# COMPOSITE ENGINEERING FOR A FLYING PERFORMANCE

**When the word 'foiling' came up in conversation 10 years ago, it was with a look of awe as people discussed the America's Cup and the AC72s that broke the mold of the historic event. The boats sailed fast, and they sailed on the edge, the sailors wore crash helmets, carried spare air and safety nets. A far cry from the Thomas Lipton days of collars, ties, and pipe smoking.**

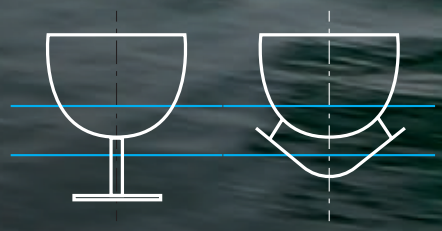
These days, foiling is not only an accepted (if still a somewhat adventurous) approach to sailing; it has also made its way into the motorboat realm.

**What is it about hydrofoils that fascinates us and inspires us to get a piece of the action, to be on a boat that quite literally flies?**

## An upside-down aeroplane?

Hydrofoils work in much the same way as aerofoils. Imagine an upside-down aeroplane, with one big foil on either side (the wings), a smaller fin at the back which is for stability, and a rudder for direction. The wings, fin and rudder are all foils. As are conventional centreboards, rudders and keels on a boat, and we have seen their evolution in the way of canting keels, and the Dynamic Stability System.

What has garnered interest more recently in the marine world, however, has been lifting foils.



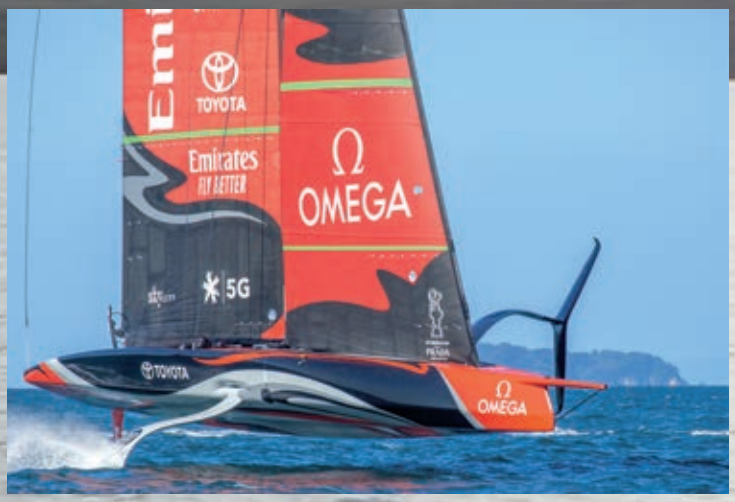
Typical cross section of hydrofoil-supported vessels: Fully submerged (left), Surface piercing (right)

## The power of hydrofoils

A lifting hydrofoil is usually a thin section that is connected to the main hull, helping create a pressure differential between the upper and lower surfaces, thereby creating a lift force (and a drag force) that can be harnessed for better performance. The main hull then appears to be 'flying' above the water's surface. Foils come in various designs, shapes and sizes, depending on what the desired outcome is. However, in general, there are two types of lifting foils:

- Surface piercing – which is self-regulating and designed to self-centre to achieve the desired performance. They are usually U shaped
- Fully submerged – which requires an operator's input. They are usually T or V shaped.
- Or a combination of the two (like the International Moth).

Their purpose is to reduce the displacement of the boat (thereby reducing the resistance).




**ETNZ's AC72 created a lot of renewed interest in lifting foil vessels**

**Chase Zero 'flying' in the Hauraki Gulf**

### What sort of boat can benefit from a lifting foil?

Boats with some levels of speed are best suited to foils, as they need flow over them to work.

