

Why Beechcraft Did Not Replace KingAirs with Starships

By Burt Rutan

Oshkosh Forum building #7

11:30am, Friday July 26th, 2024



This is a very unusual talk.
It's a summary of Chapter 34 of Burt's BRAB biography.
Its candor is enabled by two things:

- The bankruptcy of Beechcraft.
- The **GAS** factor – those at Tuesday's Oshkosh talk will know the definition.

All information in this presentation is what Burt observed during the 7 -year RAF-Scaled-Beech Starship program.
The opinions expressed are solely his own.

What is in this presentation:

- 1- A 34-year Timeline showing Beech Management and Starship development milestones.
- 2- Treatment of 'Burt & Ernie' while Starship was a covert program.
- 3- Changing Beech Advanced Design department.
- 4- Observation of Beechcraft's management decisions.
- 5- The Challenge – The difficult Starship Goals.
- 6- Attempts to achieve goals by flight test development. Scaled flying an 85% scale POC in Mojave and Beech full-scale certification flight testing in Wichita.
- 7- Throwing away the short-field performance.
- 8- What could have been done?
- 9- Destroying a Museum artifact.
- 10- Your turn --> Q & A.

A 34-year Beechcraft Starship Timeline

- 1980 - Raytheon buys struggling Beech from Olive Ann Beech.
- 1980 to 1983 - **Ed Burnes is Beech CEO**. Never at Mojave.
- 1981 Beech engineer sketched canard business aircraft.
- Early 1982 - Beech contracts RAF for design of a replacement of the dated KingAir Line.
- Late 1982 - RAF transfers Beech contract to the new Scaled Composites company.
- January 1983 - Covert start of fabrication - 85% scale POC.
- 1983 to 1984 - **Linden Blue is Beech CEO** (Covert Call).
- August 1983 - First flight 85% POC.

- October 1983 – POC flight demo, at NBAA Dallas in October.
- 1984 to 1987 - **Jim Walsh is Beech CEO**.
- 1985 – Beech, under Walsh, buys Scaled Composites.
- Feb 1986 first flight of full-scale Starship NC-1.
- 1987 to 1990 – **Max Bleck is Beech CEO**. Never visited Mojave.
- 1988 - Beechcraft sold Scaled to WUTTA, then to Wyman-Gordon while Walsh was CEO of WG.
- 1990 - Starship certified. POC destroyed.
- 2013 - Beechcraft Bankruptcy.
- 2014 - Textron/Cessna starts to build the non-jet Beech aircraft.

Note:

In early 1982 when Beech contracted RAF for Prelim Design of SCAT (Scaled Composites Advanced Turboprop), RAF had only done VariViggen, VariEze, Quickie, Defiant, LongEZ, AD-1 and NGT.

RAF then had a total of only 7 employees 1 engineer and four shop workers !

I did not tell Lindon we had a Beech program when he called me in 1983 to tell me he was going to be the new CEO of Beech. He could not prove to me that he had the new job.

When Blue became CEO of Beech, he renamed SCAT "Starship 1". He reserved "Starship 2" for a possible Turbofan jet model. The "1" was dropped when I proved to him that the Turboprop Starship did not have the airfoils needed for the speeds of a jet.

‘Burt & Ernie’
During covert portion
of Starship program
1982 to late 1983

- Why Covert? – Better optics if/when Management cancels the program.
- Burt had to park his rental car in a Management slot, not Visitor’s lot.
- Roncz could see KingAir production line with an escort, Burt could not.
- The Roncz plan to takeover Beech by a military-like attack (details in BRAB Chapter 34).

Wichita motivation destroyed when Beechcraft changed the Advanced Design responsibility

- Jim Walsh eliminated 30 of 33 designers in the Beech Advanced Design department.
- Mojave becomes the new 'Advanced Design Center' after Scaled acquisition.
- The **Fun stuff** will be in Mojave, not Andover. Starship, Catbird, ARES and Triumph would now be 'Beech Research'.

Conclusion, from a Beech test pilot:

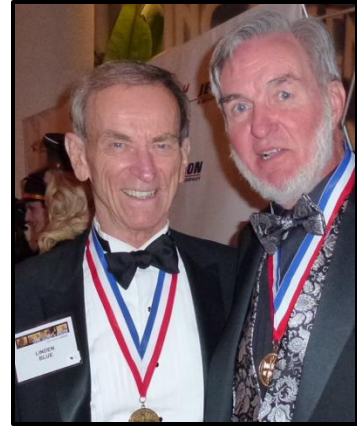
“Starship program was expensive due to decisions to tool and build it like a military fighter, with every part being autoclaved, and their use of job-shoppers from the primes. That pissed off the Beechcrafters who felt left out. Bottom line, they had to sell it for more \$ than the turbofans that were 80 to 100 knots faster”. Thus, cruise performance could not sell it.”

