A Discussion with Hanno Fischer

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ABSTRACT

Hanno Fischer presented a 20 minutes movie showing the main part of the development of the ideas of Ing. Alexander Lippisch on reversed delta wings in ground effect from the X-112 to the X-114, and their successors developed by Fischer Flugmechanik and AFD - Airfoil Development GmbH.

Most of these movies will soon be available on the WIG Page, in the movies section.

To illustrate these movies are presented here two pictures of each craft with a text extracted from the WIG Page, courtesy of Edwin van Opstal.

ABOUT THE AUTHOR

Ing.Hanno Fischer was the Technical Director to Rhein- Flugzeugbau GmbH (RFB)in Germany. He has developed around 12 different aircraft like Fantrainer, Fanliner, RW 3 and the military used WIGs X113, X114 and X114 H (X114 with hydrofoils) .They were designed as aircraft to fulfil the military requirement with free flight capability. The concepts were based on the works of Dr. Lippisch.

After retiring from RFB he founded the company Fischer-Flugmechanik (FF) together with his partner Klaus Matjasic. Their target is to develop the ground effect technology towards commercial application.

Based on their patents, they successfully designed the first generation of WIGs for civil use- the Airfisch 1, to Airfish 3, for which they granted a production licence to RFB.

In order to achieve a higher economical efficiency, they have developed the Hoverwing technology, which can be considered to be a basis for the second generation of WIGs. Their works are government sponsored from the German Ministry of R&D.

Last design is the Airfisch 8 called now Flightship 8, a 8 seater which has made the maiden flight in February 2001 and is delivered to Australia after successful flight demonstration.
Author of many articles and papers in the field of ground effects, for instance in Australia 1996.

X112

This revolutionary ground effect craft was designed by Dr. Alexander Lippisch in 1963. It is a single seat experimental vehicle that successfully demonstrated the possibilities of stable ground effect flight. After completion of a number of towing tests behind a speedboat a 19 kW engine was installed in the nose of the X-112. Later the patents were bought by RFB where the development of this configuration was continued.

The X-112 has been in the possession of the Experimental Aircraft Association (EAA) AirVenture Museum in Oshkosh, Wisconsin since the early 1970's, although it was off-display and in storage for a number of years. It was in quite good condition when it was last seen in 1998 although it is probably not flyable anymore.

Figure 1 : Note the characteristic negative dehidral along the leading edge

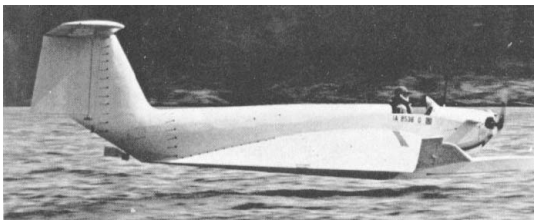

Figure 2 : One the nose of the craft can be seen a small flap that was used as a Power Augmentation, directing the flow under the wing during take-off

X113

The first German built Lippisch ground effect craft was a 1 : 1.7 scaled down version of a projected four seater, a single seat trimaran built of composite materials in a sandwich construction. The reversed delta wing has an aspect ratio of 1.7. The X-113 showed excellent stability with respect to pitch and altitude keeping. The X-113 is powered by a 28 kW propeller engine mounted on top of the fuselage. The first flight took place in 1970.

The X-113 was developed for the German navy as a type C WIG craft and it proved excellent stability in as well as out of ground effect. In ground effect a maximum L/D of 23 was achieved, but without ground effect the low aspect ratio wing only resulted in an L/D of 7.

