Vessel Performance Monitoring System

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Abstract: This paper deals with the integration of information technology with a vessel's performance monitoring. The advancement of science and technology has made it possible today, for seafarers to ease their workload and lead a life of convenience onboard. Vessel performance monitoring systems collect data with the help of various strategically placed sensors. These sensors send the information to a processing unit, the sensors and processors are connected via LAN. The processing unit also receives weather forecasts; which is made possible with the help of the vessel's communication system. Considering all the parameters from the engines and other machineries and the weather forecast the vessel's performance monitoring system suggests the favorable passage along with the appropriate settings of fuel for an optimum efficiency figure. This system also intimates the operating crew of the maintenance schedule. In light of the growing technology, a concept which this paper explores, however, is the possibility of a real-time data transfer between ship to shore.

Keywords: engine parameters, VESSEL PERFORMANCE MONITORING, optimum efficiency, maintenance schedule, real-time data transfer.

1. Introduction

The shipping industry in general is not very responsive to change. It tends to play safe and rely on hands-on approach to management and operation, in spite of reliable technology having made inroads into and been integrated with safe ship operations.[1] The reasons for inhibition are varied and justified. Shipping along with being one of the oldest trades of the world also carries the baggage of high capital risks in cases where things do not go as planned. Ship owners more often than not are reluctant to invest in technology and believe in time tested methods of human interventions. Investment in shipping has traditionally been pulled by factors such as risk and investment sharing, economies of scale, cost-control, frequency of transportation and the globalization of trade [7]. Although these are still valid factors, the necessity to innovate
in order to create competitiveness has become a more and more important factor driving owners to revaluate their stand on technological intervention in vessels.

Regardless of the uncertainty in returns, it is no wise guess that shipping has come a long way in acceptance of technology. Lately, the automation vendors, mainly in landbased industry sectors, have started the next step to physically and functionally integrate the real time control systems with the operational management systems [5]. This has been denoted as *industrial IT*. The introduction of industrial IT into marine applications has yet only started, and is still an area of research and development. For

vendors and ship operators it is a challenge to harness the potential this shift of technology gives.[6]

1.1 Need for technological advancements

There is no doubt that the shipping industry will face major challenges in the years to come. Innovation concerns change and 'what is new'. It can be an idea, an action or a material object. However, innovation does not mean that something has to be new in an absolute sense. It is sufficient that it is new for the individual organization [9]. Of all things that can change the rules of competition, technological change is among the most prominent. It has the resulting ability to achieve low cost and differentiation through its value activities. [8] It was the industrial revolution in the 18th century that got us to the brink of modernization that we witness all around us today. It is only through the continuous process of learning that any industry, ranging from manufacture to service has come to the levels of present day robotic intervention and automation. Marine being no exception to the latter.

2. Vessel Performance System:

A Vessel Performance System (VPS) which gives feeds from various engine parameters and displays them on a screen for the operating staff to adjust the settings for enhanced efficiency is a breakthrough in the maritime world. The author's in-depth review of technical literature reveals that vessel performance systems have come a long way in the past four decades to a point where, today, the live feeds from the engine can be pooled with the communication systems of a ship and be transmitted to the fleet management ashore. The managers can then, in turn can share the information with the charters. This way Charterers too can have direct access, thus ensuring that there is no manipulation by managers and increase transparency and goodwill.

Charterers have often been frustrated by the discrepancies between the daily fuel consumption rates mentioned in the charter party and the actual performance. Thus real time monitoring including raw data normalization; which is incorporating the effects of waves, wind and current shall cover for the otherwise inexplicable reasons for the variation of costs. This is what is required in the times of cut throat competition and ever rising costs.

