from the prone position, and Ed's drawing has the pilot lying back. Enjoy!

MINUTES OF THE 17 DECEMBER 1988 TWITT MEETING

The meeting was attended by June Wiberg, Bob Fronius, Hernan Posnansky, Harold Pio, Jim Neiswonger, Marshall Randall, Brian Voogd, Francisco Burgers, Phillip Burgers, Victor Millman, Emil Kremzier, Fortunato Figueroa, Andy Kecskes, David Pio, J.C. Pemberton, Jerry Blumenthal, Steve Bennett, Roger Wilcox, George P. and George P. Jr. [??], Ed Lockhart and Greg Kendall. Your Editor was protecting the USA by attending a meeting of his Army Reserve unit. Bob furnished audio tapes of the meeting, from which these Minutes were prepared. Bob Fronius opened the meeting by announcing that this was the 85th anniversary of the Wright Brothers' first powered flight at Kitty Hawk, North Carolina. He introduced the exhibits and the raffle prizes, both of which were Wright-related. June Wiberg explained how TWITT obtained the loan of the swatch of fabric (from the original flyer) that was on display.

Bob then introduced Bill Chana, an expert on the Wright brothers' career. Bill began by explaining the onset of his interest in the Wrights. It seems that when the American Institute of Aeronautics and Astronautics (AIAA) sold their building in Los Angeles in the early Seventies, they needed a temporary home for an excellent replica of the Wright flyer, which had been build by Northrop Institute and had hung from the ceiling of the AIAA's building. They lent the replica to the San Diego Aerospace Museum. In 1978, the museum burned down, losing—among many other valuable exhibits—the Wright Flyer replica. But Bill's problems began earlier, when the replica was sent down to San Diego. Those who dismantled it for transport were not very fastidious, and so the machine reached San Diego damaged in shipment and with its rigging in disarray. Bill was one of those who spent several weekends restoring the machine, and he began to feel an affinity for the builders of the original. He later found books containing correspondence between the Wrights and Octave Chanute, which only quickened his enthusiasm. At the request of some members of EAA Chapter 14, he prepared in 1976 a 1 hr., 40 minutes slideshow about the Wrights. He has since been forced to cut the presentation down. Bill then launched into his presentation. The key points which he made—at least from your Editor's point of view—were that, unlike many pioneers, the Wrights profited by their contribution to aviation. What is more, they were already successful printers, newspaper publishers and bicycle manufacturers when they began their aviation experiments. Their procedure was the opposite of Edison's random trial and error; they assembled the best scientific data available at the time and—when that proved suspect—built their own wind tunnel and carefully gathered the data they needed. Interestingly, while they stimulated rapid technical progress in heavier-than-air flight, their own designs did not advance much beyond the original Flyer. Lieutenant Selfridge, who was killed flying with Orville at Ft. Myers, Virginia, had previously flown Curtiss' June Bug. [Actually, though Bill might not know it, Selfridge's aviation work went back farther than that; he worked with Alexander Graham Bell's group, which I think was called the Aerial Experiment Association, during the 1890's. Bell was intent on the development of large cellular man–carrying kites, which he felt were the best bet for conversion to powered aircraft. The US Army Signal Corps apparently thought enough of Bell's work to detail Selfridge to work with him. Their experiments are beautifully documented in the *National Geographic* magazine—Ed.] Bill noted that the AIAA has put the $20,000 dollars of the insurance settlement for the loss of the Wright Flyer replica to good use: construction of a 6 ft (1.8 m) span wind tunnel model, a flying replica and a full-scale wind tunnel model to be tested at NASA–Ames Research Center, Moffet Field.

A fifteen–minute break followed Bill's talk, coinciding with the end of the first audio tape of the meeting. The second audio tape which your editor received does not appear to pertain to this meeting, so the Minutes have to end here.

AV 222 motor glider

length	17.1 ft	wing loading	4.9 lbs/ft^2
height	7.8 ft	glide ratio	30:1 @ 56 mph
span	53.8 ft	min. sink v.	2.65 ft/sec @ 46 mph
area	247.6 ft^2	min. flight v.	39 mph
empty weight	716.0 lbs	max. rough air v.	103 mph
gross weight	1212.0 lbs	never exceed v.	141 mph

JANUARY MEETING ANNOUNCEMENT

TWITT will meet again on Saturday, January 21 at 1:30 pm at Hangar A-4, Gillespie Field, El Cajon, California. Our featured speaker will be Doug Fronius, who will discuss the development of unmanned aircraft at Teledyne Ryan, where he works. Ryan has been in that business for a long time, with a long history of technical triumphs (and a few disasters) in unmanned flight. Be there.