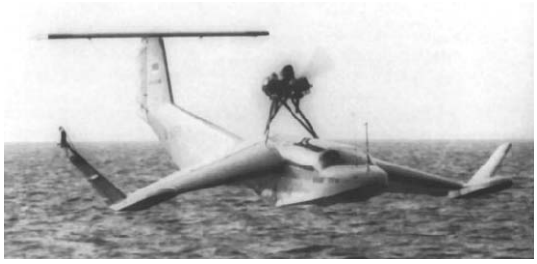

Figure 3 : The X-113 was a trimaran

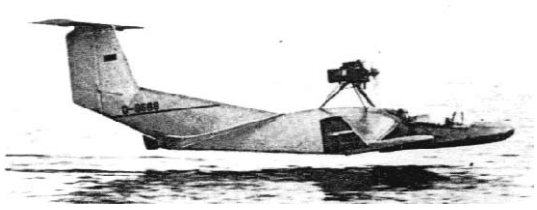

Figure 4 : The X-113 is now at the Flightship Museum in Cairns, Australia

X114

Further development of the X-113 lead to the 6-7 seat X-114, also a Lippisch configuration, but this time a catamaran (the fuselage is not a float). The X-114 is capable of out-of-ground-effect flight, but this is very inefficient. The X-114 is powered by a 150 kW Lycoming IO-360 4 cylinder aircraft engine, driving a ducted propeller. It first flew in 1977.

A later version, the X-114H, incorporated retractable hydrofoils. These were used to decrease the take-off length and they also increased the maximum weight to 1750 kg. Unfortunately the X-114 crashed due to failure of one of the hydrofoils caused by a pilots error.

Figure 5 : The catamaran nature of the X-114 is clearly visible on this picture

Figure 6 : The X-114 was capable of free flight, as required by the German military authorities

Airfish 3

The pre-production version of the Airfisch was the Airfisch 3. It successfully underwent flight tests from 1990 onwards in Germany, The Netherlands and the USA. Like the earlier Airfisches it was also built by Rhein Flugzeugbau GmbH (RFB) under licence of Fischer - Flugmechanik (FF).

The Airfisch 3 is a two seat recreational WIG vehicle. It is capable of operating in ground effect only, but dynamic jumps of up to 4.5 m height are possible. Normal operation height in ground effect is 1 metre. Power is provided by a two cylinder BMW 60 kW boxer engine driving a geared six bladed ducted propeller. In order to enhance harbour manoeuvring electrically controlled folding winglets and a retractable water screw are installed. For road transport the Airfisch can be be loaded on a trailer that can be towed by a motor car.

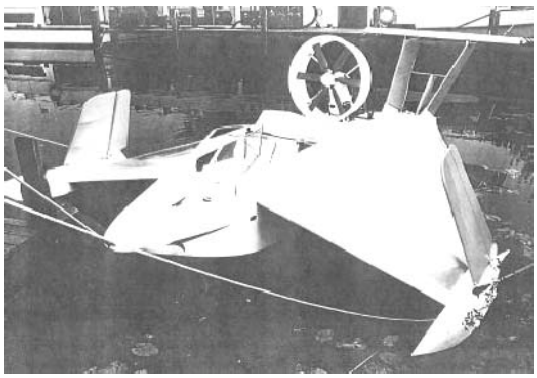

Figure 7 : Notice the foldable "winglets" used for turns, for a better navigation in habours

Figure 8 : The AF-3 was later equipped with Power Augmentation for experiments. Her two front propellers can be seen on this picture

Hoverwing 2

The experience with the Airfisch family craft led to the conclusion that the power requirement at take-off would be an obstacle for commercial use of bigger vehicles. Therefore FF started to work on the Hoverwing technology for reduction of the take-off drag after dismissing other options like power augmentation and hydrofoils.

The HW-2VT is a scaled down version of the projected 80 seater HW-80 and is the first (experimental) craft that successfully demonstrated the use of a static air cushion under the hull.

This air cushion is similar to a SES (Surface Effect Ship) and lifts the craft out of the water for about 80 %, so the remaining 20 % is to be carried by hydrodynamic forces.

The HW-2VT had its first flight on May 7, 1997. It is powered by a 80 kW Hirth F30 engine driving a propeller and a 1 kW auxiliary water drive for harbour manoeuvring. The maximum speed is 130 km/h and the normal flying height is lower than 75 centimetres, in dynamic jumps a height of 5 metres can be reached.

