50-Year History of the Homebuilt Composite Canards

By Burt Rutan

Oshkosh Forum building #7

11:30am, Tuesday July 23rd, 2024

VariViggen – The only GA canard configuration flying in 1972.

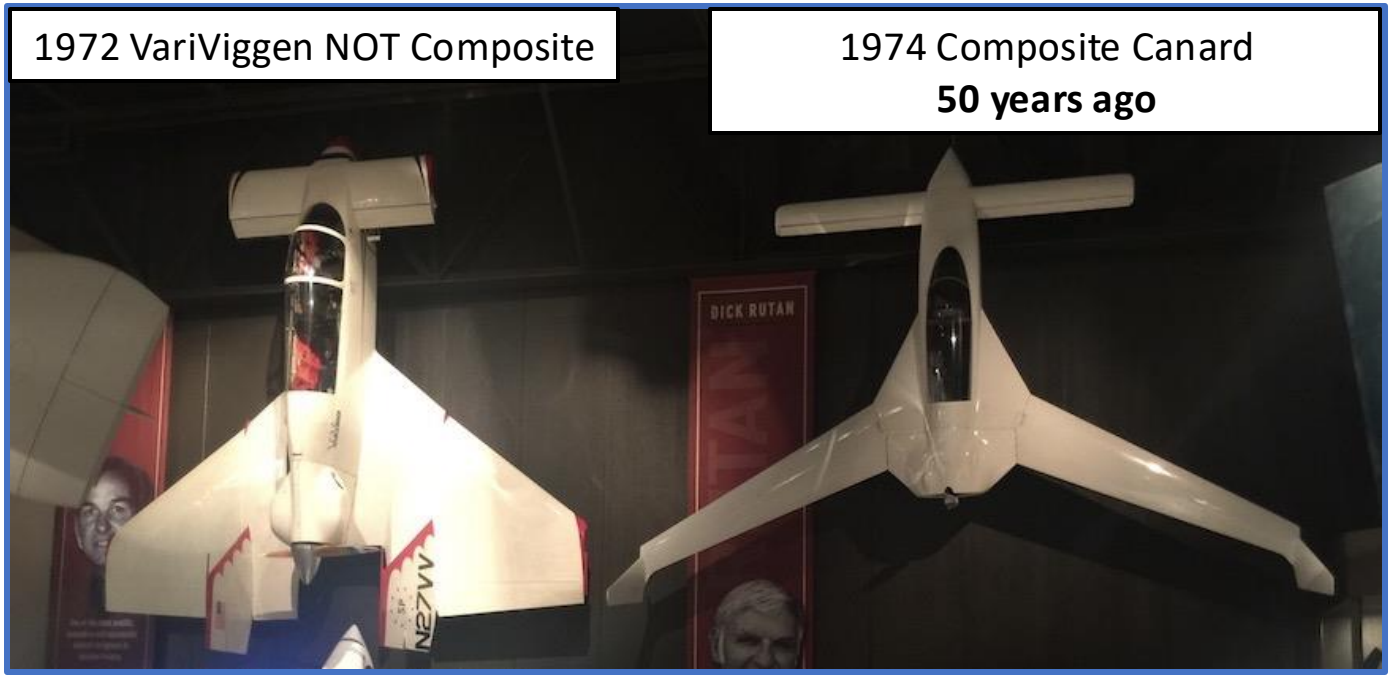
UFO Reports.

The fun to Barnstorm in 1972.

What is a "Composite Canard?"

1972 VariViggen NOT Composite

1974 Composite Canard
50 years ago



What is in this presentation:

1- Burt's initial reason for developing Canards.
(Chapter 17 of BRAB)

2- Aviation firsts, using the Canard Configuration.

