



Tripartite Conference 2019

Simon Schofield- CTO
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BAR Technologies

- Formed exploit design knowledge, technical skills and intellectual property developed through involvement in the America's Cup.
- Focused on combining computational analysis, progressive optimisation techniques, advanced materials and control systems design and supply to marine applications.
- Offer access to a cohesive team of world class specialists and develop design tools forefront of marine technological innovation.
- Drawing on our race team heritage, DNA & Motivation







BAR Technologies Offerings

SSEAT- Ship System Efficiency Analysis Tool

SSEAT is a unique tool which combines the accurate simulation and interaction of complete hydrodynamic and ship propulsion systems with bespoke optimising multiple objective performance prediction and routing software.

By design the tool set is of modular fashion, allowing the addition or removal of endless ship hydrodynamic and propulsion 'modules'. This capability enables quick assessment of not only the isolated effect of changes, but their impact on the efficiency of the ship system as a whole.

The fully customisable tool can optimise for and return results in multiple formats such as total operational cost, fuel consumption, CO₂, NO_x and SO_x emissions.

Additionally, the modular nature of the ship system configurator allows potential 'devices' or 'technologies' to be assessed against a constant benchmark whilst ensuring the 'devices' influence over the benchmark is accurately captured.

Hydrodynamic Simulation and Optimization

Solving the current GHG reduction challenges within the shipping industry starts with hydrodynamic efficiency. A more efficient hulls forms the foundation, making the implementation of any emerging technologies easier and more economical.

Bespoke and continually developed progressive optimization methodologies is central to BAR Technologies design philosophy. Our approach, rooted in the latest AI technologies has proven to be key performance differentiator between ourselves and 'traditional' ship optimization methods.

We have a proven record and have never failed to make significant efficiency gains whilst optimizing designs which were claimed to be previously 'optimized'.

Success include % efficiency across operational profile including:-

- International Power Boat Hull Range- 30%
- Platform Supply Vessel- 24% total
- Cruise Ship –17%, (7% LOA bow mod only)
- New Crew Transfer Vessel Concept - 25-55% across speed range

Wind Assistance Technology

Through the development and use of SSEAT testing various wind assisted configurations BAR Technologies has developed a deep understanding of the operational performance profile required of a wind assisted device to maximise efficiency gains.

This knowledge, coupled with over 10 year of high budgets developing R&D project simulating and testing high efficiency sailing wings for the Americas Cup has led to us conceiving a superior wing system for use in commercial shipping.

Whist highly efficient, considerable consideration has been given to the practical limitations of ship operations. When retrofitted to ship and optimised for 'minimal route operational cost' objective over a typical global set of routes and based on historic weather data, an industry leading annual fuel saving of in excess of 30% is predicted.

If fitted to a new build ship designed and optimised for wind assistance technology an annual fuel saving in excess of 50-60% are achievable.

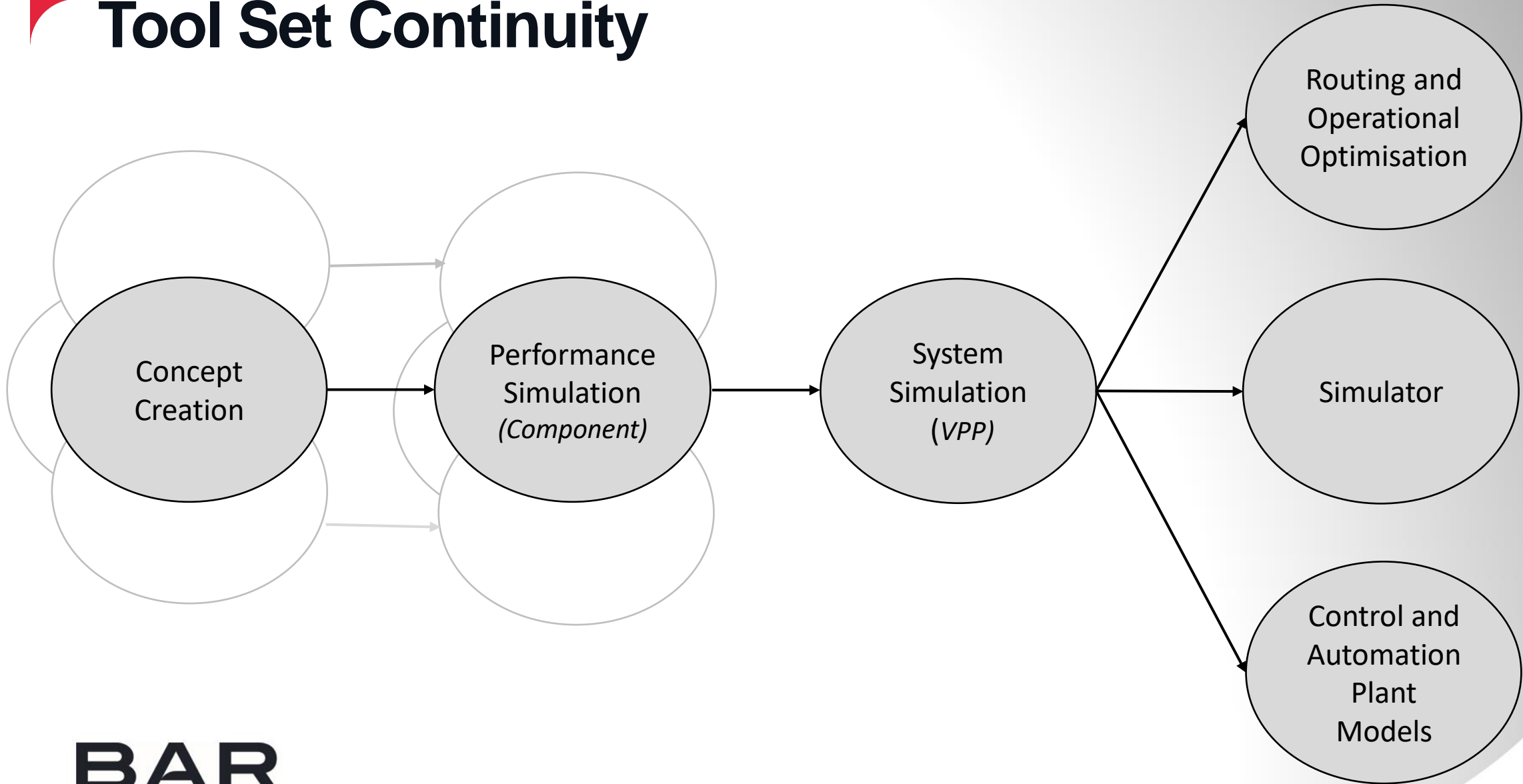


SSEAT ROADMAP

Simon Schofield- CTO

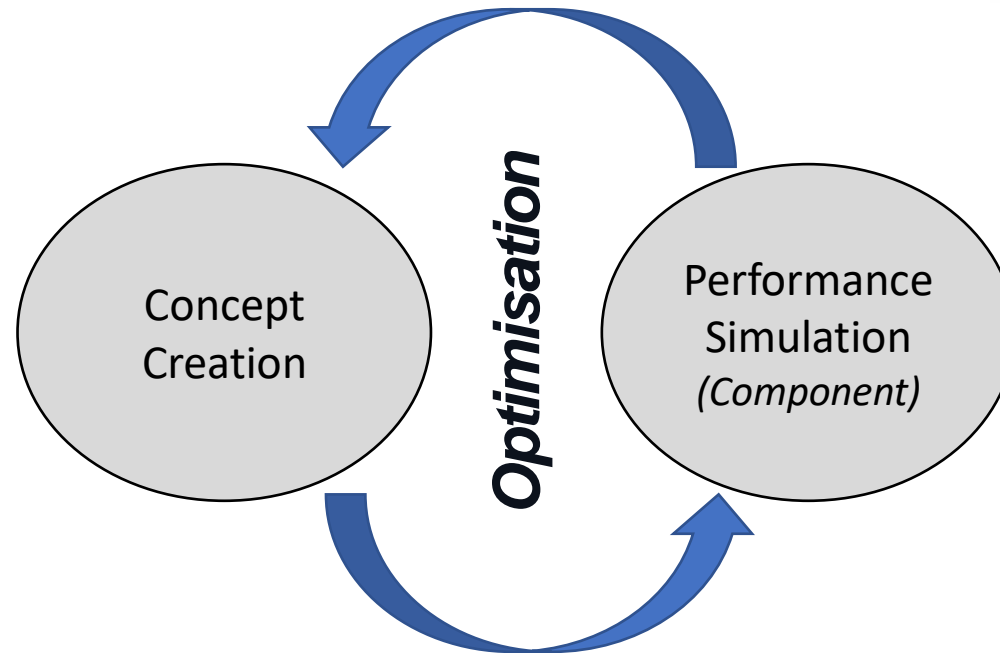
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Tool Set Continuity