An Observation:

Making sense of the senseless Starship decisions made by Beechcraft Management

- In general, top management operates to avoid catastrophe, since **history will blame them** for a corporation's failure. This is why a 787 looks like a 707 (with 50 years between them!)
- During the 7-year Starship project, **Beechcraft had four different presidents**, while Burt continuously ran Scaled and demanded (and achieved) it's original **culture**, regardless of who owned Scaled's equity.
- Scaled was unique – large variety of interface with many corporations on subjects involving risk, both technical and financial. The technical risk never frightened Burt, since all projects were **Research** where failures are **expected**. Thus, many unique configurations were built. Fun, not Fright.
- Initially, all **top Management at Raytheon** (Brainard Holmes), **and Beechcraft** (Linden Blue and Jim Walsh) were **excited** by this huge upgrade in product line (configuration, structure and avionics). Later, when Holmes and Walsh were gone, **Bleck was frightened** by the huge technical and financial risk.

Linden Blue
The visionary
Beech CEO 1yr



Max Bleck
The destroyer
Beech CEO 3yr



Difficult Starship Program Goals

Design requirements for the Starship - **all** 9 aspects of the airplane must **meet or exceed** those of the KingAir

- 1- A 'Modern Look', not like the 1960s designs.
- 2- Structure - weight, weathering & fatigue life.
- 3- Safety - stall/departure & engine-out MCS.
- 4- Cabin - size, isle stand-up, visibility & noise level.
- 5- Ingress/egress – convenient and safe.
- 6- Avionics systems - world-class, single-pilot.
- 7- Pilot transition - easy and pleasant to fly.
- 8- Performance - speed, altitude and climb rate.
- 9- Short-field runway requirements.

Did the Production Starship Meet the Difficult Goals?

Let's look at each of the nine
goals, to answer this question

1. What is a “Modern Look”?

Seeking a ‘Modern Look’, Beech ‘Advanced Design’ sketched a canard version of a King Air replacement in 1980

The 1960s General Aviation ‘Look’



The General Aviation ‘Look’, ~ 50 years later



Advantage? Yes or No Beauty is in the eyes of the beholder

From Business & Commercial Aviation magazine, 2003:

The Starship looked radical, was radical, and therefore was outside the comfort zones of most buyers. Many of these people are creative in their own endeavors, but an airplane is not where they go to express their creativity. The Starship's radical appearance turned people off. It wasn't a 'normal' looking airplane, and that was probably a fundamental problem with it.

2. Airframe Structure?

Weathering and Fatigue. **YES:** Carbon fiber vs Aluminum

Especially salt-spray, Cf advantage.

Starship has **no fatigue life-limits**. Thus, Starship has **big advantage over King Air**.

Note, the **only** Starship accident - an icy runway over-run after an aborted takeoff.

Beech claimed if it was a King Air it would have been totaled since it ended up in a ditch.

The accident aircraft was flying after relatively minor repairs.

Weight. **NO:**

Sandwich carbon fiber skins with honeycomb core was initially calculated to be lightest.

True for fuselage – where structure has high tension. But for wings & tails, where test panels showed huge strength losses due to **Damage Tolerance, and Core Local Dis-Bond (Compression on top skins, rock damage on bottom)**.

Thus, Starship structure ended up with **no significant weight advantage** over King Air.

3. Safety-Departure & Spin? 1 of 2



For takeoff and landing configuration (flaps down), Starship achieved the goal of **complete Immunity from Departure**, including with full-aft-stick combined with cross roll/yaw input at aft-limit cg. King Air would spin. Starship **not possible to spin**. Also - engine-out climb with **flaps down at full-aft stick** !

Starship engine-out Min-control-speed is **below the stall speed** for all configurations. No rollover at high AOA. For cruise configuration (flaps down, canard swept), Production Starships have a stick pusher. But it is **not** because it has an un-recoverable deep-stall problem.

YES

Fatal Accidents - Huge safety advantage for Starship over King Air.

3. Safety - Departure and Spin? 2 of 2

Scaled even tested stalls with one flap down and the other flap retracted. Unlike the King Air, the asymmetry was easily controlled at all speeds..

Scaled did not experience deep stalls during the 85% POC flight tests.



