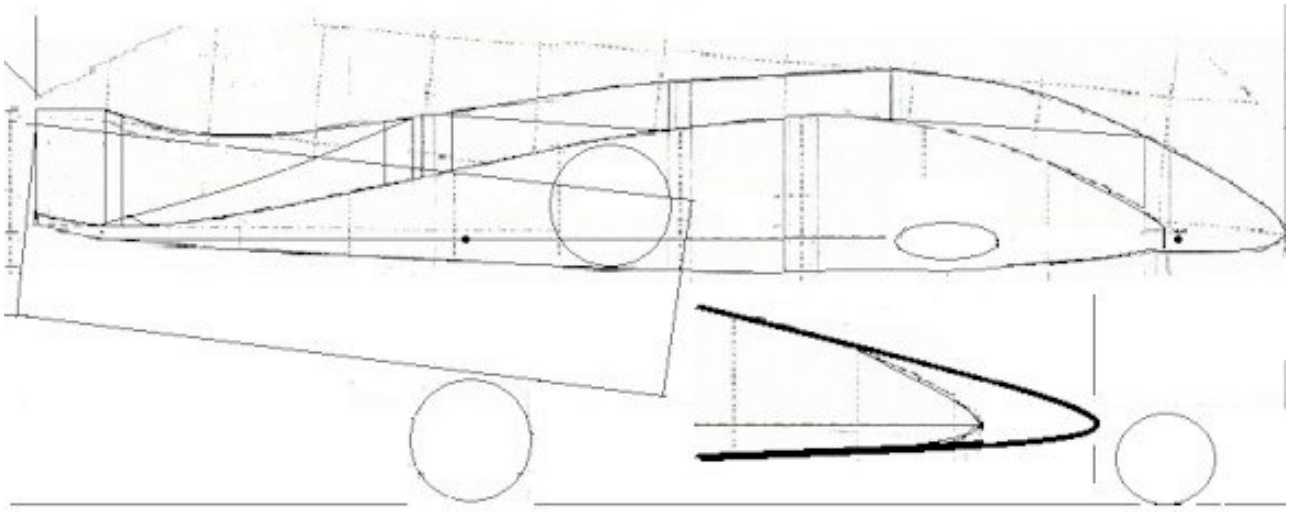
No. 271 JANUARY 2009

T.W.I.T.T. NEWSLETTER

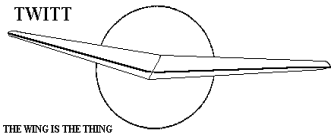


This is a concept drawing by Henry Whittle. There is more information on it in the Letters to the Editor section inside.

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., **0901** means this is your last issue unless renewed.

Next TWITT meeting: Saturday, January 17, 2009, 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.

T.W.I.T.T. Officers:

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Treasurer:
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Archivist: Gavin Slater

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Members only section: ID – **twitt2008**
Password – **08member08**

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Wt/#Issues	FRG	AUSTRALIA	AFRICA
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60oz/60	50.00	53.00	37.00

Meetings are held on the third Saturday of every other month (beginning with January), at 1:30 PM, at Hanger A-4, Gillespie Field, El Cajon, California (first row of hangers on the south end of Joe Crosson Drive (#1720), east side of Gillespie or Skid Row for those flying in).

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PRESIDENT'S CORNER

Well I guess it is a good thing I am not a meteorologist since I missed the December 25th forecast in San Diego. Instead of sunny and warm it was overcast and damp with rain coming in the early evening. My forecast did work for New Years day, but I didn't include it in my prediction so it doesn't count. I think I will stay with my day job and leave weather forecasting to others in the future.

I hope everyone had a joyous holiday with family and friends and got through a safe and sound New Years celebration.

Back issues on the web site are now back to January 1991 for those of you who weren't members way back then. That only leaves four and a half years to bring it up to date with all issues going back to our founding in June 1986.

Despite all the bad economic news from around the world, it looks like we will be able to hold our subscription prices at the current levels. The treasury is just holding even on a month-to-month basis, which is all we need to do to stay solvent and continue sending out newsletters.

I am looking forward to another great year of articles from our members and seeing further development of flying wing technology from both a commercial and personal level. There will be UCAVs coming to the forefront that are flying wings and with their success will come more public interest in this type of aircraft on a wider scale. Each small step brings us closer to realizing the dream the people will be traveling in BWB airliners. Enjoy 2009.

Andy

JANUARY 17, 2009 PROGRAM

THERE IS NO SCHEDULED PROGRAM FOR JANUARY. There will be people at the hanger if you would like to come by and just visit and look around the other open hangers in the area. There is almost always something interesting going on or a classic airplane to view.

LETTERS TO THE EDITOR

December 17, 2008

Hello:

The December number of the T.W.I.T.T. newsletter arrived this morning. The article regarding the work of Richard Keller was received with great interest. If it is at all possible to post the images in the newsletter on the website we will be the better for it.

Keller's work as an aviation artist may also be viewed in **The Horten Brothers and Their All-Wing Aircraft**. This history published in 1998 and is the work of David Myhra. The text is full of typos and mismatched photograph text. This is due to the book being printed in China by a firm with no knowledge of the English language. It is still a worthwhile text, for all of its flaws. The Library of Congress Catalog Number is: 97-68960.

Another artist of note would be J.H. Clarke, whose renditions graced the pages of the British publication **The Aeroplane** for many editions. His sectional view of the Napier Sabre engine is Internet available. It represents three weeks of eighteen-hour days on his part.

Regards,

Henry E. Whittle
<gulfrose@juno.com>

(ed. – Thanks for the letter and suggestions. I will put this material on the website probably in the Other Flying Wing section.)

December 18, 2008

Hello, my name is Dale and I am building a 1/3 scale BKB-1 and I saw your site. I was wondering if you could help me with a problem. I am looking for any pictures of the cockpit of the BKB-1. I have looked everywhere but, can't find a thing. Any suggestions would be greatly appreciated.

If you would like to look at my build site for the BKB-1 the address is:

http://scalesoaring.co.uk/cgi-bin/yabb2/YaBB.pl?num=1207754589

Thank you for your time.

