MORRELLI & MELVIN
DESIGN • ENGINEERING • YACHT SALES

SuperFoiler Design Introduction

9 January 2017
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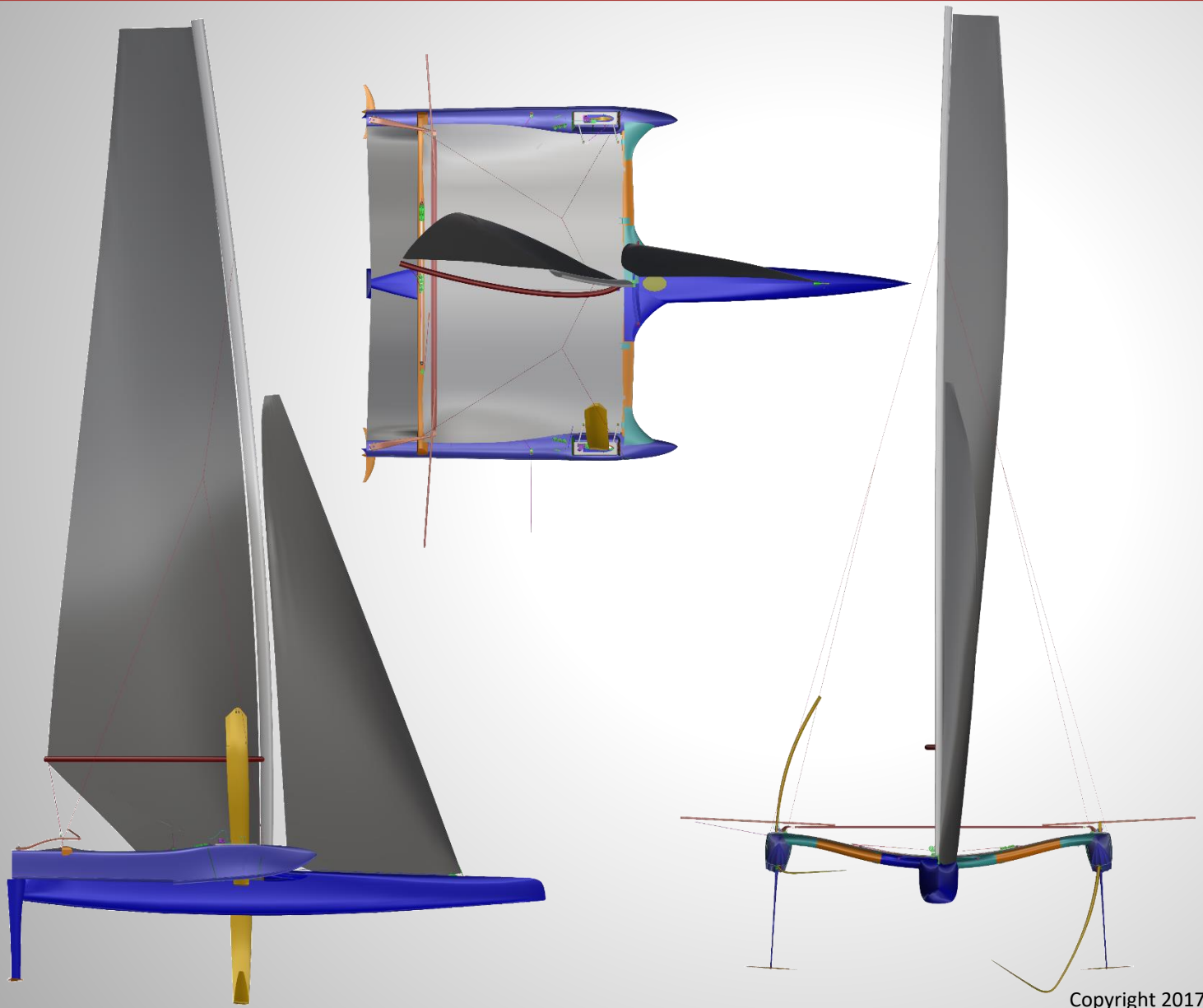
General Arrangement