3- The 19 Mojave Composite Canard Aircraft.
(Chapter 82 of BRAB)

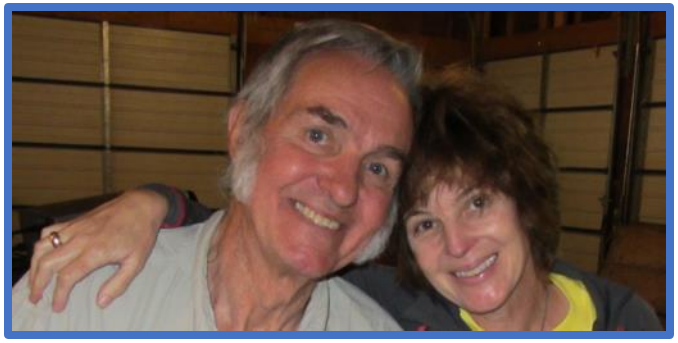
4- Others who later joined in on the Fun.

6- Prime Aerospace Canards &/or Composites.

5- Some Stories from the 50-years.

7- Your turn – Q & A

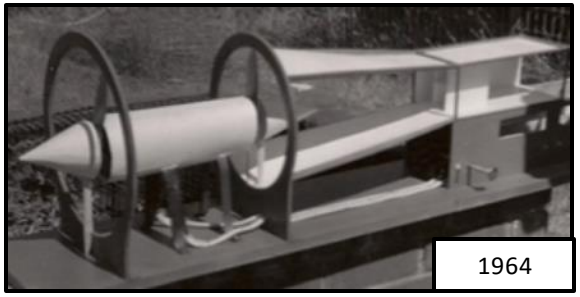
BurTonya
2011



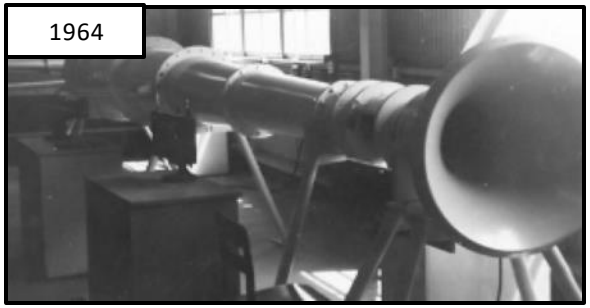
Early Canard Work Focused on Stall-Spin Safety

See BRAB Chapter 17 for detailed information

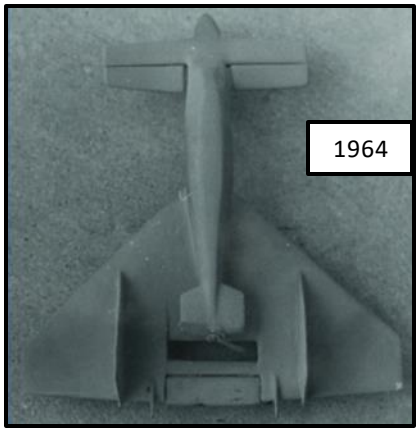
Started with a small Wind-Tunnel model to see if it had Stall-Limiting. It measured only the pitch axis.



1964

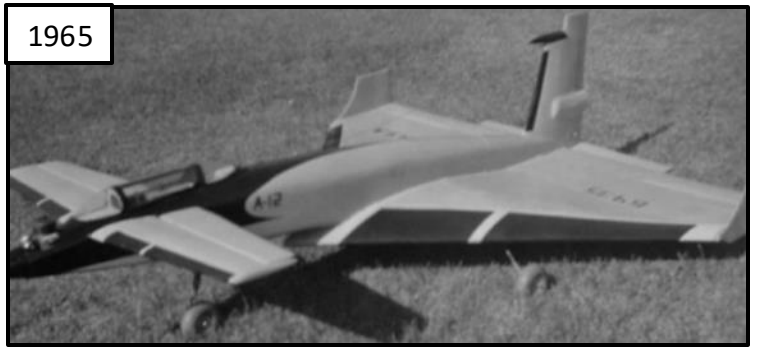


1964

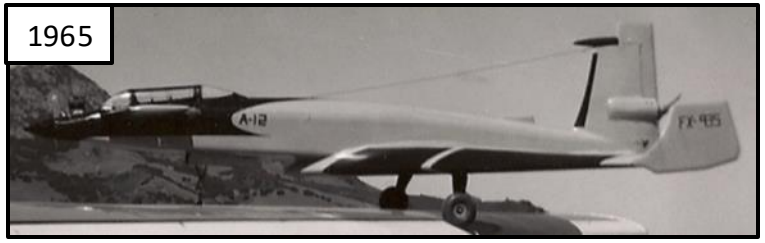


1964

Burt's first flying Canard, an RC Model, built and flown at Cal Poly SLO College. It demonstrated natural stall-limiting.

