Moving the maritime industry towards a condition-based future

ASSET HEALTH Shipowners and operators can begin to put their work to improve visibility on asset health and performance into context, writes Patrick J Ryan, senior vice president, Engineering and Technology at the classification society ABS.

Just as in the aerospace and automotive sectors, the adoption of ‘smart’ technology continues to accelerate across the maritime sector as shipowners embrace novel systems that provide better visibility of the operating health of their assets.

At present, the transition to smart shipping – in terms of data-driven vessel functions – is being enabled via the adoption of such technologies by leading equipment vendors. Advances in data science enable immediate assessments of shipboard health and performance status and, as these technologies achieve the appropriate maturity level, data-driven functions will transition from supporting crew decision-making to undertaking some or all of the vessel’s daily operations.

Enhanced systems connectivity, growing sensor deployment and advances in data processing and analytics, spur the growth of digital capabilities in the global maritime industry. Increasing amounts of shipboard data, intended to optimise operational practices, extend beyond the human ability to process and therefore require automated functions to obtain useful and timely insights.

The adoption of smart technologies is the first step in the journey that ultimately will lead towards increasing levels of autonomy in the shipping sector. But what exactly are smart technologies? What do they offer the shipowner? And what qualifies as smart?

At this stage of development, it is more instructive to think of smart in terms of functionality that leverages collection, management and analysis of the operational data of a vessel and applies various physics and data-driven techniques that are used to assist the vessel operator to make a variety of better operational decisions.

Depending on the scope and areas on the vessels covered by smart functions, collected data can be utilised for structural and machinery health-monitoring assessment, making crew and onshore personnel aware of the onset of a failure. Often, there are supplementary benefits such as monitoring and maintaining as-designed asset efficiency levels for machines and systems which typically degrade with time (such as engine fouling and performance degradation, biofouling for hulls) and operational performance management of onboard systems to maximise the asset’s performance under current efficiency levels.

Furthermore, in addition to health monitoring, smart functionality supports owners and operators by monitoring consumption and consistency of fuels, voyage performance and by collecting information for reports required by ever-evolving environmental regulations.

Because smart technologies increase the visibility of asset health and performance, they reveal pathways to both more sustainable and more dependable operations. But connecting the smart journey with sustainability requires more than simply attaching sensors to key equipment and reading the output.

How marine assets are designed and managed

In many respects, the original equipment manufacturers (OEMs) have led the transition to smart shipping. For several years some of the leading engine-makers have been offering services that put their client’s data in the cloud, from where they apply their proprietary approaches to observe and assess a propulsion unit’s operational health and performance.

The initial analyses used models rooted in physics and engineering, but they are now augmenting this type of approach with data-driven techniques such as machine learning, that offer a more comprehensive understanding of performance and health. These new data-driven monitoring techniques, data analytics applications and a greater ability to stream data for trouble-shooting and operational support are slowly changing how shipowners operate and manage their fleets.
Today’s onboard equipment has hundreds of sensors provided for a variety of purposes, all connected and accessible via a vessel’s automation system, which combined with higher speed connectivity, allows large quantities of data to be continuously generated and assessed.

The smart functionality trend is beginning to have an impact on design principles as well. Traditionally, design evolution was largely reliant on ad-hoc anecdotal feedback and reactive, root cause failure investigation. However, predictive insights brought by data analytics have many OEMs and operators re-evaluating component usage, maintenance, operation design envelopes, and the skills of the operator on a continual basis.

Advanced data analysis is providing manufacturers with an unprecedented visibility into the causes of failures, and they are using that information to provide customers with improved component designs. Smart technology provides the visibility that allows vessel and operational data to be used to assist and augment day-to-day operations and supports the transition to more cost-effective, condition-based maintenance regimes.

Recognising inefficiency, predicting failure
A proliferation of sensor technology coupled with higher speed processing produces a significant amount of operational insights for the shipowner via the scale of data analytics possible today. The output provides better visibility of what normal operations look like; but perhaps more importantly, statistical anomalies alert the operator or system when things may be going wrong or need crew attention at an early stage.

Once ‘normal’ conditions are ‘learned’ from the data model, anomalies are used to detect unusual patterns of behaviour. If properly designed, further analysis can confirm findings such as equipment damage, a shift in operating conditions, or simply a degraded sensor and issues related to data quality.

For example, data can be collected from sensors measuring specific parameters in a propulsion system which have previously affected performance. Based on experience with normal operations and several failures, a monitoring system can identify how an anomaly may be present and can alert the crew to a potential problem when the established boundaries show deviation from ‘normal’.

For the maritime industry to learn how to capitalise more effectively on the new operational insights being generated by the influx of smart technologies, the data scientists at ABS believe the best way to leverage the capabilities of such technology is to marry it with the domain expertise that has the experience to know the difference between a blip in the data and a true problem that the smart systems have identified.

Setting a smart foundation
A shipowner’s plans for smart operations need to be forged from a goal-based framework that is designed to support their corporate strategy. To support the transition, ABS published industry guidance on the implementation of smart functions in 2018, providing a goal-based approach to capturing the benefits of optimising the performance of their assets.

This initial guidance encourages owners to identify why they want a smart function on their asset and what they are aiming to achieve by deploying these technologies and systems. ABS’ approach is designed to focus on individual smart functions and the technologies enabling them to create a framework designed to maximise the benefit of the investment to achieve a defined goal.

Smart functions are grouped into broader categories such as structural health monitoring, machinery health monitoring, operational performance management, asset efficiency monitoring and crew assistance and augmentation, based on key areas of functionality.