Comments from Tom Carr, Director of Beechcraft Flight Operations and Starship Certification Chief Test Pilot:

You cannot enter this condition in a Starship inadvertently. Period. To get into this condition, we had to be at aft CG, gear up, flaps up, canard swept, **stick on the stop and fully cross-controlled for >15 seconds before it was unrecoverable with elevator only.** All the while it is rolling and yawing with slight pitch buck as the AOA ratchets its way up. In our tests, we deployed the flaps (to recover) and Raytheon didn't want to take the schedule hit for installing a spin parachute.

There is a popular misconception that the FAA required a pusher for this condition. Not really. The FAA said that Raytheon had touted the Starship as an un-stall-able airplane, and there were few cues to the pilot that a stall was becoming unrecoverable. They were worried that people would go out to see if it was indeed un-stall-able. Instead of backing off on that claim, Raytheon elected to put a pusher in. Never mind that, **if you ever did this in any other business airplane, you'd be in a spin.**

Keep in mind that this is an airplane that requires a type rating. You need to have ground and flight training in the airplane before you can even take the type rating check ride. Pilots are expected to know the airplane and its systems and would be taught why there is a pusher and when it is operational. You have to do stalls in the airplane with and without flaps to pass the check ride; on one, you'll get the pusher, on the other you won't. Pilots know the pusher doesn't work with flaps down. Still, I'm surprised that it isn't mentioned in the AFM.

Note:

Stick pushers are normally in aircraft that cannot be recovered from Deep Stall (DC-9 and some business jets). However, Starships will instantly recover by just putting the flaps down.

**I'm surprised that Flaps down will recover a deep
Stall isn't mentioned in the Flight Manual. !!!**

4. Cabin - Size, Comfort, Visibility & Noise Level.

Starship cabin size, isle stand-up-room and visibility are better than King Air.

YES

Cockpit Noise is less, but noise in rear seats (where the boss sits) was initially louder than King Air. However, it was fixed by baggage compartment tuning system

YES

5. Is it better than King Air for crew or passengers – to ingress/egress ?

YES



Entrance like Business Jets, at closet forward of passengers. Crew can observe all who enter or exit & can check door security.



Crew must walk a narrow aisle between passengers to enter and to operate or check the air-stair door.

6. Avionics systems - World-Class?

Yes,
Starship had the first digital Glass-Cockpit for Business Aircraft.
This was also before airliners had Glass-Cockpits



7. Pilot transition - easy to fly?



Yes

Several Raytheon and Beech Managers flew the 85% POC, even though it had only **a single set of flight controls**.

Most of them had little recent pilot experience.

8. Performance - speed, altitude and climb?

Certified cruise altitude – higher than King Air.

Not as good as “Advertised”, or as the Piaggio P180 Avanti.

But still better than the King Air. **YES**

Beech held onto its performance promises even while increasing the wetted area by 15%.

Duh...

Installing higher-SHP -67A engines reduced range, but the Beech boys seemed focused **only** on max cruise speed.

9. Short-Field Runway Requirements? Pg 1 of 6

Early Optimism - Landing roll on the **first flight of the 85% POC was only 500-feet**. Three months later at the flight demo in Dallas and at Beech field, the very-short landing roll was evident and noted.

Also, unlike the King Air, the Starship can apply **full reverse thrust in-flight without destroying the wing lift**. On that first flight, test pilot Dick had spooled up full reverse thrust before touchdown – a dangerous thing to do with a King Air – it would slam to the ground.

Unlike any other Canard Designed by Burt, an important feature on the original Starship made its short-field performance **independent of its cg position** because the pitch control was via Canard Elevators **AND** the Aft Elevons. Thus, pitch trim tabs were **ONLY on the Aft Elevons** and did not destroy canard lift.

This system optimized the aircraft's maximum lift at all cg positions. That unique feature made me very proud about the new Starship.

9. Short-Field Runway Requirements? Pg 2 of 6

For a Stable Canard Configuration, the low-speed performance is determined by the max lift of the canard. Four Rutan designs used a “sparrow strainer” to get speed-stability without much **loss of lift from the canard**.

POC VariEze



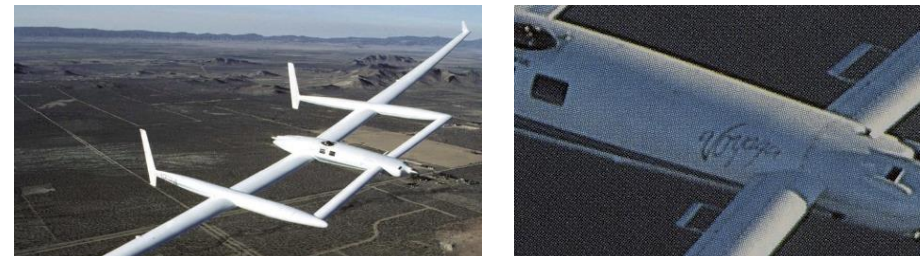
Proteus



VariViggen



Voyager



9. Short-Field Runway Requirements? Pg 3 of 6

Other Designs, Like the Homebuilt VariEze, LongEZ, Solitaire and Defiant get their max lift and speed stability via careful camber of the elevators. Pitch trim is bungee, **no pitch trim tabs**. But Speed stability is compromised.