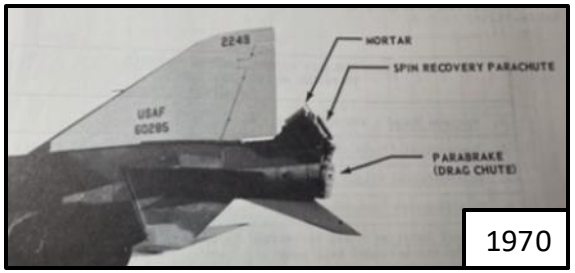


1965



1965

The Importance of Stall-Spin Safety gets personal.
F-4E at Edwards AFB. BRAB Chapter 13



1970

The on-going debate about performance advantages of the Canard Configuration.

Some "Firsts" for Manned Canard Aircraft:

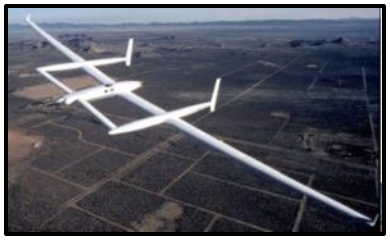
First manned, powered, sustained, controllable flight - Wright Flyer, Forth flight, 1903.

First STOL Military fighter - Saab 37 Viggen, 1967.
Mach 1.6 1,600-ft Roads

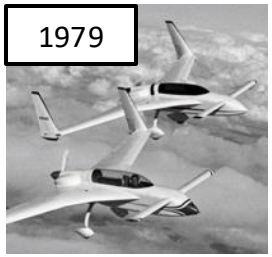
Long before 'Fly-by-Wire' F-16. It had Natural Stall-limiting.

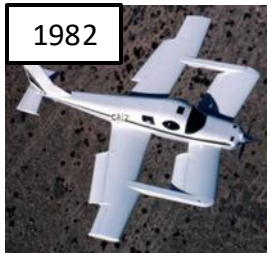
First Man-powered flight, Gossamer Condor - (Won Kremer prize), 1977.

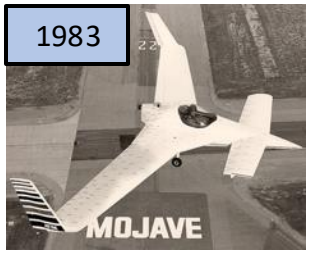
First World flight without refueling - Rutan Voyager, 1986.

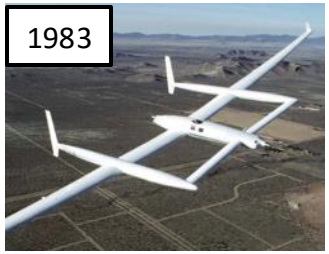


Mojave's 19 Manned Composite Canards
Ten by RAF & Nine by Scaled Composites









Not really a canard?
(3-surface, no
forward elevators)

Others who later joined in on the Fun with Composite Canards:

Gyroflug Speed Canard, 1st to be certified. 1980

Walters Dragonfly. 1980.

Nat Puffer Cozy. 1982

Dickey E-Racer. 1984

Maher Velocity. 1985

Beechcraft Starship, 2nd to be certified. 1986

Ronnenberg Berkut. 1989

Wright Stagger EZ. 2003

Prime Aerospace - use of Canards or Composites

Boeing Sonic Cruiser – real, or a head-fake when Airbus announced huge A-380?
A Canard, but NOT All-Composite.
Also, manned Fighters use Canards.

Now Look at **True All-Composite - TAC**
Bonded, without bolts, rivets or metal internal structure.

There are no Fighters or Airliners that are **TAC**.