NEW BOOK BY AIRFOIL EXPERT WAINFAN

In a recent newsletter, Aircraft Spruce and Specialty of Fullerton, California announced a 57-page collection of articles by Barnaby Wainfan (April 88 TWITT speaker) on airfoil selection. The book, entitled appropriately enough *Airfoil Selection,* consists of articles originally published in the magazine *Kitplanes.* It is available from Aircraft Spruce for $15.50.

LETTERS

Fauvel AV 222 Project

From Kenneth B. Weyand of Anchorage, Alaska:

...I was pleasantly surprised to find mention of my Fauvel AV 222 project in the Dec. 88 TWITT Newsletter. Please find enclosed $22.00 for back issues 1 through 29.

I have also enclosed a three view drawing of the AV 222 as I envision it. The drawing reflects my landing gear and canopy changes.

The photos illustrate a 1/6 size model with Fauvel's F2 17% section. It flies like any other radio plane and is stable enough for a novice to fly. All in all, very reassuring.

The AV 222 hardware is slowly taking shape. The air brake (spoiler) system is nearly complete. It's in my anodizing tank as I write. Other completed items include: engine mount, control stick assembly, landing gear, trim tabs and various bits and pieces.

I do not expect to have it airborne for a long time unless I can arrange to be on another sabbatical to work on it. If one were to get philosophical, it might be said that a homebuilt aircraft does not so much represent an accomplishment as it does a litany of things never done.

I am intrigued as to what other tailless hardware is "out there" among the TWITT membership and hope my question will be answered by the back issues.

Wishing you a happy holiday season and a joyous new year I am,

Yours truly,

Kenneth B. Weyand

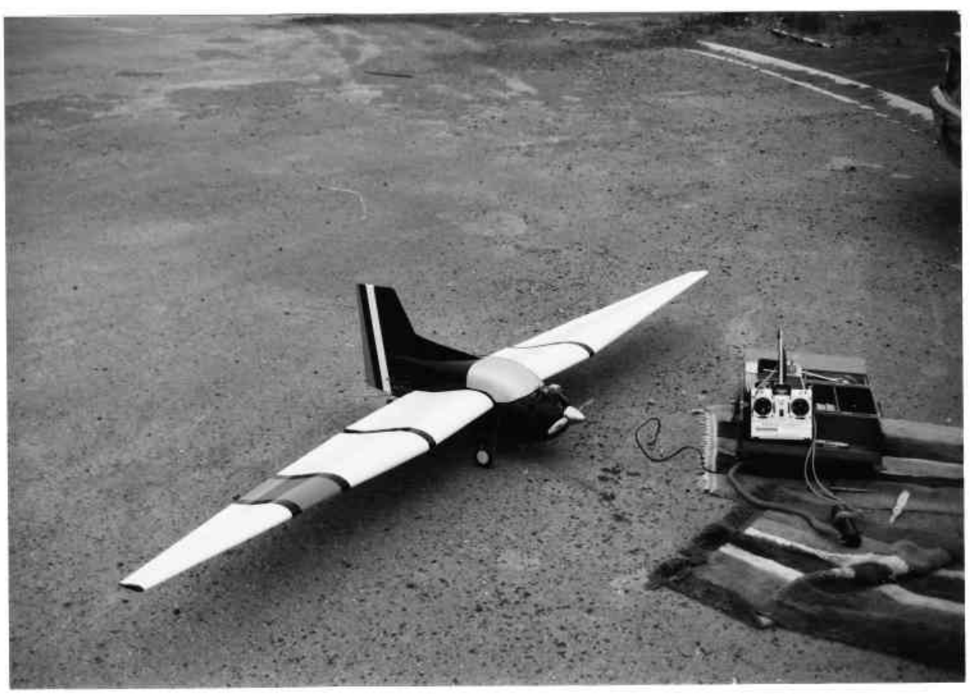
Questions about the Eppler Code

This letter is from Mr. Weyand to airfoil expert and April 1988 TWITT speaker Barnaby Wainfan, sent care of TWITT. Because the questions are of general interest, we have taken the liberty of reproducing the letter here before sending it on. With luck, we will be able to publish the answers in a future issue.

Dear Mr. Wainfan,

Having just recently joined TWITT, I elected to acquire all past news letters. Upon receiving them I was pleasantly surprised to see the summary of your April presentation in the May 1988 issue. My

Kenneth Weyand's 1/6 Scale Fauvel AV 222



attention was immediately grabbed by your findings relative to the Eppler Code and "enhanced pressure recovery" airfoils.

