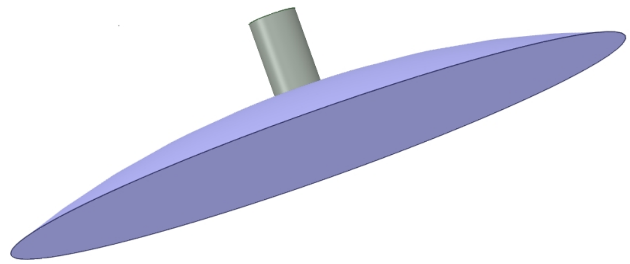
Rotating Planing Surfaces

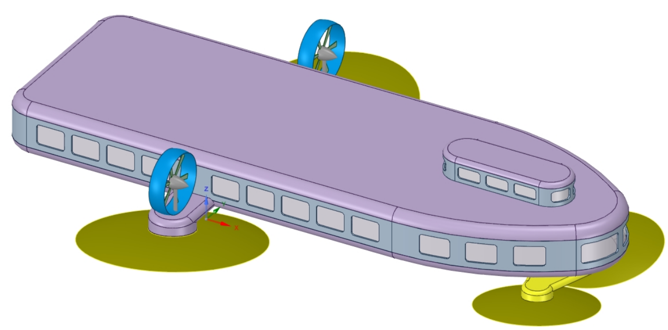
Planing Disks



A method of water travel with reduced frictional resistance and additionally having the ability to transverse other relatively flat surfaces. The present invention uses circular flat bottomed disks with a curved upper surface that tapers radially in a shallow arc from a maximum thickness at the center, relative to the bottom, to a sharply rounded edge around the circumference of each disk. Each disk has an axle that protrudes upwardly and perpendicularly from the center of the disk. Said axles are inserted into bearing assemblies rigidly attached to a watercraft or possibly an aircraft such that the disks are free to rotate around their axles and at a deadrise and attack angle relative to the craft that would commonly be used by a planing hull. In operation the craft lifts out of the water quickly and in a level fashion with little wave production as the disks act as hydrofoils when submerged. Once the disks lift out of the water they plane on the bottom outer circumference of each disk. Since the disks rotate freely the skin friction is limited to the deflection of the boundary layer into a shallow arc from the front of the planing edge of the disk to the back of the planing edge of the disk. This results in an average differential in velocity between the planing surface of the disk and the water that is much lower than a non-rotating planing surface such as a planing hull or a lifting surface such as a hydrofoil would experience travelling at the same speed.

In General

High speed turboprop passenger ferry



A typical planing hull will have a lift to drag ratio of about 5:1 and optimally when the induced drag matches the frictional. This occurs generally when the attack angle is about 5 degrees. In the case of the planing disk this would infer that since the frictional factor has been reduced the attack angle should be reduced for an optimal L/D. If this angle were 2.5° then the L/D ratio would be ~10:1 ignoring the reduction of skin friction which is the major factor at high speed.

A unique quality of the disk is that the L/D will increase with speed as less of the disk is in the water resulting in less deflection of the boundary layer. For example with 1/2 the bottom of the disk contacting the water the planing surface is twice as long as it is wide, with about 15% of the surface contacting the water the length of the planing surface is 4 times longer that its width. This might result in some energy recovery on long ocean waves. On the downside the disk losses some efficiency due to its poor aspect ratio though I might argue that as speed increases this is less of an issue as the side flow component will decrease given the inertia of the water.

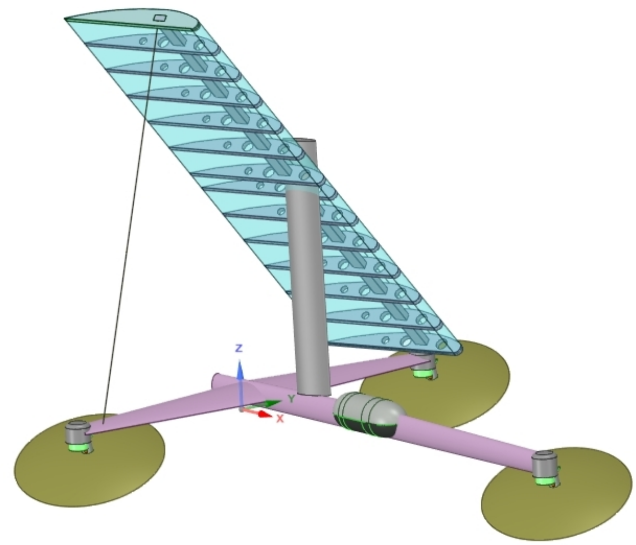
The size of disk required to provide the proper amount of lift for a particular craft appears to also provide enough displacement to fully support the craft above the waterline at rest.