Dale Bowers
<bowersdale@yahoo.com>

(ed. – We don't have any pictures of the BKB instrument panel in the archives and neither did Stefanie Brochocki. If anyone out there happened to run across this type of picture in their Internet searches or research through museum archives, please let Dale and TWITT know.)

December 20, 2008

Hello Josef

My name is Tom Jones and I am a private pilot and homebuilder in the USA. I came across your address from a question you asked on the TWITT site dated July 2001.

Basically I am asking the same questions as I am interested in building the Pelican. I just recently sent e-mail to Air Est in France, but have not had a reply. Any information you may have gathered in your efforts will be most appreciated. Look forward to your reply, maybe you built a Pelican?

Sincerely,

Tom Jones
<tjonesav8r@sbcglobal.net>

Please put Pelican in subject line of any response

(ed. – I am not sure where the original letter from Josef is located on the website since it is not under the primary section with the Pelican information. If anyone has had any recent contact with the kit factory for the

Pelican, please pass it along to Tom who just recently joined our group.)

Came across your address dated 1/01/03 in regard to you possible having several DVD of the Facet Opal made available. I would be interested in a DVD if still available.

Also since 2003 is their any additional info available regarding this unique airplane. Info like wing area, twist, airfoil, etc. Any info would be most appreciated.

(ed. – Tom managed to find a page we don't have a direct link to anymore but is still on the website. It was in response to a person in Australia who had some video of the Facet Opal and was willing to make copies if there was enough interest. However, there was any at the time and I have now lost his e-mail address with the crash of my hard drive last year. If anyone happened to had some correspondence with this fellow in Australia and got a copy of the DVD, please let me know.)

Andy:

Thank you for the reply. I am trying to educate myself on the "Flying wing design of airplanes". This is the link that gives your e-mail address as to the availability of the Facet Opal DVD.

http://www.twitt.org/FacetOpal.html

Is TWTT still an active group? If so I would like to join your group. Also have found information regarding a "Pelican" design from France from the Nurflugel site. So far I have not received a reply from the address for information. Do you have any information available about this design or other similar "Fauvel" powered flying wing design or plan sets? I would appreciate your help.

Surprised you have not received request before.

Tom

(ed. – Having sets of plans would be a great thing for the TWITT archives, but unfortunately that is not the case. Within the US this would also presents some liability issues in terms of selling or "donating" plans for the purposes of construction of a full size aircraft. I am sure there are Fauvel plans available somewhere, so if anyone has this information, we would appreciate your response.)

December 30, 2008

To: Al Backstrom

THere's a new movement in Germany called Microlight Gliding. This is somehow a return to the roots of Gliding. Microlight-Gliders have to have an empty weight of max.120 kg and also a limited takeoff weight of 220 kg´s. It must fly with a minimum speed of 55 km/h and I've heard that they will limit the max empty weight to 80kg for new designs.

The thing is, that if you own (or even had) a license for normal gliders, you get the "Microlight License" for free. And if you have this piece of paper, it is for live time and you don´t need a medical for it. So few of the older Glider-Pilots that were grounded by the doctors meanwhile converted to the Microlights. *(ed. – Klaus prefaced his message with the fact he had a debilitating illness that makes this class of glider license applicable to him.)*

My problem is, that there are only two planes that fulfill the rules for them to be a Microlight in Germany. One of them is the tailless Swift, the other one is a more conventional plane from Czechoslovakia called Banjo. Both have too small of a cockpit for me and I am to heavy for them.... I´m 6 foot4 and have about 120kg´s.

The Banjo is limited to -2 and +4 g´s and has a Vne of 140 km/h, which is a little less for our rough weather conditions. At 140 km the Banjo is "almost in a dive", which means that it has very bad speed-performance.

All this makes me dream of a simple 12m Flying Plank (somewhere between yours and Jim´s *(Marske)* designs), that weighs less than 80kg´s empty

This seems to be practical, because the foot launched 12m-Horten-Wing that we once built had an empty weight of only 45 kg. But the Horten (called "Schmankerl") had no fuselage and the pilot was lying directly on the wing behind a motorcycle-windshield.

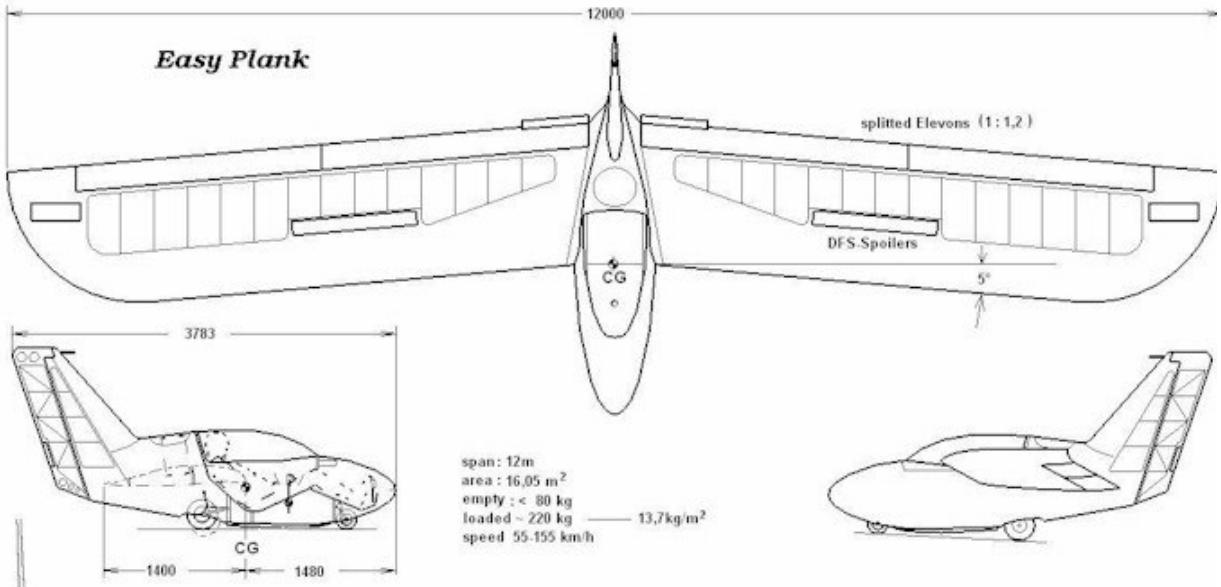
I wrote Jim this same e-mail but he told me, that he doesn't believe it is possible to keep the empty weight under the magical 80kg.