I have been running AIRFOIL II by AIRWARE. It is a menu-driven version of Eppler and Sommers' "A Computer Program for the Analysis of Low–Speed Airfoils." Some of the airfoils tested include the Fauvel F2 in varying thicknesses, aw well as Marske's modified profiles and the Wortmann FX–66H–159. None of the reflex airfoils tested to date have shown a better Cl than about 0.9 before significant separation occurs.

My questions are these:

- Which airfoil groups are considered "enhanced pressure recovery" airfoils? Are reflex airfoils in this category?
- Am I correct in assuming that, in general, the Eppler code does not reliably predict separation for reflex airfoils?
- Is the computer program mentioned (regarding "Procedures for the Design of Low Pitching Moment Airfoils") available for purchase?

My current project (and the reason for my interest in reflex sections) is a Fauvel AV 222. I was hoping to eke out some modest performance gains by "paying attention" to the airfoil. However, all results coming from the Eppler Code seem quite far from the few wint tunnel performance graphs I have. Assuming that the Eppler Code is inappropriate for performance evaluations of reflex sections, is there one you can recommend?

Riblett Airfoil Mods, NACA 747 Sections, Wampir 2...and more!

A cordial and—as usual—fact–saturated reply to your friendly Editor from the Kuhlmans of Olalla, Washington.

Dear Marc,

Thanks for the "massive epistle!" Your presentation of the laminar flow material was outstanding—quite understandable. A few other pieces are now coming together for us as well; for instance, we had heard that attached turbulent flow created less drag than separated laminar flow, and now we know why. It also occurs to us that the laminar separation "bubble" is a result of the thickening of the boundary layer due to viscosity.

Enclosed is some information regarding the Riblett sections and their design. Unfortunately, our explanation of Riblett's methods was apparently not so clear. Riblett's sections do not use the "droop snoot" per se. The "droop snoot" modification promoted by NASA actually lengthens the chord of the original airfoil, while Riblett's method does not. Too, Riblett's method eliminates the "nose radius" parameter—the nose shape is changed, not by a change in the camber line, but **by the method of adding the thickness distribution to the camber line.** The thickness distribution is combined with the camber line by always measuring perpendicular to the chord line, rather than perpendicular to the camber line. See the enclosed diagrams. Also included are copies of some of the data that Mr. Riblett sent to us regarding the reflexed NACA 747 section.

Also enclosed please find the 3-view and data for the "Wampir 2," the SB-13 and, as a bonus, the PN9QA section and a 2-view of the Paff PN9/PN9f. What is listed as the section coordinates for the PN9QA is actually the pressure distribution. Dieter Paff is listed on the Thies sketch of the SB-13 as being one of the model builders, and it appears that the PN9QA section was used for the 1/3 scale model.

Three "Flying Wings Specials" of *The White Sheet* were produced—all were/are edited by

Sean Walbank
29, The Gardens
Acreman Street
Sherborne, Dorset, England DT9 3PD
UK

Sean and Reinhard Werner [Editor of the excellent West German magazine *DELTA* devoted to flying wing models—Ed.] are frequent correspondents. It appears from the list published in the Newsletter that TWITT does not have *DELTA* #6. We have that issue and can copy it quite easily; let us know.

There have been several references in the newsletter to David R. Davis' airfoil formulae. Can you point us in the direction of some references?

Sincerely,

B^2

Farrar Flying Wing

Charles Person of Birmingham, Alabama writes:

Ms. Wiberg is in error on the workmanship on the Farrar wing. Farrar was (and is) a real craftsman. The controls were unique. This may have caused Wally [Wiberg] some consternation. Thank you for your support.

