Modern Light Water Aircraft Design, Manufacture and Flying by Tony Irwin (21st Feb. 2012)

1. Introduction

Tony is an ex RAF pilot when he flew early fighter jets. Later he joined BOAC flying and navigating initially Stratocruisers, then Comets followed by VC 10s, 747s and finally a brief run on Concorde. His employment with BOAC/BA took him round the world many times visiting most countries. During that time he accrued 21,000 hours flight time on 90 different aircraft. This was followed by one year of test flying for Rolls-Royce at Hucknall. His conversion to water aircraft, initially on float aircraft, came after many years land ops' and, to quote his words, "he realised just what he I had been missing for well over a quarter of a century of normal flying".

Tony has been involved in the design, manufacture, flying and sales of the Seawind amphibian aircraft for over 20 years. Mostly this was in Canada and then in the USA. He is currently UK Representative of Seawind LLC, Kimberton, Pennsylvania, USA.

2. The Early History of Seaplanes

The first autonomous, engine powered flight by a seaplane was made by the French engineer Henri Fabre on March 28, 1910. The aircraft was the Voisin Canard (the duck) (Fig. 1).

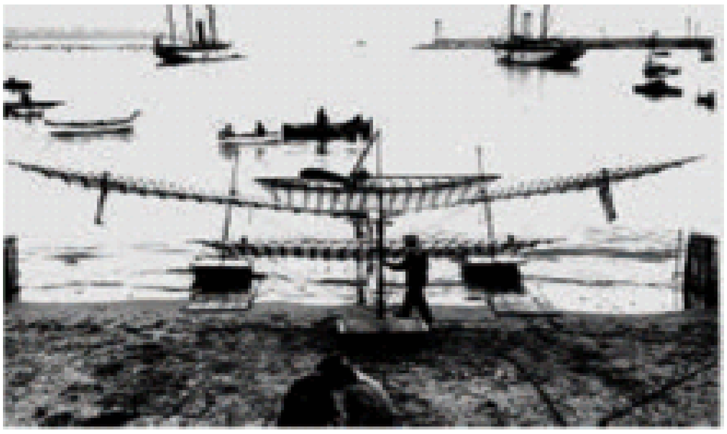

Fig. 1 - "VOISIN CANARD" of the Voisin Brothers

A year later Glenn Curtiss made a successful seaplane flight in the USA and, on March 27, 1919, a U.S. Navy seaplane (the U.S. Navy NC-4 flying boat) completed the first transatlantic flight (fig. 2). Later an Englishman John Cyril Porte joined with Curtiss to design a transatlantic flying boat, and developed a more practical hull for Curtiss' airframe and engines with the distinctive 'step' which enabled the hull and floats to cleanly break free of the water's surface at take-off. Derivatives of this aircraft in U.K. became known as Felixstowe (Fig. 3).

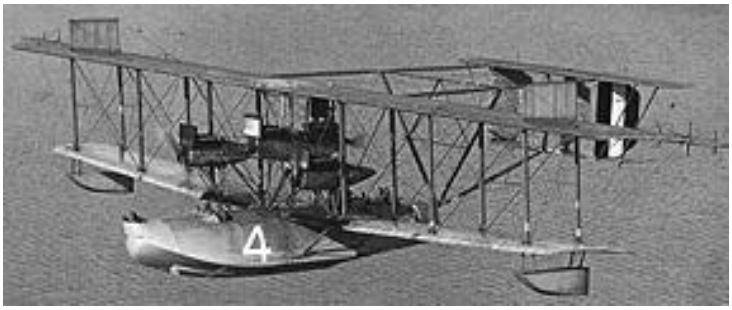

Fig. 2 - U.S. Navy NC-4 flying boat

Because of the lack of runways and the perceived safety factor over water, many commercial airlines including Imperial Airways (the forerunner of BOAC - my old Company) and Pan-American World Airways used large flying boats to provide service for long distance service across the Atlantic, Pacific and Indian Oceans.

The largest flying boat ever to be built was the Spruce Goose: Wing span: 320' 97.5 metres; weight 400,000 lbs 181,450 kgs. It flew only once for 1 mile at 80 mph (fig. 4).

The U.K.'s efforts only produced a few water aircraft post war. The ill fated fighter the Saunders Roe SR A 1 and the 10 engined Saunders Roe Princess are the best known (Fig. 5).