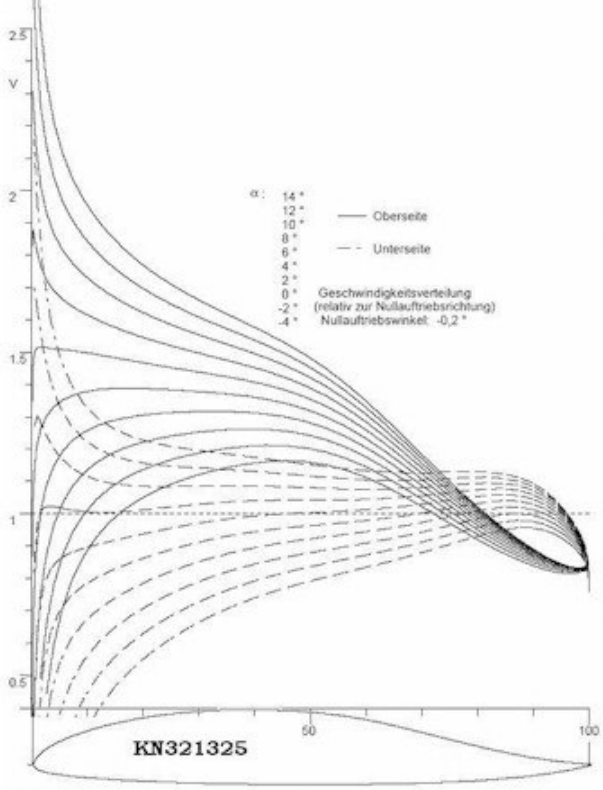
Nevertheless I think I can reach 80 kg with a one-piece wing with a carbon D-Box, carbon main spar and carbon covered foam ribs and normal fabric cover.

Instead of push rods I´m thinking of a hydraulic system, that I have seen on a powered South African Microlight-Canard. Tubes for hydraulic fluid can be a integrated part of the main-spar. Rudder and DFS-spoilers can be operated with strings as usual.

Flettners could be operated electrically by strong Model-Servos (which is allowed for Microlights).

If hydraulic fails, there is the rescue system that brings down plane and pilot in one piece. (This





KN321325

x	y	x	y	x	y	x	y
100,000	0,061	47,612	9,674	0,099	-0,374	56,200	-3,589
99,736	0,071	44,403	9,841	0,388	-0,704	59,365	-3,565
99,425	0,090	41,090	9,922	0,849	-0,989	62,424	-3,529
99,007	0,121	37,668	9,933	1,543	-1,251	65,451	-3,477
98,418	0,159	34,696	9,891	2,426	-1,478	68,354	-3,408
97,525	0,221	31,707	9,783	3,474	-1,678	71,331	-3,318
96,456	0,314	28,824	9,605	4,725	-1,869	74,134	-3,210
95,161	0,446	26,024	9,359	6,148	-2,046	76,836	-3,086
93,728	0,617	23,319	9,048	7,744	-2,215	79,509	-2,930
92,149	0,830	20,719	8,676	9,507	-2,375	82,031	-2,755
90,368	1,103	18,232	8,246	11,430	-2,525	84,404	-2,558
88,472	1,427	15,871	7,768	13,506	-2,669	86,587	-2,357
86,389	1,817	13,646	7,245	15,726	-2,807	88,641	-2,132
84,251	2,260	11,637	6,714	18,080	-2,935	90,552	-1,891
81,850	2,782	9,684	6,135	20,560	-3,053	92,301	-1,647
79,508	3,326	7,872	5,519	23,159	-3,164	93,887	-1,394
76,922	3,960	6,250	4,895	25,860	-3,265	95,299	-1,141
74,144	4,673	4,816	4,265	28,658	-3,351	96,546	-0,905
71,349	5,385	3,578	3,637	31,541	-3,426	97,600	-0,681
68,471	6,109	2,503	2,997	34,495	-3,490	98,434	-0,489
65,523	6,843	1,622	2,362	37,512	-3,539	98,979	-0,357
62,512	7,547	0,871	1,688	40,578	-3,573	99,426	-0,240
59,677	8,131	0,341	1,028	43,680	-3,595	99,757	-0,142
56,888	8,630	0,083	0,522	46,809	-3,606	100,000	-0,061
54,160	9,030	0,000	0,000	49,942	-3,609		
50,770	9,415			53,092	-3,604		

d: 13,50 %
xd: 40,50 %
f: 3,20 %
xf: 35,80 %
cm_o: +0,0250
α_o: -0,17 °

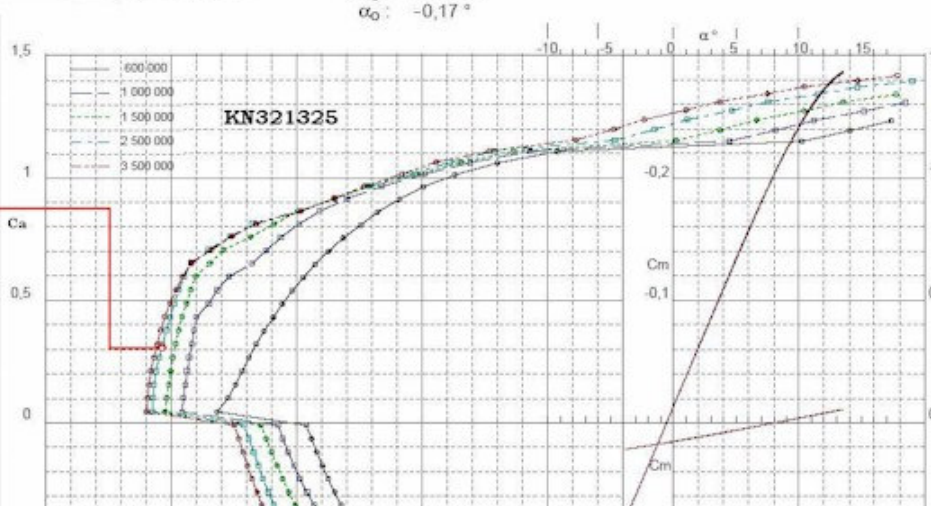
Wing only !!!! Eppler theor.

