VesselQUAD®

The most accurate Vessel & Engine Performance Assessment Application

Propulsion Analytics

Who we are

At Propulsion Analytics we specialize in
Performance Management Solutions
for the maritime industry.

We use **thermo–fluid dynamic Simulation models**,
Data analytics & **Machine learning** techniques to provide:

Engine Performance Assessment & Fault Diagnosis

Engine Hyper Cube®

Vessel Performance Assessment

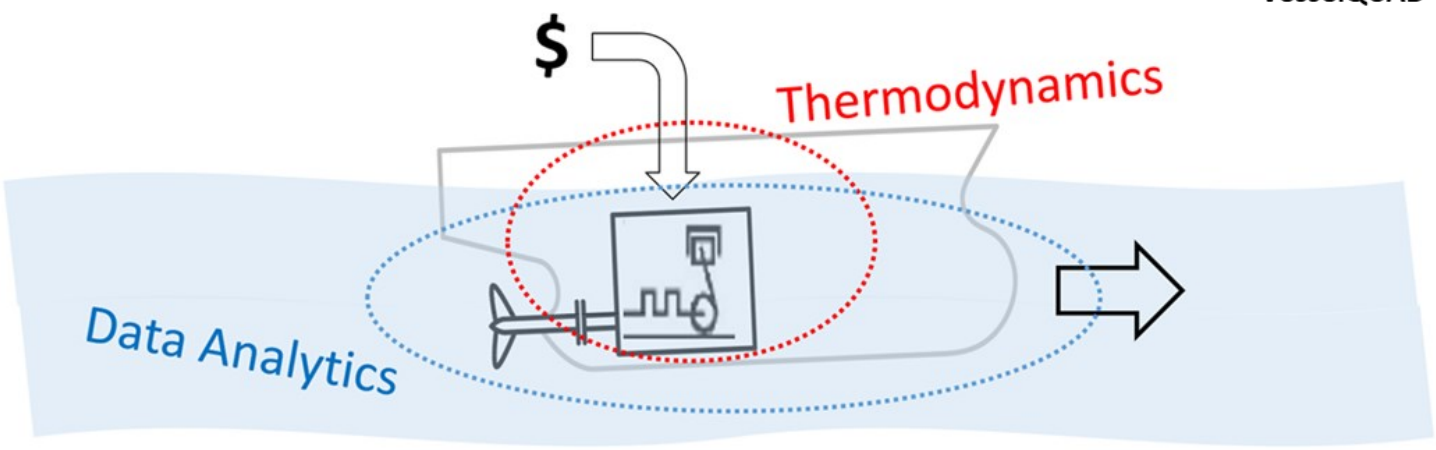
QUAD

Vessel & Engine Performance Evaluation

VesselQUAD®

Propulsion Analytics

VesselQUAD®



Accurate vessel performance is essential for continuous up-to-date Fuel Oil Consumption **(FOC)** prediction, improved, fact-based **hull** and **propeller cleaning decisions** and any assessment of hull/propeller adaptations.

Propulsion Analytics has developed and introduces a novel "**inside-out**" methodology for the **most accurate vessel & engine performance** evaluation. "Inside-out" refers to the fundamental process in ship operation of the conversion of money into **vessel speed.**

