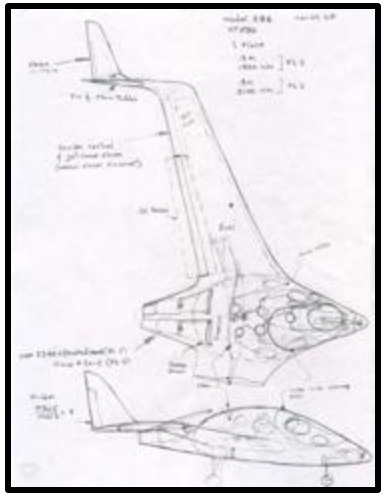
Burt's New Designs & Heroes

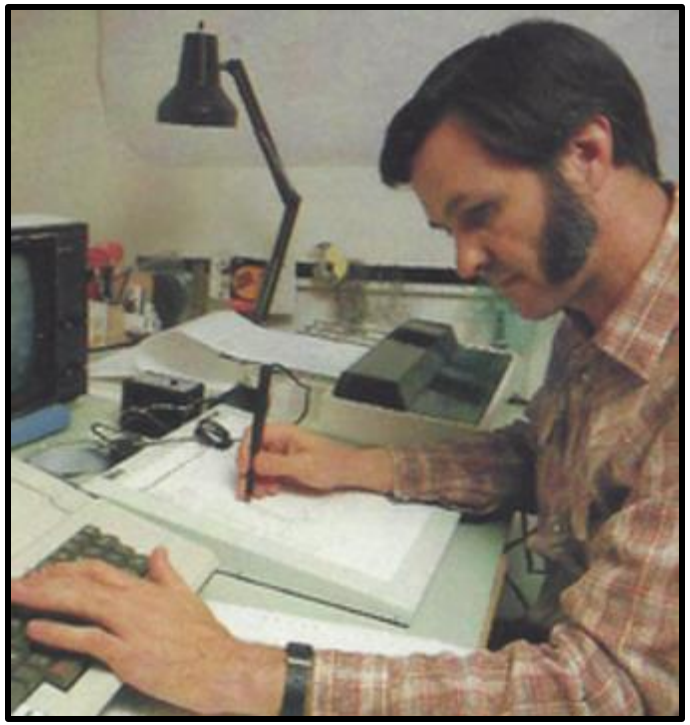
By Burt Rutan

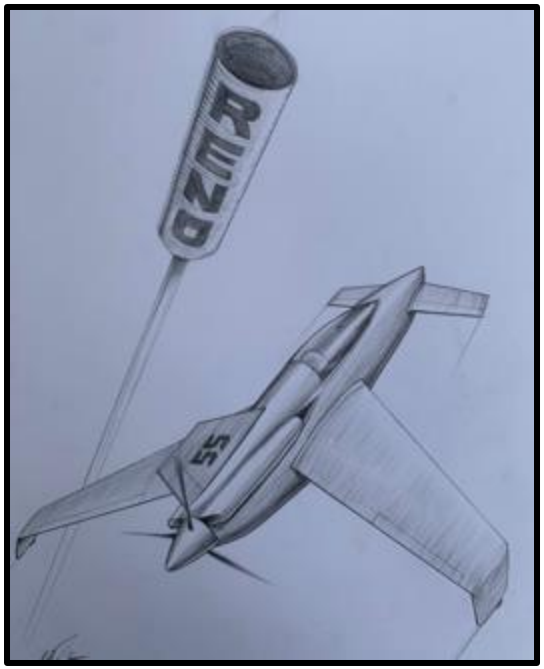
Oshkosh Forum building #7

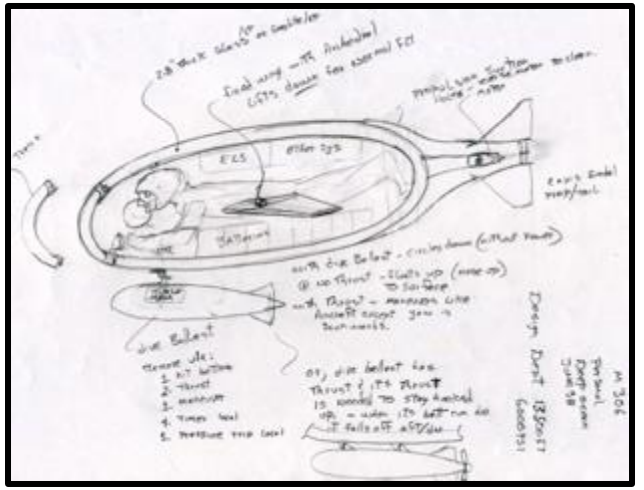
11:30am, Thursday, July 25th, 2024

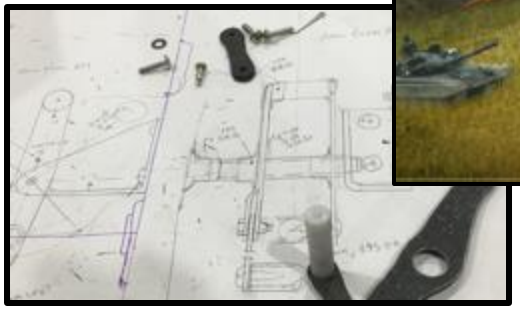


Burt's Designs You Have Not Seen

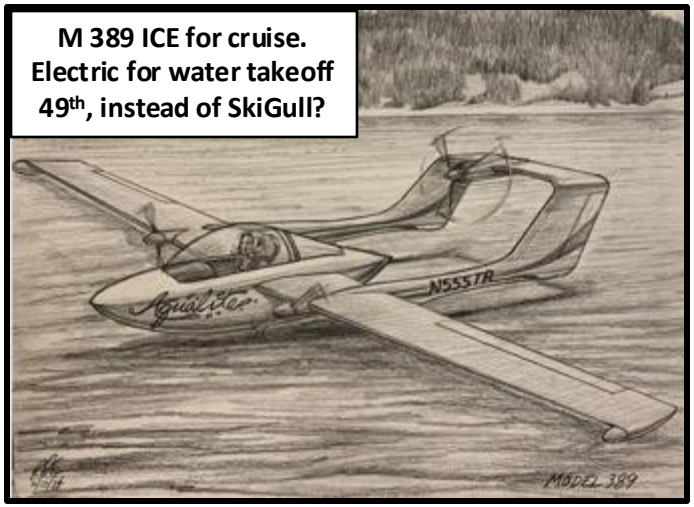




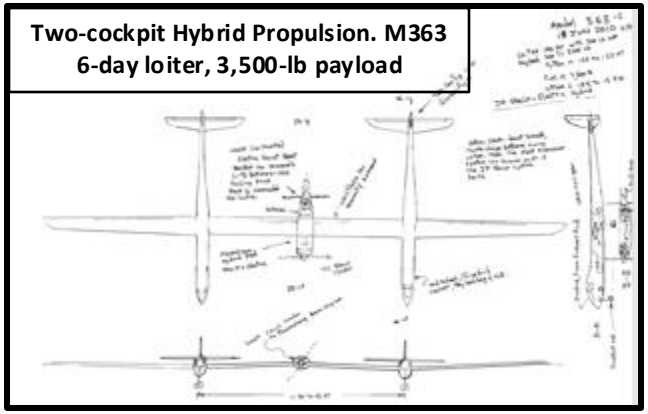


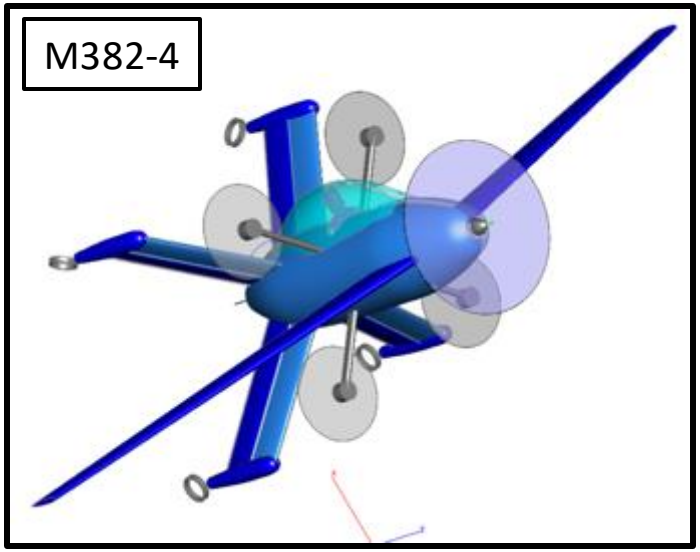


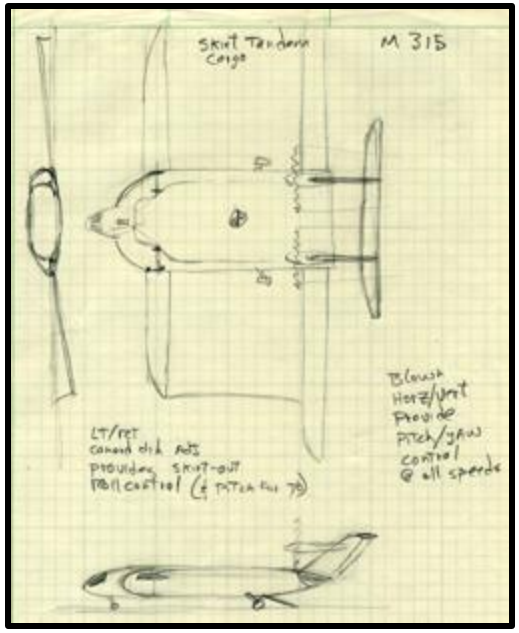
BRAB Chapter 83
Six samples of four hundred that never flew



What else can you do with a TRS-18?





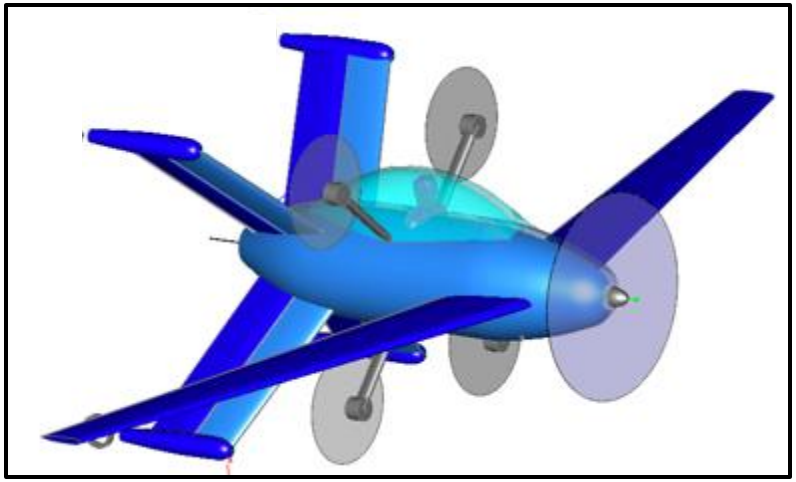


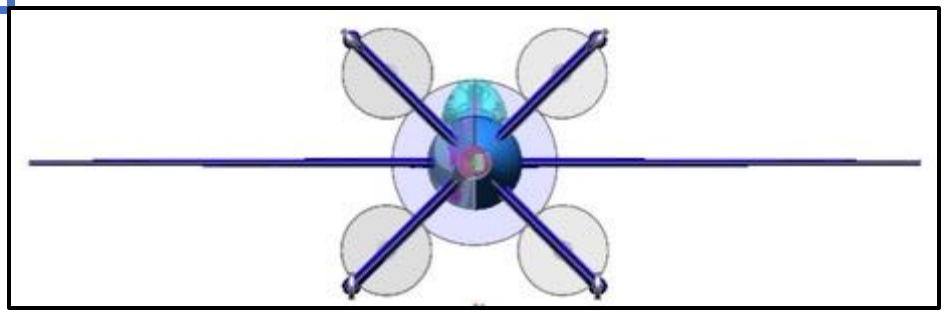
M 315 Skirt-Wing
Unique Pitch/roll control

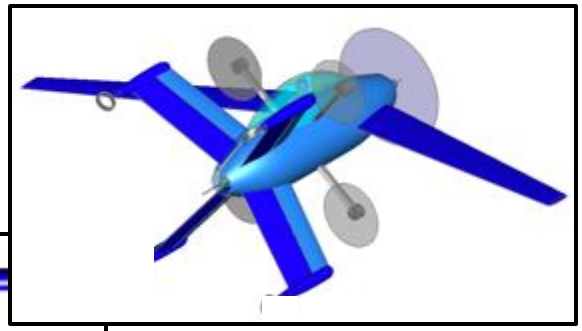
Most of the ~200 new Urban transport designs are worse than just using an off-the-Shelf helicopter.
This has a Gas engine for cruise + 4 electric props for hover.
The pilot rotates for hover TO/Landing. See next 3 slides.

