Is it a boat?...
Is it a plane?...

It is EKRANOPL

What is half boat, half hovercraft and half aeroplane? Graham Taylor provides the answer as he describes his experimental Ekranoplan model.

And now, as they say, for something completely different! My last article, 'Whatever Next?', looked at future marine transport as shaped by development of existing marine technology. In this article, I describe my experiments with an entirely new type of marine vehicle, the Ekranoplan. 'Ekranoplan' is a Russian term for vehicles which use the aerodynamic phenomenon called 'wing-in-ground-effect', often shortened to 'ground-effect' or WIG. It's a subject that I first described in 'Wise Up to a WIG' - see June 1995 issue.

Ground Effect?

Ground-effect can be demonstrated by skimming a playing card or beer mat across a table. Air travellers will have experienced it when landing: it is the extra lift that causes an aircraft to drift outward just as the pilot tries to put it down on the runway (pilots call it 'flaring'). There are numerous technical explanations for this - my interpretation is as follows. If a wing flies very close to a surface, i.e. the ground, the downwash that would flow off the wing in normal flight gets compressed and spread against the ground, which results in a considerable increase in lift and a decrease in 'induced' or 'vortex' drag. Overall, it means that a craft using ground effect does not need as big a wingspan as an aeroplane, can carry more weight, and can go faster for the same power. Ground in this case does not need to be 'terra firma' but could equally be the surface of the sea, river or lake.

This curious and mostly unwanted 'ground effect' has been known about since man first learned the secrets of flight, but has never really been exploited as a form of transport (although modern racing catamarans and hydroplanes come close to it). During the Cold War, however, the USSR invested heavily in ground-effect research with the aim of developing seagoing military vessels that would 'fly' at high speed just above the wave tops while carrying more load than could conventional aeroplanes. Just as Hoover is to vacuum cleaners, the Russian expression 'Ekranoplan' is to ground-effect. Back in 1965, with experimentation in the rest of the world still in its infancy, Russia earned the right for

'Ekranoplan' to be applied to this type of craft by building the biggest. This truly awesome machine, which NATO named 'The Caspian Sea Monster', weighed 540 tonnes and skimmed the sea at 500 km/h! Now, with the end of the cold war and greater interest in high speed ferries, people are looking again at ground-effect as a form of marine transport: part boat, part hovercraft and part aeroplane.

WIG MK1, a non-marine prototype built several years ago
improve on the draft was to have a go and build it. Many experimental WIG’s around the world look like mutant aeroplanes.

My model layout was inspired by some artwork for an ‘aircraft like’ Russian proposal, but I set out to create something closer to a hovercraft judge for yourself if I succeeded. Although normally a ‘glow-plug’ man, I chose to compound my difficulty by designing a multi engine layout which lent itself to electric propulsion. The

Right: Complicated? Yes, but the whole is greater than the sum of the parts. These are some of the parts!

Below: Close up of the business end showing the stepped hull

result, my first ever ‘fast-electric’, is undoubtedly the most ambitious model I have ever attempted.

**Features of the Model**

The model consists of a hull, main wing, sponsons, tail unit and motor assembly, most of which was made from balsa and thin ply. Because the model is so experimental all parts had to be replaceable or adjustable. The hull is stepped to prevent it sticking to the water. Its size gives it plenty of presence and easily accommodates the radio equipment and batteries. Since the optimum position of the centre of gravity was one of those great unknowns, the hull had to allow for the batteries to be moved around. Thrust is provided from two Jet Electric 450 ducted fan units fitted on the bow, connected to 2 x 7 cell packs in series, which give a run time of four minutes. The motor assembly allows the motors to swivel through 30 degrees, directing airflow either over the wing or under it for take-off. The sponsons fitted to the main wing serve to both provide buoyancy and help contain the dynamic air cushion.