Fig. 3 - The Felixstowe

The Princess was one of the last flying boats designed and built, but it never made it into service. Saunders-Roe wanted to build an aircraft that could used by BOAC. The aircraft was to be powered by ten turboprop engines. The four inner propellers had contra-rotating propellers, driven by a twin engine. The two outer propellers were single and powered by one engine.

The Princess was a double decker aircraft, designed to fly 105 passengers very comfortably. In 1951 BOAC cancelled their orders.

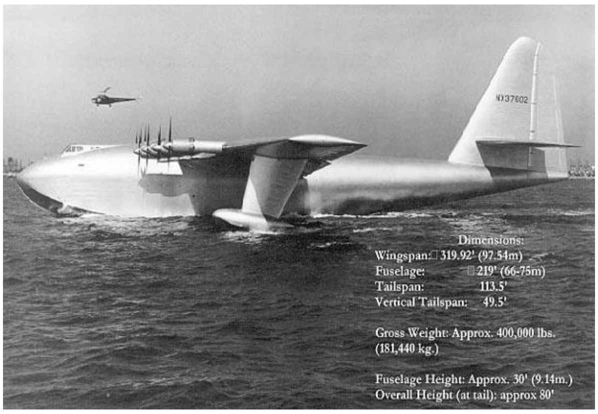

Fig. 4 - The Spruce Goose

Fig. 5 - The Princess Flying Boat

3. The Author's Initial Involvement with Seaplances

Tony's first flying from water was in a small two seat tandem aircraft, the Piper Cub, from Lake Union in the centre of the city of Seattle, DC (Fig. 6). Later he went on to fly a Cessna and a Beaver (Fig. 7).

The Grumman Mallard (Fig . 8), the main stay of the New Zealand Mount Cook Airlines, was the seaplane which most impressed Tony. Mount Cook Airlines ran a service from Auckland to the many small islands round the Bay of Islands.

Fig. 6 - The Piper Cub

Fig. 7 - The Beaver

Fig. 8 - The Grumman Mallard Amphibian

Further flights were made with micro light aircraft (Fig. 9) fitted with on floats. These are flimsy very small, one or two seaters. They are good fun, cheap to operate but not all rounders in British winters, possibly the reason for the scarcity in the UK.

Fig. 9 - A Micro Light on Floats

4. The Seawind Amphibian

Finally Tony became interested in what he believes to be the best medium amphibian aircraft in the world, the Seawind (Fig. 10). Its cabin is pleasant and comfortable (Fig. 11 and 12). There is plenty of room for five people being much wider than any similar aircraft and the view outside is panoramic.

Fig. 10 - The Seawind Amphibian

Having been instrumental in part of its design, Tony was given the contract represent the Seawind LLC's interests throughout Europe and the Near East and Russia.

Several Seawinds have been sold to Europe, but the various licencing authorities, i.e. CAA etc., have imposed significant barriers to bringing the aircraft into Europe.

Tony organised the use of part of a small factory to build Seawinds in Kaunas, Lithuania. This country was chosen because it was country with a well established history of Aviation.

The factory was a very old aircraft factory built in 1919. The first aircraft was ready to fly in the snow in mid winter – minus 35°C. That aircraft worked well although the engine was old. The engine of the second aircraft, although brand new, failed three times during the first flight.

Fig. 11 - The Seawind Interior (1)

Fig. 12 - The Seawind Interior (2)

5. Seaplane Design Requirements

5.1 Hydrodynamics and Aerodynamics

Hulls and floats create drag and add weight. The hull, with all its water resistance requirements and strength required for the initial contact with water, can result in up a 40% increase in weight and a decrement of up to 15% in speed.

The hull and floats must provide:

- Buoyancy and static and dynamic stability;
- Low water drag with the provision of hydrodynamic lift at low speeds;
- Ability to suppress spray;
- Manoeuvrability and control while taxiing.