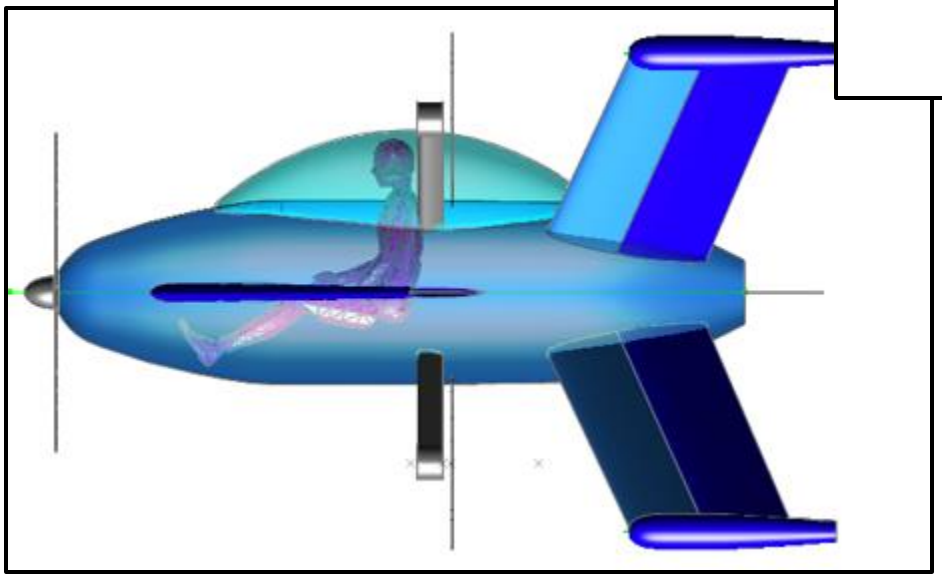
Recent Rutan Design, 1 of 4
Urban Transport Model 382-4

A Unique Solution to the issues of all those new designs coming “Soon”.

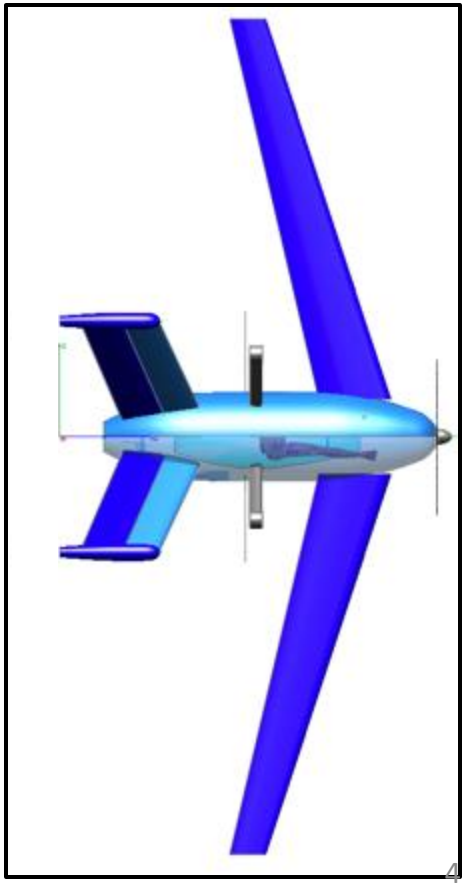






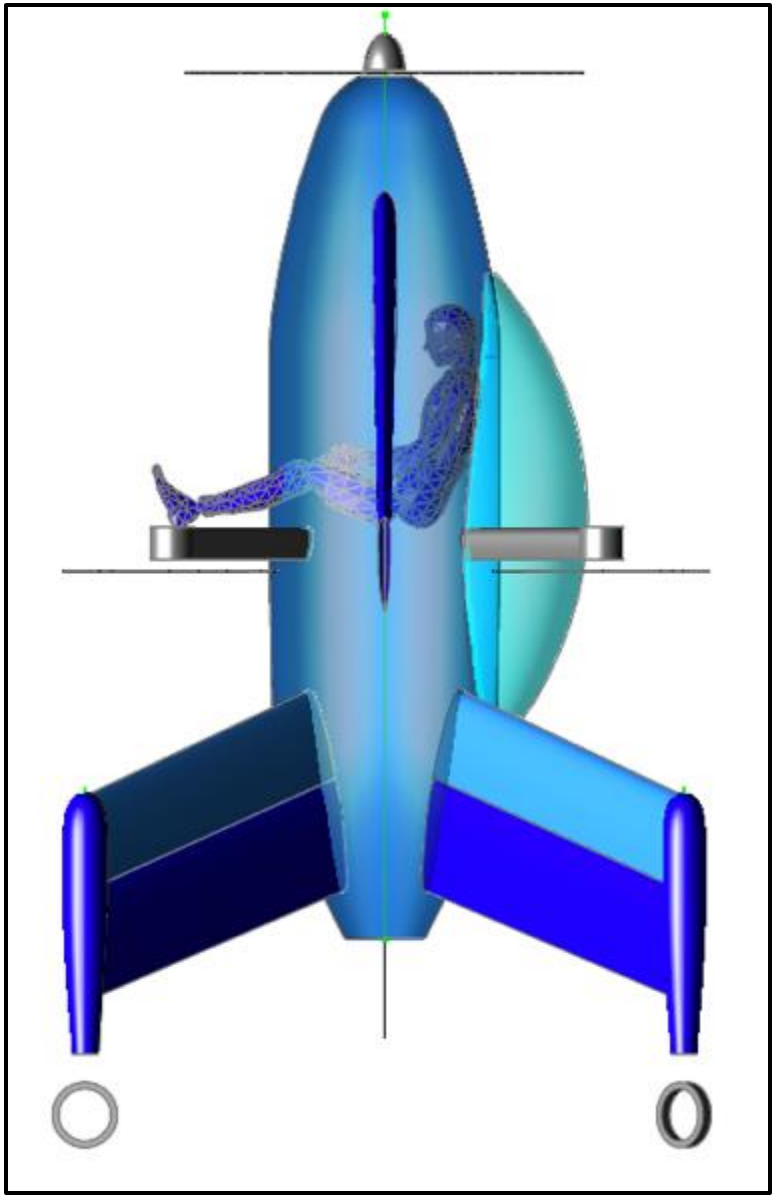


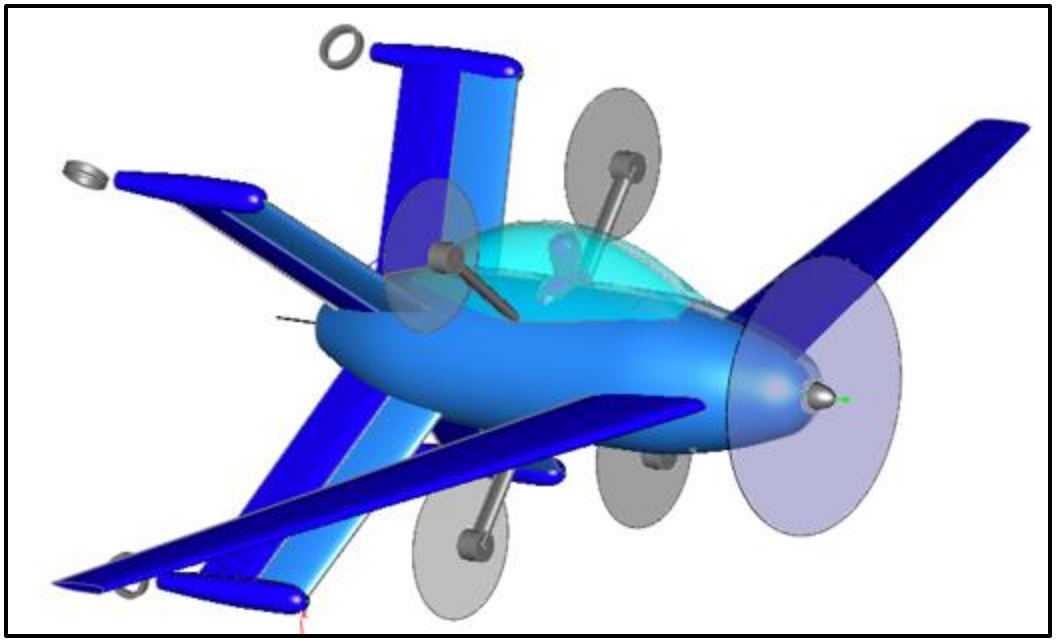
Single-place shown.
Configuration is scalable for more.

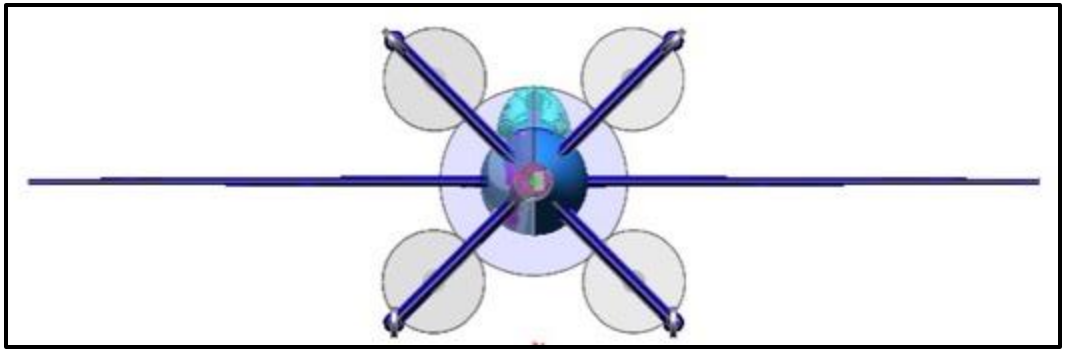


Recent Rutan Design, 1 of 4
Urban Transport Model 382-4

A Unique Solution to the issues of all those new designs coming “Soon”.







Advantages of M382-5 for Urban Transporter:

The forward engine is ICE gas, so it's easy to get a range of 500 miles at about 150 knots. Not shown in the attached graphics, but in cruise the electric props fold aft for minimum drag.

Most of the Urban transporters have huge batteries because the electric motors power the full flight. However, for 382-4 you only need to run the hover motors twice during each flight (~5 seconds for takeoff and ~15 seconds for landing). So, batteries are light and cooling the motors is easy because they are at high power for only about 5 or 10 seconds at a time.

Unlike all the other Urban designs you only need 4 electric hover motors, since all 5 props blow on the huge tails, It will not roll-over killing all on board when 1 or 2 electric motors fail.
It can even perform a non-injury horizontal belly landing when ALL the electric motors fail! Other Urban electrics kill everyone if above 30 ft altitude and all electrics fail.

There are no control surfaces on the wing - all four tail surfaces are active and mixed, to provide pitch, roll and yaw control. There has never been a light aircraft with this much challenge to design the control system.

Note that the pilot, his stick and his pedals rotate to stay upright as he transitions from cruise, to vertical hover for landing. He has the option to be upright for vertical takeoff, or he can rotate the seat, so he is on his back - like the Space Shuttle. Just gun all 5 motors and takeoff at more than 2-g just like a rocket !

Oh, only the pilot needs a rotating seat. The passengers will be level about 5 seconds after lift-off. You can get them a down-forward takeoff view with a Tesla camera and a flat monitor.
For takeoff or landing the pilot's feet and pedals will get wet if it is raining - part of the M382-4 experience. Feet outside has little effect on hover power requirements.

