SAFER NAVIGATION WITH WIDER ADOPTION OF FLS

Forward Looking SonarÂ forÂ Navigation

An increasing number of ships are venturing into areas where the only hydrographic data available do not meet the standard many of these vessels require for safe navigation. A number of recent and some not so recent marine casualties have resulted from encounters with uncharted, isolated seabed features (Russell, 2014). The situation is recognised by the IHO; but the necessary improvement to the hydrographic data will take years. Meanwhile, the informed use of Forward Looking Sonar (FLS) could contribute to safer navigation in inadequately charted areas.

Present-day commercial FLS developed from its use by fishing vessels and for obstacle avoidance by underwater vehicles. It is now a mature and robust technology successfully deployed in a range of surface vessels. In coastal waters, current phased array 3D and scanning 2D systems are capable of providing adequate warning of isolated dangers ahead of vessels under 200m in length travelling at speeds commensurate with the navigational situation. Scanning sonars are less effective in shallow-water and harbour environments.

Background

In 2007, the US National Institute of Standards and Technology (NIST) funded a 3-year project to develop a Forward Looking 3D Sonar System for Navigation and Collision Avoidance, in order to improve the efficiency and safety of marine cargo transport. The optimal system design parameters were for Long Range (2M) and High Speed (35kts) applications. The participant manufacturer commented that the Department of Commerce appreciated the potential of the technology more so than the Navy. The speed criteria have been realised in terms of the robustness and hydrodynamics of the installation and transducer design. Current production systems only have a maximum range of 1,000m.

In 2009, the owners of one tanker fleet contracted for the development of a 3D FLS with a 1000m detection range and installed the prototype in one of their vessels (3). An Indication that in some commercial quarters at least the benefit of FLS has received serious consideration.

A 2013 study into the cost effectiveness of installing FLS in tankers of various sizes (4) found that the longest detection range sonar currently available is technically suitable but cost ineffective for the smaller size oil carriers. With regard to the larger ships, sonar systems of extended detection ranges can become available shortly at a cost which will render them cost effective for oil-spill risk reduction caused by powered groundings.

In this study the Cost of Averting a Ton Spilled is the criterion for the economic assessment of the sonar system. If this is the sole factor, analysis is biased towards the higher capacity vessels. These transit oceanic routes between major terminals. It ignores the higher probability of smaller vessels grounding in coastal waters. Following a discussion with one of the authors it was accepted that the area of vessel operation should have been addressed since grounding risks are spatially dependent. A vessel's operating profile often defines vessel size. Smaller-sized ships, such as Handymax (40-50,000 DWT and typical length150 - 200m) usually serve local and regional markets implying more time in coastal waters. Hydrographic data quality then becomes another determinant of risk.

A more conservative assessment of the time required for target verification and OOW reaction was not available to the author of the paper. Required sonar ranges at the given speed of 14kts are therefore understated. Such a speed would exceed that dictated by situations in which use of FLS could be beneficial.

Current Applications: Polar Navigation and Luxury Yachts

For several adventure cruise ships operating in Polar Regions FLS is already making a significant contribution to safer navigation. In 2012, MS *The World* (Figure 1) made a successful transit of the North West Passage (5). In addition to providing warning of uncharted shoals, her phased array 3D FLS was used to assist in ice navigation and in the detection of marine mammals. While experienced ice navigators discount the effectiveness of FLS for the detection of drifting ice there is support for its use in the detection of hazardous seabed features.

The owners of luxury yachts are increasingly installing FLS to safeguard their expensive acquisitions, as they seek to provide unique experiences for their guests in remote and exotic areas. Such experiences have even included transits of the NW passage. There are lessons to be learned from yacht designers in bridge systems integration and Human Machine Interfacing.

User Comment

Captain Leif Skog, vice president of Marine Operations Linblad Expeditions, fully endorses the use of FLS, subject to the following reservations;

1. While officers with previous experience in fishing vessels can readily adapt to using FLS for navigation, there is a steep learning curve for other users.
2. Optimal operation of scanning FLS requires a protracted period of regular use of the system.
3. The system remains far from intuitive and requires considerable user intervention to adjust for varying seabed and water conditions.

He states that, once navigating officers are fully familiar with the system, it is "an outstanding tool and we use it all the time in remote areas". While conceding that the particular system in use is less effective in water depths under 20m, "and very little support in harbours", he stresses that it has proved an "excellent tool to avoid surprises in deeper waters not that well charted".

Positive, albeit qualified, feedback from scanning sonar users relates to installations in small (>100m) expedition cruise ships with traditional propulsion systems.

Michael Prince (Australian Hydrographic Service) found that the 3D FLS provided a much clearer image of the seabed than the 2D system, "just like taking away the water". However, both systems enabled the user to visualise the surrounding seafloor significantly better than the interpretation of depth contours on the chart. This can heighten situational awareness and increase the watch keepers' level of engagement.