Schwerpunkt (XD) = 0,00 m (Nasenl. innen)
Stabilitätsmaß (SM) = 10 %

(Elevons 0°)
(A0) = -0,217999 Grad
(CM0) = 0,03111
(dCA) = 4,77652 (Auftriebsanstieg)
(dCM) = -0,05415 (Momentanstieg)
(CA) = 0,31103
(CM) = 0,02758
(CWI) = 0,00344
Güte (CWI/CWI ell.) = 1,002
(v_einsatz) = 26,568 m/s (95,6 km/h)
Gleitzahl (E) = 41,57829
Steigzahl (e) = 23,18838
Sinkgeschwindigkeit (vs) = 0,638999 m/s
Gleitwinkel = 1,38 Grad

(Elevons +2°)
(v_einsatz) = 36,570999 m/s (131 km/h)
Gleitzahl (E) = 36,75917
(vs) = 0,994 m/s

(Elevons -8°)
(v_einsatz) = 15,630999 m/s (56 km/h)



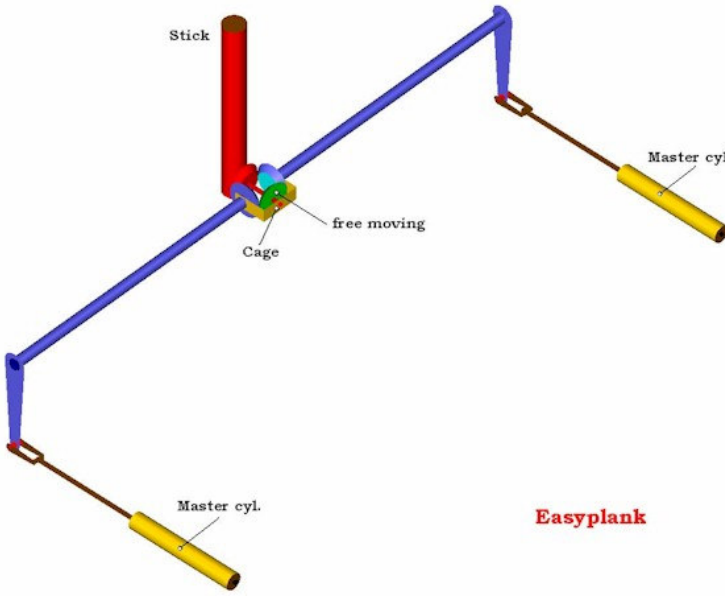
rescue-system is used in the Czech "Banjo" Microlight glider for example.) If you use one of these, you get another 20 kg of empty weight for free...

In the last days I modified the airfoil that I once developed for my Aerobonita-Projekt. But the Aerobonita is much to complicated and I can never reach the 80kg-limit with it, so I better forget it. But I think with a smaller and much easier design I could be successful.

Here is the first sight of how the "Easyplank" could look like. (The forward sweep is only because I could not reach a proper CG position with the very large cockpit and my 120kg´s.)

Please tell me what you think about it.

Klaus Niegratschka
<klaus@niegratschka.de>



Klaus, I have not done a lot on your proposal so I am only commenting about first impressions.

1. I agree with Jim that I don't think 80Kg is enough for the AC. My first plank weighed 180 lbs. [81.8Kg] empty and was a very minimal AC and only had a 26.5 ft [8m] span. I realize that it was wood and you can get lighter today but I doubt the 12m span job can get down to 80 Kg.

2. If you are using the plank configuration I would not have the sweep you show. I think it would be better to raise the wing enough to sit under it and keep the wing straight. I did an article for *Sailplane Builder* some years ago on updating the plank layout based on what I have leaned over the years that has somehow been lost and I don't have a copy.

3. As I remember in the article I had sketched a proposed lightweight design that featured a high wing so you would be below the wing for CG purposes but used a very short strut that would allow lighter weight and a thin section at the side of the pod. With the thin airfoil at the root the pilot's head could be high enough so that only a minimum restriction to visibility was created.

4. I assume you are planning to have the elevons deflect up for nose up pitch. If this is the case you should increase the wing-elevon chord in the elevon area. This has several advantages that I will not get into now.

I will be interested in following your project. Please let me know how you progress

Al Backstrom
<albackstrom@austin.rr.com>

(ed. – My thanks to Al for providing this information from Klaus and his response. If anyone is interested in the airfoil coordinates and can't read them from the drawing on page 4, let me know and I will forward the text tile. Looks kind of like a mini version of the Pioneer III by Jim Marske.)

January 1, 2009

Hello Andy.

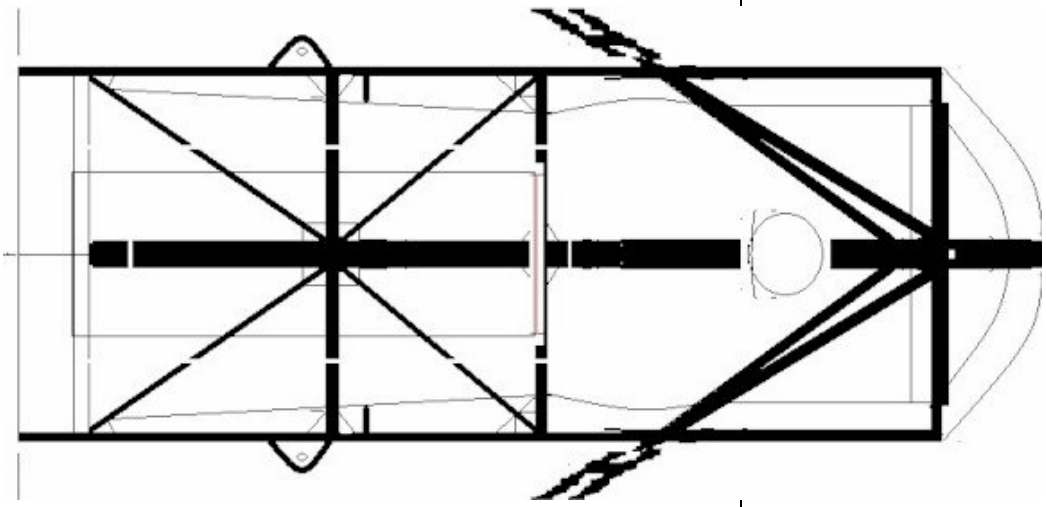
The drawing *(from the cover)* is a side view of all-wing I've been considering for some time now. This starboard side view was generated on MS Paint.