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:
CarbonFiber Prepreg with Nomex Honey comb 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 Windpspeed Upwind

Background

Background

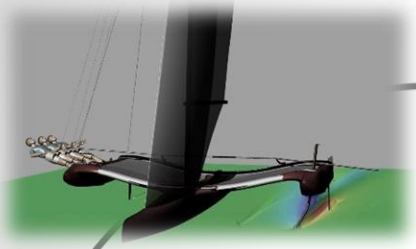
The SuperFoiler concept was developed by the Morrelli & Melvin Design Team (M&M) through the combination of numerous ideas and innovations. The project was initiated by the project founders Bill and Jack Macartney, who simply requested that we develop the most exciting 3 person inshore "sail racer" possible,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

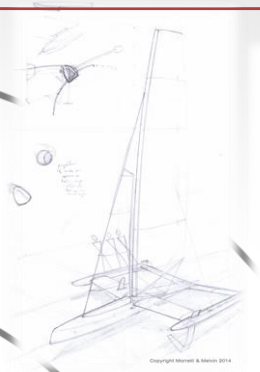
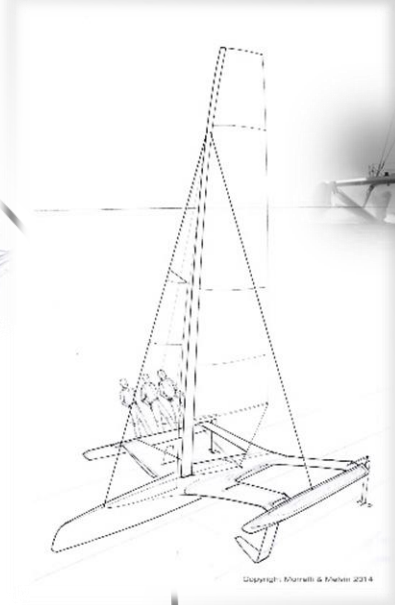
The project started after the 34th America's Cup where course-racing foiling multihulls were introduced mainstream to the public and other production foiling multihulls followed. M&M were responsible for leading the team that developed the AC72 concept and Class Rules of the 34th America's Cup, and were 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.

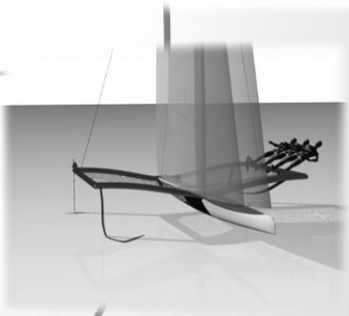
Concept Development

First Conceptional Sketches done by M&M August 2014 and final geometries delivered starting mid-2016











SuperFoiler - Design

Innovations

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

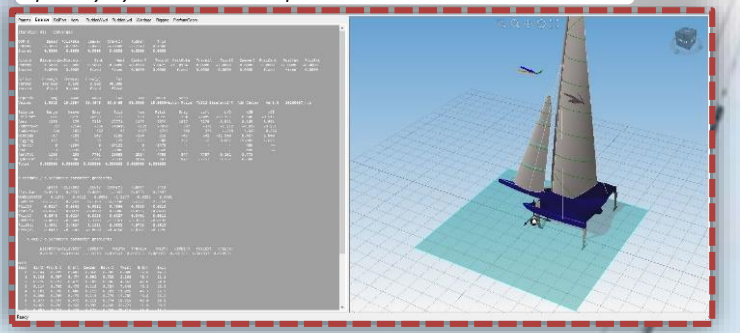
Unconventional Platform design with ***Center Hull*** and ***Outriggers*** with an integrated ***stepped-hull*** shape

SuperFoiler – M&M Design Tools

Computational Design Methodology

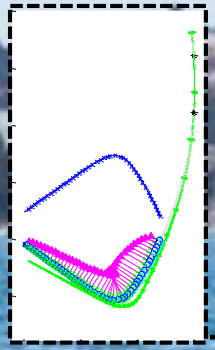
VPP – Velocity Performance Prediction

Solution of force balance requires matrices of data modules for all primary Hydro and Aero components.