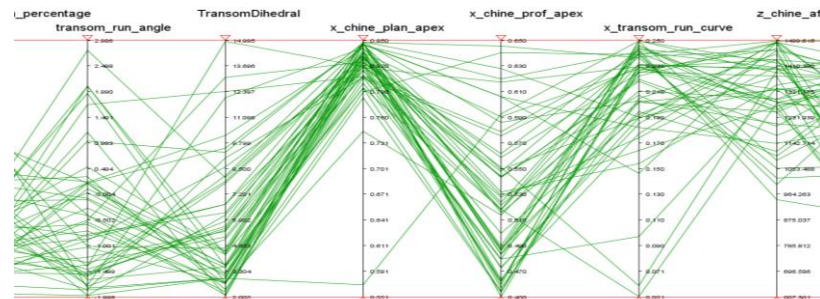
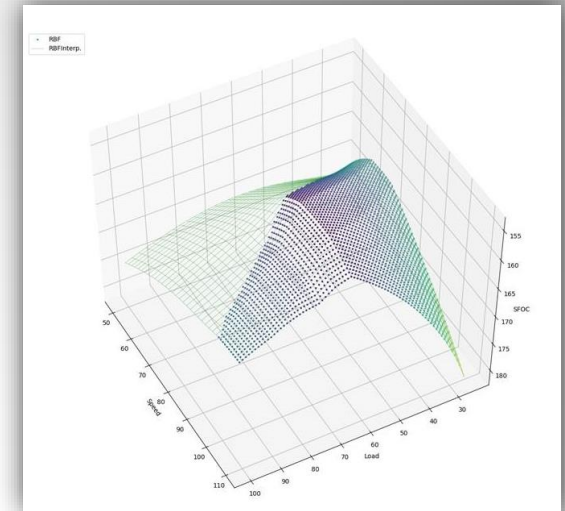
Component Design Optimisation



Component Design Optimisation

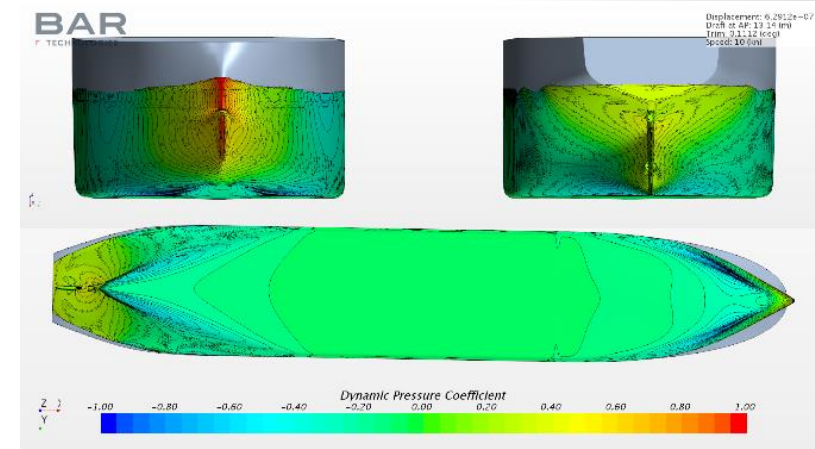
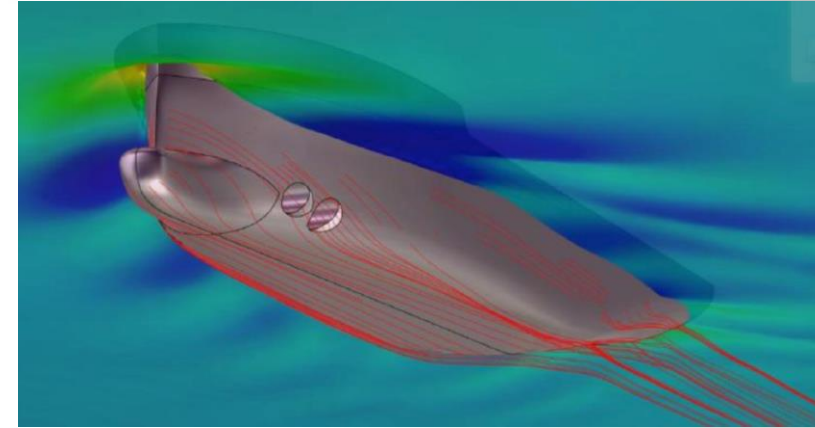
Bespoke and continually developed optimization methodologies is central to our tool sets. Over 10 years of development, Key performance differentiator between ourselves and 'traditional' marine engineering offices.

- One tool doesn't suit all- flexible tool building block which allows quick creation of specific optimization tool
- Large-scale Batch Creation of Parametric Geometries
- Automated and Highly Accurate Simulation Techniques - Primarily RANS CFD based.
- Optimisation Techniques including Progressive Neural Network/AI Techniques which aids multi-objective no stone unturned approach