**Wing Construction**

It turns out there are two ways to build wings; the easy way and the hard way. Being inexperienced, I chose the latter and built up the main wing from balsa ribs with a ply skin. Later a local model shop made me up a spare wing from veneered foam which was not only better and cheaper but they made it in far less time than I took. Because the best tail wing incidence was unknown I opted for all moving tail surfaces. Design of the servo linkage to turn the rudders but not the tail wing, and vice versa, gave me quite a headache. The resulting model has many parts, half of which are probably not needed!
The diminutive size of the fan blades seen here against the model

A Time Machine?

Einstein postulated that if something was really heavy its gravitational pull could be strong enough to drag time itself in. Now, even the model’s finished weight of 3.3 kg is not enough to explain how so many weeks of effort went into this project while nothing much came out. Even the paint job went wrong when I found the paint chosen was not suitable. To have to attack a finished model with paint stripper must be every modellers’ nightmare. Some projects are like that. This one took over a year from cutting the first rib to first trial run, but in the end it was worth it.

Throw the Switch, Igor....She Lives!

So, after trials and tribulations that I shall bore you with no longer, there came a day when all the parts were assembled and the model Ekranoplan was actually finished. Radio installed, motors wired, batteries charged - nothing else to do but find out if all the effort pays off. The controlled

Thrust testing. With twin fans tilted downwards the boat lifts high out of the water

conditions of the living room were chosen for the site of the first test. Not wishing to overload anything, I installed only one battery pack. The motors were slowly run up to speed at which point, to my immense surprise, the model gently rose onto an air cushion and drifted across the carpet.

Flypast. The boat’s reflection proves she flies clear of the water. My thanks to fellow modellers at Elmbridge Model Club who took the pictures.
On the water. Futuristic or what?

Getting a little more confident, I installed the second battery pack. This time a typhoon ripped through the room, the model leapt into the air and made for the far wall. ‘Not bad, for a boat’, I thought.

To the lake

After such early promise the difference between carpet and water soon became clear. Other modellers claimed their models worked perfectly first time but I’m not afraid to tell it how it is. I wishfully imagined my switch to electric power would bring increased reliability and put an end to the frequent need to retrieve a dead boat. This was not to be. On the first outing, the starboard motor was found to be more powerful than the other, making the boat spin in circles. Then one fan fell off and dropped in the lake. Radio contact was lost and the boat drifted for an hour, finally snagging on some reeds. Attempts to free it by lobbing clumps of earth into the surrounding water resulted in the inevitable direct hit - straight through the deck. The earth turned out to be part of an ant’s nest so, by the time the model was eventually recovered, all the expensive bits were awash in a soup of mud and ants. So much for the maiden voyage!

Development

Fortunately things have improved since then, although numerous modifications have had to be made to reduce the effect of spray ingestion and tendency for the model to dunk its motors at the end of a speed run. Surface clearance is not as great as I had hoped because she is a little overweight. Also directional control is a bit of a challenge, she has to be ‘down’ rather than ‘steered’. But much fiddling with position of centre of gravity and angles of attack has allowed me to get to know her many foibles. Now each set of trials brings better performance. The model ekranoplan does skim just clear of the water on its dynamic cushion of air, as evident from the absence of wake and, since the objective of building her was to explore the ground effect phenomenon, I have to declare the experiment a complete success. Was I converted to electric? Yes, I’m afraid I was.

More Ekranopians

Clearly it will be some time before ekranopians will be seen in everyday use but I am confident they are the transport of the future. Readers with internet access can find out more about ekranopians by checking the “WIG Page” at ‘www.io.tudelf.nl’ or simply doing a subject search on Ekranoplan.

Model Specifications

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<th>Specification</th>
<th>Details</th>
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<td>Length</td>
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<tr>
<td>Beam</td>
<td>510mm</td>
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<tr>
<td>Weight</td>
<td>3.3kg</td>
</tr>
<tr>
<td>Power</td>
<td>2 x ballaced 20 turn 540 motors</td>
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<tr>
<td>Radio</td>
<td>5 function; rudder, elevator, speed control, motor tilt, two servos each driving main wing flaps.</td>
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