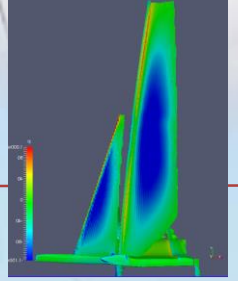
FSI - Fluid Structure Interaction

Initial fluid-structure interaction are run in 3D lifting line tool.

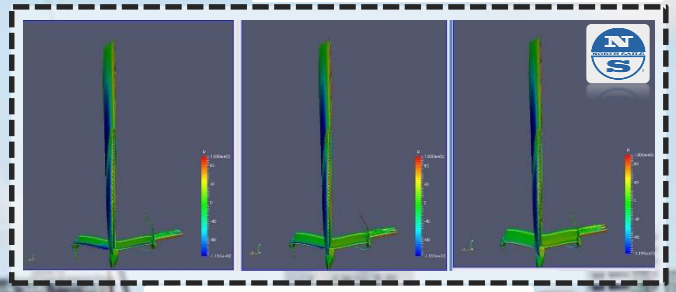


FEA - FINITE ELEMENT ANALYSIS

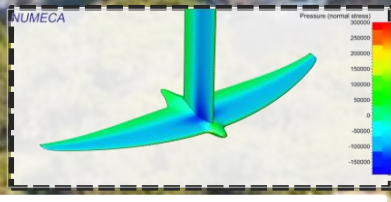
Global platform loading and structural optimization