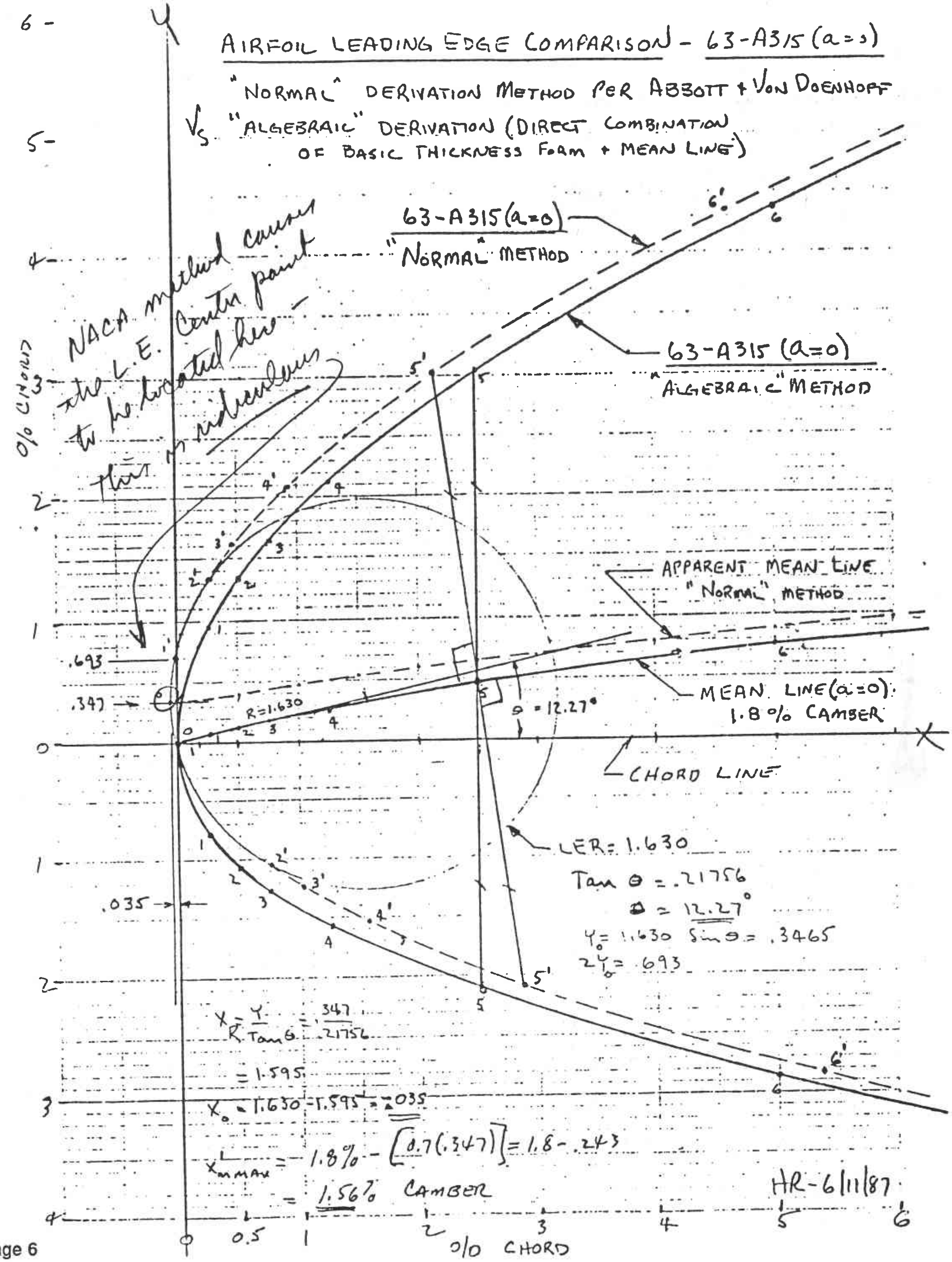
Charlie Person

And Speaking of the Farrar Tailless...

The Kuhlmans provided a copy of the Farrar article and 3-view appearing elsewhere in this issue, along with the following explanatory note:

Marc—

The enclosed came from The Bungee Cord, but we're not sure of the date of publication. The date


AIRFOIL LEADING EDGE COMPARISON - 63-A315 (a=0)
"NORMAL" DERIVATION METHOD PER ABBOTT + VON DOENHOFF
VS "ALGEBRAIC" DERIVATION (DIRECT COMBINATION OF BASIC THICKNESS FORM + MEAN LINE)
63-A315 (a=0) "NORMAL" METHOD
63-A315 (a=0) "ALGEBRAIC" METHOD
NACA method causes the L.E. Center point to be located here - that is ridiculous
APPARENT MEAN LINE "NORMAL" METHOD
MEAN LINE (a=0) 1.8 % CAMBER
CHORD LINE
R=1.630
θ = 12.27°
LER = 1.630
Tan θ = .21756
θ = 12.27°
Y_0 = 1.630 Sin θ = .3465
$2Y_0$ = .693
.693
.347
.035
X = Y / R Tan θ = .347 / .21756
= 1.595
X_0 = 1.630 - 1.595 = .035
$X_{m MAX}$ = 1.8% - [0.7(.347)] = 1.8 - .243
= 1.56% CAMBER
HR-6/11/87
% CHORD
Y
X

on the plans is 12/81, and the Horten/Scott article was published in TWITT NL #2; maybe that would help. This is the only 3-view and description that we've found, except for a photo of Dr. Farrar lying in a frame mock–up. That photo was in The Bungee Cord, also. Hope your Christman was perfect and memorable.

B²

Man from NASA Subscribes

Todd Hodges of Hampton, Virginia attended our November 88 meeting:

Dear Bob

I was the guy from NASA that visited your TWITT meeting in November. I drove Bruce Carmichael down to San Diego and made a number of comments on the wing and wing-body junction of the airplane design [by Maurice Brockington] being reviewed that day. I would like to receive the TWITT Newsletter, and I have enclosed a $ 15 check for the Newsletter. Thank you.