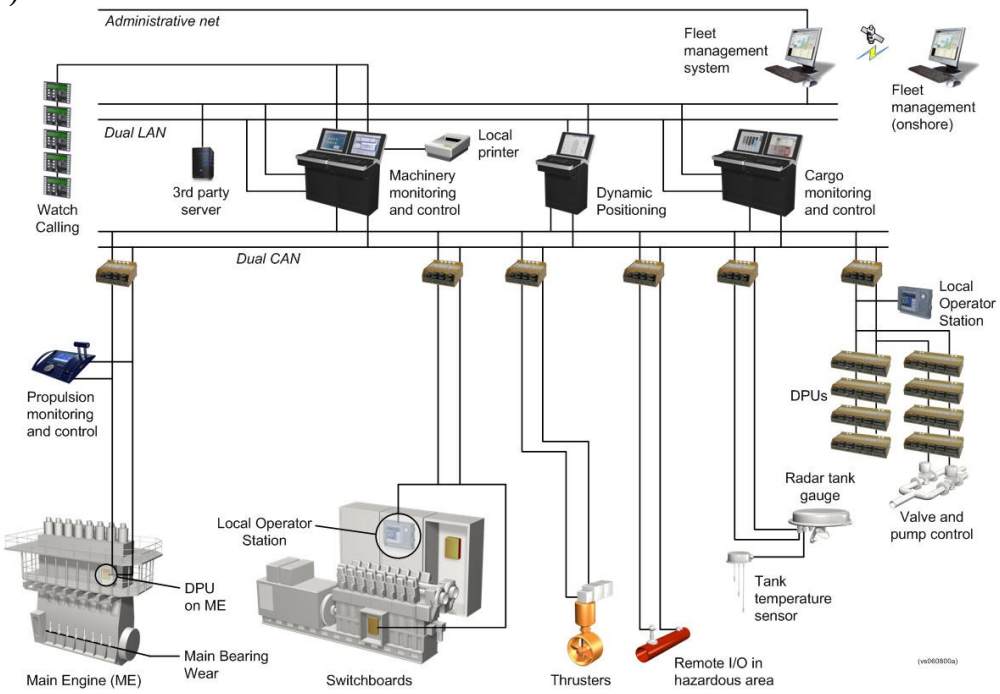
2.1 Current system

In the current process, the ship's chief engineer manages the machinery spaces from the control room and reports the performance to the shore staff of the technical management company every noon via the satellite communication in a specific reporting format. This report is scrutinized ashore, fed through the program in the office and any deviations from norms requiring attention is reported back to the ship. The ship takes the corrective action and reports back to the office.

The interested parties like owners and charterers then receive performance reports in their own specified formats.

2.2 Proposed Design

Modern shipping depends for its day-to-day operation almost as much on communication and information as on more tangible inputs like fuel. [2]. In the system that the paper proposes, radical benefits and optimization can be achieved if a vessel is fitted with a fuel and machinery performance system, with capability of accurately monitoring fuel consumptions and transferring the data to shore based organizations including Technical Management, on line and in real time(refer figure 1).



Process overview(fig 1)[10]

3. Technology in use for VPS

Extensive investments in research and development have resulted in a modular concept, which will largely contribute to improved fuel efficiency and reduced emissions. The vessel performance monitoring concept takes a holistic approach where the overall perspective is combined with focus on operational improvements for both hull and engine. Given the technological advancement and reliability of Kongsberg's technology in the marine sector, their products' mention will be used in the paper for understanding of this technology.

3.1 The Combination that Counts

The pressure on shipping to be environmentally more responsible and reducing carbon foot print are enormous today. In its quest to offer the best in environmental solutions for the shipping industry, we need an engine performance monitoring system that enables continuous monitoring of the engine condition and performance.

In combination with the powerful decision support system that gives them an outline of the various engine performances, the engineers will have an easy to use tool for maintaining the engines at optimum performance. When combined with a ShipLoad

3-D (a vessel model based loading solution[4]), information on the hull status to find the ideal draft and trim conditions for the voyage will be provided for a combination that will further increase fuel savings.

A unique solution to manage loading and unloading operations, is served by the VPS. The system, already tested on board[4], undertakes calculations to ensure optimal loading and unloading of cargoes as well as ballasting. Combined with a weather planning and an intelligent auto pilot, the system advices the crew/master on optimal trim and cruising speed to arrive at the destination at the desired time of arrival with forecasted environmental conditions.

When hull and engine performances are tuned in with the voyage planning tool it ensures that the sailing route is defined in the most favourable way-given the prevailing weather forecast which feeds in from the ship's communication system(Refer fig. 2).