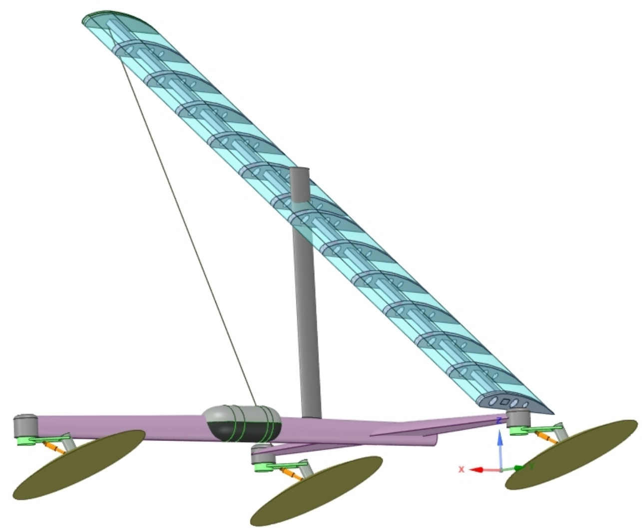
Sailing Craft

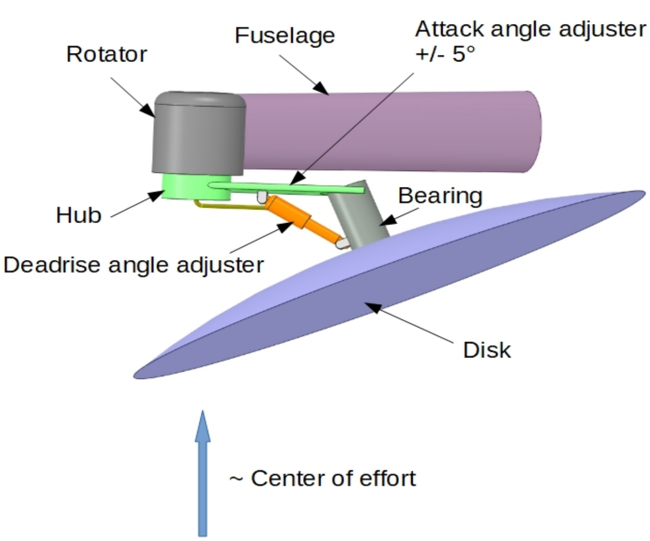
For me this is the most interesting application of the planing disks. The need to resist side slip and the relatively low power available for forward propulsion I think make the disks extremely well suited for use with sail driven craft.
The most efficient way to drive a sailing craft is with a true airfoil as is used on aircraft. To accomplish this the airfoil needs to be able to pivot from side to side depending on which tack the craft is on. On the next page (two masted cruiser) we see a rig where the airfoil can also rotate with the wind direction (not shown). However for the tri design shown here that would be problematic so instead the disks themselves rotate to set the desired course. This results in a design where the bow is always facing into the apparent wind and the craft is travelling in a sideways or even backwards direction as this is also possible.

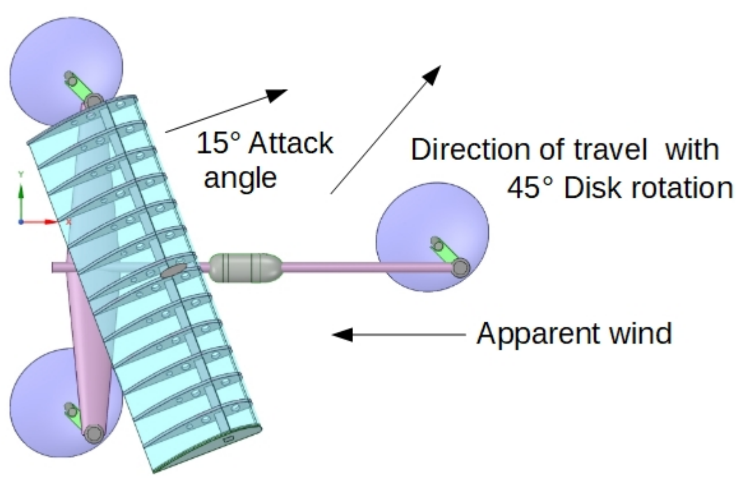
The fact that these crafts are also amphibious adds an additional degree of safety eg. they can roll over a reef and drive onto a shore.
If the disks are well sealed (foam filled) then there would be no such thing as “taking on water”.