First TAC - Beechcraft Starship, then many GA certified aircraft. (Not counting gliders)

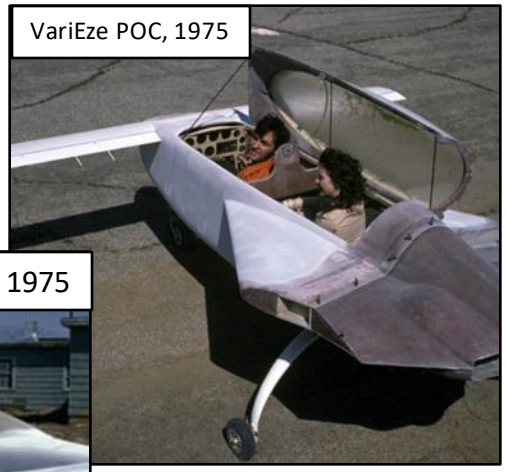
See Starship structural details in Rutan's Friday talk

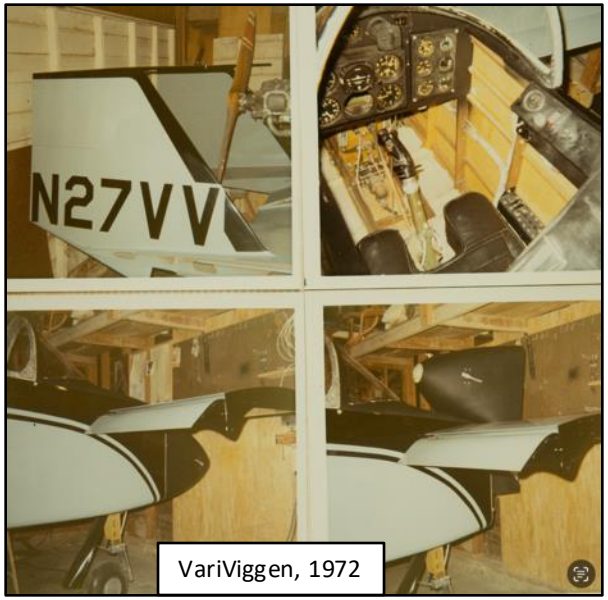
Another **TAC** – the Boeing Military un-manned Condor -huge 200-foot span.

I predict that a **manned TAC military** aircraft might appear in the future.
Hey, it's been 38 & 50 years – surely, they will muster up the courage to finally copy the Starship and the airplanes we build in our garages !

