SPARKPREDICT®

Recognizing the Value of Data in the Maritime Space

Overview

Rapidly developing technologies are transforming the way major transportation assets are managed. Innovations such as the cloud, cognitive analytics, the industrial internet of things (IIoT), and advanced cybersecurity are showing emergent signs of improving operations of afloat, ashore, subsurface, and aloft transportation assets. In the maritime space, shipowners, operators, technical managers, OEMs of shipboard machinery, and associated regulatory entities are embracing these technologies in order to better understand the overall health of their machinery.

A technology that is becoming more and more available to the maritime sector is "smart data," or the capability to ingest massive amounts of data on machinery, including every aspect of a given sea passage. This is the evolution of data analytics—from the "days of yore" logging data in a logbook, to then detecting data with multiple sensors connected to a central console, to eventually transmitting supervised data ashore, to the latest development: a deep understanding of how the machine actually behaves.

These tools and their strategic uses allow the owners and operators of machines to assess machine conditions in real time, while returning actionable guidance to the operators. Most recently, the introduction of artificial intelligence (AI) to cognitive analytics platforms has dramatically expanded the toolbox for fleet managers, creating the most in-depth analysis available in any industrial market sector.

This paper addresses the maritime industry's progression towards more proactive strategies and tools to monitor the health of shipboard machinery. It will also introduce SparkPredict®, an AI-based cognitive analytics platform from SparkCognition that uses sophisticated algorithms combined with next-generation AI-driven prognostics to allow an operator to see the current and future health of the machine as it operates.

Making the Case for Cognitive Analytics

A recent survey of maritime industry executives conducted by Sea-Asia demonstrates the degree of uncertainty in the industry about harnessing data:

12% of respondents are now utilizing a predictive analytics tool of some sort—but without any form of artificial intelligence

77% of respondents see the potential benefits of digitalization

70% see those benefits primarily as tremendous cost savings

63% identify the lack of access to meaningful analytics platforms as an impediment to getting one

50% see the need for more professionals skilled in the areas of data science to understand how to use such platforms

83% see the need to train staff to become proficient in managing the gigabytes of data that ship sensors are capable of producing

It's clear that while most companies "get" the benefits of digitalization and data analysis, they are unsure of how to go about harnessing its full value. We anticipate that as shipping markets continue to be characterized by low rates and historically low asset values—primarily caused by overcapacity—the technical management of shipowning entities will carry on seeking ways to minimize operating and maintenance costs.

We therefore anticipate significant change coming about as:

- Shipping markets improve (and they will as overcapacity is absorbed)
- Data science continues its growth into more and more industrial applications such as the maritime sector
- Classification societies and insurance markets embrace the positive impact of cognitive and prognostic analytics tools in risk mitigation strategies
- The "human element" consisting of more tech-savvy and forward-thinking executives and seafarers embrace the full reach and potential of these technologies
- The technologies become more user-friendly to maritime operators

Some are scared off by the terms "big data" or "smart data," which are technical terms that have been thrown around quite a bit in recent years, enough to reach "buzzword" status. They shouldn't be, though—all "big data" really refers to is the process of analyzing information that comes from engines, pumps, and rotors to uncover hidden patterns, unknown correlations, ambiguities, and other useful information.

Detecting Maintenance Issues Earlier and with Better Insight

The Swedish Club reports that in the period 2012-2014, its members experienced 487 claims for machinery damage, averaging $545,000 per

claim. The most commonly damaged parts were bearings and camshafts, claims for which typically exceeded $1 million.

Any industrial machine—that is to say, any piece of equipment that rotates, creates pressure or temperature, or has flow—is subject to degradation over time. In the maritime sector, we see this in main propulsion units, gen sets, cargo pumps, thrusters, hydraulic pumps (such as hatch covers and steering gear), lubricating oil and fuel delivery systems, and a fairly wide variety of other shipboard equipment.

Instead of examining such degradation in accordance with predetermined schedules, or only when vessels are idle for sufficiently long periods, consider these "what ifs":

- What if the machine could be assessed in real time with sophisticated algorithms that detect anomalies in all phases of operation?
- What if that detection was so granular that it could categorize those anomalies into minor, intermediate, or serious?
- What if those anomalies could be shown in 3D, displaying exactly which component of the machine is degrading?
- What if that detection could be built upon with automated model building that would predict when maintenance was actually needed, or when failure might occur?
- What if the megabytes (or gigabytes) of data were streamlined from multiple sensors and, using IIoT functionality, were aggregated from all vessels in the relevant fleet and transmitted to a central receiving point ashore?