The engine I'd like to use is a modification of the Rolls-Royce Trent. It, unlike most all-wing designs, is under slung. The use of an inverted butterfly structure aft allows for a rotation of the centerline that matches the thrust line of the engine, which is mounted in a forged aluminum spine that runs the length of the centerline. I'm looking for maximum strength here with a minimum of weight. Diagonal and transverse structures form the remainder of the center section of the airframe, attaching to the wing root airfoil.

Those bits of drawing just forward of the engine intake are an attempt to make some sense of a boundary layer vacuum plenum, the low pressure for which would be provided by the compressor section of the engine. This is just for the center section of the structure from root to root at 40% chord. Foil sections are incorporated in the plenum that will generate some lift, as well as provide a structure for the mounting of

pressure sensors. Reading Oskar Schrenk's technical papers as translated by NACA are the basis for this one.

The high mounted cockpit is for either one or two crew. I've drawings for either configuration. The landing gear is tricycle. Radar array is mounted on the first forward transverse structure and is armored. Ancillary antennae and sensors mounted elsewhere on airframe in order to give a more accurate sense of spatial r
elations.



ABOVE: This is the center section drawing.

I've no set material chosen for skin of this bird. Many different materials have been considered. The folks at Harvel in Easton, PA were most helpful with enquiries regarding certain plastics. Contact them at quality@harvel.com if you'd like to request one of their information packs, the knowledge contained therein is worth space in your shop. The center section is of metal construction, at this time. I've enough drawings of the internal structure of the wings done to confuse me. Various configurations of internal structure there, all with the same external form and dimensions, some slotted, some not.

This airframe has been covered in the TWITT newsletter since I became a member January of 2004. Please contact me with any critical comments or suggestions.

Regards

Henry E. Whittle
<Gulfrose@Juno.com>

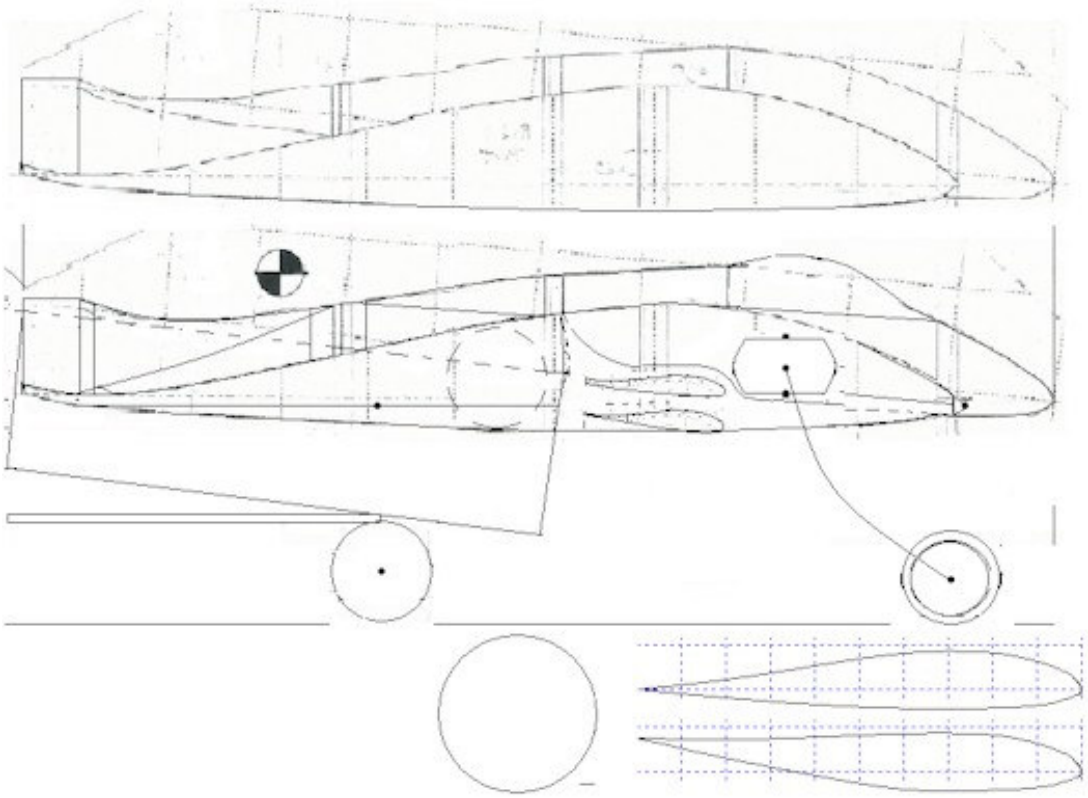
(ed. – Thanks for Henry for providing additional information on the design he is working on. He did first introduce it in the January and February 2004 issues, but this gives us a lot more to think about.)

NURFLUGEL BULLETING BOARD THREADS

December 3, 2008

Prandtl Article Citation

Hello all. I am trying to verify the correct citation for the article by Prof. Ludwig Prandtl, "Über Tragflügel kleinsten induzierten Widerstandes ("About



Wings of Smallest Induced Drag"), which appeared in the journal Zeitschrift für Flugtechnik und Motorluftschiffahrt (or ZFM, the Magazine for Flight Technology and Air Transport).

I have three potential answers:

[Issue] Nr. 24, 28 Dec 1932, on two pages in the range 713 - 740.
Nr. 11?, 1933, day/month?, pages?
Nr. 24, 28 Nov 1933, pp. 305-306.

I appreciate any help you can give me with this one.

Sincerely,

Russell Lee
Smithsonian National Air and Space Museum
202-633-2641
<russlee_99@yahoo.com>

The reference I have always used is:

Prandtl, L.: Uber Tragfugel des kleinsten indezierten Widerstandes," Zeits Flugeltechnik und Motorluftschiffahrt, Vol. 24, pp. 305-306, 28 Dec 1932.