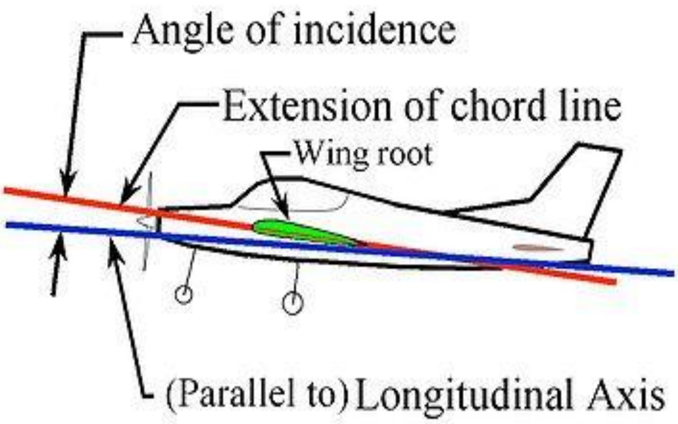

Fig. 13 - Wing Angle of Incidence

The wing incidence (Fig. 13) must be approximately 2° higher than for a land aircraft as there is little ability to rotate to get the extra lift required to get airborne. This is often quite noticeable on a float plane when the angle between the fuselage centre line and the float centre line is more evident.

Hydrodynamics demand that a "step" (Fig. 14) be incorporated into the hull (or floats if used) into to introduce turbulence in the water flow under the hull. This has the effect of reducing the water drag during takeoff. It does, however, increase drag whilst the aircraft is in flight.

Step (either in hull itself or in the floats)

Fig. 14 - The Hull "Step"

While a seaplane may fly in a level attitude when cruising along, during high speed flight constant altitude must be maintained with a nose-down trim attitude.

If the float or hull requires +*8*° for optimum operation, the wing must be set at +12° for maximum lift. It follows that the wing chord line and the fuselage reference line would be considered and the fuselage reference line would be considered to be a +2° angle of wing incidence.

5.2 <u>Materials for the Hull/Floats</u>

Aluminium has been the normal material since wood and canvas were in vogue a century ago. It is light, strong and easy to work, however, it leaks. The continual movement of the aluminium plates breaks down the seals between them. Pre-flight actions on any aluminium float aircraft include pumping out the water that has seeped into the floats. Each float can have 4 to 8 compartments either side.

Early plastics were water pervious. The types of fibreglass laminate such as ‘E’ glass and vinyl ester resin offer much improvement.

With fibre glass, the radio antennas may be in bedded into the skin of the aircraft, this leads to a very clean outer skin which is good for both hydrodynamics and aerodynamics. With carbon fibre, the skin of the aircraft acts in a similar manner to aluminium and so the aerials have to extend outside the body of the aircraft.

6. <u>Flying Seaplanes (and Amphibians)</u>

The flight characteristics of seaplanes depend on whether they have floats (Fig. 15) or a contoured hull (Fig. 16).

Fig. 15 - Seaplane with Floats

A rough water take-off can turn into a series of bounces from wave to wave. Sometimes the aircraft can be tossed into the air at minimum flying speed. Applying an extra amount of flap at that precise moment will usually keep the aircraft from stalling back onto the next wave. Again, the proper attitude is critical to avoid damaging the aircraft. The objective is to get out of the water as soon as possible at the lowest speed.

Fig. 16 - Seaplane with Contoured Hull (e.g. Seawind)

Landing on very smooth water can be the most hazardous task for the seaplane pilot. This is because the pilot cannot judge the water level and tends to think the bottom of the lake is the water level. One way of overcoming this problem is to land near the shore and thereby to sense the water level from the shoreline. Another is to use the VSI (Vetical Speed Indicator) instead of the ASI (Air speed indicator). The aim then is to use the power of the engine to keep a rate of descent of 100 -200 feet per minute and, on touchdown, to ease rapidly back on the stick to prevent the nose of the floats/hull digging into the water.

Once down it must be remembered that the aircraft has no brakes and the water rudder must be lowered. Approaching a jetty can be hazardous as it may be full of boats. When close to the jetty it is necessary to watch the aircraft wings and the boats' masts and stays. Finally the pilot (or a passenger) must jump carefully on to the landside float if present or else the jetty itself and both hold and fend off the aircraft as it comes alongside the jetty. The aircraft can then be moored up to the jetty.

Landing on a fast flowing river presents further problems. An aircraft landing on a runway will always land into the wind. This is not necessarily the case with fast flowing water when it depends on the relative effects of the water flow and wind speed. Having landed it is necessary to do battle with the current as you try to tie down ashore. One way is to stop the engine and hope you arrive by a sandy area of the bank. Taking off again presents yet more problems. Here it is necessary to rev up the engine, get the aircraft nose heading into the centre of the river and take off in the same direction as that used for landing.

The lecture was attended by approximately 70 RAeS Members, Branch Friends and Members of the Public. Tony was given a rousing vote of thanks and a round of applause for his lecture.

Notes by Colin Moss