General Comment

However, John Ritchie at CSmart observes;

The shift in the ECDIS narrative towards 'ECDIS-assisted groundings' is representative of how technology needs to be both well designed and correctly operated to be effective. At the moment, in normal conditions over 10 systems must be continuously monitored by bridge officers, and that doesn't count those that require direct interaction, Even if the sonar does present an unambiguous picture from which to make decisions, it will add further to that workload. If it has an alarm function, that would add to the number and frequency of bridge alarms, which is already generally accepted as too high.

Former UK National Hydrographer Rear Admiral Nick Lambert and Ian Halls (AHS), while acknowledging these reservations, consider that any additional aid to situational awareness merits serious consideration. Captain Skog and Professor Norvald Kjerstad – Aarlsund University College feel that in certain circumstances its use should be mandatory.

Some Issues

It is encouraging to record that the organisers of the e-Navigation Revolution conferences are sympathetic to including consideration of FLS on the agenda in future. The potential for FLS to aid navigation has been recognised by most of the author's correspondents. Effective sonar use generally requires more training than its manufacturers acknowledge together with sustained operational experience. Possibly for these reasons the shipping industry as a whole appears reluctant to embrace the capability of FLS. Users may object to yet another contribution to bridge information overload.

Proponents of 2D scanning sonars acknowledge that its effective use requires an extended familiarisation period and regular operational use. Current array processing systems, providing real-time intuitive 3D representation of the seabed and water column, are essentially operator neutral and therefore require minimal familiarisation.

Effective Sonar Ranges

Presently advertised maximum sonar ranges for 3D and 2D FLS are 1000m and 3000m respectively in optimum operating conditions. These ranges will not be achievable in shallow coastal waters, particularly in the tropics. With this proviso they are still adequate for vessels up to 200m in length proceeding at speeds commensurate with the navigational situation and their manoeuvrability. 2D systems perform at their best in waters over 20m deep. The 3D systems are less affected by shallow-water effects other than temperature gradients although the latest scanning sonars claim to be more suitable for shallow-water use.

The existence of uncharted seamounts rising close to the surface (6) could make a case for FLS to be fitted in VLCC, in anticipation of such vessels departing from their regular ocean routes. If so, there would be a requirement for effective sonar ranges to be extended beyond those currently available.

Regulation

With the continuing retreat of the Arctic ice cap, an increase in the use of both the NW Passage and the Northern Sea Route by bulk and crude carriers can be anticipated. National Maritime strategies of Arctic nations acknowledge this probability. In the drafts of the IMO Polar Code and new Ch. XIV of SOLAS, the unsatisfactory state of charting in Polar Waters is cited as a potential navigational hazard, but there is no mention of FLS.

The potential for more regular use of the Northern Sea Route (Figure 2) and the NW Passage might cause fleet operators to seriously consider the limited introduction of FLS. Marine administrations in Arctic Council Member States and insurers of transiting vessels could also influence this decision.

Mandating FLS, even in prescribed circumstances, is unlikely. This would inevitably be a protracted process. As with ECDIS, this could generate inflexible standards embedding today’s technology rather than providing for future developments. The IMO and all components of the shipping industry are at present fully engaged in the implementation of e-Navigation, making it most unlikely that FLS will merit much attention in the near future. Nevertheless, it should at least rate a mention in the ratified version of the Polar Code.

Potential

FLS is already fitted in a number of super yachts, ‘adventure’ cruise ships and research and survey vessels. The largest such user at present appears to be MS *The World* (l.o.a. 196m). These vessels are more manoeuvrable than crude carriers and pose less of a threat to the environment if grounded. Nonetheless the financial and human cost of a major casualty could be just as significant.

Assessment of the benefits of installing FLS should include the nature and location of the vessel’s area of operation, the status of charting, remoteness from SAR services, climate and environmental sensitivity. An effective sonar range of 1000m should prove sufficient for vessels up to 200 metres in length provided their speed and situation awareness are commensurate with the threat of encountering uncharted hazards.

The investigation into the grounding of the *Clipper Adventure* in the Canadian Arctic in 2006 noted that although the carriage of a forward looking sonar is not mandatory by Canadian Regulations “the unserviceable condition of the forward looking sonar deprived the bridge team of an additional source of valuable information”.

Conclusions

While FLS alone cannot guarantee a vessel’s safety in uncharted waters or where charting is derived from legacy hydrographic data, it can provide an important addition to the navigation suite. There is qualified support for this view; but issues of training, integration with existing navigation systems and cost effectiveness are recurrent concerns. One commercial driver might be the increasing use of the NW Passage and Northern Sea Route and the further opening up of Arctic waters to hydrocarbon exploration and extraction (Figure 3).

There can be no doubt that for certain applications such as coastal hydrographic surveying, littoral warfare and expedition cruising in Polar Seas FLS could be an invaluable aid to safer navigation. Installations in super yachts point to the possibility of improved integration of FLS displays and intuitive operation. In common with observed development trends in technology, FLS unit costs can be expected to decrease and capabilities and functionality increase. While the technology is already proven the case for wider adoption has yet to be made. It is hoped that this article will encourage an informed debate.

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More Information

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