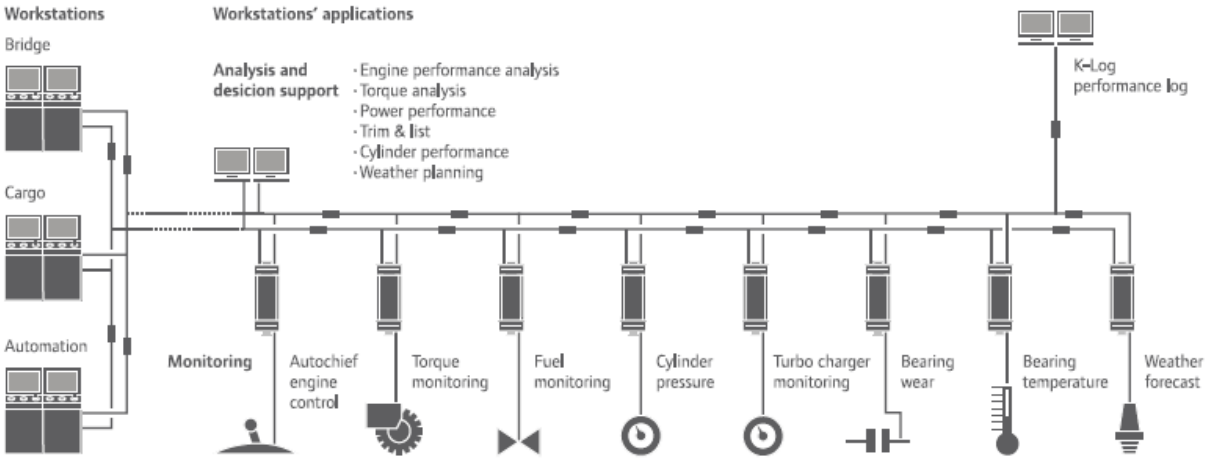


Fig (2)

3.2 Engine performance and optimization

Extant literature reveals that VPS offers even control solutions that optimize propulsion prime movers to operate cost-effectively, reliably, and with minimum exhaust emission. By integrating the performance monitoring sensors, the VPS can provide a complete solution for engine performance monitoring, including;

- slow and medium speed – fixed and controllable pitch propellers
- Continuous cylinder pressure data
- Fuel consumption
- Torque data
- Turbo Charger Monitoring

3.3 Information access modules

The product in picture is Kongsberg's K-chief 500, where, a ShipViewer software package is installed to the system and it runs on a standard PC connected to the K-Chief 500's LAN. The computer can be installed anywhere on the ship. It has similar viewing capabilities as those found in the Operator Station, but without control

functions. If installing the ShipViewer on the ship's administrative network, a Gateway computer must be installed to act as a firewall between the K-Chief 500 automation system and the administrative network.
Interaction exists between the process network, the administrative network and the Gateway. Communication principles for transfer of data from the system on-board to shore is also maintained.[1]

All the process and engine performance data is easily available from the AutoChief® control panel[9],(refer to figure 3), giving the engineers real-time information about the engine condition.
When integrated with an alarm monitoring and control systems, the engine performance and optimization module can be expanded to include a complete decision support solution, including a onboard and shore-based reporting *system.*

Fig(3) [9]

4. Current Application of VPS: K-CHIEF 600

Being specific to the K Chief 600, developed by Kongsberg, The first vessel to sail with this system was delivered to its owner on 10th January 2010. The Korean Built VLCC features an extensive Kongsberg Maritime package, led by the K-Chief 600 with integrated Vessel Performance System (VPS), which supports reduced fuel consumption and lower emissions.

Following the first delivery of a vessel sailing with reportedly good feed-back, Kongsberg Maritime already has installations scheduled for over 80 K-Chief systems, aboard further VLCCs, Ro-PAX vessels, container ships and crude oil tankers. One of the system's key advantages is its flexibility, making it suitable for a wide range of vessels, all with differing marine automation requirements. A system overview of the k chief 600 is shown in figure 1.

The heart of the K chief 600's system are many intelligent Distributed Processing Units. These communicate with each other on a redundant high capacity process bus.

All monitoring and automation functions are carried out by the Distributed Processing Units, while the centralised Operator Stations provide the human machine interface(refer fig 1).

The new build VLCC is fully integrated with K-Chief 600. It analyses all aspect of the vessel's energy use including speed, trim and weather conditions in real time. It also includes Fuel and Engine performance monitoring systems, for online analysis and prediction of main engine failures before they may occur.

In addition to the green focus of the Vessel Performance System, K-Chief 600 offers scalable functionality including full alarm and monitoring system, auxiliary control system, propulsion control, ballast automation system, cargo control and monitoring, and fire system, plus greater scope for full integration with other sub-systems onboard a vessel. Future focus for the continuing development of K-Chief 600 includes enhancements to the tank monitoring presentation and integration of a full custody transfer system.