Many ship operators and technical managers are already collecting massive amounts of data. However, without the cognitive analytics platforms behind that collection, it is not possible to distill the output into actionable guidance and realize the full value of the platform. We see this as the biggest impediment for the proliferation of cognitive analytics platforms.

Rather than reacting to a maintenance need that is predetermined by a manual or by the "feel" of the machine in operation, cognitive analytics tools provide real-time assessment of a machine and predict when these maintenance procedures are actually needed. Detecting anomalies in machine operation in this way also greatly assists the team responsible for the budget by allowing for better and more accurate planning of maintenance events. The result is that the life of the machine can be extended and the costs of maintenance can be mitigated.

Deferring capital or operating maintenance is never desirable when budgets become constrained, or when the ship becomes a candidate for sale. In the former case, deferred maintenance can become a potential liability with regard to charter party performance guarantees, safety of operation, and perhaps even class status. In the latter case, these liabilities are simply passed along, with the new owner often not realizing the extent of liability undertaken in the purchase.

With regard to main propulsion units, approximately 95% of the world's ocean-going merchant fleet is powered by large, slow-speed diesel engines that are designed by just a handful of companies. Approximately 70% of vessels have main propulsion units that are made under license from MAN B&W designs, and an additional 15% are made under license from Wärtsilä-Sulzer. The modern engines from these designs have multiple sensors to detect (and report) data on just about every aspect of the machine's operation. More recently, vessel managers have become concerned with what goes up the stack (emissions) and what goes over the side (ballast water). These concerns contribute to a comprehensive energy management program for the vessel in this new era of environmentally sound voyaging.

Data collected at the vessel and streamed to a central receiving location ashore enables greater collaboration between the shipboard engineers and shoreside staff. On board, the engine department officers are tasked with day-to-day safe operation, watch-keeping, and in-voyage maintenance and repair. A user-friendly graphical interface allows them to view real-time operating issues as they arise, and can be shared with shoreside staff. This capability is a tremendous asset in assisting the plan for remedies that can be assigned to the vessel in-voyage, in a port call, or in a shipyard.

Working with AI-Based Cognitive Systems

According to IHS Markit, the London global business intelligence group, the number one global technology trend in 2017 is anticipated to be artificial intelligence. In its write-up on these trends, it says that "machine learning has allowed AI to move quickly from formulaic logic processing to contextual language and learning. The implications can be far-reaching."

In compressive fleet management, we see that managers are beginning to appreciate the role of AI in analyzing data as they:

- Extend their understanding of the difference between traditional preventive and predictive maintenance to forward-looking cognitive-based maintenance from data streams that measure the "unseen"
- Recognize there exists capability to ingest the (potentially) gigabytes of data that have already been generated but have not yet been properly utilized
- Grow more willing to spend money on analytics technology in order to save money in other areas
- More intelligently plan major maintenance periods such as special surveys and drydockings, adjusting spare parts and consumables inventories, and supporting seagoing staff in assessing both in-voyage and long-term maintenance needs
- Appreciate there is a role for AI to play in developing a deeper understanding and improving the overall health of the machine

Imagine the scenario wherein Class informs the engineering team that the cylinder head doesn't have to be opened up on a main propulsion unit because a Class-approved AI-based cognitive analytics platform has returned sufficient condition information that permits deferral until the next special survey arises. This scenario is not far off as societies, notably DNV-GL and ABS, are reaching out to explore this potential as a benefit to its membership.

As mentioned, many vessels are producing gigabytes of operating data that are sensed at the ship and collected by various participants in the management chain. However, much of it lays unanalyzed in the office because of a lack of a coordinated management strategy to harness the value delivered by such platforms, as well as insufficient staff training with the right knowledge base to handle the output.

SparkCognition addresses these issues with its SparkPredict platform. This AI-based cognitive and prognostic system is already in use in heavy industrial machinery applications. It sources data agnostically, meaning

it doesn't care where it comes from or what form it is in. It ingests new or historical data, can be installed quickly and easily, and has a low learning curve for staff training to get it up, running, and delivering actionable guidance.