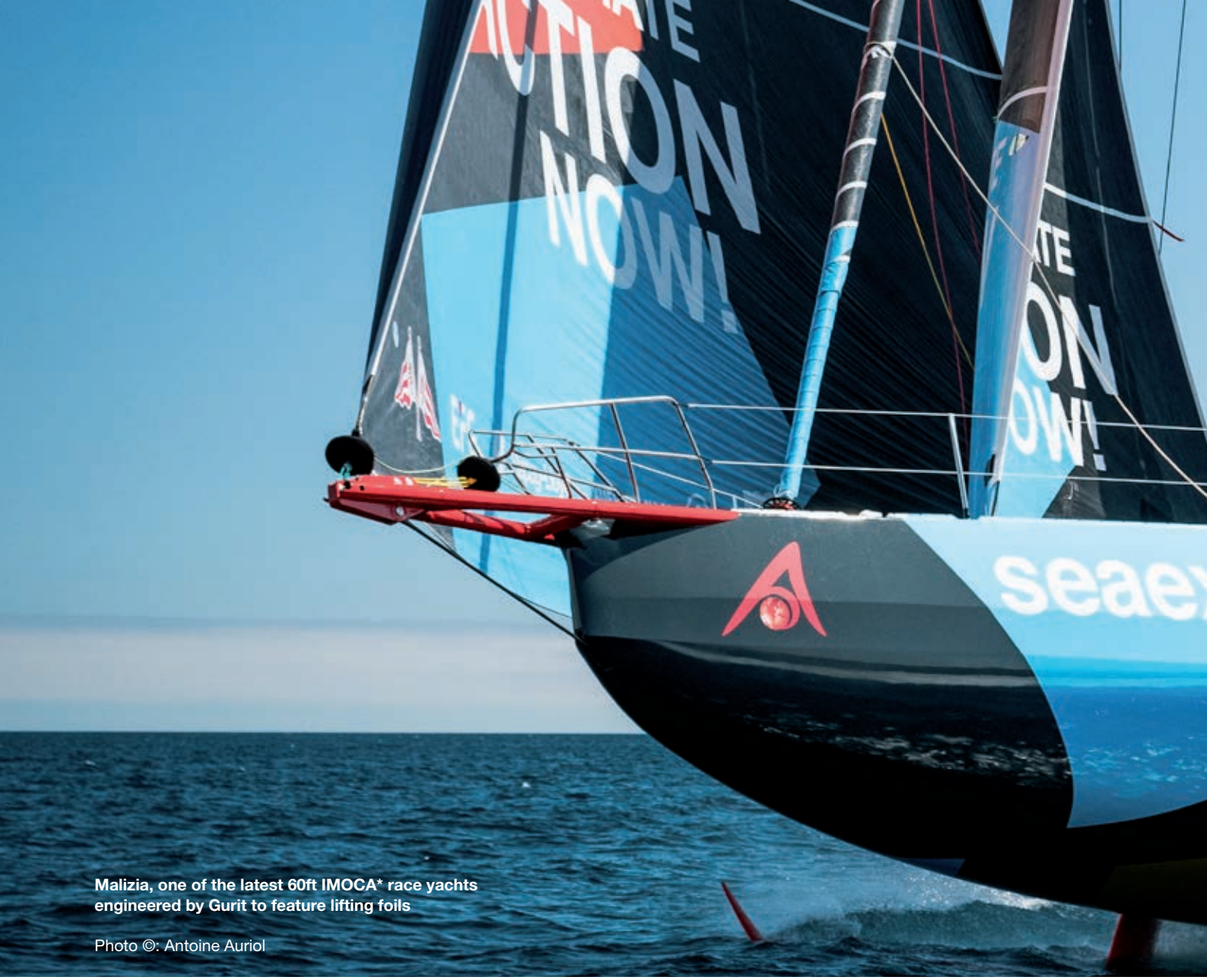
The AC72s which raced in 2013 are the best-known foiling hulls of our time, but the benefits are not just limited to F1-style race yachts. International Moths were using foils well before then and have contributed to foiling reaching the general population.

Cruising catamarans may look to foils to help them get to their destination quicker, especially in times of inclement weather.

We're seeing new electric ferries being designed as foil-assisted. This can help them achieve the same speed/range with fewer batteries, which are heavy and take up space.

And of course, foils can now be seen on a full array of watersports equipment such as paddleboards, jetskis and wingfoil set-ups.