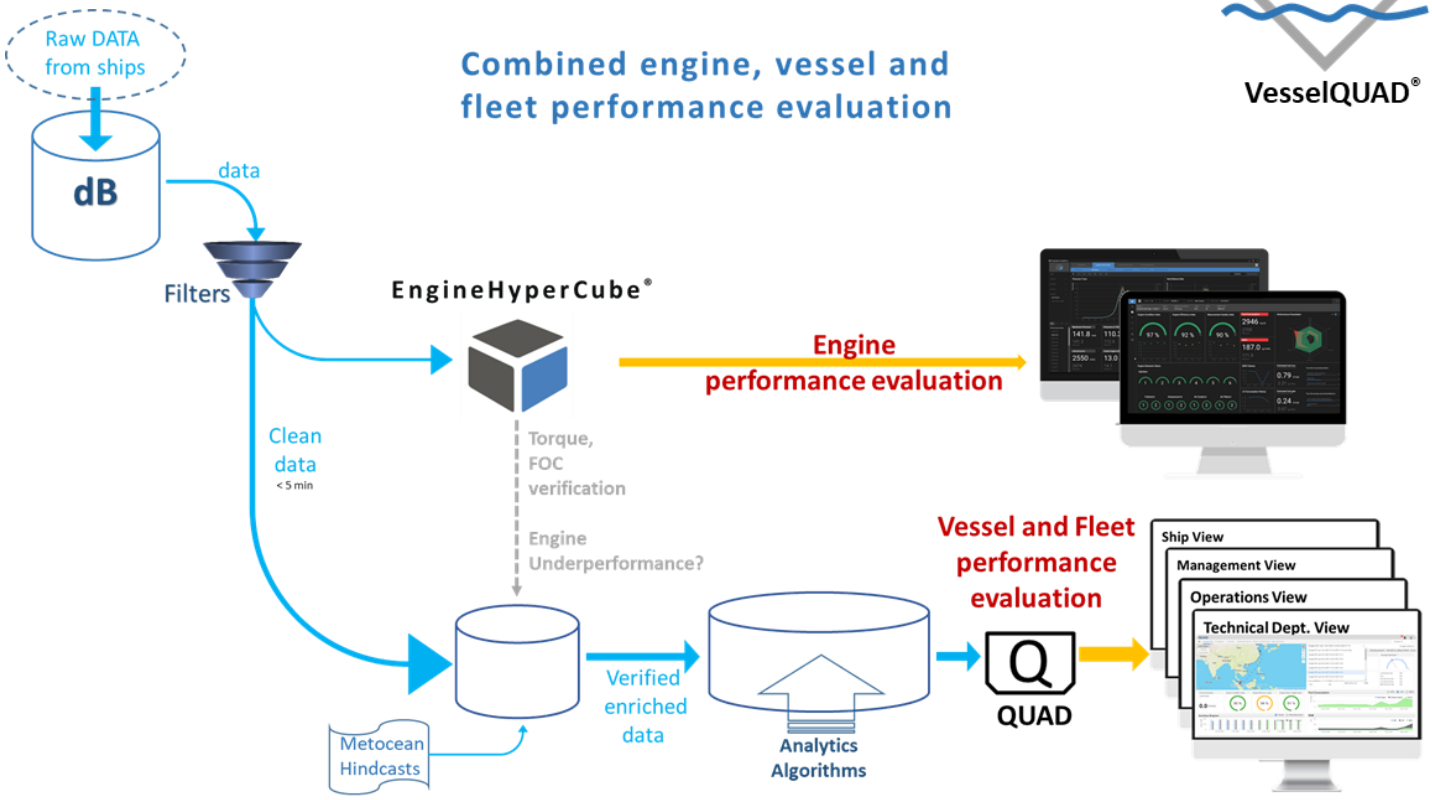
In **VesselQUAD®** the vessel performance evaluation is accomplished through a combination of propulsion engine Thermodynamics, plus Analytics (Machine Learning-ML) on continuous recordings of vessel data, from any third-party onboard data acquisition system.

The inclusion of engine thermodynamics is necessary in order to ensure that the **analytics algorithms** are fed **with highest quality data** attained through consecutive filtering, validation and enrichment of recorded data. This also leads to increased accuracy (>97%) which allows the determination of small changes in FOC (error <3%).

Propulsion Analytics

VesselQUAD®

Combined engine, vessel and fleet performance evaluation



VesselQUAD® validates and augments several important but tricky to measure parameters such as Torque, Power, FOC by high fidelity calculated values produced by the propulsion engine digital-twin application **Engine Hyper Cube®,** which also detects any possible engine faults / underperformance.

The purified and enriched datasets are subsequently scanned in the QUAD vessel performance application using analytics algorithms and Machine Learning techniques, to extract behavior patterns in vessel speed/FOC, deduce profiles in vessel operation and accurately determine the **FOC gradual increase** over time and the **FOC changes** resulting from cleaning or other events.

The **VesselQUAD®** application
integrating *QUAD* with *Engine Hyper Cube®*
can cover with authority, in one package,
the Vessel & Engine
Performance Evaluation
needs of a shipping company.