In a more generic sense, AI-based cognitive analytics platforms extend knowledge to determine the health of a machine. Not all shipowners own a fleet of ships that mimics the model of airline company Southwest Airlines, whose fleet contains all Boeing 737s with all the same engines. Imagine how simplified the maintenance function is across its fleet. Shipowners aren't so fortunate. Fleets today are a composite of vessels built in different yards, and are different sizes with different equipment installations from different OEMs. They are operated in different waters and sea states, and have differing cargo turn-around requirements over disparate time frames. Accordingly, the data generated for fleet managers to assess is equally disparate and difficult to assess.

Across any fleet, SparkPredict leverages its proprietary automated model building (AMB) solution to generate deep learning of machines. In one case, our client believed its power generation turbines had nine operating states: start-up, high RPM operation, low idle, ramp up, cool down, and so on. After initiating SparkPredict on the machines, we discovered two additional operating states that the client and the OEM didn't know about. This discovery helped convince the client that there was no better way to fully understand the turbine's health than SparkPredict, and they now have it installed on almost all of its fleet assets.

AMB is capable of performing multiple analytical techniques. Generally speaking, the client will see in graphic display, a series of scatter plot clusters, the determination of which of those clusters are "normal" versus which are "abnormal," a 3D display of the machine, and what is giving rise to the anomaly. Its capability of alerting operators to suboptimal operating conditions before harm can be caused to the machinery adds tremendous value.

In addition to AMB, SparkPredict utilizes proprietary natural language processing (NLP) technology to ingest and analyze free-form text from OEM manuals and service guides. One shipowner informed us that it attempted to engage NLP some years ago across its 105-vessel fleet in order to digitize more than 35,000 technical manuals relating to the fleet's machinery. The capacity needed to ingest that volume of information overwhelms most platforms. However, SparkCognition technologies can extract gigabytes of text and pictures from a variety of OEM manuals and PDF documents, including those that contain fractured pictures (one picture broken into many). It then displays them in 3D format in a user-friendly graphical interface. This allows the user to literally "see" inside the machine.

Shipowners and operators considering implementing this type of platform will of course want to understand the challenges that something this new presents. Dependency on a new technology to inform machinery maintenance is a new way of thinking about overall machine health. Embracing IIoT and implementing the transfer of user-friendly information is relatively new to the maritime sector. While there are many predictive analytics programs out there, none have the detail and depth of understanding of overall machine health than the SparkPredict platform.

Conclusion

Maintenance strategies based on cognitive analysis and machine learning are gaining momentum in the maritime space. Lloyd's Register, in its "Global Marine Technology Trends to 2030," offers a current estimate of a 4,300% increase in the annual data generated by ships by 2020, and "by 2030, that figure will have increased even further as this is an accelerating trend."

"The management and analysis of big data will become increasingly important, and we expect it to have a major impact on themarine world. It will be driven forward by the demand for information and the need to handle the variety of new data sources that are likely to appear. At the same time, big data will be subject to other factors that will threaten its adoption, such as the lack of the necessary data analysis skills required to exploit big data.

A greater volume of data won't always mean a better output. The quality of data is extremely important, and analysing poor quality data can lead to ambiguous and misleading information, potentially resulting in poor decision-making. Big data techniques are not a substitute for information management.

In the future, we expect new technologies to emerge that will improve big data analytics. Among these will be some of the so-called 'smart machine' technologies and computing systems that process data in a manner similar to the human brain."

These new technologies are already here. A single system that addresses all machines, all processes, and all transient events offering real time visibility eases the burden of ashore and shipboard management of complicated machinery units such as large low speed diesel engines, azipods, thrusters, pumps and motors, and other components. This is particularly important in an increasingly energy-minded industry, with growing regulations imposed by governments and flag states, and further rules from classification societies and maritime industry regulators.

SparkPredict improves operating system efficiency, optimizes energy management, and reduces maintenance and capital costs. It is capable of alerting operators to suboptimal operating conditions before harm can be caused to machinery. Installed across a fleet of merchant vessels, this platform actually makes maintenance and predictive functions much simpler for the owner/operator/manager in a forward-thinking environment.

The end result is the delivery of millions of dollars in maintenance cost savings, operating efficiency improvements to fleets and energy management, and root cause analysis at a granular level. This deliverable guidance is absolutely invaluable to compressive fleet management.

The digital age has arrived in the maritime indeed.