When hovering, the pedals roll the aircraft, not yaw it. Left/Right stick yaws the aircraft, not rolls it, so its hover controls are conventional, like a helicopter, and like an airplane in cruise. This can easily be done with mechanical push tubes and bell-cranks - a mixer keeps it conventional when the seat rotates.
For the simple, low-cost aircraft, a thumb trim-like switch can keep you upright - it's not necessary to use precision.

Of course, a big expensive one would use fly-by-wire to keep you upright and the control-sensing would be done by fly-by-wire. I did these control system designs about 25+ years ago when I did the hostage rescue military aircraft with Vought and a 4-place hovering light-plane. These graphics do not show the extra windows needed on the bottom and lower-side windows to get a helicopter - like view for the brief hover needed for takeoff and landing. When you do the space shuttle departure vertical rocket exit, you can roll the airplane for an un-obstructed view in all directions on the way upward !

Recent Rutan Design, 2 of 4

Should Burt do another Race Plane?

Rutan racing aircraft have not had success:

1- Pond Unlimited Reno Racer

Designed by Rutan, built by Scaled, then equipped and flight tested by others.

Crashed, due to cockpit fire, killing pilot just when it was first going to be competitive at Reno.

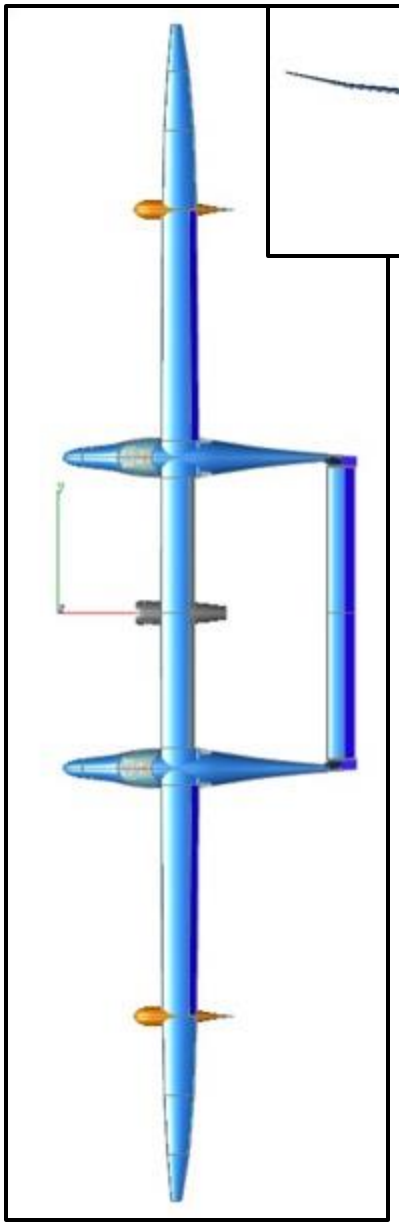
2- Amsoil Biplane Reno Racer

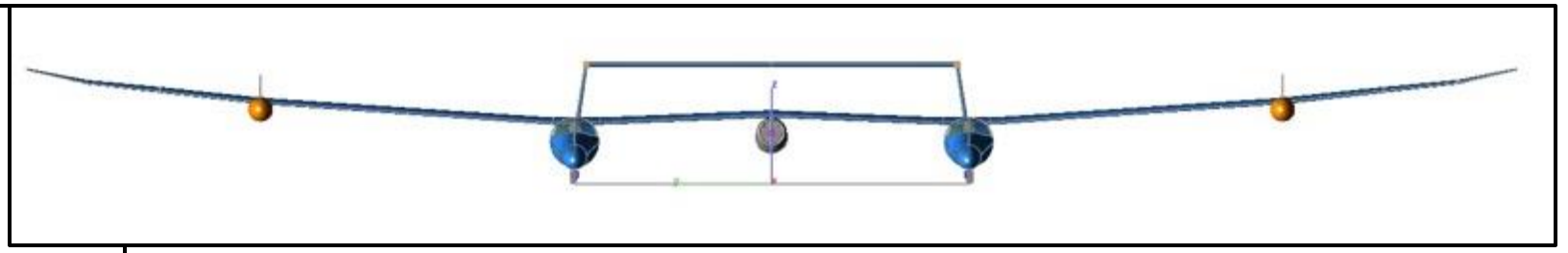
Designed by Rutan, built and flight tested by Dan Mortensen

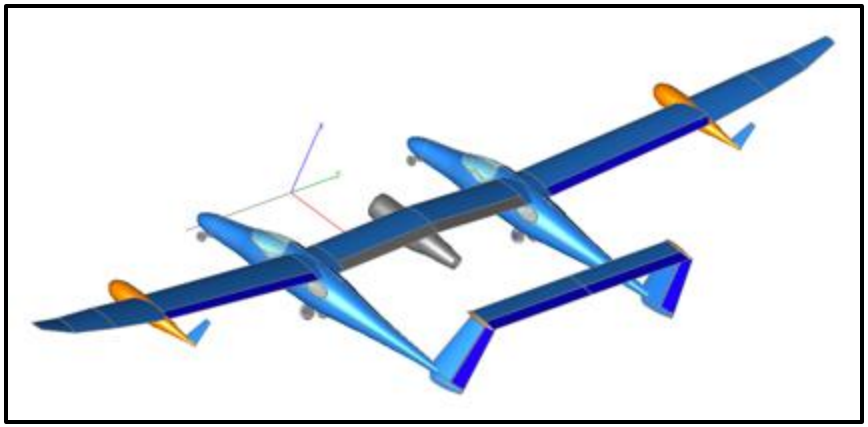
Crashed during a Reno race. Pilot error, hit wingtip on ground at full speed, but no injuries.

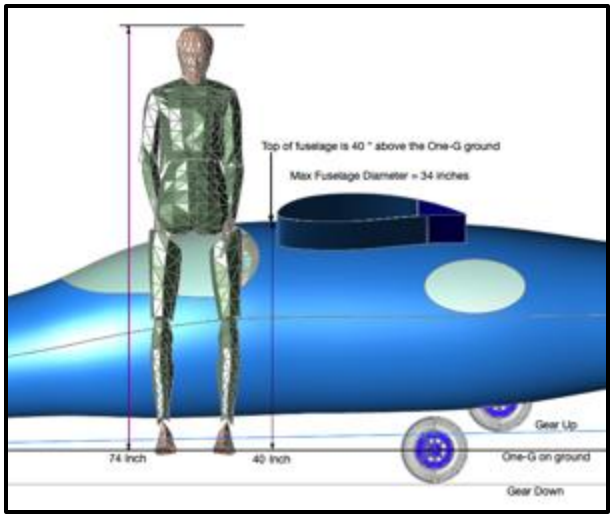
If I try another race aircraft, am I a "Racist"?

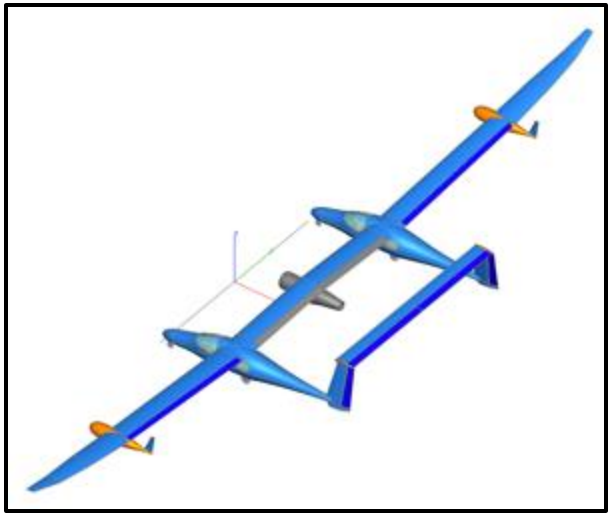
Recent Rutan Design, 2 of 4
Model 396-2

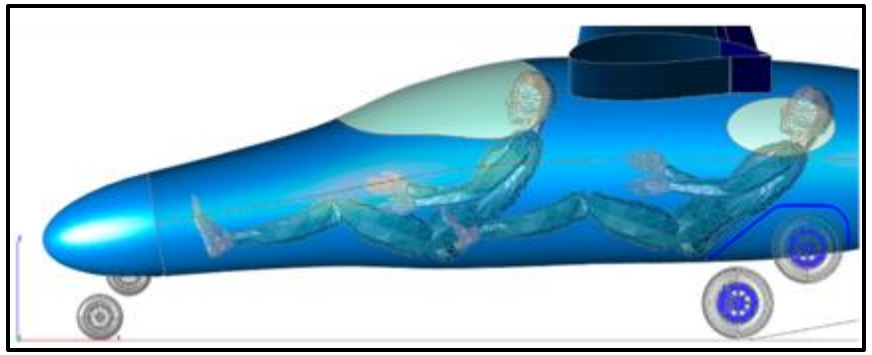












Recent Rutan Design, 2 of 4 pg 3 of 4
Mini-Voyager, RTW with **one refueling**.
Model 396-2 Racing Aircraft RTWOR.

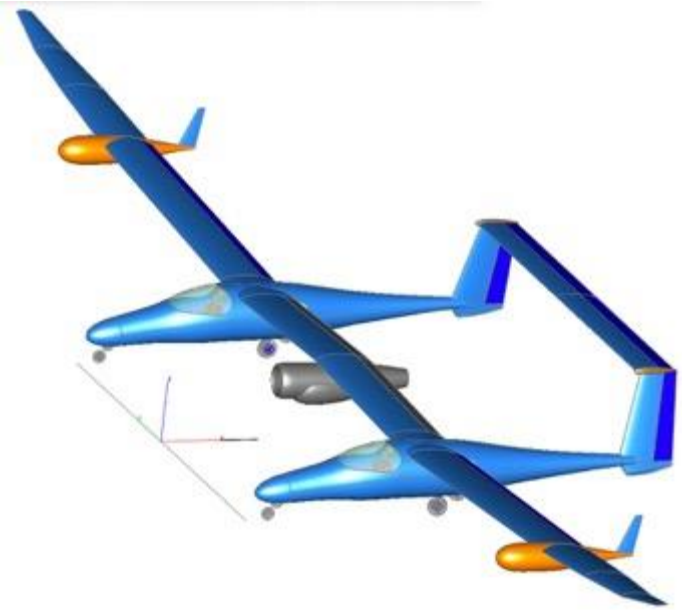
Racecourse = the world - 25,000 miles.
Race rules: Start and finish must be **at the same airport**. Refueling Pit-Stop can be any airport.

A new company FAA certifies the M396-2, manufactures 15 identical aircraft and maintains them. StarLink satellite system **transmits four inside & four outside cameras in real time.**

Unlike Voyager, **induced drag is tiny**, & its 8-g wing is stiff. Speed is not affected much by weight.

Race team = two IFR pilots + meteorologist. NewCO trains & pre-qualifies each race team. Team rents a M396-2 ~ 30,000$ & buys the fuel.

Other Revenue: Public pays 2$ per minute to observe each race aircraft (8 cameras). Millions of people can be in the "**virtual grandstands**" at any time during a race, without leaving home.



Pilot-in-Command during RTWOR mission

Off-Duty Pilot during RTWOR mission

Model 396, 2 of 4 Racing Aircraft RTWOR

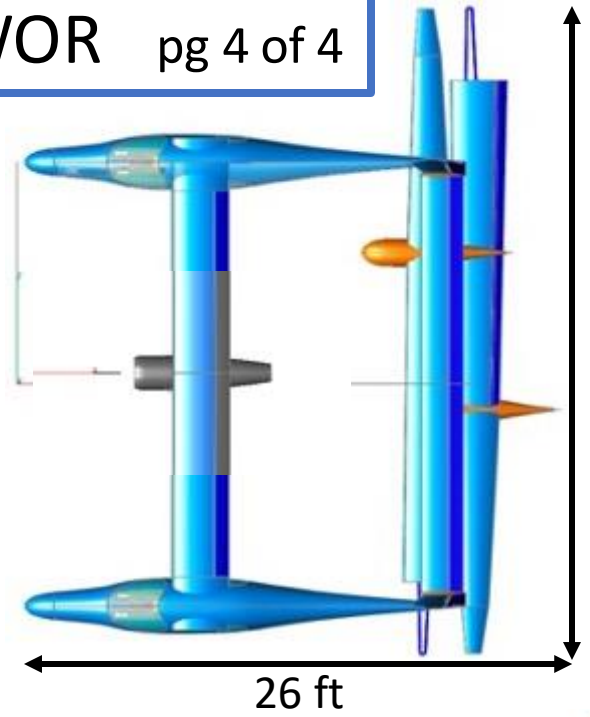
Race events can be with **multiple aircraft** (Oshkosh venue). Or with a **single race plane** to attempt a new RTWOR speed record (current trophy holder.)