Todd Hodges

SHA and SSA

This from Don Santee in Phoenix, AZ:

Dear Bob,

The Dec. TWITT came yesterday and was good, as it always is. I have enjoyed it and I thank you for sending it to me—although I realize that you did it to help SHA [Sailplane Homebuilders' Association] primarily. Financial constraints force me to say that I cannot support as wide a variety of aviation publications as I would like—so TWITT will go on without me as a reader. I'll miss it—as a very good newsletter!

As you know, I prepared an article on TWITT—and mailed it in to *Soaring*—but evidently Bertha Ryan, or someone, had beaten me to it and the article was not used due to hers appearing in the Nov. issue. This threw my publishing schedule off, as I had hoped to put something in each month. Speaking of newsletters—I haven't gotten any *SHAp Talk* for some time. We should have gotten ballots in October—so that we could elect our new officers—but nothing has come to me. I'm going to call Jim Mills to see what he can tell me.

Wishing you and yours the best in '89!

Don

U. of Minn Flying Wing

This from Ed Leiser of the San Diego Aerospace Museum:

Dear Bob Fronius,

Just saw this half-tone clipped and glued in an old album in our library, and thought of TWITT. [The clipping appears elsewhere in this issue—Ed]

Merry Xmas,

Ed Leiser

THE FARRAR TAILLESS

by Dr. Franklin Farrar

Reprinted from The Bungee Cord, the newsletter of the Vintage Sailplane Association. Original publication date is unknown.

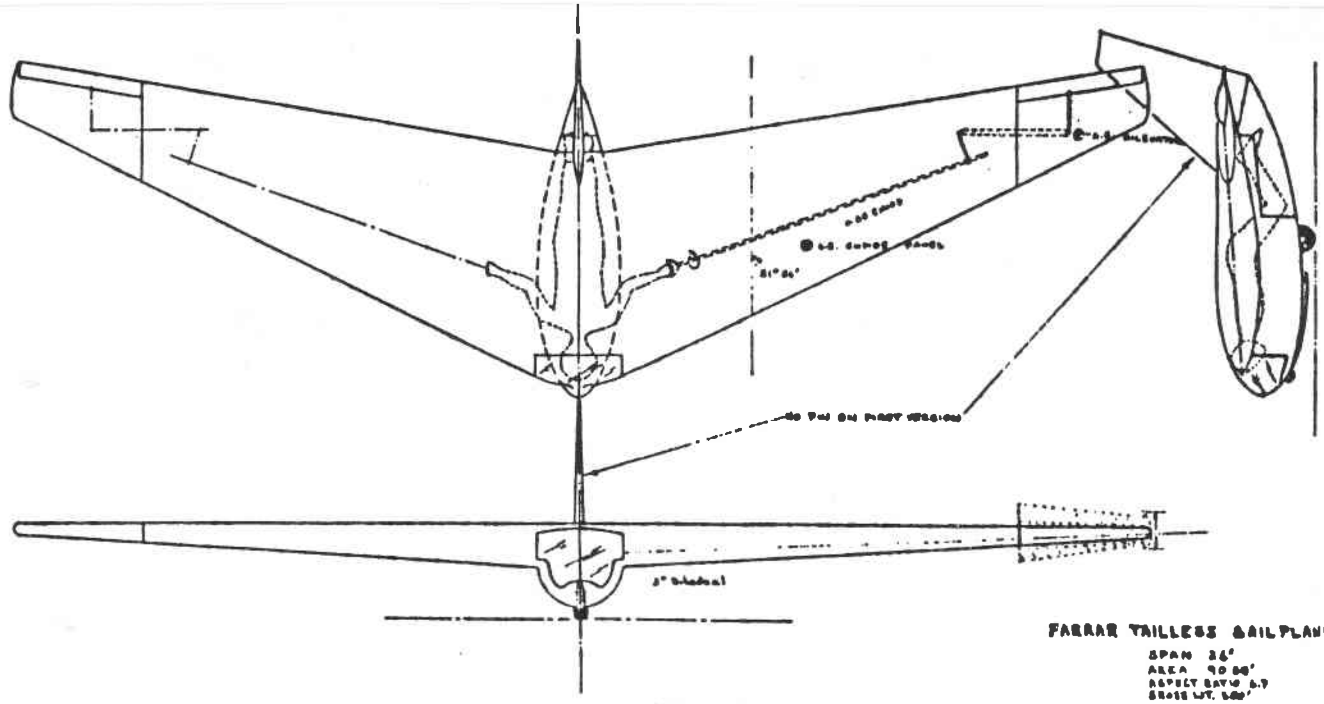
The glider was built in the Engineering School at Vanderbilt University with the aid of a Carnegie grant. It was "finished" in 1950 and we hurriedly rigged a ball joint support on top of a car so that we could mount the glider on it and drive up and down the runway to see if the unusual control system would operate properly. All seemed OK, so a few days later, at the insistence of E.J. Reeves, we took it to the Nationals at Grand Prairie, Texas where Wally Wiberg was to try to test fly it. Unfortunately, the glider was about 6 inches [15 cm] too short for Wally and we were not able to make any flight attempts at the contest. The fixed tail fin was built and installed about a month later.

