M&M SuperFoiler
PRINCIPAL DIMENSIONS

LOA: 7.97 m
Main Hull Length: 7.90 m
Outriggers Length: 4.50 m
Beam: 5.15 m
Rig Height from DWL: 13.04 m
Draft: 1.52 m
Number of Crew: 3
Sailing Weight: 350 kg

Mainsail Area BIG: 32.6 m²
Mainsail Area SML: 27.6 m²
Jib Area BIG: 9.3 m²
Jib Area SML: 7.8 m²

Foil Configuration:
3-Point Foiler; L-Daggerboards and T-Rudders

Construction:
Mainhull, Outriggers and Beams:
Carbon Fiber Prepreg with Nomex Honeycomb sandwich Core
Foils and Rudders:
Carbon Fiber high modulus Prepreg Autoclaved Cured
Rig:
Carbon Fiber high modulus Prepreg Autoclaved Cured
Sails: Doyle Sails Stratis

Expected Performance
~40 knots Top Boatspeed
~12 knots Foilborne Boatspeed
5 knots Foilborne Windspeed Downwind
7 knots Foilborne Windspeed Upwind

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Background
The SuperFoiler concept was developed by the Morrelli & Melvin Design Team (M&M) through the combination of numerous ideas and innovations. The project was initiated by the project founders Bill and Jack Macartney, who simply requested that we develop the most exciting 3 person inshore “sail racer” possible, giving the design team a lot of freedom to develop a concept like no other... fast, foil-borne, and eye-catching to the public.

The project started after the 34th America’s Cup where course-racing foiling multihulls were introduced mainstream to the public and other production foiling multihulls followed. M&M were responsible for leading the team that developed the AC72 concept and Class Rules of the 34th America’s Cup, and were part of the design team at Emirates Team New Zealand who lead the America’s Cup into foiling.

For the following 35th America’s Cup, M&M once again lead the team that developed the concept and class rules and the one-design components of the AC62 which finally turned into the AC50. This influx of research and ideas brought the motivation to re-evaluate the conventional catamaran with foils in an attempt to provide maximum efficiency for a pure foil-borne Sail-Racing Machine, which lead us to the configuration of the SuperFoiler.
SuperFoil - Design
Concept Development

First Conceptional Sketches done by M&M August 2014 and final geometries delivered starting mid-2016
Unconventional Platform design with Center Hull and Outriggers with an integrated stepped-hull shape.

Electronic Push-button Controls. For Active Control of the Lift produced by the Daggerboards and T-Rudders.

Solid Meshed Trampoline

Passive Adaptive Daggerboard Rake Control for in flight mode

Wishbone-boom

Y Split Shrouds attached to the transom and forward beam

End-plated Mainsail and Jib

'SuperFoiler' Design Innovations
VPP – Velocity Performance Prediction
Solution of force balance requires matrices of data modules for all primary Hydro and Aero components.

FEA – FINITE ELEMENT ANALYSIS
Global platform loading and structural optimization.

CFD – Computational Fluid Dynamics
Aerodynamic platform optimization

FSI – Fluid Structure Interaction
Initial fluid-structure interaction are run in 3D lifting line tool.

SuperFoiler – M&M Design Tools
Computational Design Methodology

Elevator geometric study and optimization

Design point validation for foil forces

Hull hydrodynamic VPP input matrix
Platform stiffness is critical to foil angle control and therefore, the overall performance of the boat through a wide range of sailing conditions and loads.

Finite Element Mesh >200 distinct ply regions for iterations which ultimately translated into construction drawings
Main Benefits New Platform Design

❖ Aerodynamically lower drag
❖ Structural Efficiency - center-hull functions as a structural spine
❖ Weight - significant lighter
❖ Minimum storage space onshore
❖ Look/Perception

M&M Pitchpole Analysis Program

The new platform design concept has been carefully evaluated in M&M’s pitch pole analysis program. M&M has a good database for reference information which include previous M&M designs like the America’s Cup Concepts AC50, AC72, the Nacra F20, SL33, TF10,.... etc

Typical Pitch-pole vs Recovery Moments graph indicating available energy and point of no return at negative net moment
SuperFoil - Design Features

Aerodynamically Optimized Configuration

INCREASED RIGHTING MOMENT from End-Plated Sail Plan up to 4%

Integrated sail plan & platform geometry optimize overall aerodynamics

- Main & jib 'End-Plated' to platform
- 'End-Plate' effect results in lower drag, increased thrust, and greater speed
- Lower Platform Drag
- Airfoil beam geometry
- Partially solid trampoline
- Main Beam corner fairings
- Aerodynamically fine-tuned deck layout
SuperFoilers - Design Features

Daggerboard control system - **ACTIVE**

The SuperFoilers have two different systems: a passive (no human input) and an active (human input) daggerboard rake control system. The geometric design of the daggerboards incorporates passive-adaptive stability characteristics as a function of vertical immersion. However, the daggerboard and elevator rake do need to be trimmed to the optimum setting for each true wind speed and boat heading to obtain the nominal lift for force balance at obtained boatspeed. The active control system includes:

**ACTIVE SYSTEM – PUSH BUTTON CONTROL**
- Human Machine Interface (HMI)
- Timer Functions
- 2x Daggerboard Electromechanical Actuators
- 2x Rudder Electromechanical Actuators
- 4x Motor Electronic Speed Controllers
- Master Controller
- Battery Bank
Passive Adaptive system

The L-daggerboards on the SuperFoiler are automatically adjusted by a unique mechanical passive adaptive rake system in combination with the passive geometric stability of the foil. The purpose of this system is to automatically adjust Daggerboard Rake as a function to BoatSpeed and Flight Height above the water.
SuperFoiler - Design Features

Modes of Sailing - Non Foiling

“SkiffCat”
When sailing with the Center Hull wetted, the SuperFoiler can be categorized as a hybrid of a skiff and a multihull, a ‘SkiffCat’. As you start out sailing the SuperFoiler at low speeds, the idea is to accelerate similar to a skiff, balancing the boat on its Center Hull with zero heel and the OutRiggers out of the water (see figure). As boatspeed starts increasing, dynamic lift is generated on the Main Daggerboard to leeward which translates to more righting moment available to sheet the sails harder and generate more thrust from the rig, further increasing speed. When the SuperFoiler reaches 12 knots of boatspeed, enough vertical Lift can be developed from the Main Daggerboard to overcome the total combined mass of the boat and crew and the SuperFoiler transitions to fully foiling, lifting up and flying above the water with no wetted hull area.

Daggerboard Heave or VERTICAL LIFT = \( \frac{1}{2} \rho \text{Area} c_L \text{ speed}^2 \)

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SuperFoiler - Design Features

Modes of Sailing - **FULL foILING**

**Rudder Elevators:**
- T-rudders provide pitch stability when foiling or non-foiling
- This improves control and dampens motion in all conditions

**Benefit of Differential Elevator Rake:**
- Rudders can generate additional righting moment if desired, by creating a down-force on the windward Elevator.
- Rudder differential was an important feature of the AC50s in the last America’s Cup.

Maximum Righting Moment 2320 kg-m and up to 3140 kg-m with ElevatorRake Differential

Extra RIGHTING MOMENT from Elevator Differential Rake

Red Graph: Elevators on both sides in sync (same rudder rake)

Green Graph: Maximum allowed rudder rake differential of 3 degrees, increase performance of 9-11%

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SuperFoiler - Design
From Concept to Reality

Concept to Reality - SuperFoiler Sailing in Sydney Harbor for the first time in April 2017
photo credit: Andrea Francolini