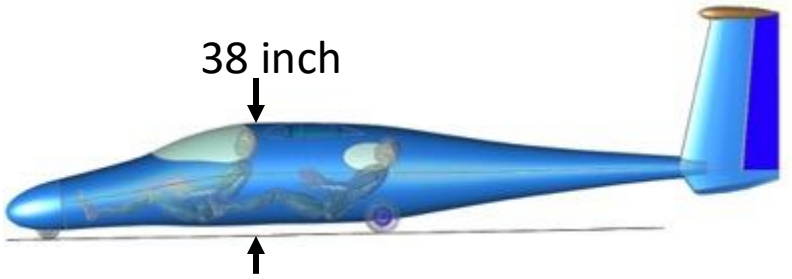
The FJ-33 turbofan is backed up by adding an off-the-shelf **cruise missile engine**, allowing engine-out flight from oceans to runways.

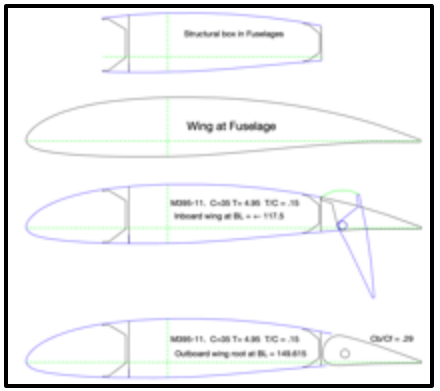
Since it is certified, it could be sold as as a "**Four-Place Personal Commuter**". It has some special capabilities: It can takeoff in 1,800 feet, then cruise up to 46,000 ft altitude and go non-stop to **ANY AIRPORT IN THE WORLD**, landing in 800 feet.

It's a **tiny airplane** with a **huge 85-ft wingspan**. Each removeable outer wing is the same size of an Open-Class, competition sailplane's wings.

With outer wings removed, the hangar requirement is just 26 x 30 ft. Except for the tails, its 38" height fits **under** most low-wing airplanes. Thus, it can fit in just about **every "Full" hangar**.







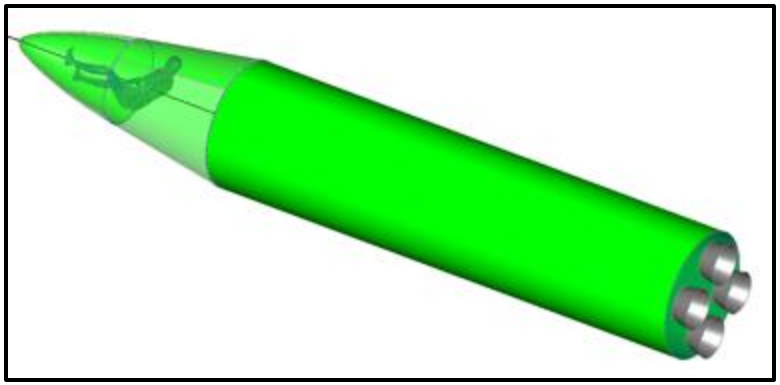
Recent Rutan Design, 3 of 4

Dynamic Launch, Min-$ Man to Orbit M404

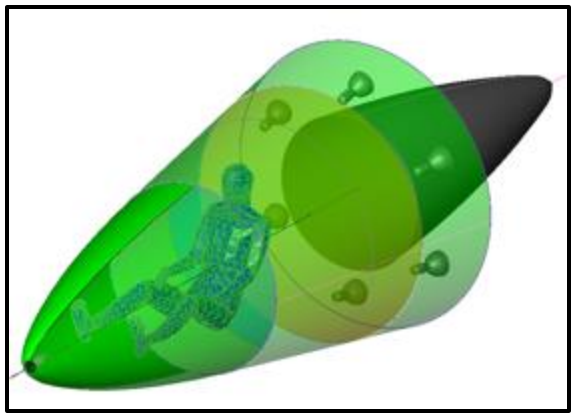
20 years since SS1 - is Burt still a "Rocket Scientist?"

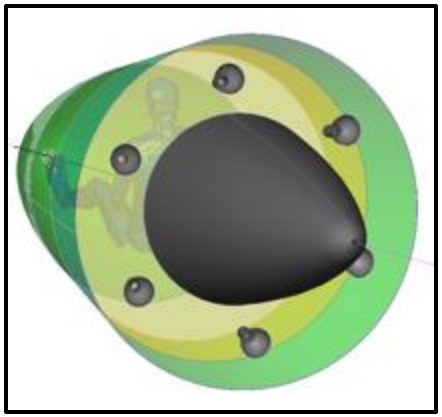
The first manned orbital system focused on **minimum cost**. All system elements are re-usable. What $ would you pay?

Spaceship and 2nd stage. Note: no orbital 2nd stage has ever been reused ("space is hard").



Spaceship with rockets for Orbital tweak, attitude control & de-orbit.





Here is the **First Stage** of the Dynamic Launch System.

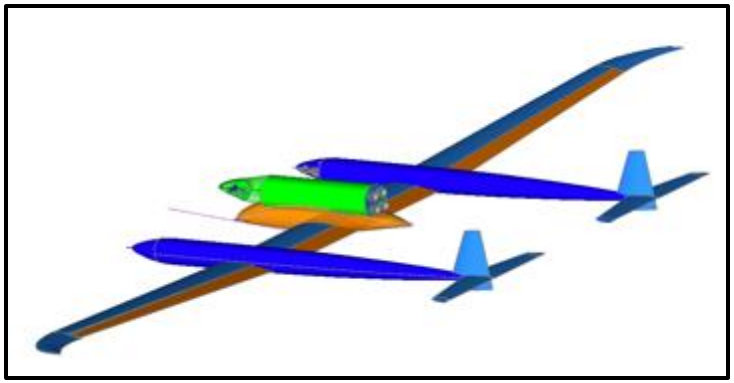
<---------- A Gulfstream IV.

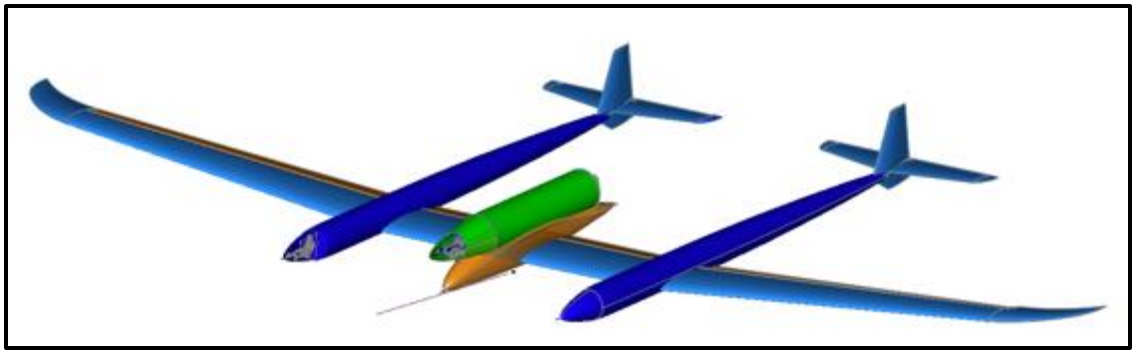
Recent Rutan Designs, 3 of 4

Dynamic Launch* M404

* Patented 10 years ago by Burt Rutan.

Add a glider with a high L/D, to accelerate the spaceship and 2nd stage rocket as it quickly gains altitude and reaches optimum flight-path angle to ignite the rocket.
The Gulfstream must be loaded to weigh ~ twice as much as the Glider/Rocket/Spaceship.
The power and energy for dynamic launch comes from **the kinetic energy of the Gulfstream**. The Gulfstream is slowed to below stall speed in only 8 seconds as the glider tries to do a loop on tow. This results in extreme tension in the tow rope and bending of the glider wing (see pg3).





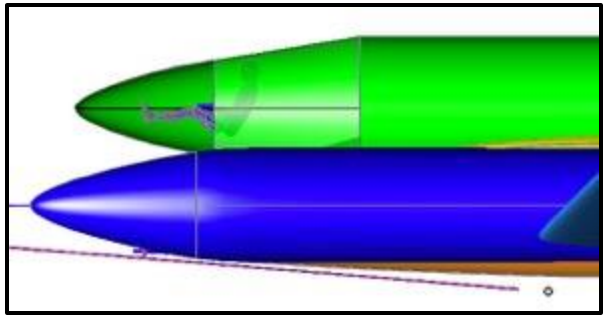
Recent Rutan Designs, 3 of 4

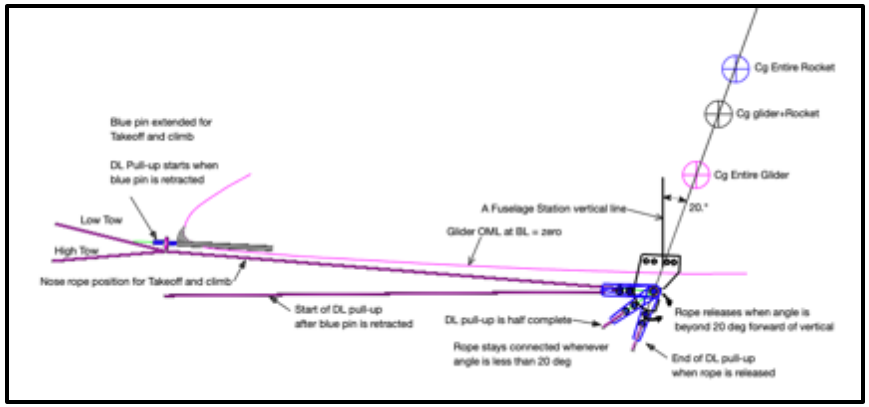
Dynamic Launch to orbit M404

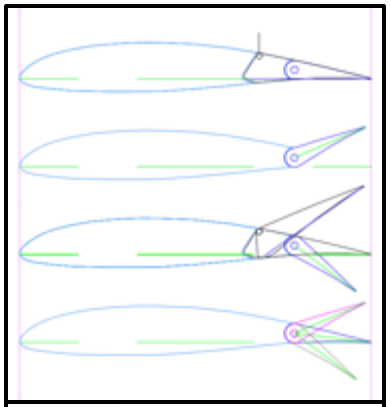
Tow rope releases at 8 seconds after pull-up starts. Tow angle = 20 deg forward to accelerate the spaceship & rocket.

Wing airfoils. Entire TE slams up when rocket is released.

