# Eugen Sanger – Gliding into Space

With NASA's decision to retire the Shuttle system after 30 years of service in 2011 and the fledgling commercial suborbital flight offerings using re-usable, two stage, horizontal takeoff, horizontal landing (HTHL) vehicles as well as the recent unmanned AF X-35B success it seems appropriate to shed some light on the pioneering engineer having thought about the HTHL-approach for the first time and contributed many basic ideas: The latest offspring being Virgin Galctic's White Knight/Spaceship-2 development, now at the brink of opening affordable suborbital flights for "everybody".

## The Man: Eugen Saenger

Eugen Saenger (courtesy DLR)

The German-Austrian Eugen Saenger, born in Pressnitz, Bohemia (22. Sept. 1905) was one of the most important German and European space pioneers. He contributed basic ideas to the development of modern rocket propulsion and ram jet technology and published his very futuristic ideas for space transportation systems already as early as 1931.
After finishing his studies at the technical universities at Graz and Vienna Saenger completed his PhD in 1929 with a dissertation about conventional airplane techniques after his initial thesis on rocket flight engineering was rejected as too fanciful. Soon after having completed his PhD he dedicated himself to his real vocation, the optimization of rocket propulsion, ram jet technology, fuels and nozzle shapes. The results, proven by many experimental test runs were published by Saenger in his book "Raketen Flugtechnik" (Rocket Flight Engineering) in 1933, which soon became the standard reference for rocket scientists.

During this time (around 1931) Saenger also developed his first ideas of an intercontinental Mach-10 rocket plane ("space-glider") using gasoline/LOX propulsion based on an earlier patent filed by R. Lorin (France) in 1908 proposing to use the air pressure at the entrance of a fast moving tube for propelling airplanes.
The publishing of those novel ideas found no resonance in Austria, but fell on open ears in Germany. Therefore Saenger joined the German Laboratory for Aviation (DVL) at Berlin Adlershof in 1936, moved via the German Research Institute for Aviation (DFL) at Braunschweig to Trauen (Lunenburg Heath) where he established an institute for technical rocket research, where he met his later wife, Irene Bredt being also employed at the institute. His expertise comprised the design of propulsion systems using high pressure combustion chambers up to 100 bar and 100 kN thrust as well as fuel pumps with 150 bar feed pressure. He investigated an aluminium-gas-oil-dispersion to be used as fuel as well as a liquid-oxigen/ozon mixture as oxidiser. He also researched unusual materials to be used for long life rocket combustion chambers which could withstand extreme temperatures and high pressures.

His tenure at Trauen was terminated abruptly by German air force officials but soon (1942) was relocated to Ainring (Bavaria) and appointed as head of the propulsion system section of the German Research Institute for Gliders (DFS).

From 1942 until the end of the war Saenger investigated propulsion techniques and flight mechanical problems of ram/scram jet engines under the umbrella of a basic research program for the German air force (Luftwaffe) at Ainring.

It is reported that he conducted 33 "ram-jet" test flights between Sept 1943 and Aug. 1944, using steel tubes mounted on a Do 217 E-2 as "carrier" achieving Mach numbers between 0.30 and 0.37 operating between 1km and 7km hight using regular airplane fuel with electrical ignition plugs for the ram jet tube aggregate.

It is speculated that he also continued with the design and improvement of the "Antipodal bomber" because in 1944 his famous proposal for the "Silverbird" (see also below) with the title: "Rocket Propulsion for long-distance Bombers" was distributed under top secret cover to air force officials.

All activities at Ainring were terminated by the end of the war in 1945.

After the war, between 1946 and 1954 Saenger was employed as an engineer in France working for various government research institutes but moved back to Germany.
In 1951 while still working for the France government Saenger was appointed as the first president of the International Astronautical Federation (IAF).
In 1954 he followed a call to Germany to be responsible as founding and leading director for the Research Institute for Jet Propulsion at Stuttgart. At Lampoldshausen, a small city close by he established an area dedicated to propulsion tests. This test area is still used today by the German Aerospace Center for (DLR) for the testing of new propulsion systems for the European Ariane rocket family.
In 1963 he became professor at the Technical University at Berlin where he was active until his early death on 10. Feb. 1964.
During his last years he was participating in the design studies for the first European launcher (Europarakete), he was strongly supporting an European cooperation in all spaceflight activities and was engaged in the founding of the European Research Organization (ESRO) a predecessor organization of the European Space Agency (ESA)

Besides his practical oriented work Saenger also studied, like Einstein the basics of relativistic spaceflight mechanics expected to happen when a spacecraft would travel with the speed of light.

Astonishingly it is not reported that the two leading rocket experts of their time Saenger and Wernher von Braun ever met. One reason might be that the two followed

different approaches for solving the problem to reach orbit: Wernher von Braun wanted to reach orbit fast and directly using liquid-fueled energy efficient A4/V2 rockets with as little cost as possible while Saenger took the aircraft approach, using a winged vehicle with rocket propulsion to carry pilots and/or payloads into orbit and bring them back again.