Propulsion Analytics

VesselQUAD®

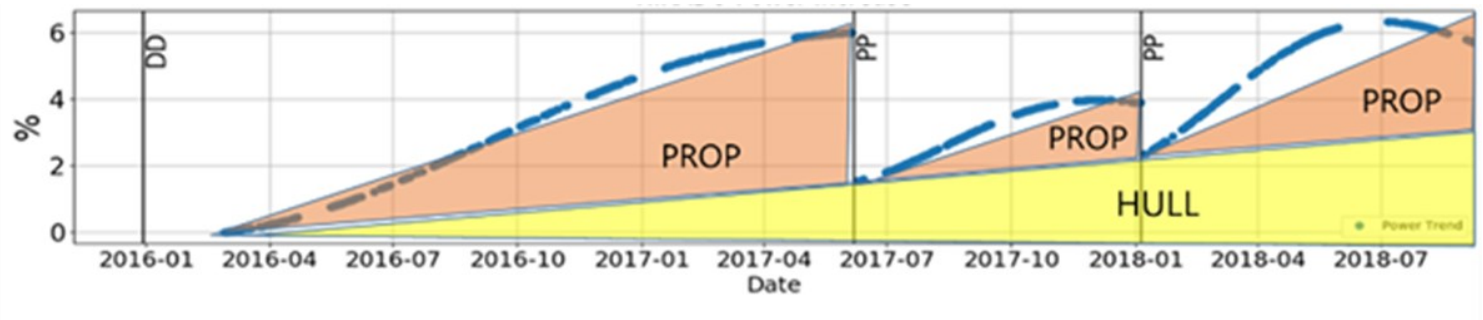
PROPELLER/HULL FOULING DISSECTION

The assessment of the relative contribution from propeller and hull to the overall fouling penalty is required primarily for decision support in cleaning actions.

As the fouling is a slow developing phenomenon, the fouling related FOC increase cannot be detected by conventional methods.

VesselQUAD®, the **most accurate** Vessel and Engine Performance Assessment Application, uses thermodynamics on the propulsion engine in order to validate and supplement torque and FOC measurements. This, combined with Machine Learning, evaluates the evolution of fouling penalty over time, & the effectiveness of each cleaning action.

The detailed analysis leads to charting of power demand increase over time:



The **analytics algorithms** use the data recordings from the periods shortly before or after a major event as “training” to create a reference and then scrutinize the power demand for each subsequent sailing condition.

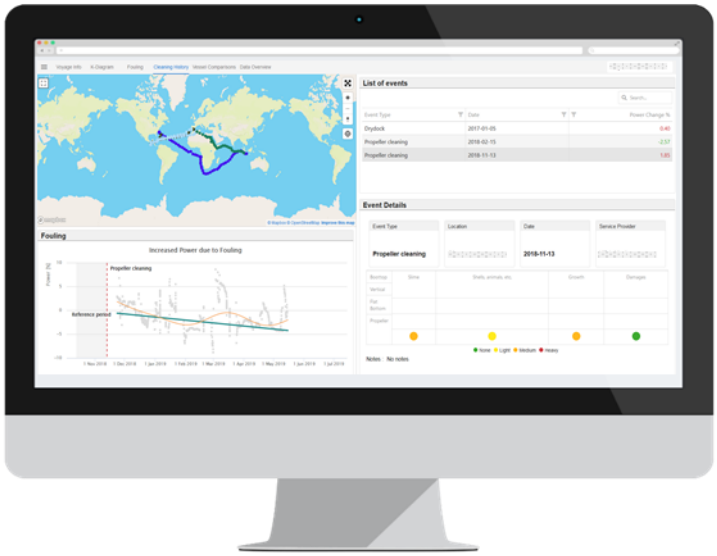
The algorithms remove the effects of weather conditions and vessel attitude and extricate the pattern of the slow developing **overconsumption** due to f**ouling** over time.

The slope between events signifies the **rate of fouling increase.** After a period of time **VesselQUAD®** will amass sufficient data to also stratify and reveal accurately the effects of composite cleaning events.

Propulsion Analytics

VesselQUAD®

EVALUATION OF ENERGY SAVINGS



The evaluation of vessel retrofits for propulsion system optimization, such as propeller ducts, fins, bulbs influencing the torque to thrust conversion, as well as **various hull resistance reduction** measures, is an intricate task due to the complex interaction of many parameters.

The Propulsion Analytics "inside-out" methodology in the **VesselQUAD®** application links the engine power to resulting speed/FOC patterns with very high precision, allowing skimming the datasets via Machine Learning and separating any small changes in FOC before and after, thus allowing accurate assessment of the retrofits.

CLEANING EVENT EVALUATION

Cleaning events are characterized by several items such as:

- Type (propeller cleaning, combination propeller/hull, hull portions)
- Technique (type of brushes, usage)
- Contractor
- Location
- Cost, etc.

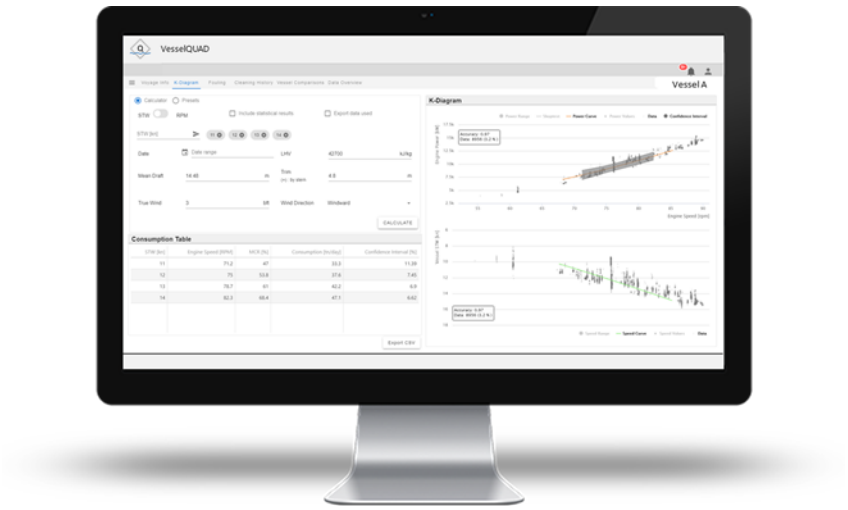
Meta-data on the cleaning event characteristics, allows further profiling and evaluation of different geolocation, contractors and techniques.