The original POC and production Starship had blended pitch control on **both** the canard elevators and the aft ailerons.

POC pitch trim was via trim tabs on the ailerons. **NO Canard trim tabs**. Thus, the max lift of the canard was achieved, even at forward-limit cg.

This feature is unique to original Starship (until they later screwed it up by adding pitch trim tabs **only** on canard elevators !)



A Starship Configuration, 4 or 6-place homebuilt kit ??

9. Short-Field Runway Requirements? Pg 4 of 6

No aircraft designed by Burt ever had conventional trim tabs on the canard elevators. That would destroy canard lift when you need it most – at forward cg and gross weight

Beech CEO Bleck had huge pressure from Raytheon to certify at a certain early date, to stop the cash-flow burn. Then, nearing certification, Beech insisted we flight test with trim tabs **only** on the canard elevators ! When I insisted it would **ruin the stall speed and runway requirements**, to get me to behave, they promised they would redo it after certification. They **never did the redo**. The redo would likely have been to use the military aircraft methods to have redundant control linkage – a small, <15- pound penalty. But doing that would not meet the Raytheon-forced certification schedule.

9. Short-Field Runway Requirements? Pg 5 of 6

I have been criticized that the Starship is a **SD**, (Tuesday's talk) since its flaps make only a small reduction in its minimum speed, so why bother with flaps & sweeping canard complexity?

Well – **DUH**, if you destroy the minimum speed by destroying lift of the canard you should not **expect** to get much help with flaps.

To those who understand this issue, get ready to
Vomit

9. Short-Field Runway Requirements? Pg 6 of 6

Did they care about runway requirements?
A 'bad' airplane makes it easier to shorten their
responsibility for support & thus to **kill** the Starship.

Is the Short-Field capability of
the production Starships
better than KingAir? **NO**

Full-up trim !



Full-up trim, for Forward cg



Full- down trim !!!



The great feature of having only
the aileron tabs trim the airplane
in pitch was **removed**.



A nice original canard tip
without horn balance.



The Ugly ice-catching horn
balance, was added to reduce
pitch forces after tab was added.