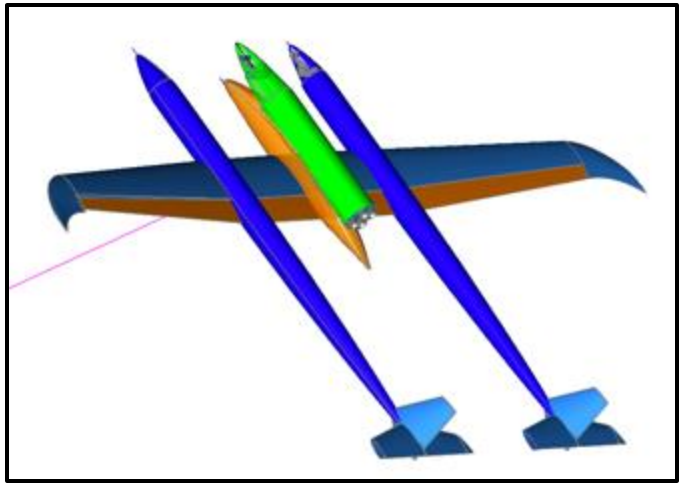
Tow rope for takeoff and climb to launch altitude

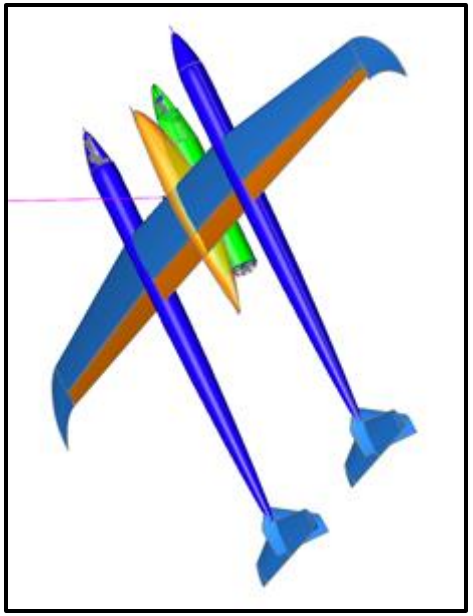


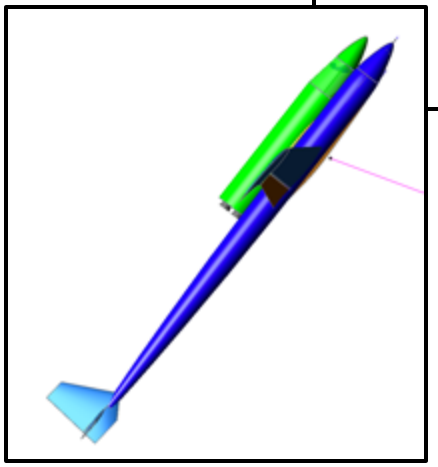


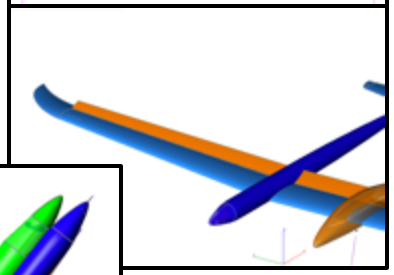


Three views at tow-rope release, well above Gulfstream.









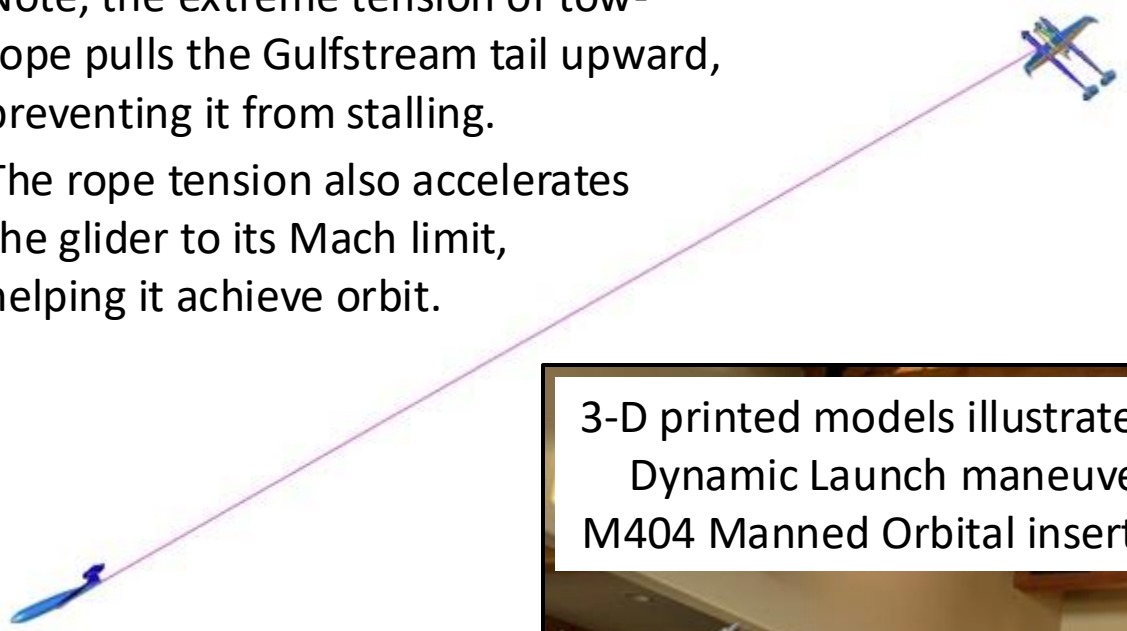
Recent Rutan Design, 3 of 4

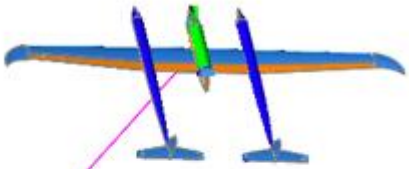
Dynamic Launch to orbit M404

Positions shown at tow-rope release

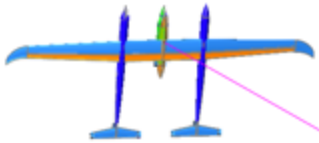
Note, the extreme tension of tow-rope pulls the Gulfstream tail upward, preventing it from stalling.

The rope tension also accelerates the glider to its Mach limit, helping it achieve orbit.





3-D printed models illustrate the Dynamic Launch maneuver. M404 Manned Orbital insertion.



Note, the extreme tension of tow-rope forces the glider to the correct AOA, regardless of its elevator position.

By Danno Kreigh and friends

All 3 elements: Tow plane, Towed Glider & Live Rocket

After Towline release, then rocket on its way

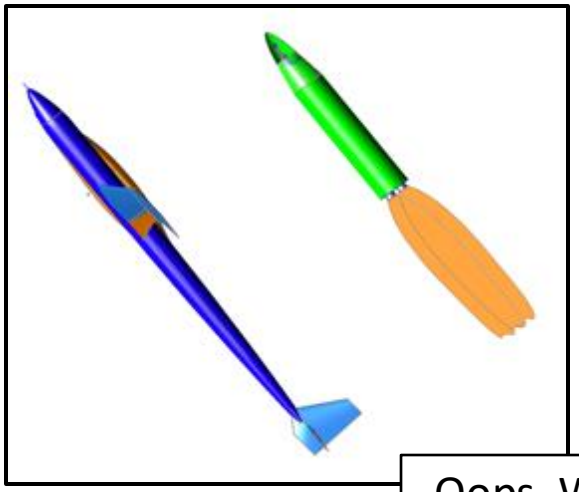
Glider under tow with Rocket on top

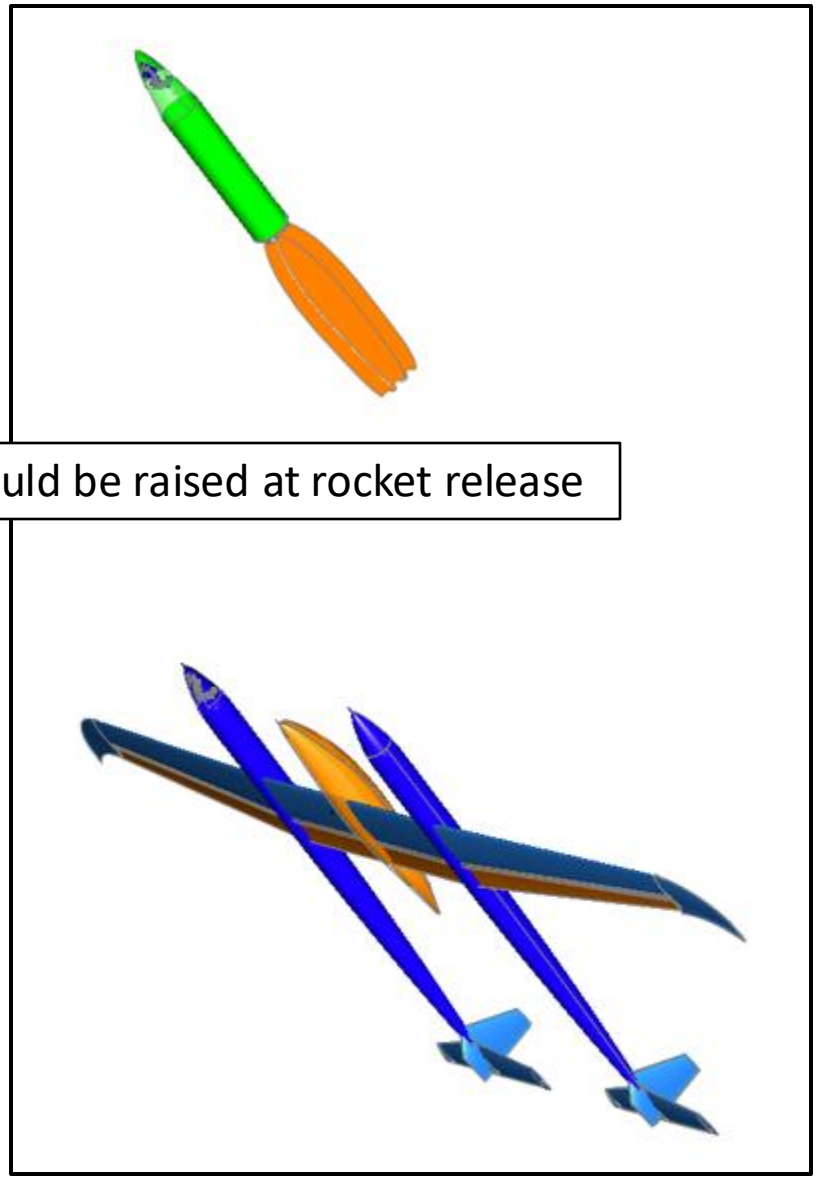
At rocket ignition
Camera is on glider wingtip

Recent Rutan Design, 3 of 4

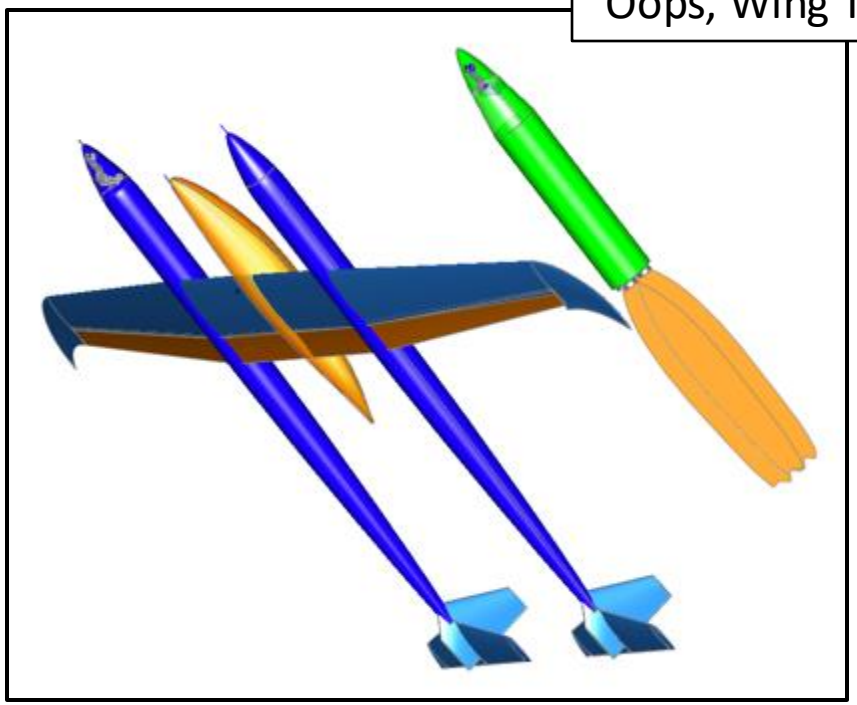
Dynamic Launch to orbit M404

After Rocket/Spaceship is released from glider





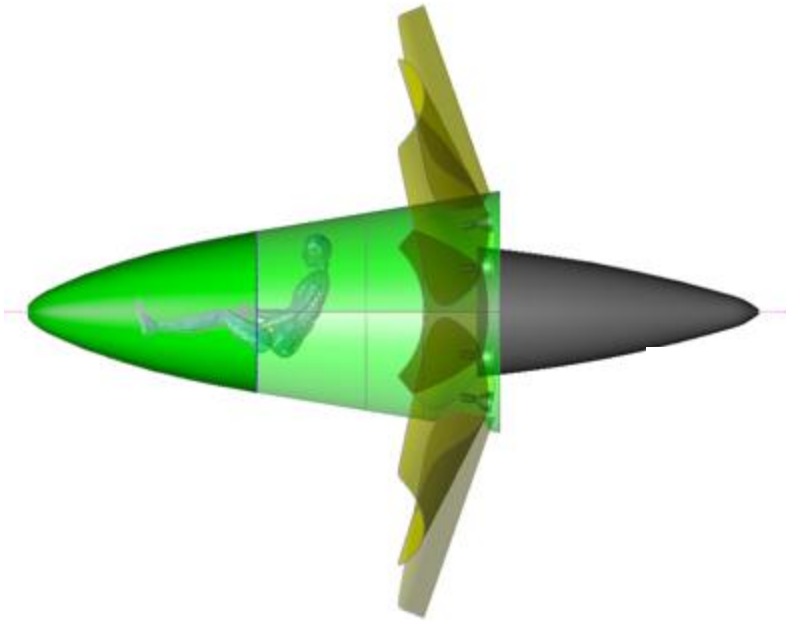
Oops, Wing TE should be raised at rocket release