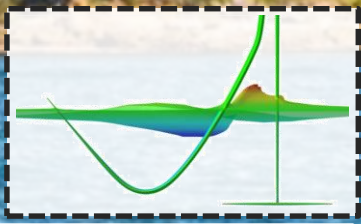
CFD – Computational Fluid Dynamics



Aerodynamic platform optimization

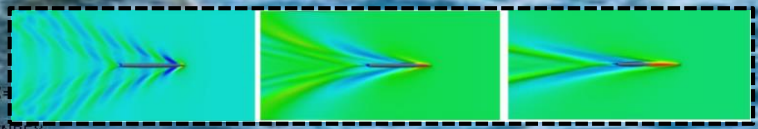


Elevator geometric study and optimization



Design point validation for foil forces

Hull hydrodynamic VPP input matrix



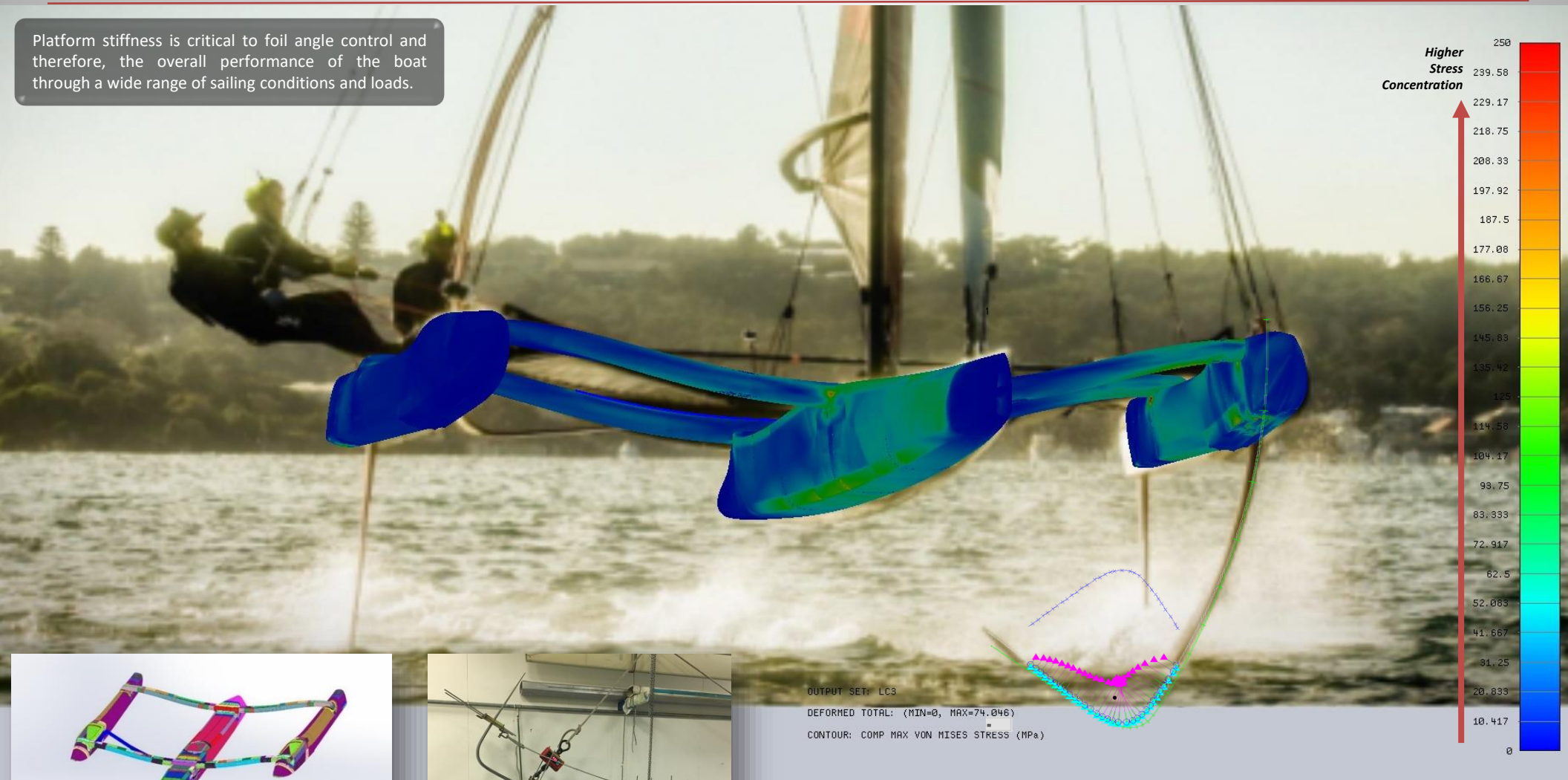
OUTPUT SET: LC3

DEFORMED TOTAL: (MIN=0, MAX=