In the original version, the wing tip control surfaces were controlled by the 20% chord tabs. The tabs are controllable mechanically thru +30° to -30° relative to the tips and additionally could be split to act as drag rudders. The tabs were operated by rotating a handle on the inner end of the control tube. Pulling the tube axially caused the tabs to split. The two wing tip control surfaces were not conected together except through the pilot. The system was too complicated to be operated correctly by the pilot, especially since there was no way to practice except on the ground, which of course gave no indication of response by the glider.

About ten years later, the control system was modified by connecting the tips together and operating them with a single lever. The tips as well as the tabs were now mechanically operated. This worked much better and we were able to fly the length of the runway behind a car several times. In a freak accident, I tore the entire bottom out of the center section and haven't rebuilt it. My face grew back together in about three weeks.

Structurally, it was a spruce and plywood frame, covered with plywood and then covered with balsa wood which was sanded down to contour and then covered with light cotton fabric to protect the balsa.

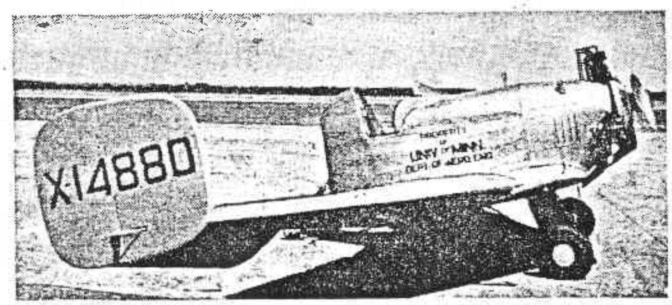
I think it failed mainly because I tried too many unusual things at one time, and it was too small.



FARRAR TAILLESS SAILPLANE

IS THIS YOUR LAST ISSUE?

Beginning with Newsletter Number 21, mailing labels have had on them a four-digit code for the year and month of the last newsletter the subscriber will receive under his current subscription. If your label reads "8901," for example, your last Newsletter will be this one. Please check your label now, and take the time to renew if your subscription is nearly expired. While we're at it, let us remind you that all back issues are still available at $ .75 apiece. Subscriptions still cost $ 15.00 per year. Payment must be in US Dollars.



This unusual flying wing was built by University of Minnesota students, has slots, flaps, unusual controls, a 55 h.p. engine.

Maurice Brockington Displays his Design (November 1988)

FLYING WINGS AND CANARDS.
A Discussion of Design Aspects in General Terms.

Karl L.Sanders
E.A.A. Meeting, San Diego Aerospace Museum, 9 December 1988.
"Conventional vs. Unconventional Aircraft Configurations"

INTRODUCTION.

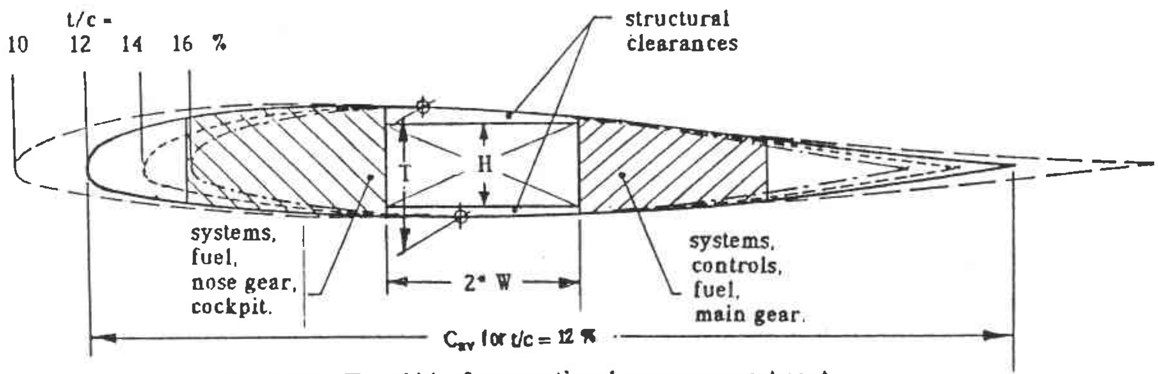
The past fifteen years or so have seen the revival of some well known but less established configurations, most importantly the Flying Wing and Canard. The pros and cons just cannot be resolved by emotional debates or controversial competition formulas, but must be seen and judged in the light of engineering design, analysis and comparison. It is unfounded and unfair to believe that the industry, or the professional community at large, categorically decline the flying wing or canard concept. Each decade has seen extensive studies and reexaminations which support this statement.