Early RAF Photos

VariViggen First Flight May 1972


VariEze POC, 1975



VariViggen, 1972


Proof-0f-Concept EZ, VW-Powered Mojave. 1975

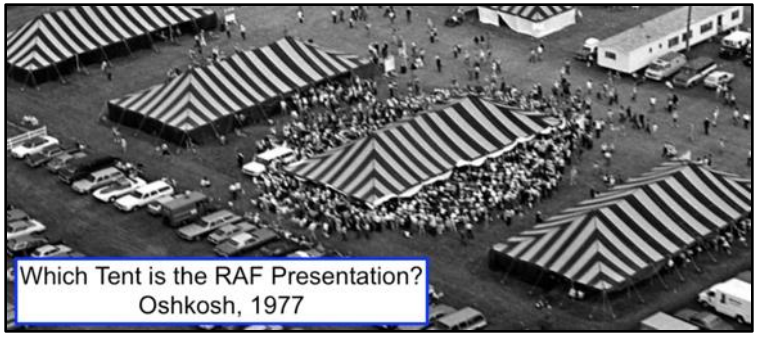

Early RAF Flight Suit

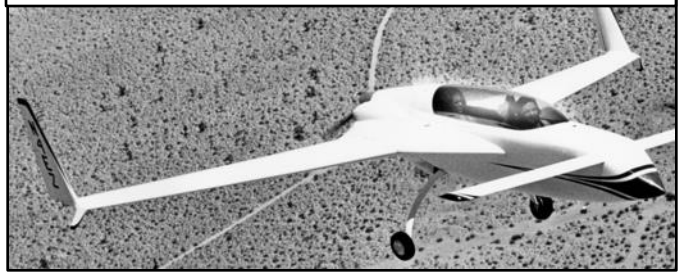

First VEZ wind Tunnel. 1974

Original RAF Facility Building Sign 1974

Original RAF Facility 1974

1st Pin-up on SA Cover 1973


Which Tent is the RAF Presentation? Oshkosh, 1977


Homebuilder's VariEze Continental O-200 1976

Sign on the original RAF building
See red brackets on previous page

50 years in the desert sun/wind

Homebuilt Manned Composite Canard Photos

Rutan Aircraft Factory Manned First Flights

#5 Quickie Homebuilt Model #54 November 1977

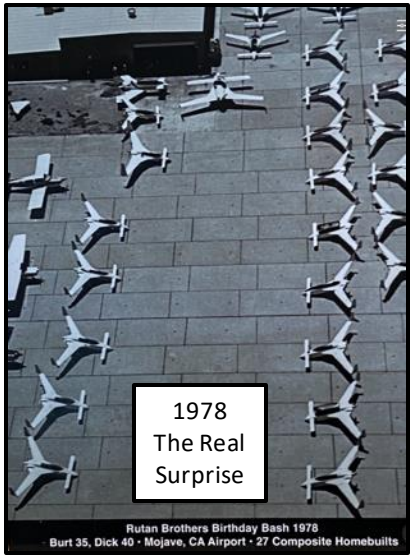
Rutan Aircraft Factory

RAF Logo

Rutan Aircraft Factory Manned First Flights

#9 Amsoil Biplane Racer Model #68 August 1981

Surprise “Every-5-Year” Birthday Bash



Rutan Brothers Birthday Bash 2013
Burt 70, Dick 75
There Was No Party This Time

Some RAF Stories during the 50-Years- the next 5 slides

Subjects

First work with "Bed sheets & Honey"

1974 Mini-Viggen. Scary first VariEze Flight – a **SD**

The Rutan VariViggen is a **SD**

Near accident at Lake Powell

RAF Office Management & Builder Support

VariViggen safety - not really. Stall-proof, but **SD**

Starship, subject of Friday's Forum talk

Witnessing the tragic first flight of a RAF customer

Considered being a 'Normal Engineer'

RAF getting sued. Australia move?

Lawyers, please leave. Lee Horton ok
Suffering from **GAS**

VariEze initially was a **SD**

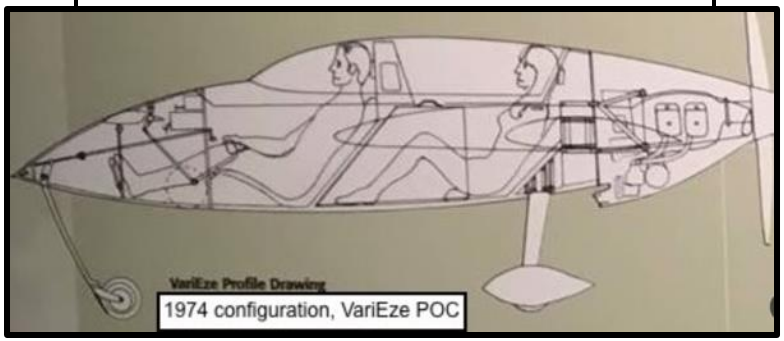
For some, the VariEze is still a **SD**. Thus, the LongEZ

"Approving" Modifications

The **SD** VariViggen:

1- Departure risk - **Achieved**
2- Backwards Power Trim change – **SD**
3- Marginal Directional stability – **SD**
4- High/Hot altitude climb at GW - **SD**

The **SD** VariEze- obsessed by simplicity
Roll control only on canard elevators



DEVELOPMENT OF MOLD-LESS STRUCTURE

July 1974 - 50 years ago, I was busy doing what we later called “Bed sheets and Honey” — carving rigid foam and doing Contact, Room Temperature layups in a sandwich configuration without an oven or vacuum bag.

I initially doubted that this new way of building primary airplane structure could be safely done by an unskilled person in his garage — it might look OK when it was actually structurally weak. Later, I found that it might be **safer than aluminum** like Thorp T-18 (crack if bent too tight) or **welded steel like a Piper Cub** (one bad weld and the whole fuselage totally fails).
Hmmmm. Is this structure a breakthrough?