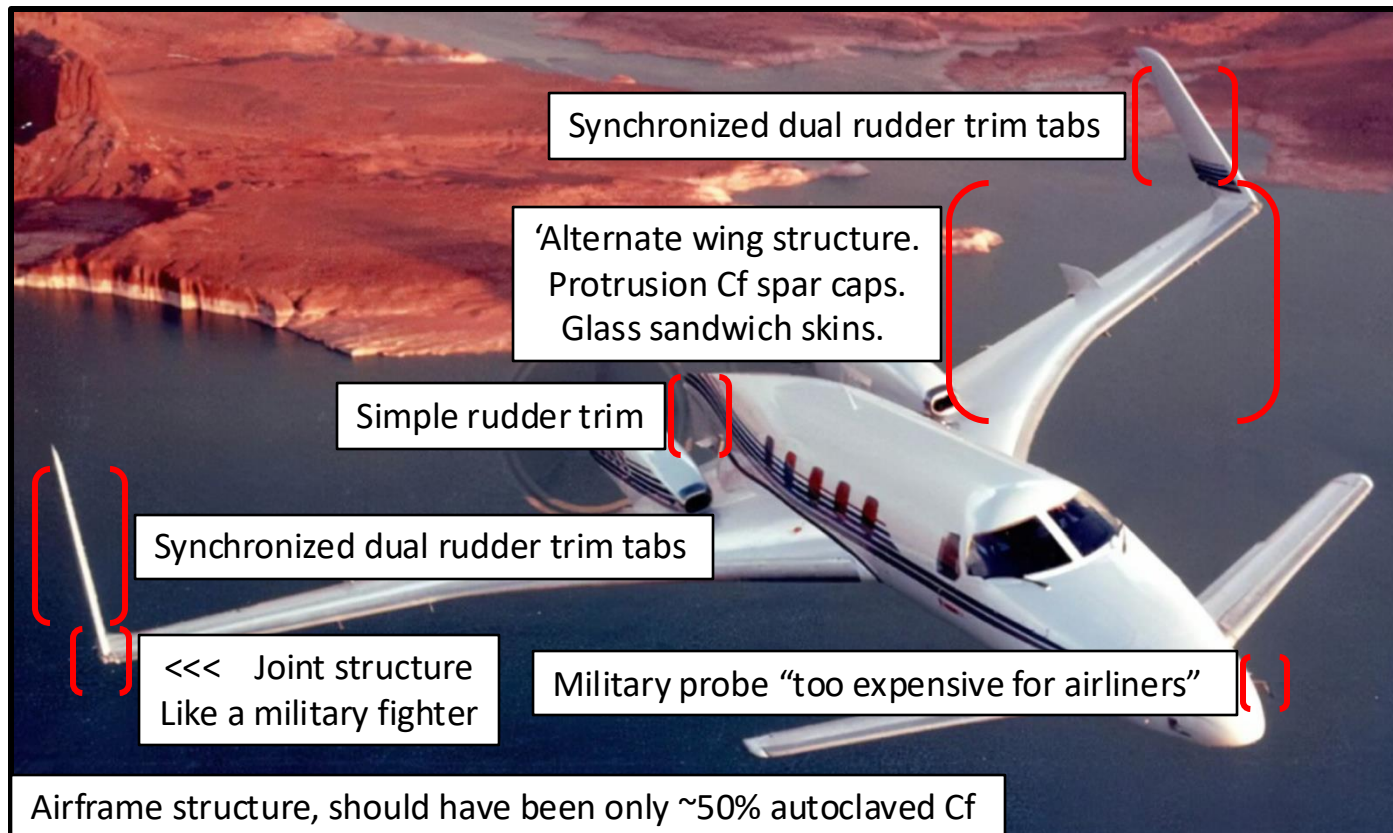


Why was the Starship so expensive?

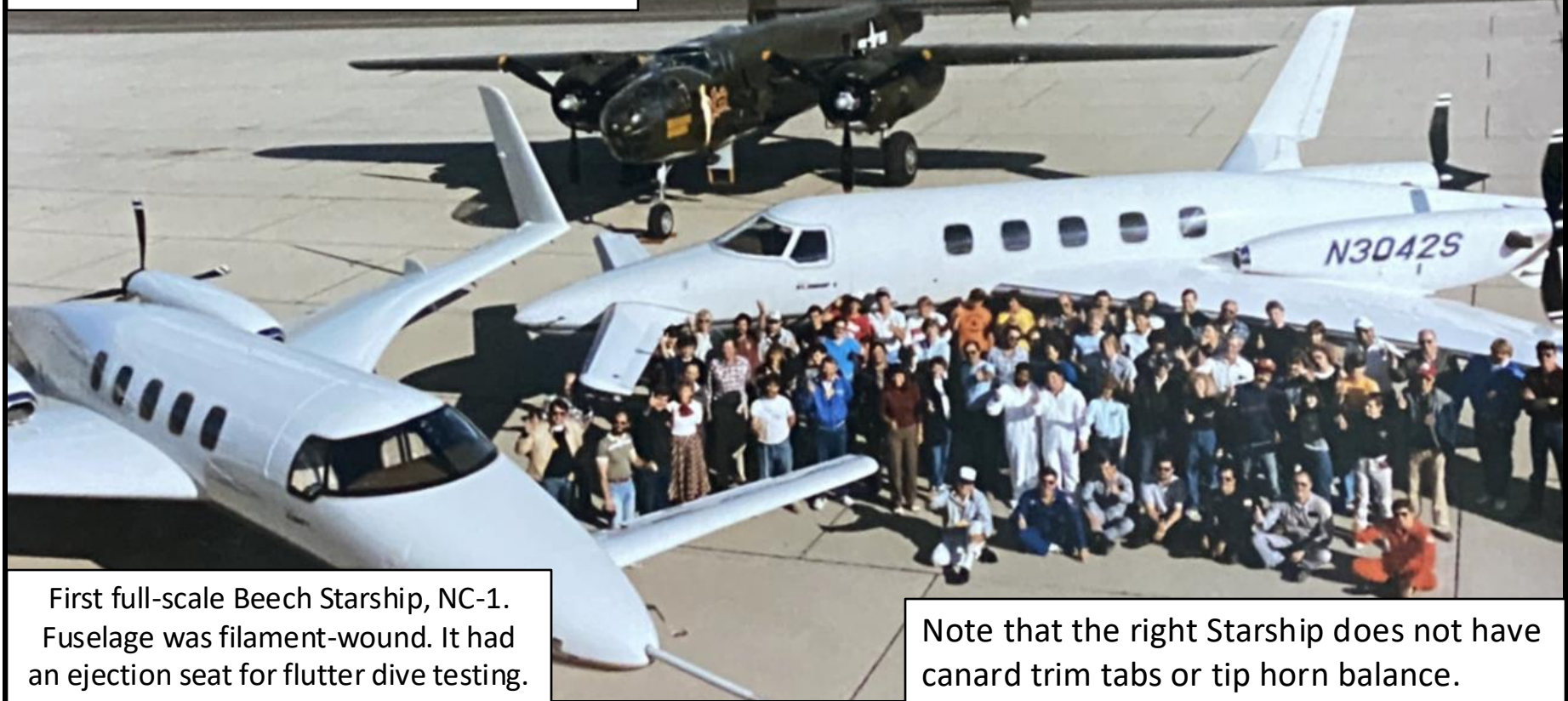
Cost to produce a Starship was **more** than the faster modern Turbofans – the reason for poor sales.