Once the goals are determined, they are filtered through a risk framework to establish the principles for validation and verification against which they are assessed. With the framework set up, the focus turns to assessing smart function implementation for candidate vendor equipment through a validation and verification scheme.

The next milestone
The next milestone was laid in April 2019 with the introduction of the ‘ABS Guide for Smart Functions for Marine Vessels and Offshore Units’ (The ABS Smart Guide). These class notations cover smart machinery and structural health monitoring, together with requirements for approval of service providers and their respective hardware and software being utilised for the service delivery.

Smart functions can also lead to increasingly condition-based approaches to both maintenance strategies and class surveys. While the functions themselves are designed to help owners and operators proactively manage asset health and performance, they also make possible increasingly data-driven approach to conducting surveys after construction activity within a condition-based class (CBC) programme. The Guide introduces three new notations that support the recognition of a vessel’s data infrastructure as well as health monitoring functions, which can be used to support survey activity directly.

- Smart INF: data infrastructure for smart function implementation;
- Smart MHM: machinery health monitoring;
- Smart SHM: structural health monitoring.

The approach laid out in the ABS Smart Guide applies a risk-informed set of easy-to-apply prescriptive requirements for engineering review and survey of the smart technology applications. To support the efficient integration of vendor products and services related to smart functionality, the Smart Guide also lays out a product design assessment scheme coupled with a service provider approval process to support equipment manufacturers, shipyards, owners as well as third party software providers, as they develop products and services for smart functionality for use on board ABS-classed vessels.

Smart functions related to operational performance, asset efficiency, and crew support that provide a mechanism for sustainability and improved uptime may also be recognised by ABS via a verification and validation process defined in the Guide.

Shifting corporate skillsets
The maritime industry’s fledgling steps into the era of smart operations are already having an influence on the corporate skillsets of leading organisations.

Workforces skilled in traditional areas such as structures, machinery and marine operations – those that tend to focus on independent systems – are now coupled with non-traditional areas of expertise. New graduates understand the integrated digital networks that connect, monitor and control shipboard systems and equipment. This influx of new skills and thinking is impacting the industry from within.

Mechanical engineers and naval architects are being supported with engineers specialising in systems, cyber security and risk management.
as well as data analysts and computer scientists. The boundaries of maritime employment roles are expanding and deepening, and every position is being asked to do more on a larger scale with more technical sophistication.

In practice, the skillsets of the next generation of naval architects and marine engineers will move closer to those of their colleagues in the aerospace and automotive sectors, where a core emphasis on design and innovation are fundamental.

The pace at which smart technologies are adopted will continue to increase across the maritime sector, but that does not mean the benefits will become immediately visible. Despite rapid technological advancements, investment in smart systems should be seen as having a strategic horizon that will mature with adoption cycles, not technology improvement cycles.

Most commercial vessels that operate today rely entirely on humans to make operational decisions and good human decision-making takes years of learning and experience to develop. Smart operations will take the industry to the next level of efficiency by empowering humans with better information to make better decisions, using technology to assist in that process.

Expertise and experience with smart technology will continue to influence maritime system design and operation with the aim of enabling better human decision-making.

Avoiding unplanned downtime

GEARBOXES | In cooperation with Bachmann Monitoring, the German gearbox specialist Reintjes has developed a condition monitoring system which measures vibration characteristics to identify possible component damages or other unusual incidents of a gearbox at a very early stage. As the gearbox has a longer service life than many other parts of the powertrain even under heavy strain, highest quality, reliability and longevity are of utmost importance, the company said. Reintjes sought an answer to the question of who is in charge of unplanned vessel downtime in case of a failure in the machine room if the gearbox is not monitored. The sooner Reintjes can identify a necessary maintenance based on anomalies in the gearbox’s operational condition, the better a downtime can be scheduled, it said. Thanks to remote monitoring and a high sampling rate, Reintjes can interpret the signals and inform the vessel about a service case in advance, the company added. Simultaneously, it can realise a faster spare parts supply as the production, based in the headquarters in Germany, can start the manufacturing process at an early stage. The Argos Cies, a fishing vessel operating in Spain, is already using the condition monitoring system successfully, helping Reintjes to advance the customer business case in the best possible way and continuously optimising its products for a high user-friendliness.

New EHM system under development

ELECTRONIC MONITORING | Rolls-Royce and ZF Marine are collaborating in the development of an equipment health monitoring (EHM) system to raise uptime and reduce fuel consumption and emissions. The system is already being tested on board the Halunder Jet, a 56.4m-long passenger ferry owned by Förder Reederei Seetouristik (FRS) which operates on the route between Hamburg and Helgoland. The shipping group operates 58 vessels deployed on ferry services and crew transfers for offshore wind farms in Europe, North Africa, the Near East and North America. It currently has 40 MTU engines in service. The large number of vessels and engines, combined with the diverse nature of the FRS fleet, means that working in the development project offers an interesting opportunity for the vessel operator. The EHM system, likely to be commercially available from 2021, collects and analyses data from the MTU engines, the ZF transmission systems and other key components, taking into account external factors including wind, waves and currents. Tim Kurs- man, managing director of FRS Helgoline GmbH & Co. KG, said: “Reliability is what we value most of all. When you have 680 passengers standing on the St. Pauli Piers in Hamburg, waiting to board the Halunder Jet to Helgoland, the reliable ship operation is of top priority.” The next steps in the project will be to set up an interface from the ZF transmissions to the EHM system, monitor and collect data from the various components of the vessel’s powertrain and then analyse the data obtained. More than two thirds of MTU’s marine engines have been supplied with ZF transmission systems.