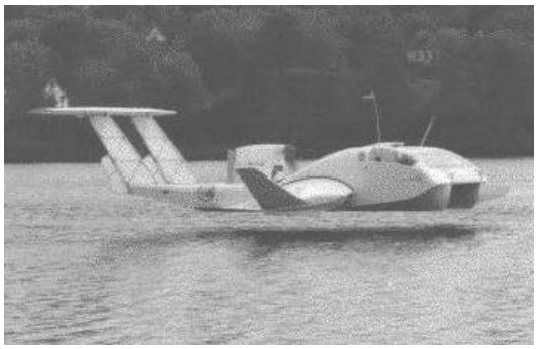

Figure 9 : 40 % of the lift is generated by the airfoil-shaped body of the craft

Figure 10 : The Hoverwing 2 is a small prototype that embarks only two persons

FS-8

The FS-8 was developed in Germany at AFD Airfoil-Development GmbH (AFD) in accordance with a cooperation Agreement with Flightship. Initially the FS-8 was assigned the Airfisch 8. The number 8 denotes the maximum number of passengers (including 2 crew). The first flight of the FS-8 took place in February 2001 in the Netherlands. The wave height at take off must not exceed 0.5 metres, but in cruise flight the FS-8 can negotiate 2 metre waves. The FS-8 will be of FRP construction and powered by a 337 kW 6.2 litre Chevrolet V8 engine. It will cost approximately US $ 800.000 in standard layout. Flightship received the right to produce FS 8 under licence from AFD.

The Flightship FS-8 will be registered and operated like a boat. At full power the maximum flare height is 3 metres.

Figure 11 : The FS-8 is a scaled up AF-3.

Figure 12 : The FS-8 was too small to be of the Hoverwing type, due to its limited seat capacity

DISCUSSION

Laurent Boireau (LB), ENST Bretagne

How did you get the idea of the reversed delta wing ?

Hanno Fischer (HF), Fischer Flugmechanik

The whole Lippisch design is principally scaled up from the X-113 and the X-114, and then the Airfishes 1, 2 and 3. So this this is all scaling and optimization in small steps. Our next step in the 20-seater. In principle, especially when you have such an unknown situation, to make many small steps instead of one step that would be to big and could end up in a disaster, killing our ground effect concept.

LB

But how do you work to develop your models ? What kind of tools are you using ?

HF

In my next presentation I will show you more precisely. We trial with a lot of testing to make sure that everything is OK. In principle, we make the calculations first, then the verifications : aerodynamic tests, wind tunnel tests, tow tank tests, model testing in round circles and so, step by step we verify that the theory is right. So we install a lot of testing equipment in the models

Jean Gaël Duboc (JGD), Euroavia Toulouse

I will be very pragmatic. Could you tell us how long it takes to build a prototype once the studies are finished ?

HF

We received the order from a group in Australia and Singapore to build to 8-seater with very strong specifications. It told payload, volume, range, noise, etc. and after that we started the design, then the model testing and the whole process lasted three years from the receiving of the order to

the delivery of the craft. The production time lasted about 50% of that time and the design and testing the other 50%. So we are now really able to offer a customer the guaranty that we deliver the ordered performance, when it is reasonable. It was the same with the Hoverwing. We received specifications by the government and I'll show you that every point of a big book had to be fulfilled.

JGD

And from the customer point of view ? What will be the price ?

HF

Good question ! The price is always a question about how many crafts you build. There is what is called the learning curve, and for an aircraft for instance, as I am also an aircraft designer and producer, when you build 100 crafts, the first crafts cost roughly 12 times the price of the production cost. So you collect with the prototype a lot of money. The amount of money to develop the FS-8 from zero to delivery is of the area of 2.5 millions of Euros.