What could have been done? A **real focus** on costs.

Just a sample of the **hundreds** of wrong decisions:



All Scaled Employees at Mojave during a Starship video shoot for an early ad.



First full-scale Beech Starship, NC-1. Fuselage was filament-wound. It had an ejection seat for flutter dive testing.

Note that the right Starship does not have canard trim tabs or tip horn balance.

A note about the Mojave and Wichita flight test programs

The Mojave-based 85% - scale POC was an all-new, configuration without a previous example to guide its design details. Our new company, Scaled signed a **fixed-price contract** with a schedule incentive to fly it to the Dallas NBAA show 10 months after fabrication began !

The POC had many faults on its 1st flight. In 2.5 years of flight testing, it had many modifications. All were done very quickly. Then, by the time of the full-scale first flight in Wichita, the POC was **a great aircraft**.

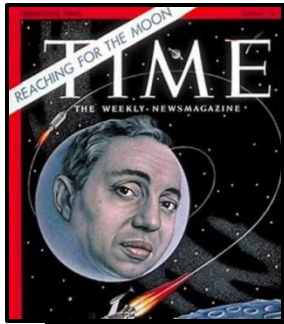
On the Beech full-scale first flight many of the POC modifications were not initially installed (aileron fences, vortilons, etc.) Their analysis indicated those might not be needed.

Nearing Certification, Beech found that they could not meet a certification requirement for forward-cg landing speed in the event there was a **pitch control linkage failure – control yoke to canard elevators**.

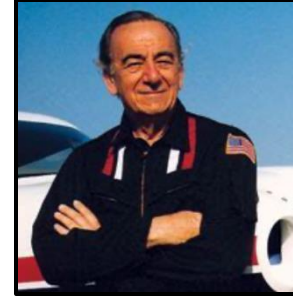
They could not fix that within the Raytheon-demanded schedule. It was **“quicker” to just put trim tabs on the canard elevators**.

They promised to fix the problem after certification, but they **never did**. Other things they said they would fix later, they did not.

They seemed to not **care** about getting the King Air's short-field performance.



Brainerd Holmes (1921 – 2013), was an American engineer and business executive. He was perhaps best known for **directing NASA's crewed spaceflight program from September 1961 to June 1963, when John Glenn made the pivotal first US orbital spaceflight.** Later, Holmes became the president of international defense contractor Raytheon. He retired from that post in 1986. Brainerd visited Mojave twice during the Starship program and **flew the single-control POC aircraft.**



In a 1979 interview, Roy LoPresti predicted that by the year 2000, most general aviation aircraft would be **unchanged in airframe and powerplants.** He felt radical new designs and materials would not be marketable and **only a few examples would be produced.**

He then became the Vice President of Engineering at Beechcraft in Wichita to **lead the development of the all-new Starship.... Duh**

The Starship development was completed as the general aviation market was in a process of rapidly downsizing.

The Proof-of-Concept Starship was beautiful Scaled employees were rightfully **proud**



Where is the Proof-of-Concept Starship now?



Max Bleck, having never been to Mojave, **never** saw the POC.

In 1990 he **hired** a team to **destroy** it.