CONTOUR: COMP MAX FAILURE INDEX

Fluid Structure Interactions

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

Load Testing Validation of Main Daggerboard

SuperFoiler – Design Features

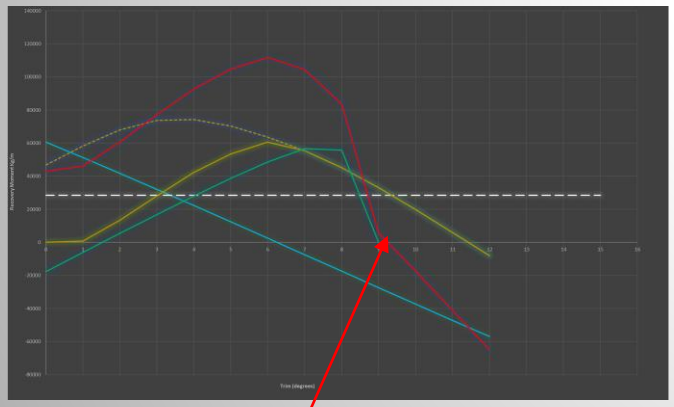
Platform – Pitch Stability

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



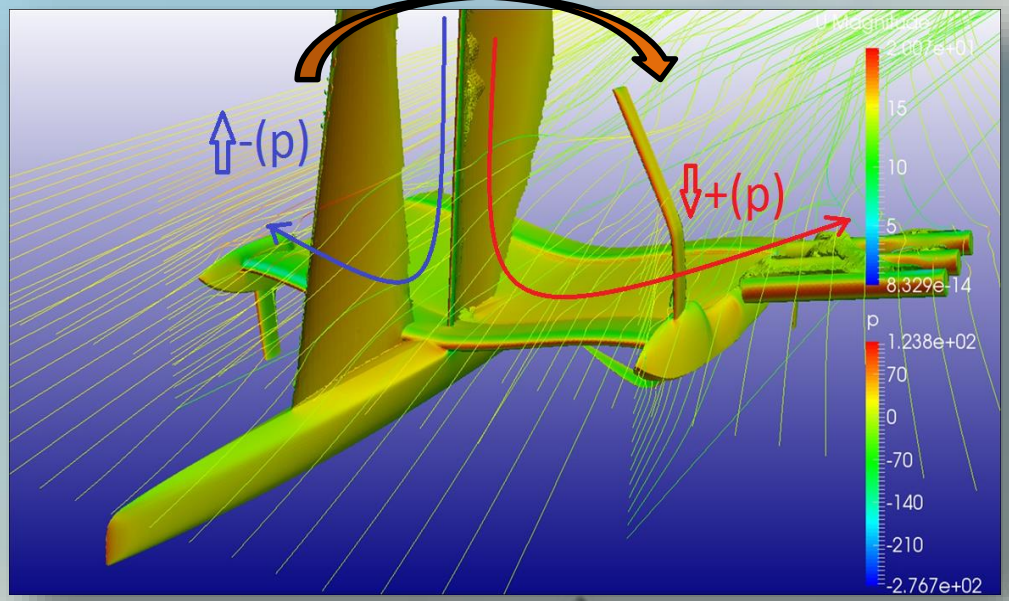
"POINT OF NO RETURN"