Let me send you the PDF scan I have of the article. I scanned the cover of the magazine as well...

Al Bowers
<Albion.H.Bowers@nasa.gov>

It appears that Al has your answer. I note though that R.T. Jones cites your third version in his article in Soaring, 10/79.

Serge Krauss
<skrauss@ameritech.net>

Serge, since R. T. Jones, Klein and Viswanathan ("Approximate Solution for Minimum Induced Drag of Wings with Given Structural Weight," Engineering Notes, Feb 1975, 126), and Lippisch ("Bestimmung der Auftriebsverteilung längs der Spannweite, Zusammenstellung der Ergebnisse," Flugsport, 7 February 1934, 50) all agree on Vol. 24, Nov 1933, pp. 305-06, I will go with that.

I have the same cover page as the one in Al's PDF - that is what threw me off.

Russ

It¹s possible we¹re all quoting the same bad info. I cannot verify page numbers. All I have are the three pages I sent you (I hope everyone else that asked for them got them as well). Which I think I got FROM you a decade ago!

I did note the "Nr" numbers do not necessarily correspond directly to year numbers (this is not uncommon, as when a publication begins part-way through a year, the Vol/Nr numbers will not directly correspond with years). You get used to this kind of insanity in the US Federal Government because our Fiscal Year starts in the September BEFORE the calendar year starts. So right now I am in FY09 ALREADY, in fact I¹m almost one quarter into FY09...

Don¹t try to think about it, you¹ll get a headache... >8-/

Al

December 5, 2008

New Concept

Dear Al

I have a 1:2 scale model R/C flying wing performing as follows:

- Roll rate at ~Va: >1000°/s
- Max controllable alpha ~50° AFT CG settings, ~70° with normal CG settings
- Ability to perform 360° skids (sort of pulling the handbrake of your car and drift while spinning)

This is with no artificial stability, no thrust vector, no nothing. Just 2 years of work out of my head, computer and hands

I'm going to build this 1:1 and fly it manned in 2009, if I manage to keep my life in one piece, as i've been living in a nightmare for keeping this project up without any help from anyone. Before I kill myself in the testing, i would like to know if you down there at Dryden are interested in this.

This is no joke. I have registered this patent too: US6273371 - see it explained "in english" here http://www.karenfuxia.com/projects/as3.htm

Marco Testi
<mrk@karenfuxia.com>

Find my CV here or browse on my site to know some more, but info is not updated
http://www.karenfuxia.com/publishing/mrkcv.pdf

December 6, 2008

Horten VI in Washington

Russ Lee,

Now that the H VI glider is finally on display in Washington, did anyone in Berlin take a look at the rigging angles of the wing while they were restoring it? Do we know which lift distribution layout was employed? And at what percentage of mean chord was the center of gravity?

Chris Bryant
<chris@palanquin.plus.com>

December 19, 2008

X-20 Dyna Soar Discussed -
From Space Daily -
Cult spacecraft Part One: The Little Space Plane That Couldn't

Artist's impression of the X-20 after test flight. Image source Wikipedia/Dan Roam <http://www.deepcold.com>

By Jeffrey F. Bell
Honolulu HI (SPX) Dec 04, 2008

It's an odd feature of aerospace history that many prototype aircraft that never went into production become "cultplanes". Some prominent examples are flying wings <http://www.century-of-flight.freeola.com/new%20site/frames/flying%20wing%20frame.htm>, Avro Arrow <http://members.tripod.com/arrow206/tpage.htm>, B-70 Valkyrie <http://xb70.interceptor.com/>, anything designed by the Nazis in 1945 <http://www.luft46.com/>.

Cult planes have their own Web sites run by amateur enthusiasts who are slightly dotty. These cultists take all the public relations hype from the designers as gospel truth and ignore all the potential problems. They argue that if their particular pet aircraft had been given a chance, history would have been changed: Canada would still have an aerospace industry, or supersonic airliners would be common, or the Nazis would rule the world.

Mockup of X-20 (Source: http://www.astronautix.com/craft/dynasoar.htm

Some of these sites have a strong paranoid slant, claiming that the Holy Plane was sabotaged by the Sinister Forces of U.S. Imperialism, International Communism, or the Established Aerospace Corporations. You can still see long-disproved conspiracy theories about the B-49 <http://www.dau.mil/pubs/arq/2001arq/Baker.pdf> and the Arrow <http://scaa.usask.ca/gallery/arrow/thesis/index.htm> presented as historical facts on the Web.

We Space Cadets have our own "Cult Spacecraft". The blogosphere is full of ardent fans of ex-projects like X-20, X-30, DC-X, X-33, X-34, X-38 etc. who are convinced that their particular favorite would have been the key to cheap and reliable access to space if only the Sinister Forces hadn't killed it. These cultists are constantly calling for one of these dead projects to be revived as an alternative to the boring multistage expendable boosters we are still using.

This way lies madness - or at least irrelevance. Most of these cult programs were technically impossible. They often had severe political and management problems as well, but the main reasons for their failure were fundamental laws of physics, aerodynamics, and engineering that haven't changed today and never will. Trying to revive them is wasted effort that only makes the space advocacy community look technically illiterate and reduces its credibility.

So I have decided to expand an earlier article <http://www.spacedaily.com/news/oped-05zy.html> on this subject into a series that will explain in plain English the reasons why some of the more popular Cult Spacecraft would probably have been dead ends, even if they had received unlimited funding and had perfect management.

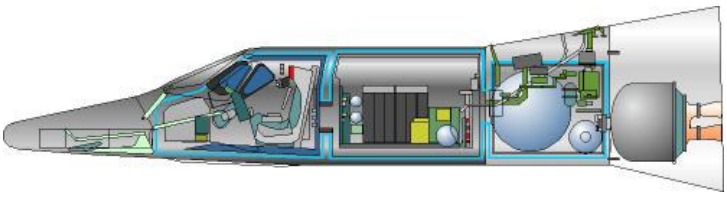
The obvious place to start is with X-20/Dyna-Soar. This little black space plane is not nearly as nutty as the other projects I will discuss in later articles, but it does have several cult web pages full of wishful thinking.

