WHERE DIGITALISATION TRENDS MEET MARITIME NEEDS

Monitoring and benchmarking are the key to driving real value from digitalisation in the maritime industry, writes **Panos Theodossopoulos**, CEO, Propulsion Analytics

Monitoring and benchmarking combined in Propulsion Analytics' Engine Hyper Cube dashboard

In today's shipping industry, issues like energy efficiency, condition-based maintenance and asset management are increasingly gaining the attention of ship owners and operators. This leads to the operation of ships under advanced supervision and monitoring in order to improve reliability, safety and economy. In addition, fluctuating oil prices and stricter environmental regulatory frameworks are becoming the norm in which ship owners are called to operate their vessel power plants, often in conditions outside their 'standard' operational envelope.

As a response to all these issues and following what other industries (including power generation, chemical process plants and air transport) have been doing for decades now, the shipping industry is entering the era of asset performance management and condition monitoring. In the digitalisation era, the two pillars that are essential for this are those of monitoring (i.e. measuring) and benchmarking (i.e. comparing with a reference), both equally important towards an end result that brings real value.

Already in 2014, a study by the Energy Institute of UCL noted that among 94 ship owners/operators and management companies, the number one reason (97% of the respondents) for monitoring fuel consumption was to identify potential cost-saving or energy efficiency opportunities. That was followed (at 67%) by benchmarking and target setting purposes. That shows a trend in the industry to become more sensitive and also leverage the developing technology trends. It is interesting to note that the need to satisfy regulatory and legal requirements were ranked much lower. That shows a trend in the industry to become more sensitive and also leverage the developing technology trends.

Technology comes to the rescue here. On the monitoring side, the evolution of smart sensors and data acquisition systems, along with advanced telecommunications for transferring data from such systems (whether manually or automatically) to the shore office, provides a solid basis for the primary source of information needed.

However, lack of data is not typically the source of the barrier to effective asset performance management and condition monitoring. "Everything is logged," goes the typical complaint from a shipping company technical manager. "The problem is that the available data is not understood, interpreted or used correctly."

THE SECOND PILLAR

What this technical manager is missing is the second pillar mentioned above - benchmarking. The quality of condition monitoring and performance evaluation depends on the existence of large amounts of reliable data collected over time, as well as the availability of simulation models allowing for generation of the reference and benchmarking points against which these measurements are to be compared. This, in turn, is what produces useful diagnostic and prognostic results. Once again, technology comes to the rescue, as detailed mathematical simulation models in conjunction with big data technologies and machine learning techniques allow the production of all needed benchmarking set of data.

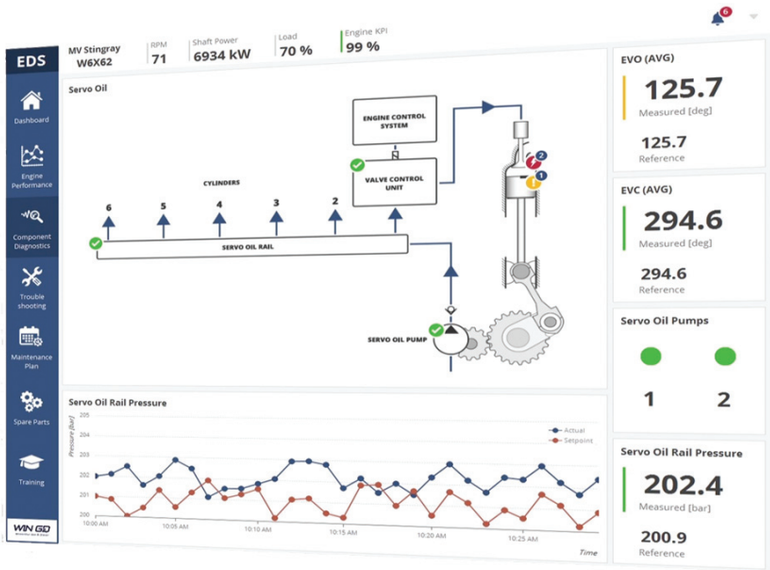
In a Financial Times article in August 2013, Brian Courtney, then general manager of industrial data intelligence at GE Intelligent Platforms, wrote: "Industrial data is used to help us determine the health of our assets, to understand if they are running optimally or if they are in an early stage of decay. Analytics is used to predict future problems, training machines to learn algorithms that can help identify complex anomalies in large data sets that no human could interpret or understand on their own."