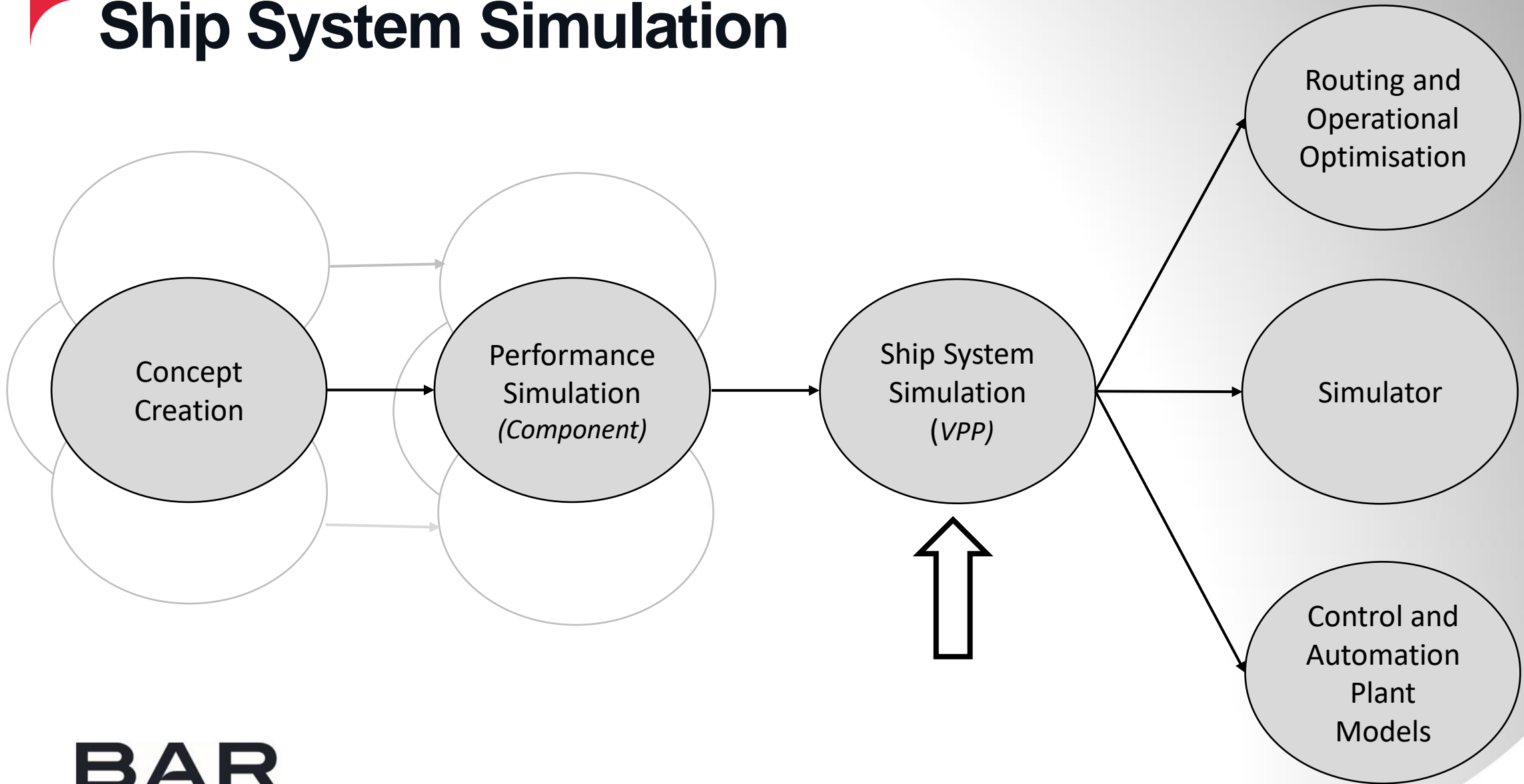


Hull Optimisation

- Proven technique and approach
- Very powerful when applied to ship hulls
- Typically +/- 15 parameter, 10~12 geometrical
- Automated geometric creation and RANs CFD
- AI derived hull shapes
- Multi-objective, weighted performance profile approach – No cliffs
- International Power Boat Hull Range- 30%
- PSV- 10% Hull drag (bow and stern mod), 24% total
- Cruise Ship – 9-17% across operational profile, (7% at bow only)
- New Crew transfer vessel concept up to 25-55% speed dependent



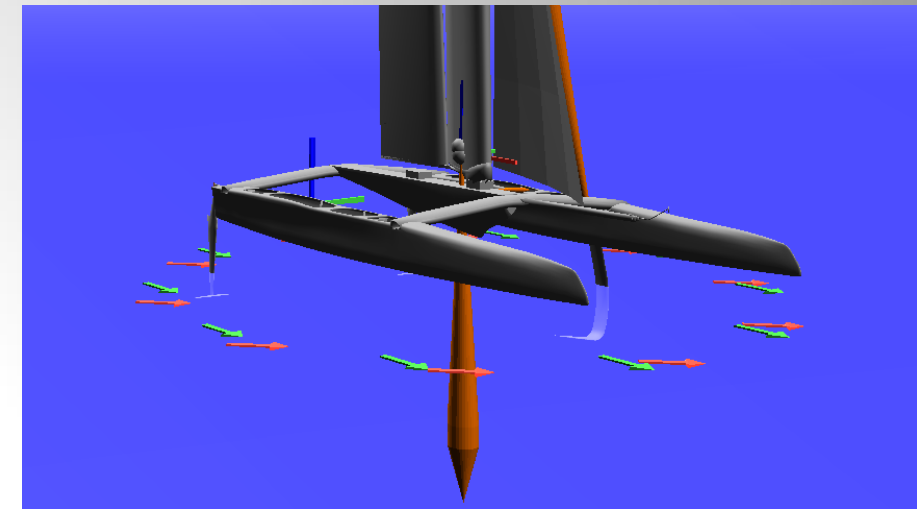
Ship System Simulation



Performance Simulation & Analysis

Dynamic 6 DOF Marine Performance Prediction Software

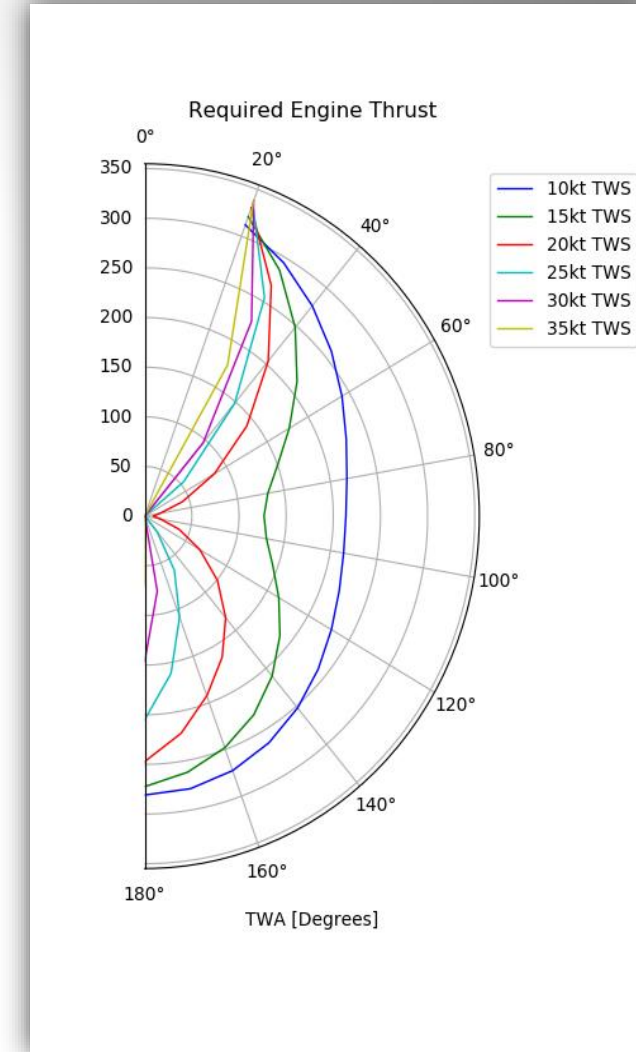
- **FULLY MODULAR**
- Hull and/or appendage models including rudder, bilge board and other devices
- Secondary hydrodynamic devices
- Propeller operational and efficiency model
- Plant model (*which may include information such as engine mussel diagram and operational limits, the inclusion of hybrid capability, shaft alternators, aux generators etc*)
- Aerodynamic force models for aero assistance devices (*models including full trim, twist and depower capabilities*)