The production cost is about 750 000 US Dollars and it is the third of the price of an aircraft with the same number of seats. Indeed, the price per seat for a WIG is roughly one third of what it is on an aircraft...so you see that the economy is much better. Again, if one remains under $1000km$ distances !

Jean Margail (JM), Airbus

You said that you received an order from Singapore and Australia. Are you agressive, commercially speaking, or just waiting for customers ?

HF

Of course we are looking for customers ! We have gained *know how* and my definition of *know how* is nothing else than perhaps to have the chance to make a lot of mistakes and not to repeat them ! So we made a lot of mistakes to learn, to understand what Pr. Rozhdestvensky explained in equations and convert it into the real world. Now we try to bring it to production.

The next step is the 20-seater but I have to explain that the Airfishes are from the first generation, without any take-off aid. The Hoverwing technology is from the second generation, and has the advantage that you reduce considerably the installed power to overcome the hump speed. This is the main key, and we have seen this with our Russians colleagues, this hump drag determines how many horse power or kW you must install. I think the answer was yesterday that the L/D was about 2 or 3 and this is the price that you have to install. It costs money, weight, and it costs payload at the end. So the answer for commercial use is to reduce this installed power to a minimum.

Jean Margail (JM), Airbus

My last question : who or what are your competitors ?

HF

Mainly aircrafts. The requirements came from a question about islands. Every day, they have airliners arriving with 300 to 350 tourists and they have to move these people to the 50 islands around from $20km$ to $300km$. So imagine that with a boat, to cover $300km$ takes as long as the flight from Europe. Then they started with helicopters. But helicopters cost a lot of money, they are mainly Russian helicopters, so the spare parts are not available and the people claim it is very noisy. Now they are mainly using Cessna Caravan on floats but they already had 2 accidents and it costs a lot of money. On long terms, this is the competition : sea planes or float planes. So we

will replace, we hope, these crafts for 30% of the price. Our crafts are simpler than aircrafts, we are always over the runway so the price is lower.

Mario Mihalina (MM), Euroavia Zagreb

Can you tell me what you think will be the worst possible accident that could happen with this kind of craft ? We saw it yesterday with the models[1]. It is a problem because when a boat is sinking, people have the time to wear their life jackets. Here it would be much faster.

HF

I understand the question and this is the same with the authorities and especially the German authorities. The main point is to have an absolute natural stability. It means that the craft must be inherently stable and shall not rely on the electronics or any device that can be critical. Also we must prove that we can land in $2.5m$ waves. We must fill all the conditions fixed by the IMO and so we can say we are sure that the craft is stable etc. This is why we make so many testings.

I fear that the biggest accident will probably be a collision with another craft. You know, the boats are much slower and they are almost standing still. The faster crafts always have to give way to the slower, this is a basic rule. So we have to show that, flying at $170km/h$ speed, we can make a pass at a distance of $50m$ from a vessel ship and prove that there is no collision. This is one point. The other point is when we have a bad visibility. They are asking for a RADAR. But you know the shape of a marine RADAR : this is an air-brake. So we are discussing on the tolerated clearance in which we can operate. Next summer, we will operate in the Baltic Sea to show that we are safe. More, now we are trying to install some kind of a braking system, as an emergency stop. Imagine that you are going around an island, and then suddenly a craft appears, like a race boat. If it is small you can jump over, but if it's too big, you need an emergency stop. We are developing such a system that would give a 1G deceleration, like a car at its maximum breaking performance. Then we would stop in a distance of $200m$ at $180km/h$. And this system would have some RADAR or laser to detect anything on $400m$, so we would be safe against collision.

MM

And what about wind gusts ?

HF

Usually wind gusts come fast and go slow. When the gust comes from the front side, you have the craft that goes a little bit up, but we never had a problem with a gust that came from the rear side. The craft just went closer to the ground. We never touched the water.

Anyway the Germanish. Lloyd has installed many gauges on our craft to measure the impact loads. They found loads in the area of $1kg/cm^2$ on certain points.

[1] One of Graham Taylor models rolled over during one run. The Editor