4.1 **Human machine interface(HMI)**

The K-chief 600 monitor images are user-friendly. Being similar to other Kongsberg systems, the operator will be familiar with the layout and the main functions. The custom made images have easy-to-read information about the system. The Vice President – Integrated Automation, Merchant Marine Division, Kongsberg Maritime, Mr. Bente Lise Melås was quoted saying, "The new HMI has been developed to meet ongoing demands from the industry for modern HMIs on critical systems such as navigation and automation."

5. **Fleet Performance Monitoring:**

The introduction of sophisticated systems like the K Chief series, have brought into light another concept of, Fleet Performance monitoring. Ever soaring fuel prices make ship performance an important issue in shipping. Coming regulations on ship emissions furthermore stimulate operators to reduce the ships fuel consumption. Using, performance monitoring systems, a ship's performance is now visible at multiple stages. From fleet comparisons it is known that the fuel consumption of sister ships on the same trade may vary up to 10%. Optimum trim, routing, speed control, autopilot and propeller pitch setting and propeller cleaning can reduce fuel bills by more than 5%. Therefore, besides detailed monitoring of single vessel's performance, detailed analysis can be done comparing performances of individual vessels to draw conclusions and gainfully optimize the complete fleet operation. [11]

6. **Paperwork relief:**

Another take on the Vessel Performance Systems might imply the reduction in paperwork required onboard. There were times when a chief was kept away from his accustomed atmosphere in the engine room, to his day cabin where his morning coffee was spent on analyzing and calculating the details required for a "detailed report following the breakdown" that he would be required to submit to the shore office. This report will constitute of the reason, technical parameter, a list of preventive actions, another list of corrective actions taken and so on. However with the onset of the VPS, the amount of paper work can be significantly reduced owing to the use of auto-log feature(refer fig. 2) present in these systems. The ease has

escalated to the limits where sailors were quoted saying that they only have to make two to three entries on the paper in an entire day, all the rest is taken care of by the auto logging systems which are integrated with VPS.

Breakthroughs like these set the benchmark for the industry's bright minds, who set them as yard sticks and plough further to make life onboard comfortable.

7. **Practicality:**

Such automation techniques need to fulfill demonstrable Class requirements on safety and reliability which are very stringent. It includes the monitoring of entire control systems with built in self-diagnostic facilities and complete redundancy support. This implies that in events of failure of the system, there must be sufficient alternatives to gain control of the vessel. Both the hardware and software need to adhere to major classification societies' requirements, for periodically unmanned engine room operation.

Pomeroy and Tomlinson (2000) yet caution that while it is a well established practice that ship systems are protected by strict design standards, redundancy and by a feedback process that will activate alarm or even take corrective action, however, as the systems get more complex with interconnected and interactive equipment, its exhaustive assessment and testing gets unviable. Traditional type approval and certification examines a product against an agreed standard or set of rules, usually involving some form of demonstration through a test program. For more complex systems it is likely to be more complex to correct faults that are found, and even if rectified, the correction involves only topical fixes or expensive rework. The assessment procedure also does not incorporate ergonomic factors or human consideration.

8. **Conclusion:**

Being all praises for the VPS does at times leaves the mind asking, is the system flaw less, will it work 24X7 without fail and the biggest question of all, will it be worth as much money as will be pumped in to install it in the first place, or will it be an apology of a technological advancement that failed just when it was needed the most.

Importance and practicality of this system could not be reiterated more however the high levels of sophistication makes it seemingly difficult for personnel onboard to fix a fault. Training in dealing with problems with automation systems needs to be imbibed at the very basic level, however there might still be some time before officers trained to handle sophisticated mishap see the light of day.

Given the human nature of being lured by convenience at the very sight of it, will this system only make the ones, oh-ever-so-fit mariners blokes on a desk, or a sailor's insight will always tell him the right path for operation?

Another question that rises in context to one part of this paper is, will it be feasible to invest what on the face will look like a truck load of money into a technology even though the current system works fine? Also, does a charterer really need a real time data transfer of all the parameters?

Every new technology is born as a concept, the concept is pursued. Every coin has flip side how ever in case of a VPS, the flip side happens to be very non existent.

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