The Exospheric Bomber: Dyna-Soar had an

unusually checkered development history. It had at least 4 different names (BoMi, ROBO, Dyna-Soar, and X-20), two prime contractors (Bell and Boeing), and a bewildering variety of launch vehicles.

It originally wasn't a spacecraft at all, but an alternative method of delivering a big thermonuclear bomb from the USA to the USSR. And it originally wasn't an orbital vehicle intended to travel in vacuum, but a "boost-glide" aircraft that was boosted to high altitude and speed by a disposable booster, then flew once around the Earth in the upper atmosphere where it was supported partly by wing lift and partly by centrifugal force.

The goal of this original BoMi (Bomber Missile) or ROBO (Rocket Bomber) was to attack the Soviet Union at altitudes and speeds higher than the Mach 3 B-70 bombers and Navajo cruise missiles under development at the same time. Speed/Altitude graphs for BoMi show that it was designed to attack the USSR over the South Pole, instead of the direct North Pole route.



Cutaway of basic X-20A - from left, pilot compartment, equipment compartment, secondary power bay, and transition section with the abort motor. Source: http://www.astronautix.com/craft/dynasoar.htm

The boost-glide concept poses formidable problems of navigation, bomb-aiming, and thermal protection that are not adequately addressed in the available sources. The vehicle would have left a hot plasma trail, attracting both radar- and IR-guided missiles like a magnet. Course changes would have been almost impossible. By 1958 it was clear that the plain ballistic reentry vehicle was cheaper, lighter, and more survivable than the "exospheric bomber" could every be - so BoMi was restructured as a research vehicle.

It was given the name Dyna-Soar from the phrase "dynamic soaring" which supposedly described its flight mode. Later it acquired the parallel designation X-20 to indicate its new role as a successor to the X-15 as a high-speed research vehicle.

In traditional X-plane fashion, it was planned to fly X-20 at gradually increasing speeds and altitudes, starting with B-52 drops at Edwards AFB and proceeding to sub-orbital flights from Cape Canaveral to Caribbean islands or Brazil. Later the X-20 would launch from Canaveral on a Titan IIIC, make one low partial orbit around the Earth, and land at Edwards AFB. Eventually a multi-orbit capability would be developed. This final version of X-20 would have retained the partly fueled Titan Transtage for orbital maneuvering and retrofire.

Zen and the Art of Spacecraft Design: The requirements of even fractional-orbit space flight are so demanding that the X-20 turned into an ultra-minimalist design that just barely met the once-around mission requirements. Like the more recent X-38, it was not really a complete spacecraft in the sense of Gemini, Soyuz, or Apollo. There was no radar, computer, or maneuvering thrusters to change orbit. Attitude control was by hydrogen peroxide thrusters with a very limited fuel supply. And the life support system had very limited capacity, apparently only for three orbits in the final design.

A major reason for this very austere systems fit was the weight and space demands of the elaborate thermal control system needed to survive reentry. X-20 had no external thermal insulation like the Shuttle; it would have been covered with metal shingles made of rare elements like zirconium, molybdenum, columbium and tantalum.

This metal skin was highly vulnerable to oxidation and needed a silicon over-coating that might well have been as fragile as the Shuttle tiles. It also had a high thermal conductivity; reentry heat flowed freely through the "Thermal Protection System" which only protected itself, not the spacecraft structure underneath.

To cope with this heat conduction, the wing, fuselage, and landing gear structure of the X-20 was made of somewhat less exotic alloys and allowed to heat up freely. But the pilot and internal systems still needed protection. This was provided by a 3-stage active cooling system:

Stage One was a layer of insulation to delay heat propagation into the spacecraft interior.

Stage Two consisted of a double cabin wall enclosing a layer of water, which was stabilized by a gelling agent. This "water-wall" would boil off during reentry.

Stage Three was a traditional aircraft glycol cooling loop that dumped heat into a flow of liquid hydrogen from a huge spherical tank that took up about 20% of the X-20's fuselage. The hydrogen was then burned with liquid oxygen in APUs that provided hydraulic power for the aerodynamic control surfaces.

This thermal control system was extremely wasteful of mass and internal volume. Attempts to give X-20 some minimal operational capability were severely limited by the available space. Every cult web page about Dyna-Soar shows a cross-section of an "X-

20X" 5-seat space station crew ferry configuration - but if you look closely you see that the escape rocket has been removed and the passengers are crammed in so close that ejection is impossible.

Active cooling also placed a strict limit on the orbital stay time of the X-20, since the LH2 would have been boiling off continuously in space. This system could never have been used on the Space Shuttle orbiters as some have suggested. The LH2 tank alone would have taken up most of the cargo bay.

A supposed advantage of a robust TPS is that the vehicle is reusable without elaborate and labor-intensive refurbishment. But the surviving Dyna-Soar documents indicate that reusability was only a long-term goal of the program. Boeing built mockups of a conventional production line that would supply new X-20s for every mission. Ironically, the competing Gemini capsule did demonstrate reusability when /Gemini 2/ was reflown as /Gemini B/ during the MOL program.

The Curse of the Bomber Generals: X-20 was managed by the U.S. Air Force whose generals at that time were almost all former WWII bomber pilots. Through the whole history of space travel, pilot-astronauts and pilot-managers have shown a visceral dislike for ballistic RVs and a psychological need for traditional stick-and-rudder controls. In the Dyna-Soar this syndrome produced truly insane results.

The whole basis of the program was piloted reentry, but it was a very strange sort of piloting. The X-20 astronaut would have sat in front of a circular display with a grid of lines indicating various bank angles and angles of attack. Below the display was a row of ten buttons bearing the names of various US Air Force bases. (X-20's wire-brush landing gear would only work on concrete runways, not dry lakebeds or dirt strips.)

Before reentry, the pilot pressed a button to choose a runway. After that, a computer would project onto the display a pip indicating the flight angles needed to reach the selected runway, and a second pip indicating the actual angles currently being flown. The pilot had only to keep the two pips together like a human servomotor.