This paper presents the subject in GENERAL terms and points out the peculiar design aspects that must be investigated on a case-by-case basis. Such a thorough investigation could then lead to the acceptance or refusal of an "unconventional" configuration, depending on whether it offers significant advantages over the "conventional" in size, gross weight, power and fuel required, cost and handling qualities, for a common design requirement.

THE POWERED FLYING WING.

Certain powered flight conditions impose an upper limit on the wing section thickness ratio (t/c) for compressibility drag reasons, depending on the selected sweepback angle and whether sub- or supersonic flight or both are intended. As an example, let us consider a subsonic "spanloader" with a typical 25 to 30 degree sweepback angle and an average t/c of 12%, permitting cruising just below the drag-rise Mach number (alias drag-divergence Mach No. M_{DD}). Payload dimensions and volume are dictated by the customer, and are to be fully accommodated in the wing. For this purpose we adopt the fuselage crossectional dimensions of a typical transport.

The minimum chord length for the desired t/c ratio that accommodates the payload dimensions is found by layout as shown in the sketch below.



H = height, W = width of conventional cargo compartment

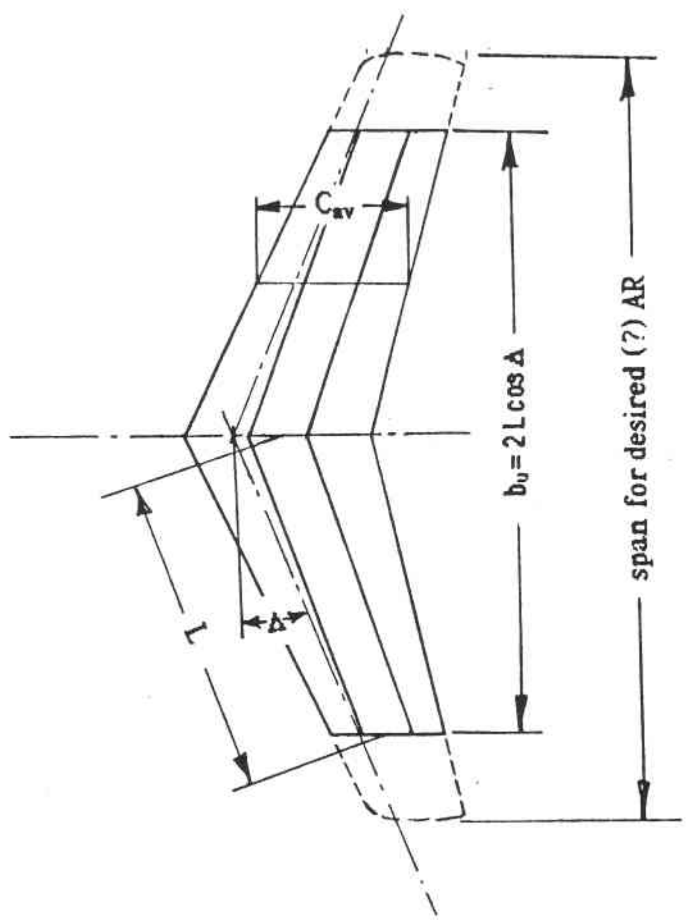
* this factor is for the desired multiple of W and limited by what is feasible and practical in each case.

Very roughly, the chord length is given by :

$$C_{av} = \frac{T}{(t/c)_{req}} \qquad (1)$$

Other things must be accommodated also: fuel (for a long range transport this can be as much as 25% of the take-off weight), cockpit, landing gear, APU, and all of the subsystems and equipment.

Depending on the spanwise extent of the required payload and fuel, a *utilized span* b_u is obtained as shown in the sketch below.



The *utilized wing area* is then $S_u = C_{av} \cdot b_u$, and the minimum available aspect ratio is $AR_{min} = b_u^2 / S_u$. If you add more span to get a higher AR of your liking, you also, maybe unwillingly, increase the wing area resulting in lower wing loading (W/S) and C_L that could be mismatched with AR (unless you accept another cruise speed or altitude), as well as increased wing weight and friction drag. The reasons for this are discussed in more detail on page 4. This is a typical flying wing problem: wing optimization is hindered by geometrical constraints imposed by the useful load; in fact it drives the AR towards values lower than for a "conventional" wing.