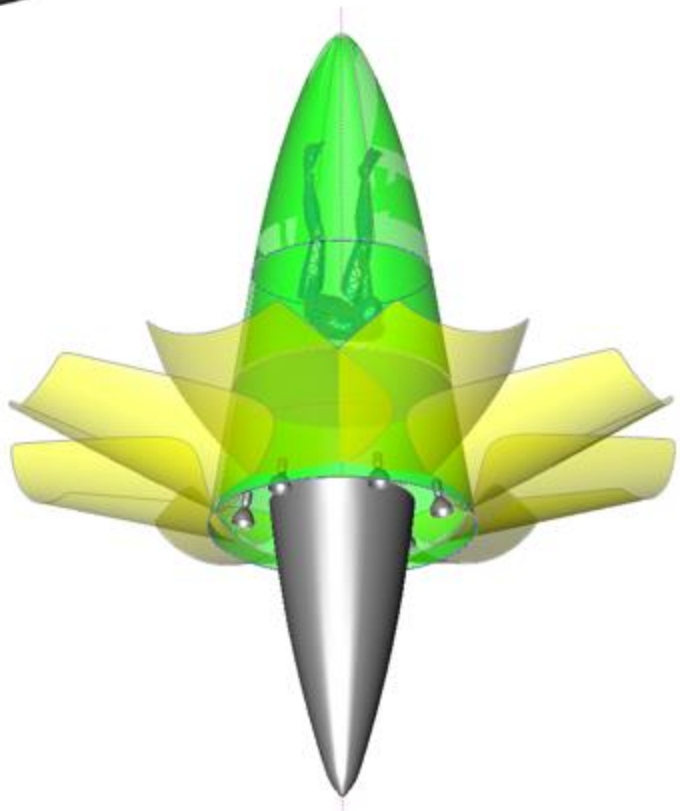


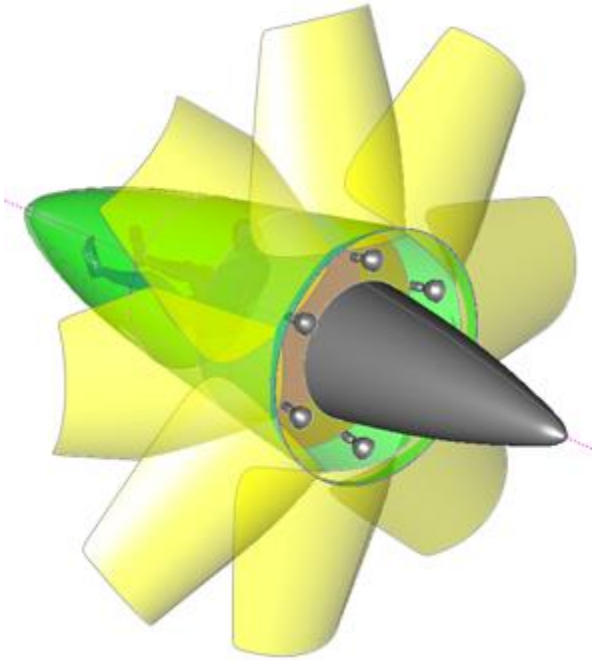
Recent Rutan Design, 3 of 4

De-Orbit M404 Spaceship

Atmospheric Entry







Manual feather deployment in space. Parachute recovery. Snagged while airborne by helicopter. Crushable cone and stroking seat assures land or water survival in the event of parachute failure.

Feathers shown are only notional. Asymmetric for 3-axis steering and no overlap.

Recent Rutan Design, 4 of 4

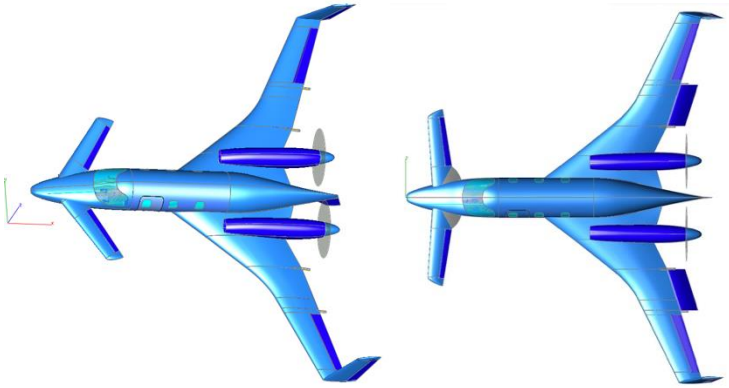
Homebuilt Starship pg 1 of 2

It would be cool to see a flock of Starships at Oshkosh, not just one.

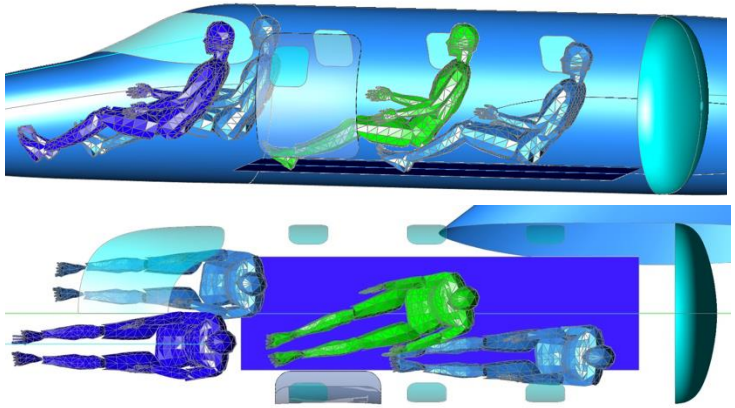
Since Beechcraft REFUSES to cooperate, we can do it ourselves!

A 4-place homebuilt
Size 68% of Full-Scale Starship
Engine options:
Recip, Turbo Recip, Turboprop & Turbojet

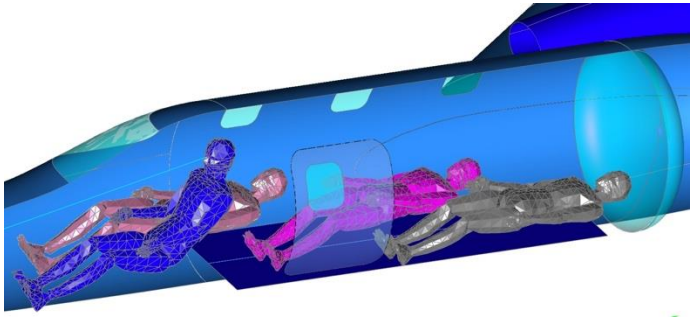
Recent Rutan Design, 4 of 4
Homebuilt Starship pg 2 of 2



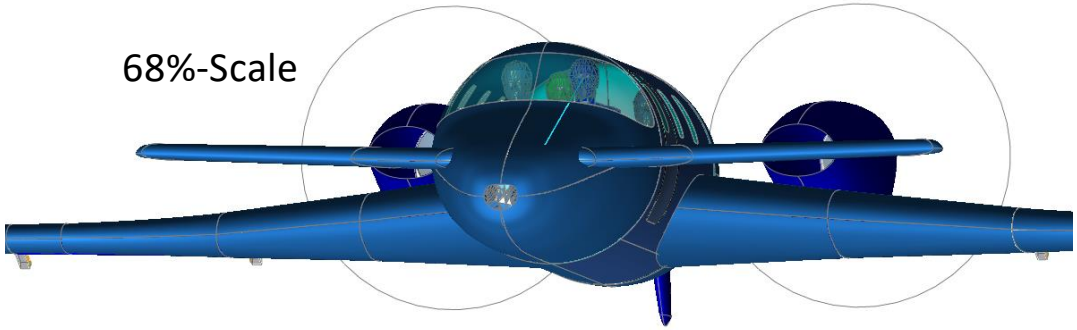
Seating for cruise



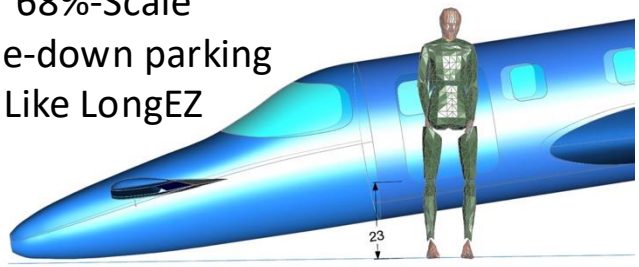
Three can fully recline to sleep



68%-Scale



68%-Scale
Nose-down parking
Like LongEZ



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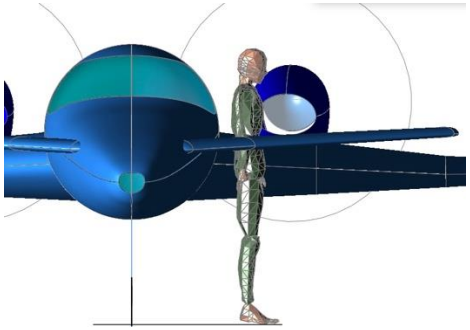
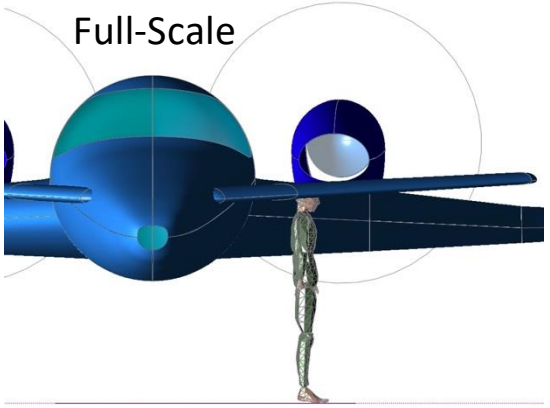


Full-Scale



Let's look at who are Burt Rutan's Heroes of Aircraft & Spacecraft Design

Burt's list - Aircraft/Spacecraft Designer Heroes
Alphabetical Order

1. Rostislav Alexeyev
2. Werner von Braun
3. Glenn Curtiss
4. Max Faget
5. Ed Heinemann
6. Kelly Johnson
7. Artem Mikoyan
8. Elon Musk
9. Jack Northrop
10. Edgar Schmued
11. Pavel Sukhoi
12. John Thorp
13. Andrey Tupolev
14. Richard VanGrunsven

Rostislav Alexeyev 1916 - 1980

Lun Wing Ship Ekranoplan 1987

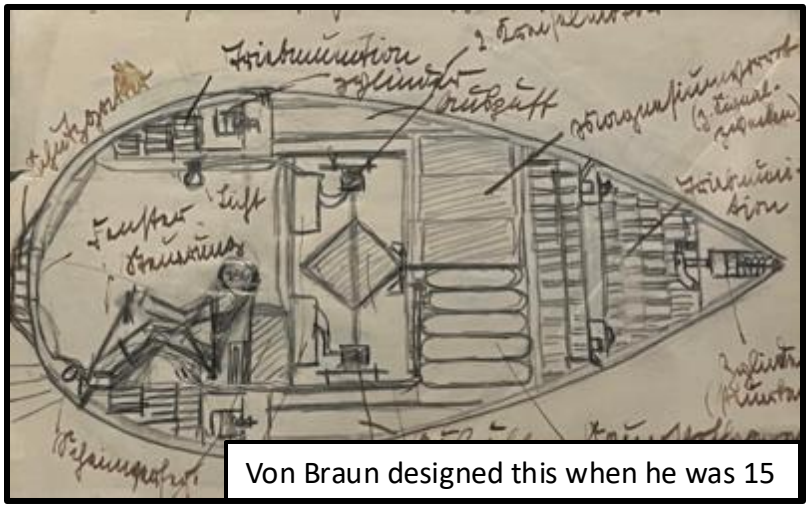
KM **Caspian Sea Monster** 500T 1966
A plan for nuclear-powered 1,000T

On its first flight in 1966, the KM was co-piloted by Alexeyev, which was unusual as Russian aircraft designers never operated their own creations.