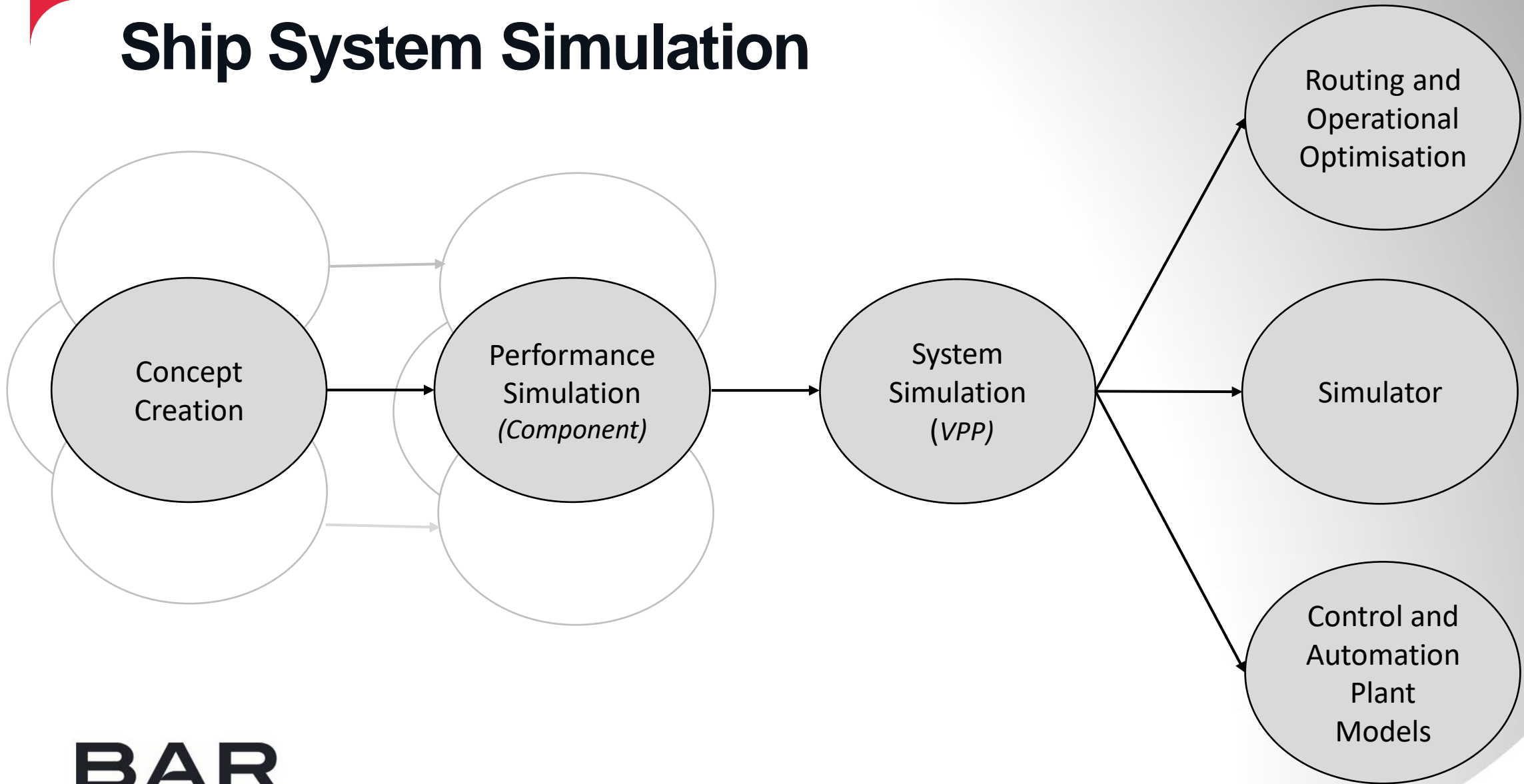
Performance Simulation & Analysis

VPP RETURNS

- *Performance Prediction – for given set of parameter – Polar plots*
- *Static or Dynamic*
- *Can be Self Optimising*
- *Live Interrogatable model*



Ship System Simulation



Custom Routing and Trajectory Optimisation Tool

SSEAT incorporates an inhouse weather routing tool which integrates the custom VPP to directly assess or optimise the route based on various input and output criteria

Considers the ship system holistically and optimises route and ship parameters as one

- Financial models encompassing Opex costs (*i.e. charter day rates, fuel costs, costs of cargo finance etc..*)
- Route models, which are made up of multiple legs and include varying load conditions, any leg duration requirements etc.
- Weighted profiles can be applied to multiple criteria. E.g. *Total trip cost, fuel consumption, CO₂, NO_x and SO_x emissions, leg departure/arrival dates.*
- The tool returns in depth route analysis based on user inputs with route sensitivity studies possible and the ability to select from various route optimisation methodologies





Wind Assisted Ship Study

- Bespoke Hydrodynamic models including leeway, rudder and yaw balanced
- Aerodynamic models including wing trim optimisation algorithm
- Bespoke weather routing simulations
- Dynamic directional stability study
- Single force model change comparisons- the ability to assess the effect on a single system component whilst correctly capturing its effect on the whole ship system

Wind Assisted Ship Study

With a prescribed:

Multi-leg route and loading conditions, weather gribbs and operational financial model

The toolset optimised and reports:

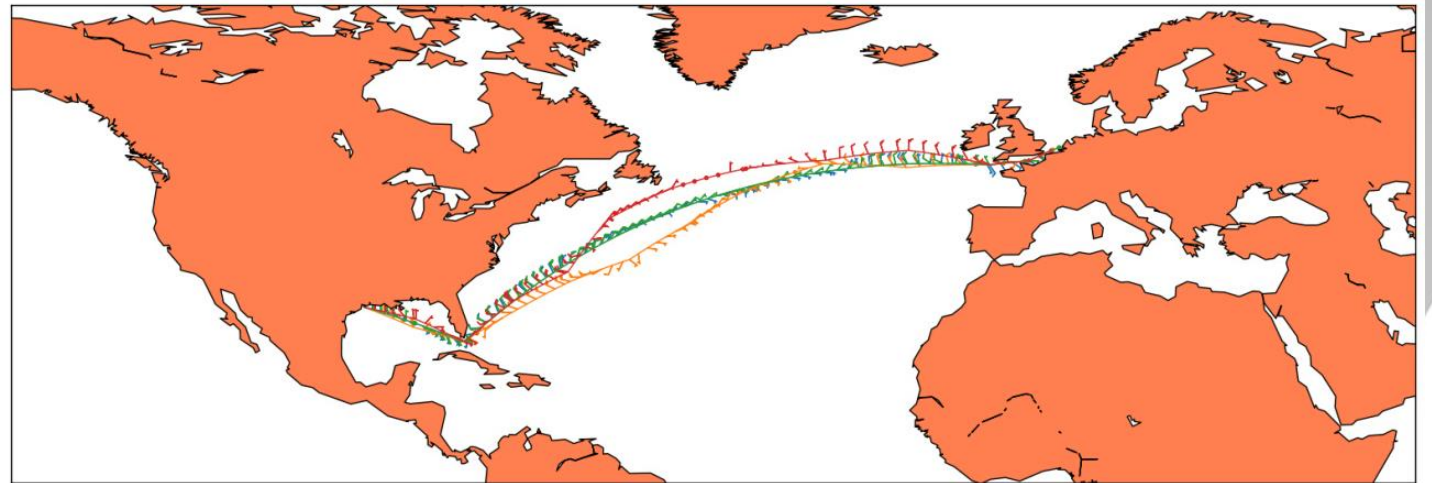
Route, Boatspeed RPM, Shaft Alternator Load, Propeller Pitch, Rudder angle, 3 x Wing Sheet angle, 3 x Wing Camber and 3 x Wing Twist Profile

Whilst maintaining:

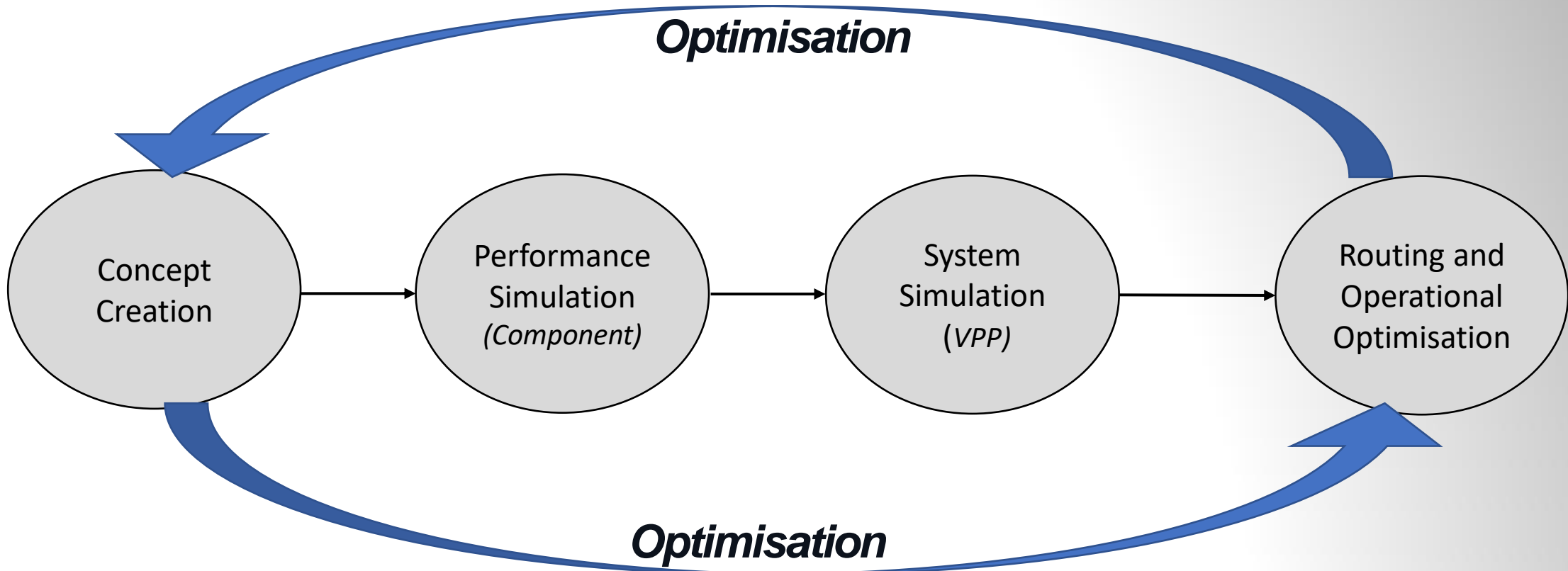
Rudder angle caps and manoeuvrability limits, heel and stability criteria, operational restrictions

To Return:

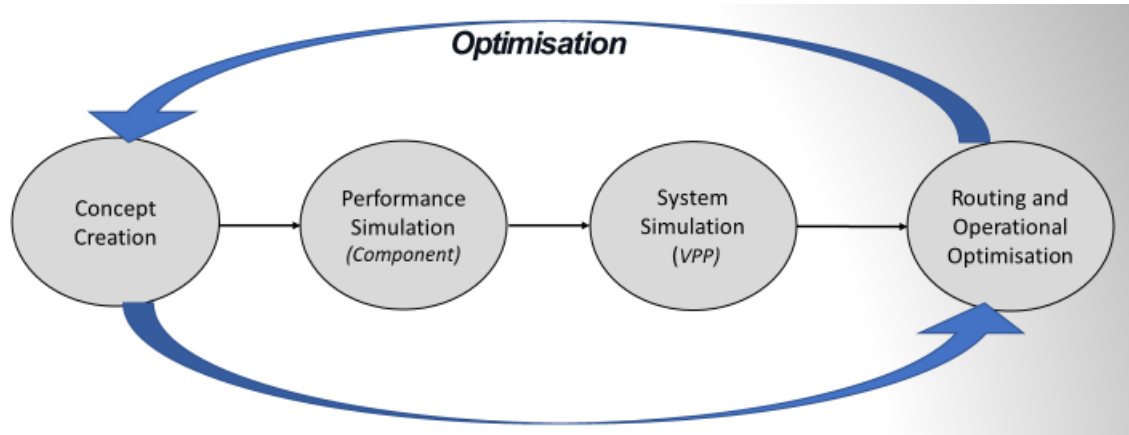
Minimal Operation Cost, Minimal Fuel Consumption



Second Order Optimisation



Second Order Optimisation



Wing sail device development

- 60% the construction of the area of base line design
- 30% reduction in fuel consumption annually over typical global route
- More to come!

BAR

TECHNOLOGIES

THANK YOU

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Company Overview

BAR Technologies

History

- Formed in 2016 to exploit design knowledge, technical skills and intellectual property developed through involvement in the America's Cup.
- Focused on combining computational analysis, progressive optimisation techniques, advanced materials and control systems design and supply to marine applications.
- Offer access to a cohesive team of world class specialists and design tools providing technical excellence at the forefront of marine technological innovation.
- The team has grown with the recruitment of talent from various engineering sectors including grand prix yacht design, motorsport, marine defence, ship research institutes, and oil and gas industries.

Drawing on our race team heritage and DNA to ensure we deliver competitive advantages to our clients and their products.



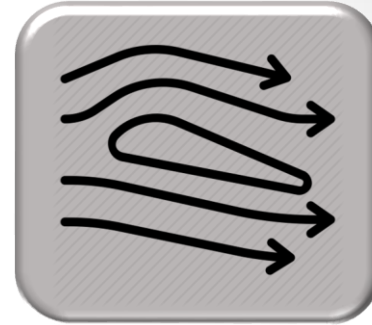
Capabilities



Naval Architecture



Design Optimisation



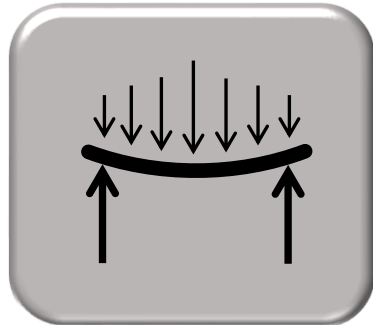
Computational Fluid Dynamics



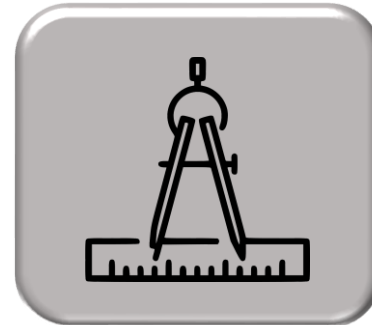
*Performance Simulation
& Analysis*



*Control System Design &
Software Development*



Structural Analysis



*Mechanical, Composite &
Detailed Design*



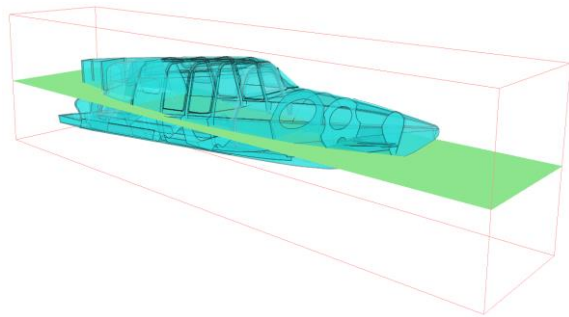
*Project & Supply Chain
Management*



Naval Architecture

Sitting at the core of the majority of projects, modern Naval Architecture is key to ensuring projects deliver technically, to customer requirements and budget.