Incidentally, the low AR solution is not to be taken lightly. In the late fourties, two diametrically opposed design philosophies led to Boeing's B-47 (high AR, high W/S) and AVRO's Vulcan (tailless, low AR Delta wing, low W/S) both of nearly equal range/payload performance. The Vulcan was easier to fly since C_{Lopt} was about 50% of C_{Lbo} (buffet onset) while for the B-47 it was hugging the C_{Lbo} for extended periods (at that time called "coffin corners"), requiring constant throttle adjustments to avoid heavy buffeting (local shock induced stall), degraded stability and handling. The rigid structure of the Delta wing, its low structure weight and large volume are other attractive advantages. Note that wing weight is proportional to $AR \cdot S^{2/3}$ and volume to $S^{3/2}/\sqrt{AR}$! The lower $(L/D)_{opt}$ of the low-AR Delta wing will however require more power and fuel for the mission, depending on partial offsets from lower structure weight and compressibility drag, as the case may be.

As for other transports, the wing should be made as thick as possible. Three choices exist: (1) low AR (Vulcan-style), having long chord lengths hence large thickness for any t/c. (2) increase sweepback angle and thickness to maintain the M_{DD}, with the side benefits of longer control surface arms and improved longitudinal damping. Wing weight increase due to increased sweep is nearly compensated by the increased thickness. However, the tip stall tendency at low speeds is more pronounced ($\Lambda° \geq (400/AR)$ is excessive), and (3) adopt supercritical sections; but these are not a good solution owing to their high pitching moments that must be trimmed by elevons, causing trim drag and a deteriorated span load distribution which increases the induced drag.

These aspects are dealt with in the conceptual design cycle with all its alternatives and trade-offs during which engine size, wing size and shape, among others, are systematically varied until convergence on the optimum configuration and final dimensions has been achieved. Because of the volume considerations, a pure flying wing transport (span-loader) will always have more wing area than the conventional transport for equal payload and range. In fact, there are many more "tailless" than flying wings since optimum wing size did not permit stowage of the entire useful load into the wing.

The objective is of course to find the best AR and wing area (i.e. W/S) for maximum specific range (nm/lb fuel) at the desired cruise speed and altitude. This requires that we always must fly at the optimum L/D ratio and the corresponding C_{Lopt}. For the conservative case of a symmetric parabolic polar, these optima are easily derived and summarized in the table below.

propulsion type	$(L/D)_{opt}$	$C_{L_{opt}}$
propeller: $P_{req} = D \cdot V$	$\frac{0.5}{\sqrt{K \cdot C_{D_0}}} = (L/D)_{max}$	$\sqrt{\frac{C_{D_0}}{K}} = C_{L_{L/D\,max}}$
jet: $T_{req} = D$	$\frac{0.47}{\sqrt{K \cdot C_{D_0}}} = 0.94 \cdot (L/D)_{max}$	$\sqrt{\frac{C_{D_0}}{2K}} = 0.707 \cdot C_{L_{L/D\,max}}$
$K = \frac{1}{\pi \cdot AR \cdot e}$; $C_{D_0} \approx 0.01..$ for flying wings		

But here's the clincher: W/S is again involved here! We must actually achieve the $C_{L_{opt}}$ in flight. Therefor, we must match the wing area (i.e. W/S) to $C_{L_{opt}}$ (i.e. to any AR we select). From the equality $L = C_L\, q\, S = W$ for unaccelerated level flight follows the matched wing loading:

$$(W/S)_{opt} = q \cdot C_{L_{opt}} \qquad (2)$$

where $q = \rho/2\ V^2$ = dynamic pressure, ρ and v air density and speed at desired cruise altitude, respectively. Note that $(W/S)_{opt} \propto \sqrt{AR}$. The higher the AR the higher the required W/S, i.e. the smaller the required area. The explanation is in the table above. The higher $C_{L_{opt}}$'s for the higher AR's are achieved by loading up the wing sections correspondingly, i.e. by increasing W/S (a pressure !). The higher wing loadings however, may need flaps to meet take-off and landing requirements. The required wing area (not more and not less!) is then :

$$S = \frac{\text{initial cruise weight}}{(W/S)_{opt}}$$

As fuel is consumed, altitude increases progressively to maintain the equality (eqn. 2); this is standard procedure in a Breguet cruise.

Another equality for 1g level flight is $T = D = W / L/D$, which determines power setting (RPM) and fuel consumption for the flight plan, as well as the total installed thrust and engine weight. Interestingly, T/W (or HP/W) and W/S are often determined by take-off distance or one-engine-out R/C.