Photos on this page courtesy of Emirates Team New Zealand



**Malizia, one of the latest 60ft IMOCA* race yachts engineered by Gurit to feature lifting foils**

Photo ©: Antoine Auriol

## Challenges to overcome

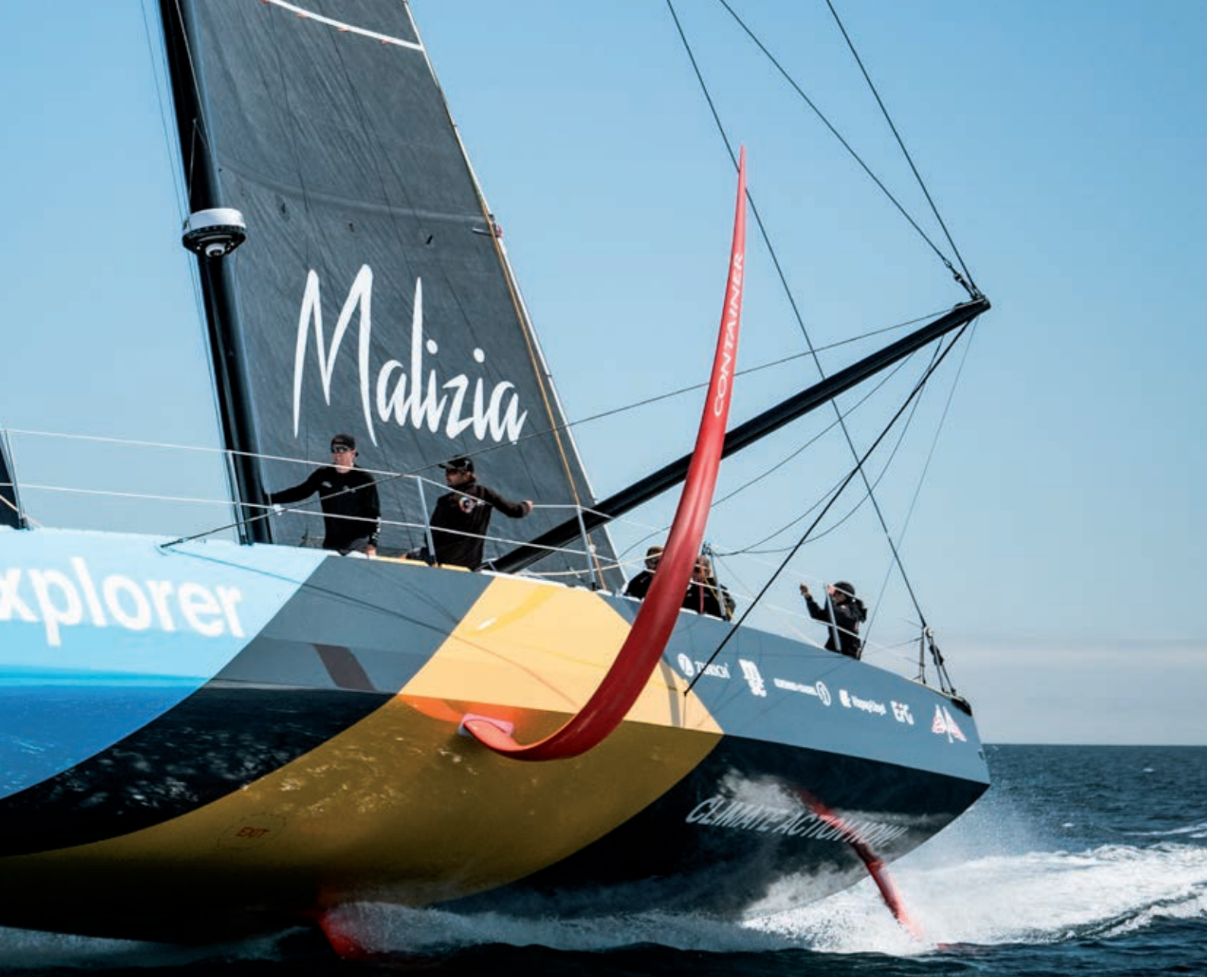
There are, however, considerations to be made when designing a foiling vessel.

- The cost, weight and interior space needed for the foiling system may be prohibitive to the project.
- Hitting a submerged object with a foil will have a greater impact and more significant outcome than without a foil.
- As the hull of a power boat lifts, so do the propellers, which then has the opposite effect and slows the boat down.
- Draught and operation into harbours, and transporting on trailers, may be affected.
- The thinner the foil section, the more efficient; but the higher the stresses on the foil.

***"We have seen an increasing demand for hydrofoiling vessels in the last couple of years. Not just for performance sailing yachts, but power boats and commercial vessels. These types of boats are not necessarily looking for speed, but often a reduction in diesel costs or a reduction in the number of batteries they carry."***

**Tony Stanton**

Engineering Manager – Gurit Asia Pacific




## The composite advantage

The beauty of composite materials is their versatility and the ability to design a part that meets the exact criteria. Gurit Engineers can help owners and project managers overcome what initially present themselves as limitations and get the performance advantage from foils they are looking for.

Regardless of whether it is a performance sailing yacht wanting to go as fast as possible on a very limited energy source (the wind), or an electric ferry wanting to hit a certain transit speed with a minimum amount of installed energy, keeping the total platform weight down is a key consideration. Weight, strength and formability play a big part in the success of a hydrofoil, so often carbon fibre is the enabler. Less weight means less vertical force and lower drag. And modern materials are making these design advancements feasible.

In Gurit's recent work on the latest generation of IMOCA* projects, this technology is going to the next level, and these boats push the envelope in terms of foil geometry and performance. The lessons learned on the race track are brought to bear on commercial and leisure power boats, including several exciting vessels now in design, featuring carbon lifting foils to drive efficiency.

Vessels such as ETNZ's Chase Zero, to which Gurit provided materials and structural engineering services, are opening the doors to an exciting new world for commercial and leisure craft, one where the boat operates at minimum power demand while flying calmly and smoothly above the ocean waves.

*The International Monohull Open Class Association manages the class of 60-foot (18.28 metres) open monohulls, who compete in the Fastnet Race and the Vendee Globe.