I intentionally did lousy layups then broke the structure. I found that by simply adding a Ply of glass, a lousy layup is as strong as a good layup without the extra Ply.
Hmmmm….. I also had to add an external ply **where sanding for primer/paint could compromise structural safety.**

I then built and broke samples of the critical structure like a tail without a spar (full core ridged foam IS the spar), attachment of wing to tail, hard-points for engine and gear mounting, etc. Doing that I quickly learned to **NOT TRUST published data** for strength of coupons when doing design. Had I trusted them I would have had failures due to workmanship quality - people doing primary structure for the first time on a manned airplane.

A well-known homebuilt designer and aluminum-lover who’s name rhymes with Martin Holman, wandered into my shop and said I was crazy to sell plans for this structure — a homebuilder could not inspect it like Lockheed does and he predicted that many homebuilt airplanes would fail in-flight. He visited EAA chapter meetings and warned them about my ability to do safe structure for homebuilders.
He said he had tried to build a composite Cessna 150-type main gear, and it failed at a low load where it kinked. He did not seem to realize that it works, if its shape is a continuous curve like the main gear of VEZ, LEZ, Defiant, Lotus MicroLite and my Skew-wing jet aircraft done for NASA. There were issues with mounting it, but this main gear itself is very successful structure.

At that time, I knew very little about **damage tolerance or about UV weathering**. Those solutions came after some research and a lot of testing. It was later, while being on the Starship Structural Certification Review Board **SSCRB** that I would learn those technologies. Simple load testing of completed poor workmanship airframes had managed to get me by with success.

1974 MINI-VIGGEN DESIGN

In early 1974 I had designed the basic configuration of what later became the VariEze (initially I called it “Mini-Viggen”). And, since the aerodynamic software I had written based on my wind tunnel tests did predict the 1972 VariViggen, I had confidence in the VariEze’s stability and control acceptability. **I was wrong.**

Early in 1975, The initial flight testing of EZ POC went horrible, nearly killing the test pilot (me) (directional stability, poor roll control and pitch sensitivity).
Once I got it to fly **sort-of-ok**, on flight #5, I took wife Carolyn for a ride.….**That** Was Stupid.

LAKE POWELL NEAR-ACCIDENT

in my Defiant, I almost made the same mistake that recently killed a good friend Jon Karkow while he was demonstrating the Icon A5 amphibian.
On my way to Oshkosh in 1980, I let down to enjoy beautiful lake Powell at 20-ft above the water. I took a wrong turn and was in a dead-end, narrowing leg of the lake. Trying to do a 180 turn from the middle, I was at full-aft Stick, heading for the left rock wall. I barely made it. I did not want to alarm my passenger, so I told him the close wall pass was intentional. Stupid - my body would have been found with shit in its pants….

OFFICE MANAGEMENT & BUILDER SUPPORT

Wife Carolyn & I had worked very hard to start/run RAF and made a nice nest-egg by selling hundreds of EZ plans. When accidents & lawsuits happened, she divorced me, partially to preserve her half.
I hired Mike/Sally Melvill and let them solve the 'girls are paid less than boys' issue – yes it was an issue even in the 70s. I offered a total package salary, then **let them decide** who gets most of it !

Lacking the internet and selling hundreds of EZ plans I was on the phone so much I could not concentrate on the 'Next Design'. I needed someone qualified to do Builder Support. Mike Melvill had built a VV and was thus qualified to support VV builders & he soon built his own LEZ making him qualified to support all EZ builders.
With brother Dick's training, Mike became an excellent test pilot and later an Astronaut ! So, he took over Test Pilot duties with me, when Dick departed RAF in late 1979.

VARIVIGGEN SAFETY

In the 70s the biggest cause of fatalities in GA aircraft was low-altitude stall/departure. Over-shooting final on a tailwind base leg, then pulling to stall/departure.
VariViggen has always been safe from departure at Full-Aft-Stick. I was **initially proud** of my success of solving the most-common killer in General Aviation.
However, the VV has a **poor overall safety record**.