- User Requirement Management
- Hull Development
- Appendage & Foil Development
- Weight Estimation and Control
- Stability Assessment
- Seakeeping Analysis
- Design Spiral Management
- Parametric Model Development
- GA and Layout Development
- Classification & Classing
- Drive Train Specification
- Model Testing

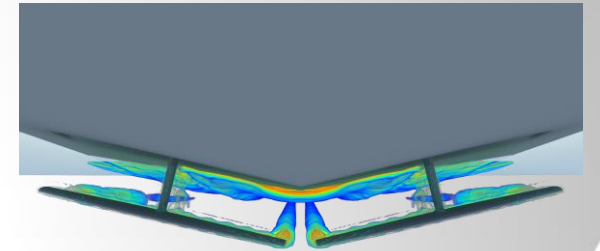
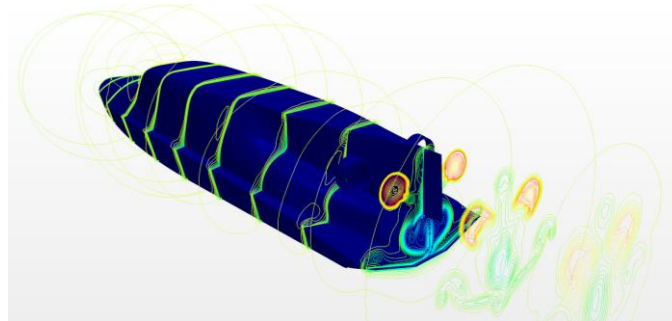
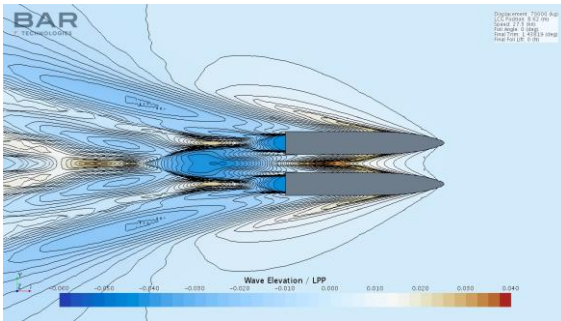




Computational Fluid Dynamics

Our team of aero & hydrodynamicists have state-of-the-art CFD capabilities, a life time of tank testing and validation experience & use best in class software and hardware.

- Flat Water Powering Curves
- Seakeeping and Dynamic Stability Simulations
- Dynamic Manoeuvring Simulations
- Bollard Push, Detailed Propeller Modelling
- Cavitation Simulations
- LES Computations
- Close-coupled FSI methodology with High and Medium Fidelity Toolsets
- Aerodynamic Simulations

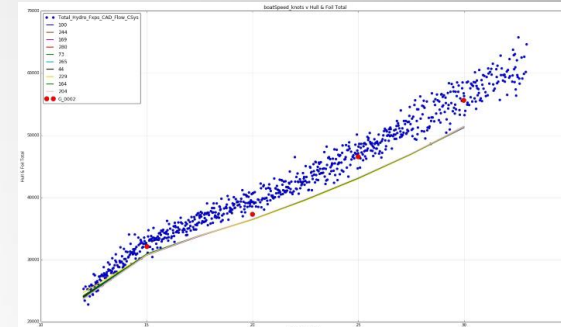
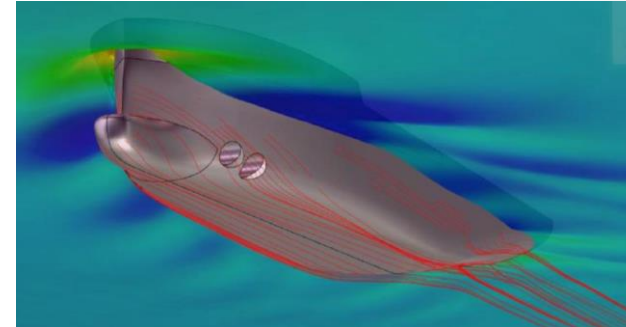
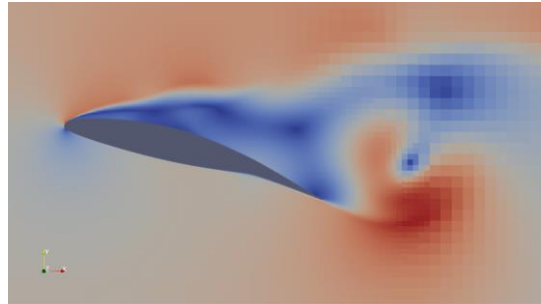
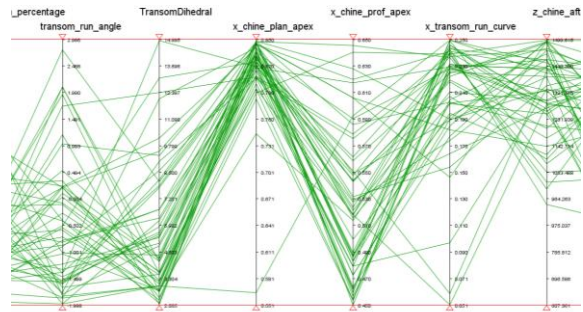




Design Optimisation

Bespoke and continually developed optimisation methodologies is central to BAR Technologies design philosophy. Our approach is proven to be key performance differentiator between ourselves and 'traditional' marine engineering offices.

- Project Specific Optimisation Tool Development
- Large-scale Batch Creation of Parametric Geometries
- Automated and Highly Accurate Simulation Techniques
- Heuristic Optimisation Techniques including Progressive Neural Network/AI Techniques

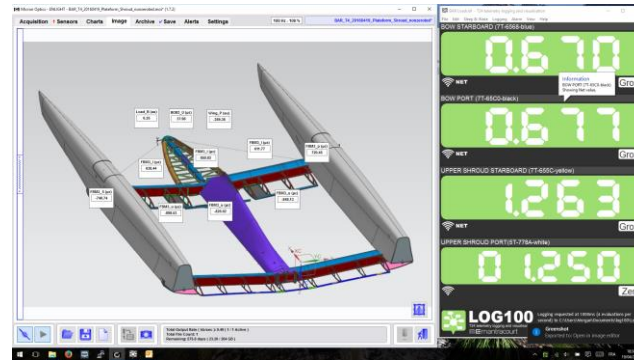
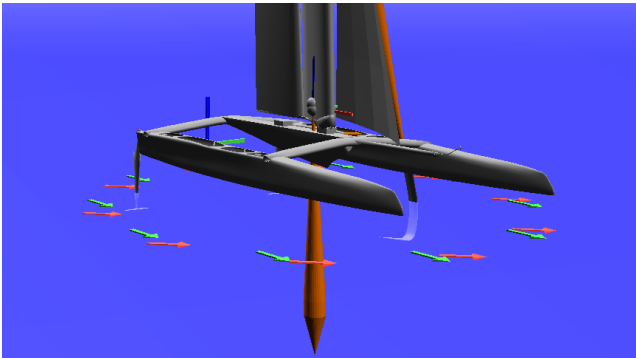




Performance Simulation & Analysis

Combining numerical simulation specialists with bespoke and agile tools sets which are developed and configured to the specific requirements of each project.

- World Leading Dynamic 6 DOF Marine Performance Prediction software
- Custom Routing and Trajectory Optimisation Tools
- Suite of In-house Data collection, Analysis, Verification and Viewing Tools.
- Development of Full Immersion Simulations with Access to Full Motion Platform`

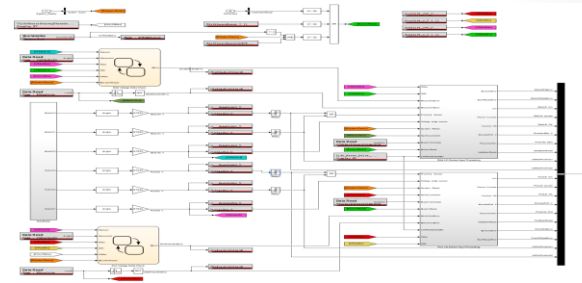
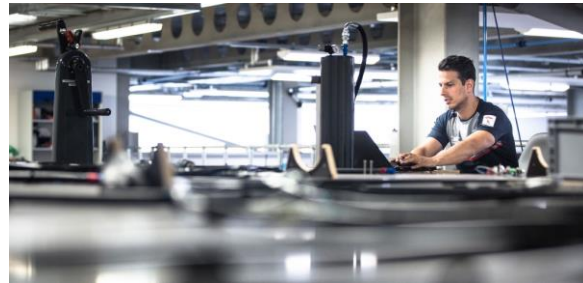


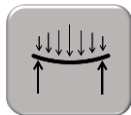


Control System Design & Software Development

Utilising capabilities and expertise imported from the motorsport arena our team harness expertise in electronic & hydraulic systems, telemetry, software, sensor technology, simulation and predictive analytics to provide integrated, intelligent control solutions which are a step ahead of current marine solutions.