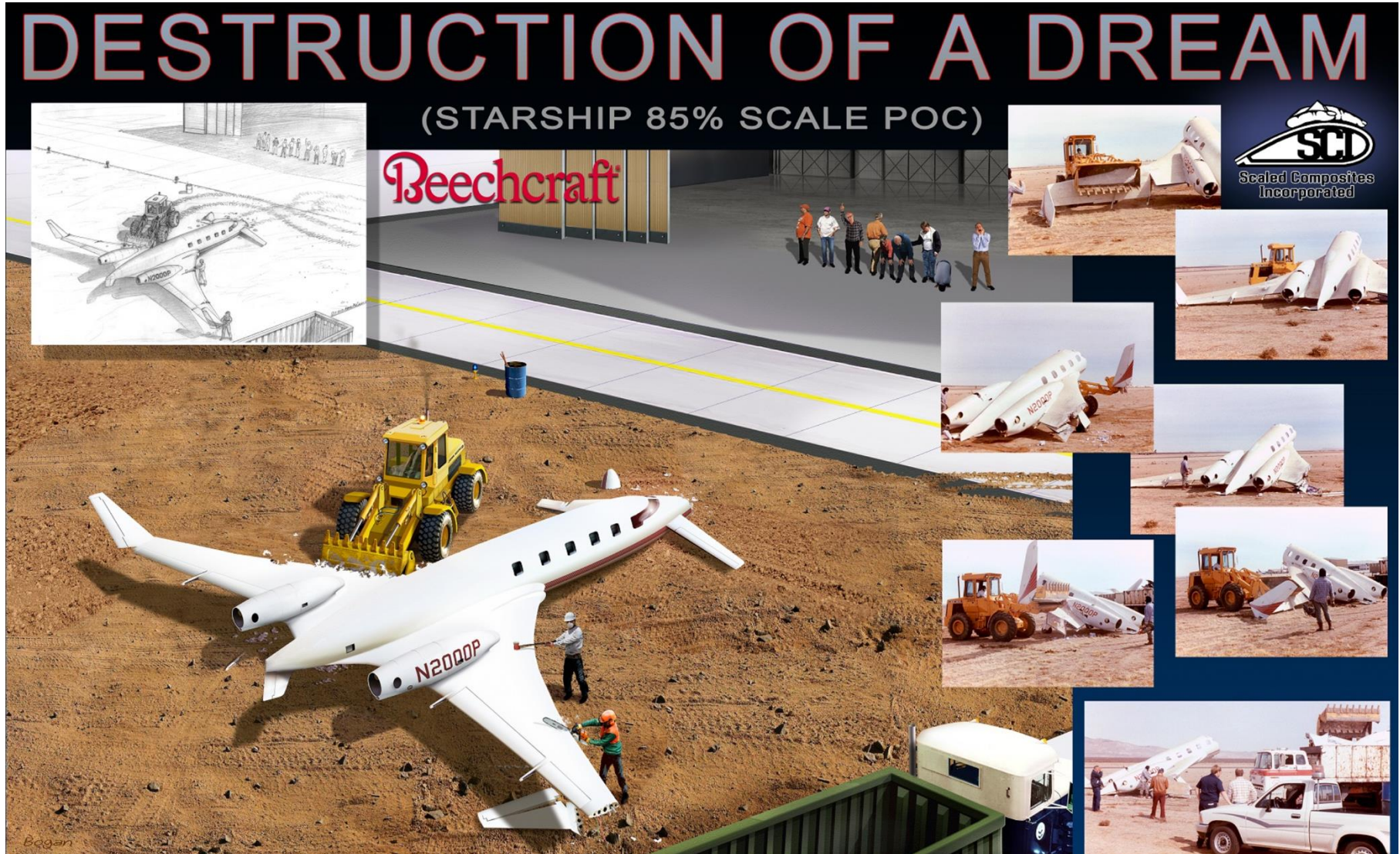
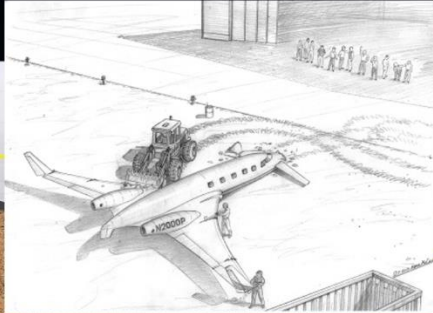
Why destroy an historic aircraft, when
four museums ask to display it?