Ignoring some of its faults, my "Safe" aircraft was **NOT safe**, like it could have been. It suffered from a **backwards pitch-due-to-power problem, poor directional stability and inadequate climb for obstacle clearance when at max gross weight takeoff at high Density Altitudes.**

Thus, **VV is a SD**. I will use **SD** many times here but will only define it once - it is a Shitty Design. I try to avoid bad 4-letter words, but s h i t t y is a 6-letter word !

My lesson learned- safety for light aircraft involves **every** aspect of aircraft design, not just solving the one most dangerous single cause of fatal accidents.

STARSHIP

A bit about the Starship - The Scaled 85%-scale POC, like most POC prototypes needed mods to make it GR8.
85% Had faults on 1st flights. After many mods it was a GR8 aircraft. It had single controls - no yoke or pedals on the right. And many who flew it were Beechcraft/Raytheon Management with little current flight experience.

At Wichita, Beechcraft, nearing Certification of the production Starship, made a change that ruined one important flight mode. That made it, for runway requirements, a **SD**. They said they would change it back after Certification …… they never did.
Because of their desire to put a bookend on their support responsibility the ones they sold or leased still have a flaw that makes it **not** a GR8 aircraft.
If interested in Starship, come to Friday's talk in forum 7 to learn all details of "The rest of the story". And, read BRAB Chapter 34 when it gets published.

THE JIM CAVIS ACCIDENT

I gained a full understanding of accepting flaws at Falcon field near Scottsdale, Arizona, when I witnessed the crash that nearly killed Jim Cavis in the first customer-homebuilt VV. I had stopped by Scottsdale Arizona on my way home from Oshkosh in a VEZ, hoping to help him on his first flight testing. I stayed in his home overnight, planning to flight test his VV the next morning. Learning that the FAA had **not yet given him his Experimental Permit**, the next day I planned to only taxi his VV.
The taxi tests with Jim in the back seat showed it was just like my VV.

Despite knowing it was not yet legal to fly, I taxied to above stall speed and illegally lifted it off to convince myself that it was a good airplane and to demo that to an excited Jim in the back seat. Then, one of us was to taxi to the hangars and the other was to drive the car there.
The big mistake I made was to not be in the back when Jim did his first taxi. Jim planned to do just a slow taxi back to the hangar and I saw nothing dangerous about that. I did not realize that Jim, being so busy to build his VV, **did very little flying** while it was being built.

Several people with me watched in horror what happened next. He had applied power to get to a taxi speed but failed to reduce power to maintain that speed. Finding that he was far too fast he abruptly pulled back the power without moving the stick forward. We and Jim were shocked to see it jump into the air in a steep climb. He shoved the stick forward and had several PIOs (Pilot-Induced Osculation's). Focusing hard on pitching, he failed to keep roll level and crashed onto a wingtip, and it fell hard to the ground upside-down. He had not installed the rollover protection structure, but it hit so hard it might not have saved him.
The spectators ran toward the wreckage while I ran back to the VW car and raced to the scene. I was the first one to arrive at the horrifying wrecked VV aircraft on top of Jim. I feared he was dead.
Fortunately, the accident was also viewed by two Emergency Medical Technicians from across the runway, who landed their helicopter there within 2 minutes and began working on Jim, saving his life.

Devastated, I was shaking when I called his wife to tell her she would soon see her badly injured husband arriving in a helicopter. She was at work in the ER of the hospital where the helicopter was taking Jim.

I was horrified – the first RAF homebuilder to fly a plans-built airplane nearly died right in front of me.

SHOULD I HAVE BEEN A 'NORMAL ENGINEER'?

Someone needed to guard the wreckage before the FAA could arrive. I spent all night in that VW, parked next to the wreckage. That sleepless night I considered closing RAF, selling no EZ plans & being a 'Normal' engineer working for Cessna or Lockheed. But that experience became yet another building block of motivation to persevere in the pursuit of aircraft safety.