- Embedded Control Software and ECU Development & Supply
- Control Strategy Development and Electronic/Hydraulic Configuration
- Agile Software Development Processes & Model based design and development
- Distributed Control, Continuous integration and SIL, MIL and HIL testing
- Automotive and Marine Network Communication Protocols

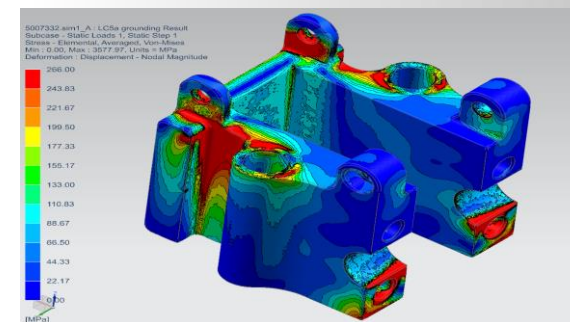
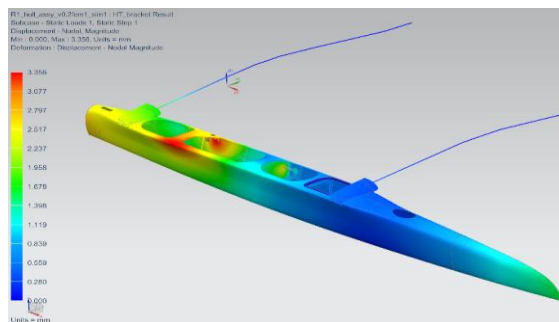
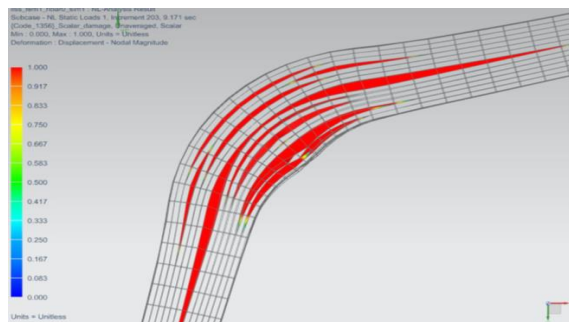




Structural Analysis

Fully integrated into the detailed development team our structural engineers ensure designs are structurally efficient in concept and optimised in detail. Equally versed in both composite and metallic structure our teams tools and skills include:

- Integrated parametric structural solution
- NX Nastran Linear/Non-Linear Static, Optimisation & Advanced Non-Linear Implicit and Explicit Solvers
- SAMCEF for Progressive Through Thickness Failure Analysis
- FEmap for Pre/Post Processing Aero/Hydro Elastic Models
- Custom 'LaminatorKit' for Local Composite Reinforcement Modelling
- Coupled Multi-Object Optimisers
- Design to Classification Requirements



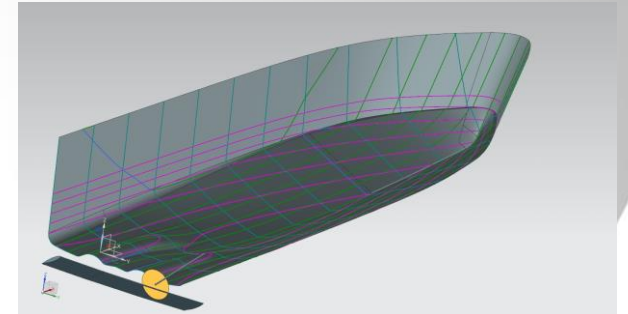
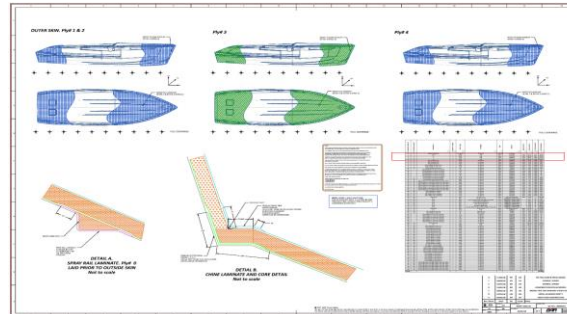


Mechanical , Composite & Detailed Design

To ensure our designs deliver on their potential, our inhouse team of detailed design engineers balance complexity with performance gains for individual components according to brief.

Working with a suite of parametric and PLM tools, disciplines covered include:

- Mechanical Engineering on assembly and detailed component level
- Hydraulic and Electrical Engineers
- Composite Design
- Class A Surfacing Capabilities





Project & Supply Chain Management

In addition to design and engineering consultancy services BAR Technologies also offer full project and supply chain management services to aid the facilitation and implementation of new technologies.

- Design Specification, FMEA, PFMEA, HAZAID & Safety Case Development and Management
- The Design, Supply and Development of Product Prototypes
- Sourcing, Assembly, Supply and Commissioning of:
 - Mechanical Components (including Additive Manufacturing Techniques)
 - Composite Structures
 - Control Systems
- Project Management, Build Supervision and Yard Inspections



Industry Sectors

Leisure Marine

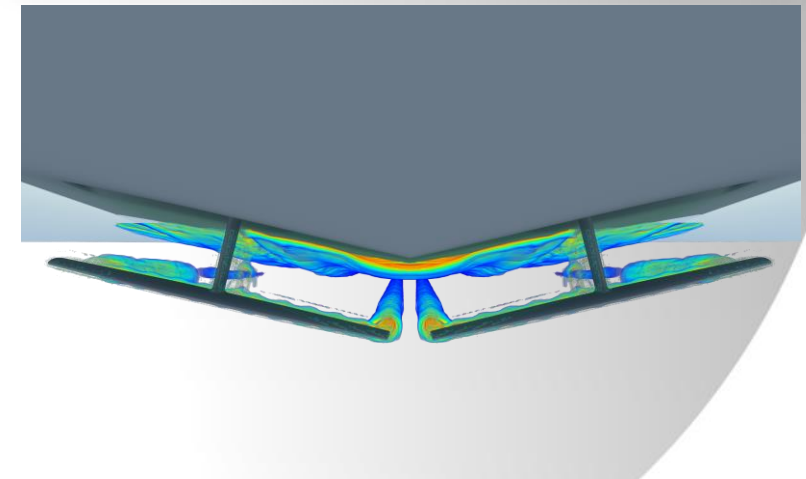
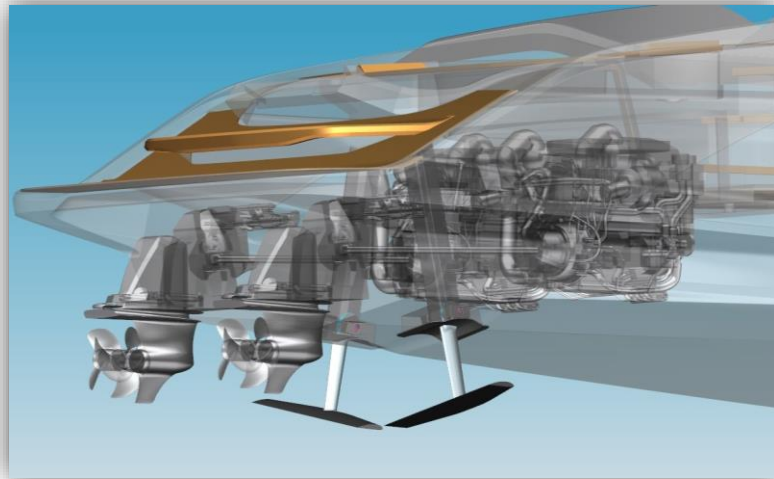
*Performance /
Super Yachts*