Orlyonok 1972

Lun 1998

Werner von Braun 1912 - 1977

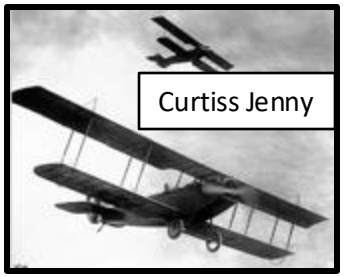

Von Braun designed this when he was 15

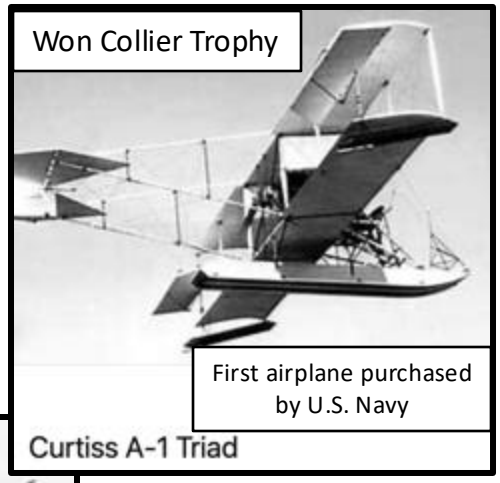

With Walt Disney 1955


Dr. Wernher von Braun in front a Saturn IB Launch Vehicle at Kennedy Space Center in 1968.

Note: Sergei Korolev initially made my list because I had thought he was Russia's von Braun. However, Korolev was not a Scientist, not a Designer: he was a brilliant Manager.

Glenn Curtiss 1878 - 1930





In 1904, Curtiss became a supplier of engines. The first dirigible in America was powered by his Curtiss V-twin motorcycle engine.

In 1907, Alexander Graham Bell invited Curtiss to develop a suitable engine for heavier-than-air flight experimentation. Bell regarded Curtiss as "the greatest motor expert in the country" and invited Curtiss to join his Aerial Experiment Association (AEA).

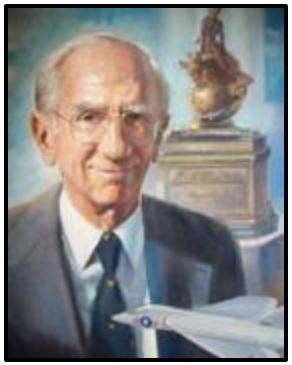
Max Faget 1921 - 2004

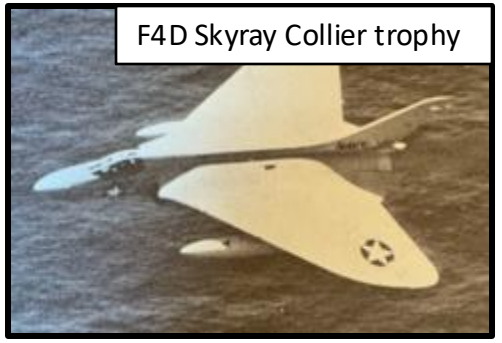
"He was a true icon of the space program. There is no one in space flight history in this or any other country who has had a larger impact on man's quest in space exploration." -- Dr. Christopher C. Kraft, flight director on Project Mercury.

Faget was selected as one of the original 35 engineers as a nucleus of the Space Task Group to carry out the Mercury project. Faget led the initial design and analysis teams that studied the feasibility of a flight to the Moon. As a result of his work and other NASA research, President John F. Kennedy was able to commit the U.S. to a lunar landing by the end of the 1960s.

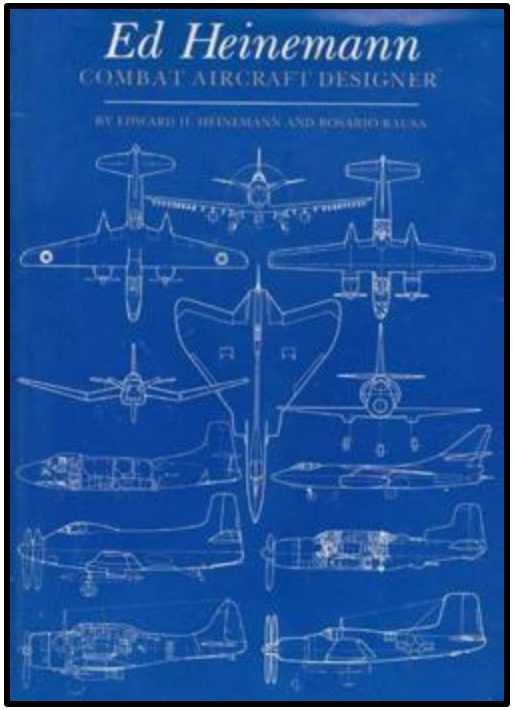
Ed Heinemann 1908 -1991

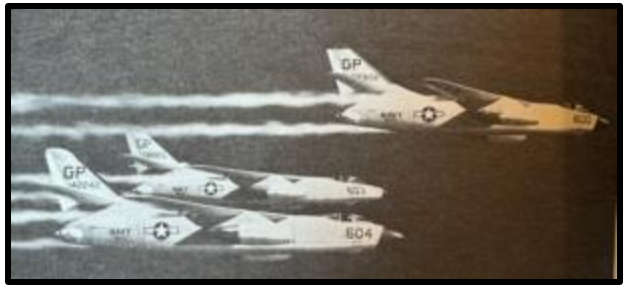
Douglas Military aircraft Designer





F4D Skyray Collier trophy

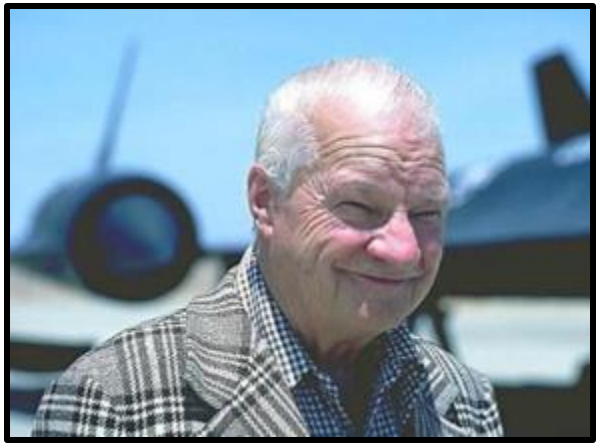




Kelly Johnson 1910 - 1990

Johnson shepherded some **forty military and civilian aircraft** into production. Countless medals and honors followed, including Collier Trophies, the Medal of Freedom, National Medal of Science and National Security Medal.

But it was Kelly's boss, who summed up his abilities best - "That damn Swede can actually **see air**."



Artem Mikoyan 1905 - 1970

Mikoyan Design Bureau - Designator MiG

From 1952, Mikoyan also designed missile systems to particularly suit his aircraft, such as the famous MiG-21. He continued to produce high performance fighters through the 1950s and 1960s.

He was twice awarded the highest civilian honor, the Hero of Socialist Labor.

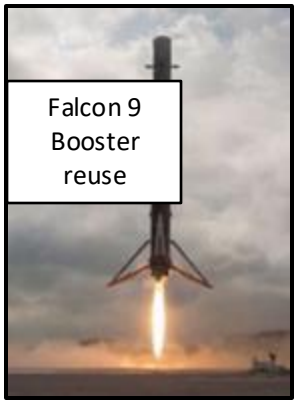
Many more designs came from his design bureau - the MiG-23, MiG-29 and MiG-35.

Elon Musk born 1971

The Ultimate Multi-Task Human?
While not formally educated as an engineer, Musk is a brilliant, self-taught designer of Aerospace rocket systems.
His unique development methods have achieved breakthroughs previously thought to be impossible. Musk initially 'proved' 5-times that it **is impossible to reuse Orbital Boosters** !


Falcon 1


Falcon 9


Falcon 9 Booster reuse


Falcon Heavy dual booster reuse

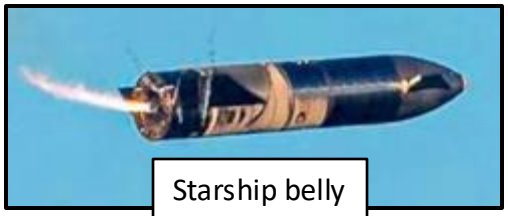

Starship & Super Heavy launch stack


Falcon Heavy


Super Heavy booster


Dragon Manned Spaceship

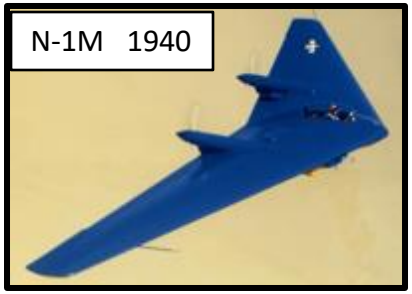

Dragon Commercial Crew


Starship belly flop recovery


Elon Musk at Mojave in 2004 (before Tesla & SpaceX)
At that time Burt had more employees than Elon

Jack Northrop 1895 - 1981

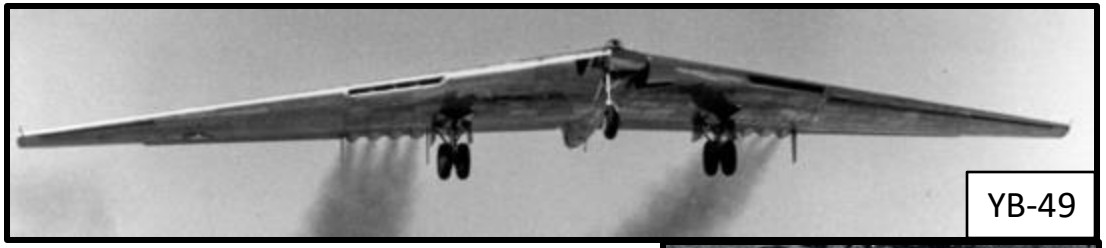

Lockheed Vega


N-1M 1940


Northrop Alpha


YB-35


XP-56 Black Bullet


YB-49

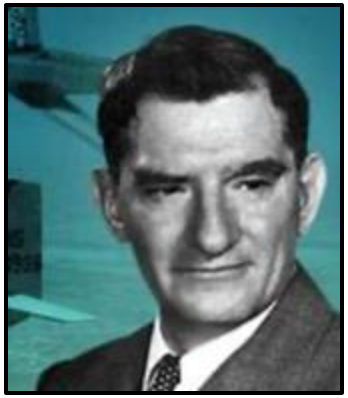

P-61 Black Widow


F-89 Scorpion

I had lunch with Jack Northrop at EAFB in 1976. Five years before he died.