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

SuperFoiler – Design Features

Aerodynamically Optimized Configuration

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

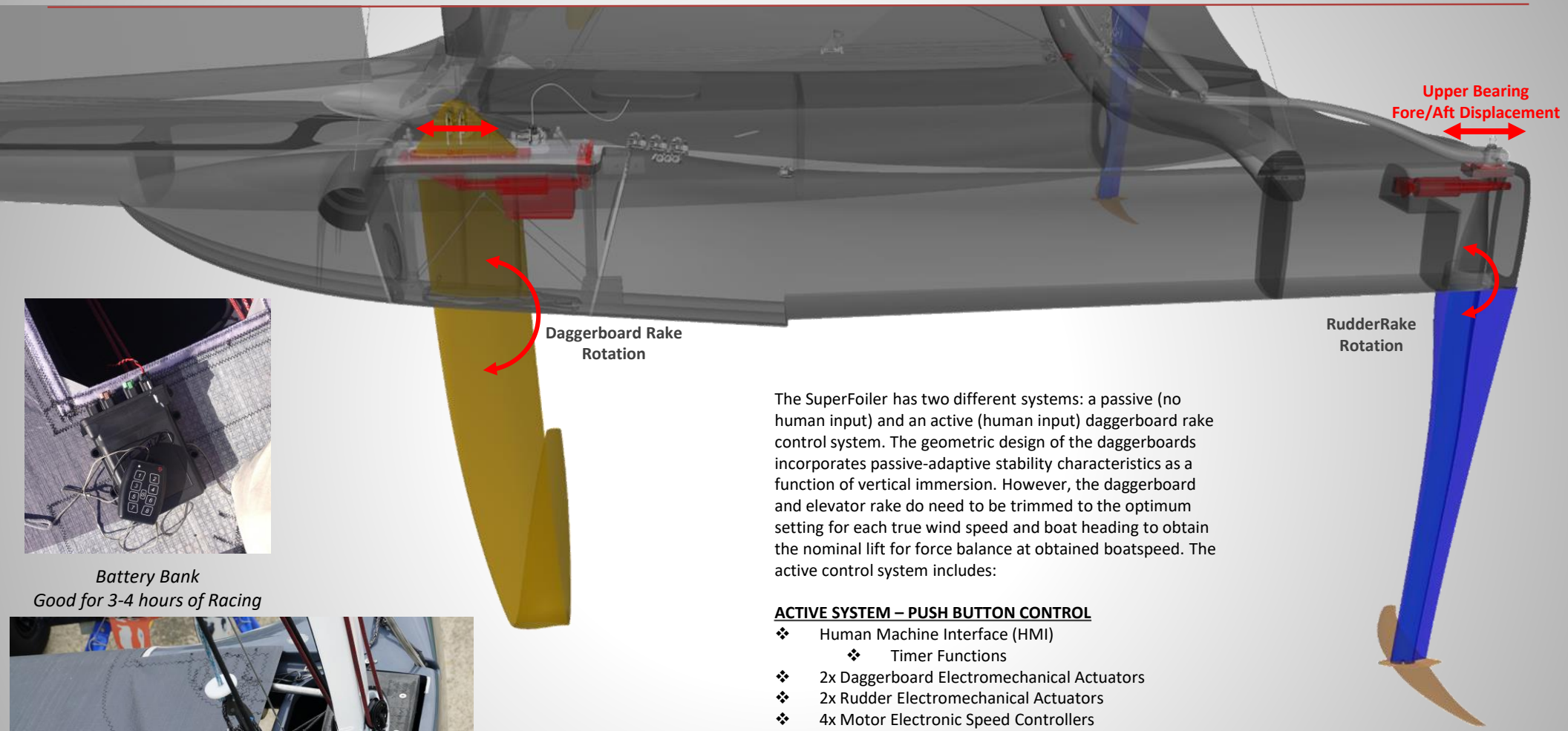


Integrated sail plan & platform geometry optimize overall aerodynamics

- 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

SuperFoiler – Design Features

Daggerboard control system – ACTIVE



Battery Bank
Good for 3-4 hours of Racing

The SuperFoiler has 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:

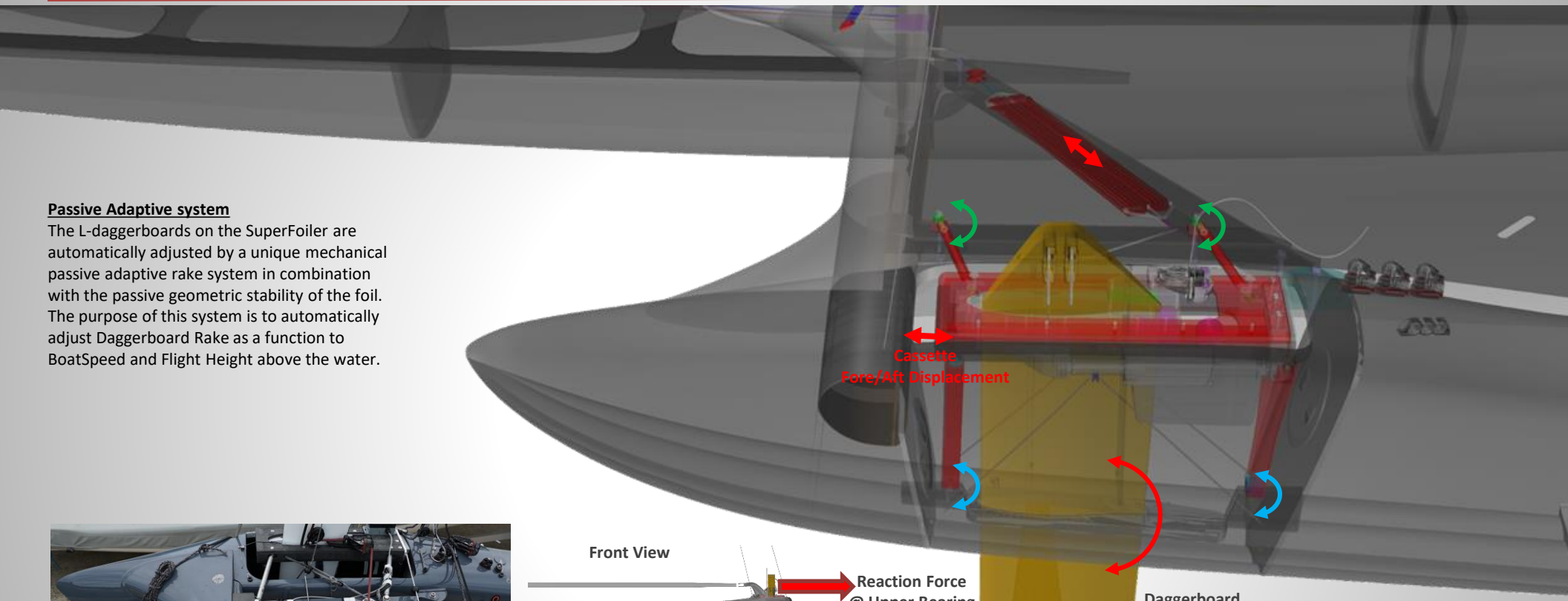
ACTIVE SYSTEM – PUSH BUTTON CONTROL

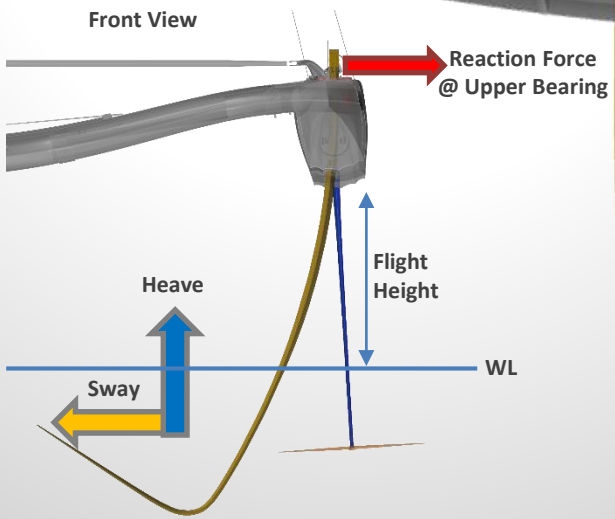
- Human Machine Interface (HMI)
  - Timer Functions
- 2x Daggerboard Electromechanical Actuators
- 2x Rudder Electromechanical Actuators
- 4x Motor Electronic Speed Controllers
- Master Controller
- Battery Bank

Daggerboard control system – PASSIVE

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.