*Commercial/
Defence*

Heavy Marine

Foil Optimised Stability Systems

- FOSS Concept Inception and Development
- Hull & Foil Optimisation
- CFD Analysis & Performance Simulation
- Full Vessel Composite Design & Engineering
- Foil System Mechanical Design & Engineering
- Active Foil Control System Development
- Prototype Design, Supply and Testing Program
- Experimentation design, conduction and data analysis



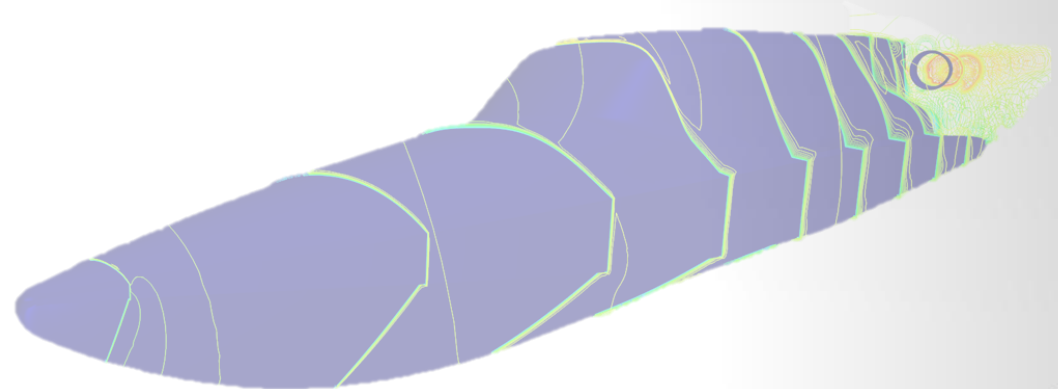
DSS System Design and Supply

- System Layout and Integration
- Composite Case Design and Layout
- Bearing and Actuation Components Mechanical Design
- Detailed Finite Element Analysis
- Board Design & Engineering Consultancy
- Mechanical Assembly Component Supply



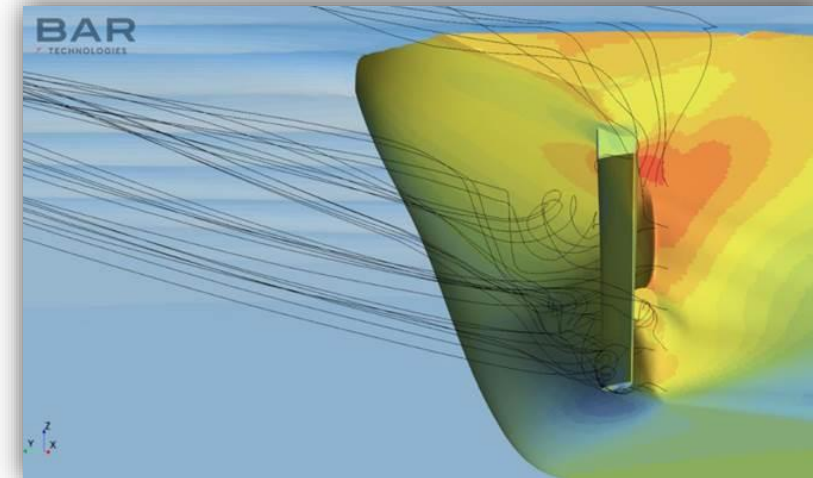
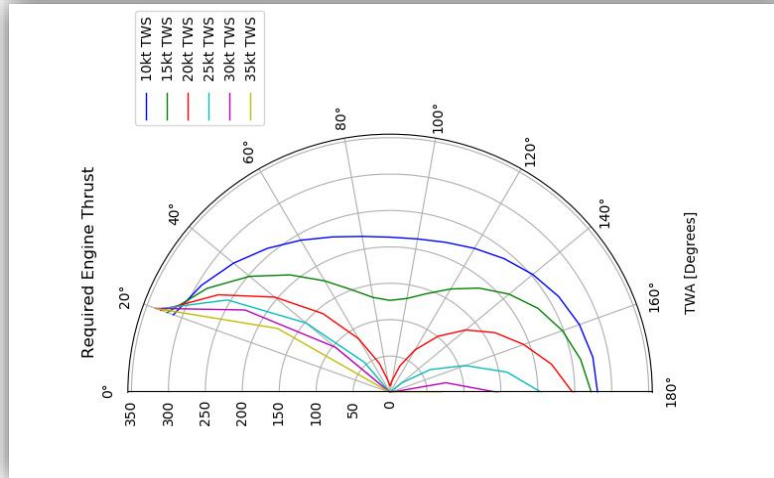
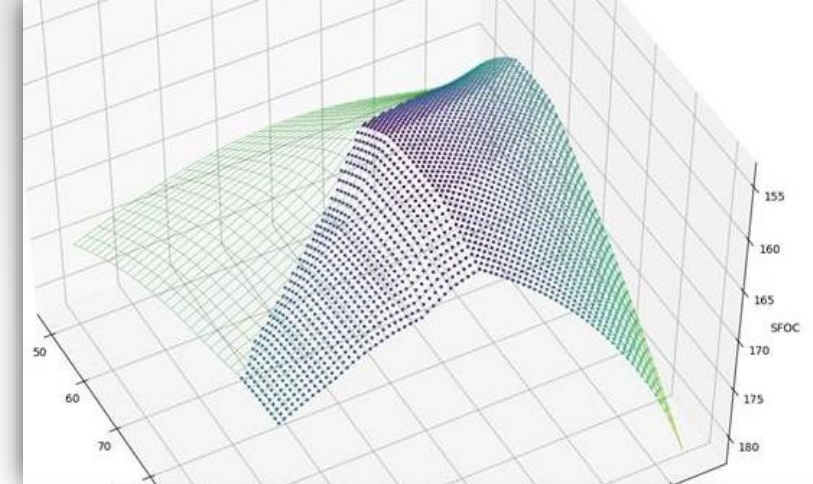
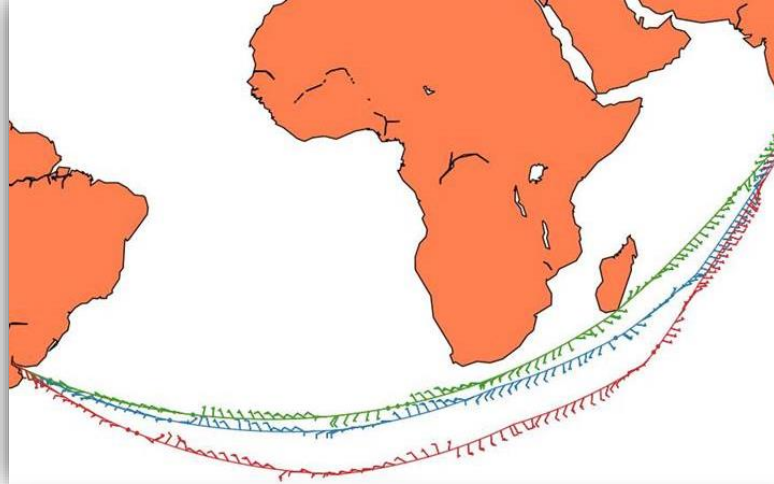
High Speed Insertion Craft / Submarine Hybrid

- Design Concept Development
- Analysis & Performance Simulation
- Extensive Surface and Sub-surface and transient CFD Simulation- Static, Dynamic & Manoeuvring
- Complete Design Package Development
- Surface and Sub-surface Stability modelling
- Control System Specification, Development and Supply
- Mechanical Assembly Design and Specification
- Full Composite Structural Design
- Naval Architecture and Class Submission



Efficiency enhancing and carbon reduction performance analysis for commercial shipping

- High Volume CFD Simulations of Ship hulls, Appendages and Wing sails
- Development of Wing Trim Optimisation Algorithm
- Development of Unique Performance Prediction Tools
- Bespoke Weather Routing Simulations
- System Integration Investigations



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