100+ kph Solo Transatlantic Challenger





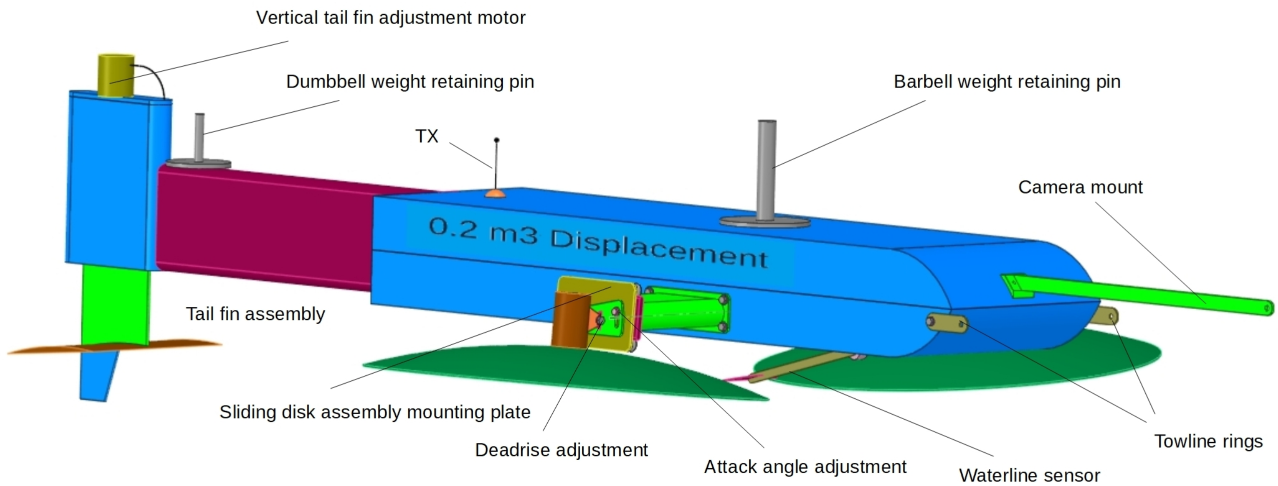




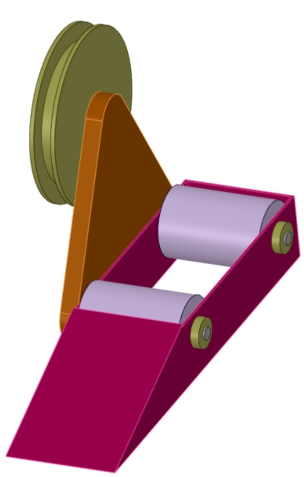
Test bed

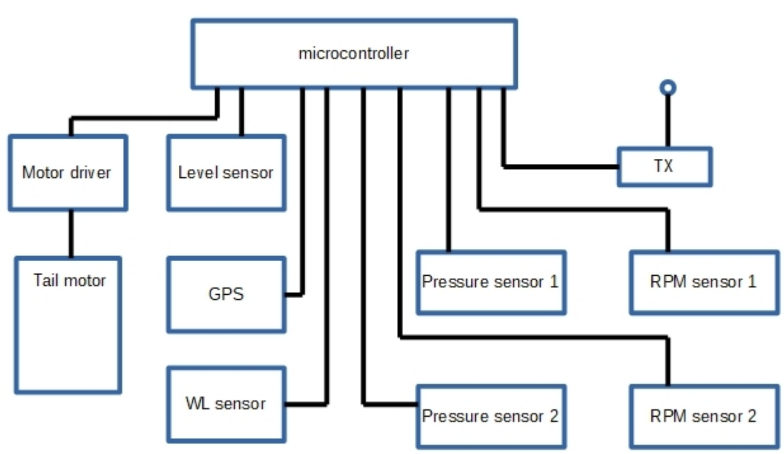
The test bed shown in combination with a high speed (car wheel) winch is designed to measure the lift/drag ratio of what I call planing disks.
The disks mount to the test bed via sliding plates which in turn press on pressure sensors. In addition each disk bearing assembly contains an RPM sensor.
The disk mounts can adjust the angle of attack between 0 and 12 degrees and the deadrise angle between 5 and 45 degrees. A level sensor in the hull in combination with a vertical actuator connected to the tail fin maintains the test beds horizontal orientation throughout a test run. A retaining pin directly over the disks allows for barbell weights to be added to vary the disk loading. A smaller pin for dumbbell weights at the rear of the tail allows for any trimming that may be required. An onboard GPS unit calculates velocity additional equipment includes a waterline sensor and a camera mount (focused on disk/water interface). An onboard transmitter continually sends sensor data back to the base station, laptop etc. The disk attachment arms and the tail assembly are easily separated from the hull for transport.

90 cm diameter disk test bed



Car wheel winch (3.5:1 ratio)





Some Data

I have done very limited model testing. I once built a towable model consisting of 4 – 2 ft. diameter disk on an aluminum "H" frame. We had done 1 run down the harbour and were turning for a second (now with scale attached) when another boat crossed our towline and destroyed the model. But from the 1 run the model lifted out smoothly with disk rotating (only the ball bearing resistance to overcome) and cut smoothly thru the chop as you would expect given their hydrofoil like cross section.

The planing surface should be as smooth as possible as per any planing surface. The induced drag is a combination of the weight and the planing surfaces angle of attack the fact that the disks spin should have little to no effect. Once a planing hull gets to about 40 fps velocity skin friction starts to dominate exponentially.

Planing hulls are most efficient when the induced drag and skin fiction are equal. This implies that for the disks you would have more surface area in the water but with a reduced angle of attack.

This RC toy model that I built scoots around the bay at about 50 mph.
(front disk area was reduced and more tail rudder surface was added after 1st test)