Edgar Schmued 1899 - 1985


P-51 Mustang



F-86 Sabre Jet

F-100 Super Sabre

T-38 Talon

Pavel Sukhoi 1895 - 1975


SU-57 5th Gen 'Stealth'


SU-27

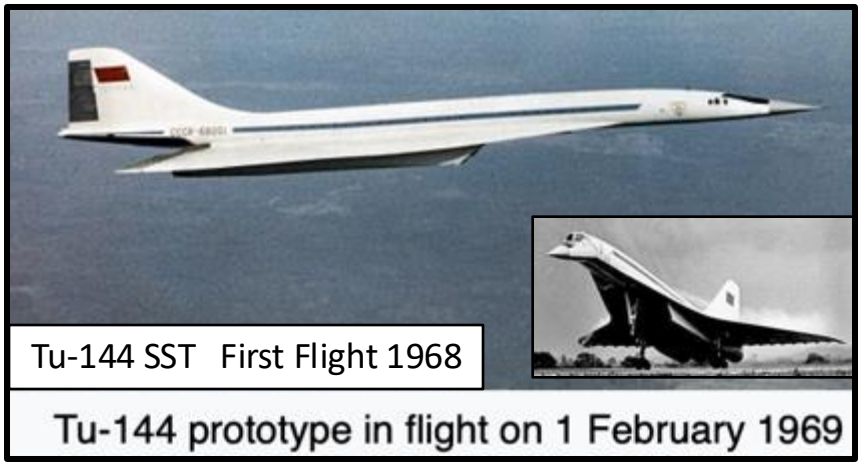
Sukhoi SSJ 100

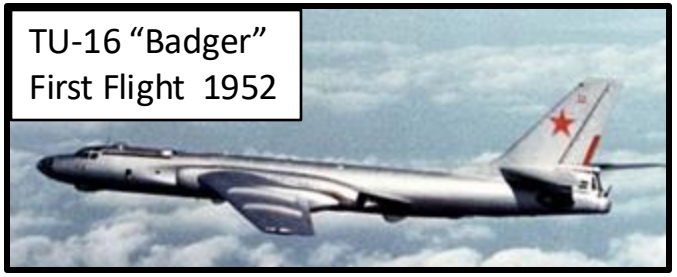

SU-80 STOL commuter

John Thorp

1912 - 1992

Andrei Tupolev 1888 - 1972





Tupolev designed or oversaw the design of more than 100 types of civilian and military aircraft in the Soviet Union over 50 years

Richard VanGrunsven born 1939

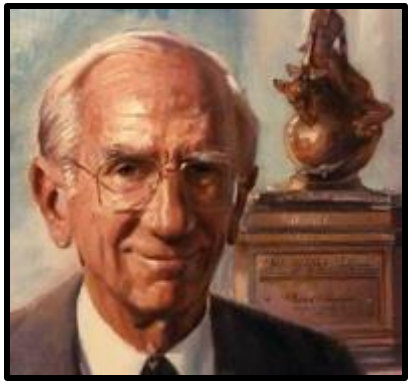
Flying magazine in 2013 ranked VanGrunsven 22 on its list of the "51 Heroes of Aviation" and has labelled him the "**undisputed leader in kit aircraft manufacturing**".
His company has sold over 18,000 kits or sets of plans, with over 7,500 aircraft completed.

The **Van's RV-6** and **RV-6A** are two-seat,

e **Van's Aircraft RV-10** is a four-seat,

The **Van's RV-12** is an American two-seat,

Burt's Top 5 Aircraft/Spacecraft Designer Heroes



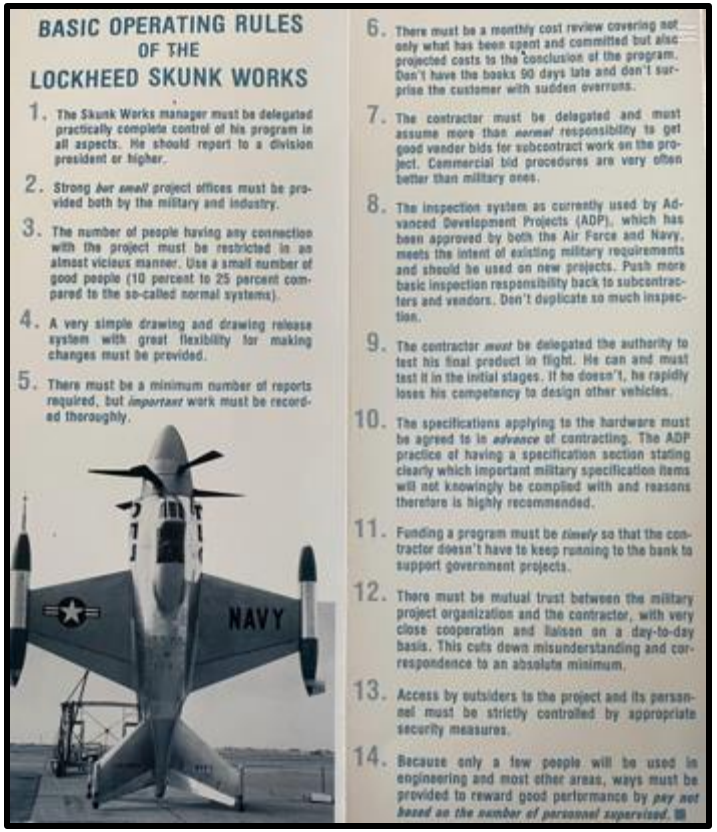
1. Kelly Johnson
2. Glenn Curtiss
3. Ed Heinemann
4. Elon Musk
5. Werner von Braun

What !!!

Let's look at the Rationale

Burt's Top 5 - Aircraft/Spacecraft Designer Heroes 1 of 5

1. Kelly Johnson
2. Glenn Curtiss
3. Ed Heinemann
4. Elon Musk
5. Werner von Braun



BASIC OPERATING RULES
OF THE
LOCKHEED SKUNK WORKS

1. The Skunk Works manager must be delegated practically complete control of his program in all aspects. He should report to a division president or higher.
2. Strong *but small* project offices must be provided both by the military and industry.
3. The number of people having any connection with the project must be restricted in an almost vicious manner. Use a small number of good people (10 percent to 25 percent compared to the so-called normal systems).
4. A very simple drawing and drawing release system with great flexibility for making changes must be provided.
5. There must be a minimum number of reports required, but *important* work must be recorded thoroughly.
6. There must be a monthly cost review covering not only what has been spent and committed but also projected costs to the conclusion of the program. Don't have the books 90 days late and don't surprise the customer with sudden overruns.
7. The contractor must be delegated and must assume more than *normal* responsibility to get good vendor bids for subcontract work on the project. Commercial bid procedures are very often better than military ones.
8. The inspection system as currently used by Advanced Development Projects (ADP), which has been approved by both the Air Force and Navy, meets the intent of existing military requirements and should be used on new projects. Push more basic inspection responsibility back to subcontractors and vendors. Don't duplicate so much inspection.
9. The contractor *must* be delegated the authority to test his final product in flight. He can and must test it in the initial stages. If he doesn't, he rapidly loses his competency to design other vehicles.
10. The specifications applying to the hardware must be agreed to in *advance* of contracting. The ADP practice of having a specification section stating clearly which important military specification items will not knowingly be complied with and reasons therefore is highly recommended.
11. Funding a program must be *timely* so that the contractor doesn't have to keep running to the bank to support government projects.
12. There must be mutual trust between the military project organization and the contractor, with very close cooperation and liaison on a day-to-day basis. This cuts down misunderstanding and correspondence to an absolute minimum.
13. Access by outsiders to the project and its personnel must be strictly controlled by appropriate security measures.
14. Because only a few people will be used in engineering and most other areas, ways must be provided to reward good performance by *pay not based on the number of personnel supervised.*

The Rationale

A good engineer values **results** over prestige. Kelly's designs **helped America win the cold war**. He ran the Skunk Works by doing what is right & saying **NO** when appropriate to the various inept Government customers. Ben Rich worked hard to keep the culture and the 14 rules but fell short. He did not have Kelly's courage/ability to say **NO**. After Ben Rich retired, Lockheed's former competitor managed the Skunk works, getting the results one would expect. **DUH**

All of Kelly's 40 research programs were done **at or below the contracted cost**. Most were completed on **unbelievably short schedules**. Many were to meet important National Security goals.

Burt briefly met Kelly just once ~1975 or 1976.

Burt's Top 5 - Aircraft/Spacecraft Designer Heroes 2 of 5

1. Kelly Johnson
2. Glenn Curtiss
3. Ed Heinemann
4. Elon Musk
5. Werner von Braun

The Rationale

Most think the Wright brothers led the early development of powered, manned, controlled flight. However, **their feats were few when compared to Glenn Curtiss**. He ran a small shop and was continuously trying new ideas for important customers. He also designed & built the best aircraft engines.
Only three people have earned two Collier Trophies for individual achievement – Glenn Curtiss, Kelly Johnson & some guy from Mojave.

In 1911, Curtiss made the first flight demonstration by taking off and alighting on both land and water. The A-1, which was primarily a seaplane, was equipped with retractable wheels, also making it the **first amphibious aircraft.**

Curtiss trained the Navy's first pilots and built their first aircraft. He is considered in the US to be **"The Father of Naval Aviation"**.

Curtiss did not relax after developing aircraft. He and his family moved to Florida in the 1920s, where they **founded 18 corporations**, served on civic commissions, and donated extensive land and water rights. He developed the cities of Hialeah, Opa-Locka and Miami Springs.

Burt's Top 5 - Aircraft/Spacecraft Designer Heroes 3 of 5

1. Kelly Johnson
2. Glenn Curtiss
3. Ed Heinemann
4. Elon Musk
5. Werner von Braun

During his career at Douglas, Heinemann designed more than **20 combat aircraft, primarily for the U.S. Navy**, including many that became legends. His designs included the following aircraft:

SBD Dauntless dive bomber
A-20 Havoc light bomber/attack
A-26 Invader light bomber/attack
A-1 Skyraider attack aircraft
A-3 Skywarrior bomber
A-4 Skyhawk light bomber
F3D Skyknight night fighter
F4D Skyray carrier-based fighter.
Douglas Skystreak and Douglas Skyrocket research aircraft

The Rationale

At the age of 21, his first aircraft design was the 1929 Moreland M-1 Trainer - a braced-wing parasol-wing monoplane.

Ed was the **Chief Designer for all the military aircraft produced by the Douglas Aircraft Company from 1936 to 1962.**

Then he joined General Dynamics as Corporate Vice President of Engineering. In that position he oversaw the development of the F-16. He retired in 1973.

In 1988, when Burt showed drawings of his ARES attack aircraft to Ed, he pounded his fist on Burt's drawing table and said "Damn - I tried for years to get Douglass engineers to do that"… (Fade-Out sketch vellum 10/inch).

Burt's Top 5 - Aircraft/Spacecraft Designer Heroes 4 of 5

The Rationale

When I first met Musk, during his early development of the Falcon 1 (and its rocket engine) I was impressed by his description of the day's challenge – fixing cavitation in the engine's turbopump. I was surprised to later learn that he had no engineering degrees.

When he showed me his small shop, I was also surprised that he was doing **all aspects of rocket development in-house** – structure, engine, navigation, telemetry, etc. It was clear in 2002 that he was **focused on solutions to solve the biggest problem of orbital rocket systems - the huge costs.**

That year he visited Scaled to learn how we were able to quickly do manned space with a tiny team. I had no idea he would later find a solution to what others had assumed was impossible (reuse of 1st stage). Now, SpaceX launches >85% of the world's payloads to orbit!

1. Kelly Johnson
2. Glenn Curtiss
3. Ed Heinemann
4. Elon Musk
5. Werner von Braun

His fans enjoy his self-criticism and humor in his many talks and interviews. But in 2009 he did not have a good reputation for public speaking. So, after he was nominated for the Collier Trophy for developing Falcon 1 (the first non-Government orbital launcher) he asked me to give the in-person plea to the Collier judges in Washington DC. In BRAB chapter 55 I will show what its like to be alone with him in a tiny room for 10 hours.

Is there anyone else who has a goal of having a backup to human survival on earth? His **goals are wild**, but he relentlessly **works to achieve them**.

Burt's Top 5 - Aircraft/Spacecraft Designer Heroes 5 of 5

The Rationale

At this point you might be wondering **how** von Braun, whose Apollo program's technical goal was the most historic single milestone in human history, could be ranked below the four above.

This ranking is not about history – its about listing Burt's heroes in Aerospace **design**. True, von Braun was clearly the best in defining the prestige of the goal and making it understandable.

Werner was indeed a good designer (he began sketching his rocket design concepts as a teen), but his greatest skills were engineering management and communication, rather than design.

1. Kelly Johnson
2. Glenn Curtiss
3. Ed Heinemann
4. Elon Musk
5. Werner von Braun

I met von Braun just after graduating from college in 1965, at a small social for those receiving design awards at a major AIAA meeting in San Francisco. It was easy to identify him as I entered the room – he seemed to be a giant, surrounded by a dozen engineers who were capturing every word he said.

But he was also listening carefully to everything the engineers said – a very special talent.

Questions?