The cleaning event evaluation and related KPI in the **VesselQUAD®**, involves **comparison of FOC before/after**. It has been found that propeller cleaning events usually result in approximately 1.5-3% improvement in FOC. Such a comparison is only possible with accuracies >97% in prediction (<3% error), which is attainable only with high quality data ensured by this accurate approach combining thermodynamics and Machine Learning.

This applies also to the evaluation of different hull anti-fouling coatings.

Propulsion Analytics

VesselQUAD®



SPEED/FOC TABLES

To achieve the requisite accuracy in FOC estimation, a combination of techniques is used in the QUAD application, involving thermodynamics, statistical analysis and corrections for fuel and operational issues.

In the **VesselQUAD®** application once the raw data has been cleaned and verified, data mining is employed to establish **speed/FOC relations** for any specific hull condition and weather state, also considering any engine underperformance.

In such a way the FOC/speed tables can be produced with authority, to be further used as needed by the shipping company.

TRIM/FOC TABLES

The raw data from the vessel, after cleaning, verification and enrichment are available in a data repository in the **VesselQUAD®** application, as a multitude of sample sets, each sample set obtained at a respective time instant and containing measurements (elements) from respective sensors (Draft, STW, Power, etc.).

Subsequently, using **data mining techniques,** the relations of various parameters of interest can be extracted, based on actual measured ship data.

It is then possible to construct related Tables and a procedure to advise on **Trim so as to minimize Power (FOC)** for a certain ship attitude and conditions.

Propulsion Analytics

CO_2 EMISSIONS INTENSITY DURING OPERATION

The fusion of engine and vessel performance assessment in **VesselQUAD®**, provides the requisite data quality to allow for the detection of even small changes in performance, resulting in the most accurate evaluation.

The **VesselQUAD®** application, when linked to an onboard data-acquisition system, can accurately calculate the actual GHG emissions intensity of a voyage using real operating data. A voyage should be considered from the discharge of the previous cargo to the discharge of the present cargo. The carbon intensity evaluation requires the calculation of CO_2 emissions for a specific transport work.

The engine performance facility Engine Hyper Cube®, can provide at any instant, for any fuel, thermodynamically correct values of:

- Fuel consumption
- CO_2 emissions

The vessel performance facility QUAD can provide :

- Actual Deadweight (or cargo load) for a certain voyage.
- Distance travelled per time-interval using log (STW) and GPS (SOG) speed.
- CO_2/speed projections for a specific hull condition and any intended voyage, cargo loading, weather (for clean & fouled vessel).

To assess the climate alignment of a single voyage of a vessel, the voyage carbon intensity can subsequently be compared with the decarbonization trajectory for its respective ship type and class. Supplemental comparisons of CO_2 emissions intensity can be made on sister vessels and across a fleet.

Aggregates of vessel or fleet emissions intensity over any time period, such as per day or per year, can be composed.

Propulsion Analytics

CO_2 EMISSIONS REDUCTION OPTIONS EVALUATION

The **VesselQUAD®** application can provide a true baseline for subsequently benchmarking a GHG emission reduction SEEMP plan.

It can provide accurate ex post evaluation of any effected measures for emissions reduction, such as engine power limitations or efficiency improvements, alternative fuels, operational changes, such as slow steaming or weather routing, as well as vessel related measures, such as hull friction reduction and propeller thrust improvements.

The **VesselQUAD®** methodology is future proof. The engine performance core is reconfigurable and can account for practically any retrofit on the engine, such as derating measures, turbocharger upgrades, auto-tuning, eco cams and nozzles, but also future hybrid thermal/electric arrangements.

Any vessel effected retrofits, aiming to reduce the thermal power demand for propulsion, including even futuristic measures for creating thrust such as sails, foils etc., will lead to different behavior patterns and will be evidenced in the incoming monitoring data. This will be picked up by the analytics (machine learning) algorithms and then reflected in the CO_2 emissions intensity calculation.

Propulsion Analytics


+30 210 45 35 382


info@propulsionanalytics.com


@propulsionanalytics


propulsion analytics