RAF GETTING SUED

Later, RAF began being sued following accidents. It was always from a passenger or someone flying another's homebuilt. I never got sued by someone who had bought a product from RAF - the very **definition of Product Liability.** Of course they would sue ME, not just RAF. The suits caused me a lot of stress, but not much money. At one point I even considered moving RAF and my home to Australia where the loser pays both sides' legal fees – essentially stopping the frivolous suits.

ASK LAWYERS TO LEAVE THE FORUM

At this point I had been planning to ask the lawyers in this audience to leave, because this talk is not intended to be about how some of them ply their trade.
However, I am changing my mind because I suffer from **GAS**, and I am not referring to a fart. I have found that at 81 years old, the **GAS** Factor goes way down. Of course, **GAS** means Give A Sh#%.
As some of you may remember, I once brought my lawyer Lee Horton to Oshkosh, and he did a joint forum talk with me. I always think about Lee as a Vietnam helicopter pilot, not an attorney. He went to law school after Vietnam, then did something wonderful – he located homebuilders that could not afford to defend themselves from the practice of extortion - extracting settlement $ by filling frivolous lawsuits and he defended them Pro-Bono, i.e., he did it for free. RIP, Lee.

HELICOPTER JOKE

Oh, I must tell you about optimism: "An optimist is a helicopter pilot who smokes and thinks he will die of cancer.

HOMEBUILT VARIEZE WAS A SD

When I first sold plans, I quickly learned that my homebuilt VariEze was a **SD**. Being **obsessed by simplicity and light weight**, the original plans sold for VEZ had roll control only on the canard elevators. This was dangerous for those that built crooked airplanes and found that they needed rudder to remain upright on first flight!
What followed was panic testing of aft-wing ailerons and a delay of the next CP newsletter's mailing to include aileron plans (no Internet/email). **Is there anyone in the audience who first flew his VEZ without ailerons on the wing??**

Another danger – Lots of builders on VEZ had only Cessna 150/172 experience. There was no opportunity initially to get training on a EZ before first flight. We now have RAFE.

Later in 1980 I announced that the reason for the new LongEZ was long range and the avail of Lycoming vs Continental O-200 engines.
Homebuilders then did not buy new engines and the VEZ were using up the supply of Continental O-200s.
A joke then was to get an engine for your VEZ just pick a real windy day and sneak onto the ramp and untie all the Cessna 150s….. ☺
However, there was another reason for the LongEZ — the accident rate of the more sensitive VEZ.

Fun vs Danger
Pilots who had always flown their Cessnas conservatively were seen doing low buzz jobs and acrobatics in their new VEZ. Thus, the homebuilt VEZ for those pilots is a **SD**.

The Swiss and other Europeans preferred VEZ over LEZ. It was they who developed shocked/damped nose gear for their lumpy grass runways. I later tested their modification by taxiing over 2x4s. And approved it via CP newsletter.

In general, the **LEZ is not a SD** and by the time **Defiant** plans were sold it too was **not a SD**. I had nearly 2,000 hours flying the Defiant when I first sold plans in 1984 just a year before I stopped selling plans & licensing homebuilders.

MODIFICATIONS

An interesting side-note on modifications.
The original VariViggen Plans (sold by RAF for 28$) had the following statement:
"Contrary to the philosophy of most designers, I **do NOT insist** that you build your airplane exactly like the plans. Individuality and inventiveness is what the EAA movement is all about. My plans are merely my conveying to you how my prototype was built. If you desire an all-metal airplane, for example, you will benefit even more from the educational aspects of aircraft building by learning alot about metal structural design. I am interested in following any derivatives of the VariViggen under construction, but probably will not have time to assist you in design changes - join your local EAA."

Later, when supporting VariEze builders' requests for me to approve mods. I started by candidly giving my honest opinion. For mods that looked dangerous I said they were, even without having Flight Tests to prove it. SO, homebuilders were **testing their own mods**, and many had **no idea how to safely do Flight Test**. So, on Lee's suggestion, I had to resort to the more proper method - to say, "I could comment only if I had done flight tests to see that it is safe".

Molt Taylor had advice for me: "Always insist that folks who buy your plans build their aircraft EXACTLY to the plans, then **pray that no one ever does**"…..

Questions?