DESTRUCTION OF A DREAM

(STARSHIP 85% SCALE POC)

Beechcraft

SCI
Scaled Composites
Incorporated



Raj Narayanan operates two Starships and is likely the high-time Starship pilot. He was not happy when he read a magazine article that was critical about the failed Starship program. The following is his answer to the un-informed magazine writer:

Hello Mac,

I certainly appreciate the article on the Starship and some of the negatives with the aircraft. What must also be considered is that to be first and revolutionary you have to take chances. Aircraft designs in the 70-80's were not as solid and vetted as they are today (and today I argue that every airplane I see is just reconstituted designs from the 80's). Analysis methods and technology were not robust enough on any platform in that era. Certainly composites, certification of composites, and process control was not robust in the 80's as most of the process control was still being proven out. Yes Beechcraft embarked on a revolutionary change in design, manufacturing, and certification. Hindsight is 20-20 and obviously it wasn't a success. However, I submit that the lessons learned from starship formed the essence of subsequent platforms in the aerospace industry including the Premier and 787 and many military programs. Yes, commercially Beechcraft failed, but had they not been acquired by (bean counter led companies) instead of aviation purists (designers, pilots, engineers, coupled with fiscal sense) that could pursue true design change, it might have been a different story.

While your article certainly is not complimentary of the design or technology, you don't mention any of the incredible technological lessons learned from Starship that cascaded into various parts of the company, and not including Textron.

From an owner/operator perspective the starship is a fine airplane. 30 years old it has not succumbed to many of the metal fatigue/corrosion issues of King Airs, Citations, Merlins, and other similar aircraft. 30 years later its systems including landing gear, and other mechanical systems are easily repairable and supportable in the field.

Ask yourself this question - if I bought a similar type airplane (Piaggio, 500 series citation, Piper Cheyanne) where would I be at 30 years of age on that platform? I will submit that the citation suffers from horrible reliability of its airframe due to corrosion and fatigue. The Piaggio suffers from a terrible supply chain problem including a landing gear that costs in excess of 200K to overhaul, and the Cheyanne is just a sub-par build quality airplane (my opinion) as an (aerospace engineer, aircraft mechanic, and an ATP).

Mac, I invite you to study the operational and sustainability argument as part of the starship in so much as any airplane. It is never the acquisition cost as many of us know, its the maintenance and sustainability costs. Those also should factor into the equation in any prognosis as to the good/bad of an airplane.

Furthermore, I invite you to interview the 3 guys flying the airplane and the guys that work on the airplane and keep them flying.

Yes, I am defending the Starship. I am defending it because I have 3000+ hours in a Starship and continue to successfully operate 2 aircraft today 30 years later. However, having worked on the airplane, modified it, and upgraded it in the field, I am going to tell you very few aircraft that were made in the last 30 years, much less today have the simplicity of design as the starship today. You want to rig an engine today? Send the box in and get a 100k\$ bill. You want to fly past 10,000 hours - aging aircraft inspection here we come at a bill of 1M\$. You want to overhaul your landing gears (special tools, and 1 OEM) here we come. In fact, I spend 95% of my life designing replacement solutions for obsolete products on aircraft and or repairs to keep older airplanes flying? Why is that? none of these GA designs are optimized, much less the starship. Textron, Gulfstream, Embraer build airplanes like new cars. Fly them for 2500 hours, scrap them. God help you if you want to sustain the platform for 10+ years of longer.

My point is this: Starship was a commercial failure. However, the design lessons learned, the sustainability of platform lessons learned, and the composite manufacturing lessons learned were instrumental for the aerospace industry. If our industry had more risk in its nature we would design more, fly more, test more, fail more, but MOST importantly LEARN more.

I will submit to the group and to this article the following: You tell me where you can find an airplane that will fly at Flight Level 35.0/36.0, Cruise north of 300 KIAS, 95 GPH of JetA, 6 passengers, and go 1200 NM, Single Pilot, and have TRUE SAFETY REDUNDANCY? Has an unlimited life of validity for its airframe? has no fatigue critical or corrosion based aging aircraft inspections?

You might find that while short on initial design and performance expectations, the Starship 30 years later has allot to offer in terms of performance, reliability, safety standard, IFR/IMC capability etc. Including that fact that the safety systems and its certification basis being to FAA/FAR Part 23 Commuter category created one hell of a robust platform for future durability and reliability.

Feel free to reach out to Robert or myself. we would love to chat and share the good with the bad so that more perspective can be given on the Starship story as misaligned as it's been.

Regards,

Raj Narayanan

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Owner, Mechanic, Pilot

Starship 2000A

What is the same about these six Beechcraft airplanes?

Queen Air 1958



Baron 1960



C90 King Air 1964



Duke 1966



M1900 Regional Airliner 1982



King Air 360 2020



What is the same about these six Beechcraft airplanes?

Queen Air 1958



Baron 1960



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Duke 1966



M1900 Regional Airliner 1982



King Air 360 2020



All six have the **same outer wing as the 1947 Beech Bonanza !**



Why did you not know this?

The Joke configuration for the Triumph Beauty Pageant.

Questions?