Data science, the study of data, brings together mathematics, statistics, data engineering, machine learning, analytics and pattern matching to help us derive meaning from data. All of

these can come together in order to serve the top priorities and concerns of a chief operating officer in a shipping company, namely to minimise downtime and to operate assets in the most efficient way possible.

A typical process of performance monitoring and assessment comprises three steps. In the first step, one collects measurement data from the on-board operation, either in a manual, automatic or most frequently hybrid approach. The quality of data gathered is crucial for the reliability of the analysis and the conclusions to follow, so it is crucial to be able to verify their integrity, either through physical sensor redundancy, which is an expensive path, or through a virtual sensor approach, as we do in our company, allowing the best quality of input to the analysis and evaluation steps.

The analysis phase that follows, shown in step two, is the process of utilising the appropriate reference/benchmarking points against which measurements are compared. This is what then provides the end value shown as performance evaluation, in step three, namely diagnostics, prognostics, optimisation opportunities and information towards condition-based maintenance.



WinGD's advanced engine diagnostics platform builds on modelling and analytics expertise from Propulsion Analytics

THERMODYNAMIC MODELLING

Our company addresses the above process steps, concentrating on benchmarking and performance evaluation, and develops and offers products and services focusing on vessel/engine performance monitoring. It has pioneered the use of thermodynamic simulation models in conjunction with machine learning techniques, for performance assessment, fault diagnosis and optimisation in service.

In the core of our methodology lies our main product, the Engine Hyper Cube, which involves the use of a simulation model for each specific shipboard engine. The model is tuned to be an exact replica (or digital twin) of the actual engine in operation, reflecting the physical relationships of all primary parameters (temperatures, pressures, rpm) and resultant performance values (including, torque, fuel consumption and emissions) and how these are influenced by ambient conditions, load, speed and fuel type at any operating point.

> "Industrial data is used to help us determine the health of our assets, to understand if they are running optimally or if they are in an early stage of decay

When we first started working with our customers, especially for their engine performance needs, we soon realised that the first benefit our products and services offered to them, was the improvement of the process of performance monitoring itself, both in terms of process compliance as well as quality of data input. Numerous process and measurement issues were firstly identified and resolved. It was only when this was in place that the real value of performance assessment and fault diagnostics/prognostics came to light.

Further, we started by using only the routine engine performance data (a standard form, as mandated by the engine designers, typically filled by the on-board engineers once per month for both main engines and auxiliaries). Although this data set remains to be the core source of input for the assessment, we soon realised the value of adding more data into our analysis, component running hours, wear measurements etc. being some of them.

This is where the combination of simulation models with machine learning algorithms comes into the game and allows us to not only analyse performance, but also assist our customers in their maintenance planning - through the prediction of the remaining useful life of components - as well as their overall operations. We are now crossing the thresholds of shipping companies' technical departments and are starting to talk with operations people, since all technical issues and concerns have an operational trade-off.

ADVANCED DIAGNOSTICS

Technologies like the ones mentioned above are not only applied in the shore office environment but are starting to appear in the so-called 'edge' computing space, in our case the vessel itself. Our company collaborated with two-stroke engine developer WinGD to develop an advanced engine diagnostic system as part of the WinGD Digital Expert (WiDE).

The jointly developed system acquires and analyses data on the performance and condition of engines and subcomponents in real time and provides fault diagnosis and live troubleshooting advice to the crew. The data are analysed in real-time using thermophysical simulation models, big data analytics & machine learning techniques as well as expert/knowledge-based algorithms.

The data are further used to improve performance based on load profiles acquired over complete voyages, as well as enabling shipowners to diagnose and troubleshoot abnormalities and integrate maintenance planning and spare parts inventory. A prototype of the system is already in place, with full release across the WinGD engine range forecasted during 2018. First customer orders for delivery in 2018 have already been placed.

Satya Nadella, the CEO of Microsoft in his first email to the Microsoft employees stated: "Our industry does not respect tradition -- it only respects innovation". Perhaps for shipping, a rephrase is needed. Our industry should embrace innovation while respecting tradition.

■ *Propulsion Analytics is an engine performance monitoring supplier that combines thermodynamic simulation models with machine learning techniques. The company operates in Greece and abroad serving a wide spectrum of needs in the shipping industry, from large containership operators to tanker and bulker companies.*