From piecemeal to proactive: getting smarter on data-enabled vessel operations

PRACTICAL APPLICATIONS Shipowners want practical applications to implement the smart opportunities of today that build foundational capabilities for autonomy in future, writes Derek Novak, vice president, Technology at the classification society ABS

The use of drones is becoming more and more popular in the maritime industry

There is little doubt that we are in the age of smart shipping: the technology and data infrastructure that can enable real-time health monitoring and performance optimisation are already here. Real-time monitoring techniques, data analytics applications and use of streaming data for troubleshooting and operational assistance are changing vessel operations and management. Machine learning algorithms, used to extract data correlations from processes on board to detect anomalies and predict potential problems, are being developed and deployed on many fronts.

At the industry's leading edge, a fully instrumented ultra large container ship (ULCS) sailing today could have as many as 7,000 channels monitored for system control, situational awareness and alarms, with as little as 0.05 seconds between each measurement. In service, the same ULCS could have up to 2,800 sensors hardwired into its main control system, collecting and storing up to 2GB of data every day.

Upgrading pilot projects

To date, the industry has been embracing 'smart' technologies by plugging in new systems and software and seeing how they work in a pilot approach.

For asset owners, the need is to derive conclusions from such pilots and piecemeal developments to start answering the larger questions as to what the implementation of smart functionality is designed to achieve and how to derive value from its implementation.

Until now, general guidance has been available mostly in loose framework form. There is a need to consider a comprehensive goal-based implementation framework coupled with practical, flexible and prescriptive requirements for smart function implementation in multiple applications with various degrees of sophistication.

Smart shipping is enabled by defining specific goals relating to vessel operations aimed at improved decision-making by all stakeholders, including both crew and shore-based personnel, to manage vessel operations more effectively in the fulfilment of the vessel's mission.

This supports owners and vendors in defining and implementing smart functions through a goal-based approach and from a risk perspective. A client can therefore set a goal and then assess implementation of a particular smart function and its contribution towards achievement of that goal.

A structured and practical risk evaluation approach relies on careful examination of main risk factors such as the algorithms and methodologies employed, the level of decision-making and autonomy and the sophistication of the integration with onboard systems. A set of appropriate risk-based prescriptive requirements can then be applied, coupled with the added robustness of targeted risk assessment.

The above approach recognises the need for flexibility; prescriptive requirements alone will not nurture and encourage the emergence of a smarter shipping industry; this space is moving too fast for that.

Laying the foundations

It stands to reason that gathering the right data of good quality is key to smart operations. A robust data infrastructure is the cornerstone to achieve the defined goals of smart function implementation. Built on top of the data infrastructure, smart functions enable health and performance awareness, augment and optimise vessel operations and lead to informed decisions in support of a more sustainable shipping

future – one that is safer, greener, and more economical.

The principal model for smart shipping is grounded in the use of operational data coming from sensors, connected via the Internet of Things (IoT) with data transmitted via increasingly reliable broadband communication at reasonable cost to OEMs, fleet managers and other stakeholders.

Publicly available data sets, such as AIS and hindcast/forecast weather, are combined with proprietary data for processing and sharing on increasingly powerful hardware and cloud-based platforms. Data analytics and artificial intelligence-facilitated modelling is another key enabler that integrates with physics-based, simulation capability, domain knowledge and expertise.

For a smart function to achieve its benefits, a vessel's data infrastructure must be able to provide a robust level of data quality and data integrity. Hence, there is a similar need for software quality control and verification and cyber security, including a programme for management of change within the data gathering and processing environment. These aspects can be considered fundamental to a smart vessel.

The ability of smart functions to perform health assessment and anomaly detection for critical equipment or vessel systems can also support class programmes by developing complete and properly targeted risk profiles, supporting the evolution of class activities towards informed, targeted and condition-based models.

Smart objectives

In view of their specific objectives, smart functions commonly monitor vessel health, performance and aim to enhance crew situational awareness.

Health monitoring falls into two main categories, structural and machinery monitoring. The former uses monitoring and response to exposed structural loads and health conditions to enhance safety and integrity and track the potential for damage and failures.

Machinery health monitoring combines the use of the traditional approaches to condition monitoring with a wider use of operational data to detect operational anomalies that could lead to system failure and unplanned downtime and drive a maintenance strategy towards a more predictive approach.

The other main facets of smart functions relate to asset and operational efficiency and crew operations and asset efficiency. Asset efficiency monitoring and operational efficiency management is used to assess asset design efficiency, vessel performance and degradation, and also drive optimal operational performance management behaviours and practices from the crew. Crew assistance and augmentation is designed to assist crew activities and augment the crew's ability using techniques such as night vision, obstacle detection or collision avoidance.

Smart functions can also provide much-needed help to relieve the burden of reporting from crew and reduce human errors via integrated systems that can assist in identifying and suggesting resolutions to problems, moving decisions from ship to shore.
In terms of investment, it is possible that a smart technology-based approach could maximise return on investment by delivering a reduction in spares inventory, lower fuel costs and maintenance outlay. Operating costs could be greatly reduced with an optimisation of the maintenance, spares, and fuel consumption costs from running the asset more efficiently.

A new class-based approach

Recognising smart functionality as a key factor for improving operational efficiency and driving sustainability, ABS has recently issued the first in a series of publications Guidance Notes on Smart Function Implementation to assist the application of smart technology in shipping.

The ABS notes provide a practical and flexible approach to smart shipping in the present day context of the technology.

They clarify the goal-based framework for smart function implementation, discuss the risk assessment approach for setting technical requirements built on verification and validation principles for various risk levels, and explain the different stakeholder roles and proper alignment via an implementation roadmap.

The principal benefit is the logic and flexibility of using a goal-based framework, as this provides the ability to cover a wide range of potential solutions. Clients can develop systems internally, buy off the shelf from third parties and have a qualification path toward less intrusive class surveys based on the vessel's risk profile using condition-based class models.

The Guidance Notes are not intended to dictate to clients the route they should take towards achieving their goals, but form a basis they can use to establish those goals and work logically towards functions and implementation that will help achieve them.

This 'Smart Series' will ultimately help owners understand how ABS will review and approve smart functions on board classed vessels from design, construction or retrofit through to their utilisation during in-service surveys where applicable. And also how ABS will recognise and certify third-party vendors to provide such services or equipment with smart features on classed vessels.

The guidance will be published in several stages. The initial publication lays the foundations by defining key functions that smart ships might need, the goal-based implementation framework, and the risk-based verification and validation principles for owners to achieve smart functionality with class support. ABS's independent verification and validation gives a degree of confidence that the implemented smart functions have a sound technical basis, are sustainable, and can achieve what they are designed to do.

The goal-based framework and risk-based approach are critical when we think about the next-generation of highly efficient and low emission ships. There is a longer term need to understand how shipyards will want a smart specification to look, as well as how that affects equipment vendors and service providers. The ABS Smart series of publications will assist in outlining a digital strategy, but we believe the market and clients will drive the speed and scope of its adoption.

The path to autonomy

The ABS Guidance Notes provide a flexible approach to smart shipping in the present-day context of the technology but stop short of considering autonomous systems. However, they lay the foundations for what would be necessary to achieve a more autonomous future for the maritime industry.
These could relate to navigation functions and control of the ship from shore, building on crew augmentation functions and including health and performance monitoring functions, creating the ability to act or enable remote support via a shore-based control centre.

Ultimately, a smart ship will have the ability to sense, analyse and provide health and performance awareness conclusions as decision support to the operator. It is important to note though, that these smart functions at present are targeted at augmentation of human functions; they are therefore an enabling, not a disruptive technology.