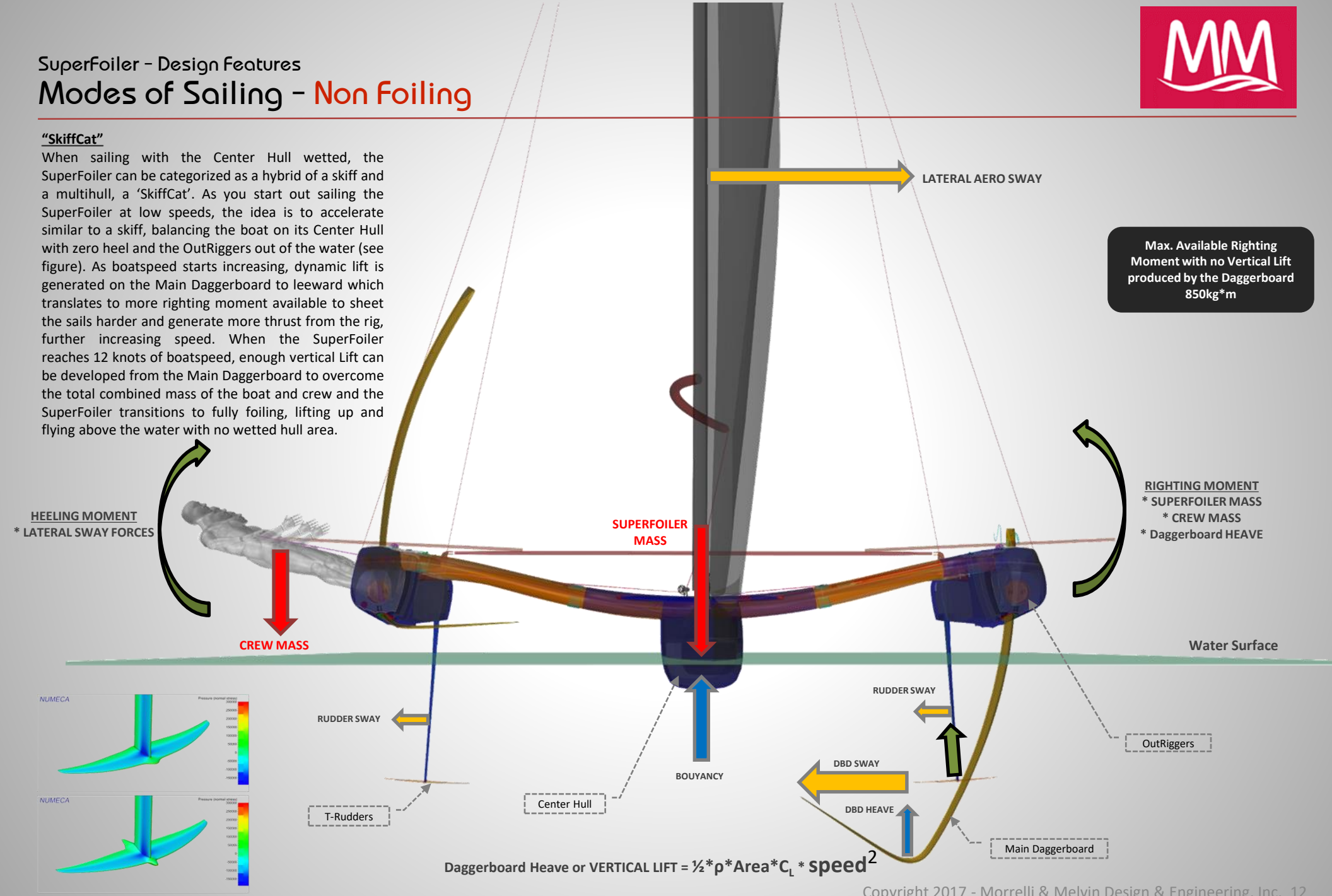




Modes of Sailing – Non Foiling

"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 = ½*ρ*Area*C_L * speed^2

SuperFoiler – Design Features

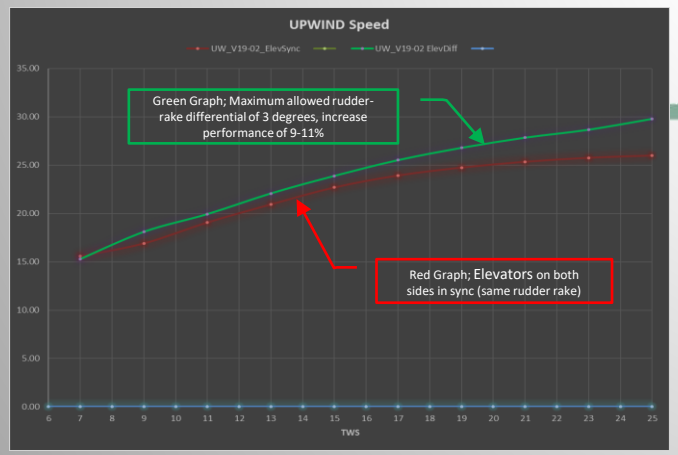
Modes of Sailing – FULL FOILING

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.



LATERAL AERO SWAY

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

HEELING MOMENT
* LATERAL SWAY FORCES
* DAGGERBOARD HEAVE

CREW MASS

RIGHTING MOMENT
*SUPERFOILER MASS
*CREW MASS
*RUDDER HEAVE

Water Surface

T-Rudders

SUPERFOILER MASS

DBD HEAVE

RUDDER SWAY

DBD SWAY

RUDDER HEAVE (with Rudder Differential)

RUDDER HEAVE (with Rudder Differential)

Extra RIGHTING MOMENT from Elevator Differential Rake

From Concept to Reality

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