Von Braun's A4/V2 rockets ascended through the atmosphere as quickly as possible to operate in vacuum while Saenger's idea was to use the atmosphere for "flying", in particular during launch and landing phases enabling the re-use the vehicles, like it was practiced with the Shuttle for over 30 years. (*)

**The Idea: "Silverbird"**

Wind tunnel model of the "Silbervogel" (Wikipedia)

As mentioned above E. Saenger developed the first ideas for an intercontinental airplane (space-glider) flying at a speed of Mach-10 in the upper atmosphere using a gasoline-LOX rocket motor in 1931. He published his ideas in 1935/36 in the Austrian journal "Flug" (Flight) with no resonance in Austria but found interest in Germany. So he moved to Berlin in 1936, then via Braunschweig to Trauen where he became the director of the rocket test facilities. His work at Trauen was terminated abruptly by the chief of staff of the German air force in 1941 (reason unknown).

But Saenger (was) moved by the same forces in 1942 to Ainring/Bavaria to become the head of the propulsion section of the German Research Institute for Gliders (DFS). Although not officially funded it is speculated that there he expanded his earlier idea of a "space glider" into a long distance rocket bomber ("Silverbird") which should have the capability to "skip" along the atmosphere to cover vast distances.

The appropriate report was titled "Rocket Propulsion for long distance Bombers" and was distributed in 1944 to a selected circle of persons within the German air force (Luftwaffe) obviously in an attempt to come up with another secret weapon to turn the odds against loosing the war.

Designed to fly at a suborbital altitude of 145 km the Silverbird would be launched on a 3 km long horizontal rail using an separable rocket booster (speculations suggest a bundle of available 30 EMW-A-4 rocket engines) to be lifted to the border of the atmosphere with its own 100 ton propulsion aggregate to cruise at a speed of 22.100 km/hr. Remaining drag forces would lower its altitude until a "lifting body" effect of the denser atmosphere would cause it to "skip" to higher altitudes to use this effect again and again, like a "skipped" stone on a quiet lake. Later analyses revealed an underestimation of the "re-entry" heat loads, however would have been solvable if the plane had been built. In reality it never got out of wind tunnel testing because of the end of the war in 1945.

Some of Saenger's basic ideas about a re-usable HTHL space transporter were implemented by the US space shuttle system – in particular using aerodynamic breaking techniques for re-entering the atmosphere. Another of Saenger's inventions became standard on every rocket: using the liquid fuel as means to cool the nozzle by circulating it around the nozzle and pre-heat it at the same time before burning in the combustion chamber (Saenger-Bredt design).

In the early 1960's Saenger's HTHL ideas were studied again and further developed in stages, starting with the original one stage approach the scope was expanded into a two stage system with a sophisticated ramjet/rocket propulsion system (combination-propulsion).

ERNO, Junkers and MBB each conducted their own study. The Junkers study was supported by E. Saenger and named "Saenger-I", (Junkers was later taken over by MBB).

Saenger-II
Junkers Saenger-I (Junkers study results)

The activities were discontinued in 1967 because of the too early death of Saenger in 1964 with only 59 years old.

**The Project: „Saenger-II"**

During the years 1988 – 1993 the German Research Ministry (BMFT) initiated a Phase-1 study for horizontal launching, re-usable space systems called in honour of Eugen Saenger "Saenger-II". This was a joint effort of BMFT, Industry (MBB) and Universities as well as research institutes (DLR). The study was called "Space Transportation System Saenger". After the cancellation of the European Hermes space-shuttle the German BMFT wanted to provide alternatives for future hypersonic transport systems to carry "man and material into space".

The basic system requirements for "Saenger-II" were: robust design and high reliability achieved by automatic failure identification systems, at least 500 flights for the carrier system and 120 flights of the second stage "glider". Horizontal take off and landing at conventional airports and minimum turn-around and maintenance times as well as minimization of air pollution.

Saenger-II as proposed by MBB was designed as a two stage launcher consisting of a carrier airplane with liquid hydrogen rocket propulsion and an orbiter, using its own liquid hydrogen propulsion to reach orbit. The carrier aeroplane takes off from a conventional runway and accelerates to Mach 6-7, then separates the orbiter at approx. 30 km hight which accelerates to orbital velocity with its rocket propulsion delivering its cargo. The carrier flies back to its landing port, the orbiter after re-entering the atmosphere "gliding" back to the landing base as well.
The orbiter comes in two versions: a passenger version (Horus) carrying up to 36 passengers to an orbiting LEO destination (ISS or "space hotel") and a cargo version

(Cargus) carrying a payload up to 10 tonnes into LEO.

The technical data were impressive: Carrier wingspan of 44m with a carrier length of 82m, Orbiter wingspan of 18m with a total length of 33m. The total lift-off mass would be 405 tonnes. The Saenger carrier would use liquid hydrogen rocket propulsion advanced turbo-ramjets to provide the orbiter separation speed of Mach 6-7 of course posing some technical challenges with respect to air-breathing and heat loads at those speeds.

Horus

Saenger-II

Saenger-II carrier Aeroplane with mounted cargo version

(CARGUS)

HORUS 38-seat passenger version (right)

(MBB study results)

Interestingly enough MBB also suggested a supersonic airliner based on the Saenger-II carrier aeroplane for a cruising speed of Mach 4. Unfortunately the Saenger-II study was cancelled in 1995 because of enormous cost projections of around 80 billion DM (40 billion Euros or 52 billion US$).

Nevertheless the idea is living on and the future will show whether the concept was far ahead of its time or a dead-end development.

**(*) All biographical data of Eugen Saenger are derived with friendly permission from the quarterly magazin "Raumfahrt-Wirschaft" Astro-Verlag, published by Wolfgang Engelhardt, Cologne, Germany".**

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