Not content with this, the USAF actually insisted that the pilot should "fly" the booster during the ascent to orbit, again robotically following instructions presented by a computer while subjected to the crushing g-force and intense vibration of a rocket launch! Studies of this absurd guidance mode were actually continued after X-20 was cancelled.

The designers at Boeing pandered to pilot prejudice even more with a proposal for "Synergetic Orbital Plane Change." In this maneuver, Dyna-Soar would have made a retro burn to drop its perigee into the atmosphere, rolled onto its side and used aerodynamic lift to make the plane change, then lifted itself back into stable orbit with another burn.

The author of this idea seems to have forgotten that Dyna-Soar didn't have a rocket engine - all its delta-vee was in the partly-fueled Titan III transtage. With the flimsy and explosive transtage still attached, this maneuver is quite impossible. This doesn't stop some cultists from citing it even today.

Even the overall airplane-like configuration of the vehicle was fundamentally wrong and obsolete by 1963:

1) A winged configuration is about three times as heavy as an equivalent semi-ballistic capsule, and therefore costs three times as much to launch. The one-man X-20 was operationally less capable than the two-man Gemini, yet it required the expensive 4-stage Titan IIIC instead of Gemini's cheap 2-stage Titan II. A major element of this weight was a huge abort rocket (based on the Minuteman I Stage 3) that had to be carted all the way to orbit.

2) A winged spaceplane located on top of a booster is an aerodynamically unstable configuration, akin to an arrow with the feathers at the front. The guidance packages and thrust-vector controls on 1960 rockets were not capable of steering the stack in the lower atmosphere. Huge tailfins were designed for all the proposed boosters to maintain static stability. (This problem cropped up again in the X-37B program and resulted in a big payload shroud being added.)

3) A manual runway landing requires big windows in the front of the vehicle, where reentry heating is intense. X-20 addressed this problem with a detachable metal heat shield covering the windows. If this failed to jettison, the unfortunate pilot would have no forward view at all.

4) The pilot is seated in the correct position to take the launch g-forces "eyeballs-in", but during reentry he is oriented in the unfavorable "eyeballs-down" direction. This is tolerable during a normal shallow low-g lifting reentry, but not in many launch abort scenarios where the initial entry angle is very steep.

This "black zone" problem seems not to have been discovered until the program was well under way. Robert Godwin's book reproduces a report of April 1958, which states that the Dyna-Soar pilot would be subjected to a peak g-load of 22 gravities during the worst-case launch abort. This is about the same as in a Soyuz abort - but in a Soyuz the crew is correctly oriented eyeballs-down.

Was McNamara Right? When Secretary of Defense Robert Strange McNamara and his staff of "Whiz Kids" subjected X-20 to a series of reviews in 1963, it was revealed as more expensive, less capable, and less safe than the existing semi-ballistic

spacecraft, Gemini. By the time X-20 would actually fly in 1967-69, it would be an embarrassing anachronism: a spacecraft with Mercury-like capability flying alongside Apollo.

Furthermore, McNamara and at least some members of the Dyna-Soar review panels were aware of the rapid progress being made by top-secret unmanned military spacecraft such as CORONA and GRAB. These programs were already far more capable in 1963 than any operational variant of X-20 might have become circa 1975. Declassified documents indicate that discussions of Dyna-Soar usually ended up discussing whether any manned military space program was justifiable.

McNamara's decision to axe Dyna-Soar in favor of a military version of Gemini was really a compromise, designed to keep the Defense Department involved in manned space at minimum cost. But "Blue Gemini" evolved into Manned Orbiting Laboratory (KH-10 DORIAN), an expendable one-shot manned spy station.

MOL was absurdly more expensive than the parallel KH-9 unmanned system and was cancelled in turn. The Soviets actually did deploy the Almaz manned military space stations which proved beyond doubt that there is no useful military role for men in space.

Dyna-Soar cultists have argued that McNamara was wrong in evaluating the vehicle as an operational military spacecraft, since it was intended as a pure X-vehicle to develop and evaluate the spaceplane concept. It is politically incorrect to defend the man who gave us the F-111B, the joint service belt buckle, and the Second Indochina War - but I'll put my neck on the chopping block and claim that McNamara was correct - at least from his perspective in 1963.

The whole purpose of experimental aircraft is to develop technology for future operational vehicles - but all the new technologies being developed for X-20 look like losers.

But from the perspective of 45 years later, I wish that McNamara had made the wrong decision and allowed X-20 to continue. The program would have been a waste of money in the short term, but it might have saved both the USAF and NASA much more money and agony in the long term.

The Dyna-Soar configuration was close to that eventually adopted for the Space Shuttle Orbiter, much closer than the unmanned ASSET and X-23A vehicles that were the only "winged" RVs actually test-flown in the 1960s. Like the earlier X-planes, X-20 would have carried a huge package of electronics to record aerodynamic data during reentry. A similar package was carried by the first Shuttle /Columbia/ in 1981 - about a decade too late.

If X-20 had actually flown in the late 1960s, that instrumentation would have supplied the Shuttle's designers with a priceless database. They would not have been forced to rely completely on wind-tunnel data and primitive computer models and would have produced a better design. For instance, the Orbiters carry two tons of lead blocks in their noses to compensate for an error in aerodynamic models, and X-20 data might well have prevented this mistake.

It is even possible that X-20 would have convinced NASA and USAF management that a winged vehicle was the wrong way to go - that the operational problems and parasitic weight were just too crippling to be worth the supposed advantages of high cross-range capability and runway landing.

Many people came to realize this unpleasant truth during the test flights of /Columbia/ in 1981-82, by which time it was politically impossible to abandon the Shuttle or cut it back to an X-program. Since then, spaceplanes have been rejected in favor of semi-ballistic capsules every time they have competed for the same mission, most recently in the Hermes/ARD, Kliper/ACTS, and OSP/Orion programs.

So this is my own alternate aerospace history fantasy: If there had been a few X-20 flights, and the data base from these flights had been available in 1971, it is possible that we co uld have avoided the whole Space Shuttle fiasco? Might we have stuck with capsules instead of getting lost in a blind alley? Could Dyna-Soar have saved us 14 dead astronauts and over $100B of wasted money? Could we have spent the last 35 years doing something useful in space, if that useless little black spaceplane had actually flown?

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