Artificial Intelligence in Shipping



THE HONOURABLE COMPANY OF MASTER MARINERS

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This paper looks at emerging Artificial Intelligence (AI) systems technologies on merchant ships and looks at how these might shape the future of shipping.

Technology in modern shipping is evolving quickly. Satellite technology has introduced electronic communications and positioning onboard ship, bringing greater navigational accuracy and shore connectivity. Since the 1990s global positioning systems (GPS) have become normal for ship navigational awareness. GPS accelerated passage planning processes and routing feedback. GPS led to electronic charting systems, with display units around the navigation bridge, heightened situational awareness and route monitoring and recording. Integrated navigation bridge systems (IBS) further modernised these procedures by connecting to other control centre rooms (CCR) around the ship, including the engine room and cargo control room.

Operators and technology companies have recently focused on the collection of electronic data from ships by using box recorders fitted to individual systems onboard in the IBS and CCRs. The purpose is to increase shore awareness and scrutiny of operations and research and develop commercial safety and efficiency for cost benefit.

Emerging technology onboard ship includes the advent of Artificial Intelligence (AI) and its use for onboard decision-making. NB: simple automation is not the same as artificial intelligence:

> 'Artificial Intelligence is a science and engineering of making intelligent machines' (John McArthy). 'AI is all about trying to make machines or software mimic, and eventually supersede human behaviour and intelligence' (Kamila Hankiewicz).

Electronic equipment at present reads from multiple ship sensors permitting increased automation by allowing the OOW to focus on mission critical tasks. As technology has developed, these automated tasks and processes require less OOW supervision. Engine room compartments can also be unmanned and monitored, depending on operational risk and requirements, and cargo systems can be monitored while at sea from the bridge.

As the call for more efficient automation continues, many developers and engineers turn to emerging AI technology to improve quality. This development is true for all sectors, not just maritime. The first step to utilising these technologies onboard is a boost to the amount of data collected and handled. Machine Learning (ML) is a sub section of AI using sophisticated algorithms to improve the utility that results from its swift computation. By maximising the volume of data collected, the results provided from ML software can be extremely accurate. This capability has proved increasingly effective at accurately predicting future performance. Significantly it is more economical than traditional methods. these calculations can be performed shore side as well because it makes use of improved satellite communication and cloud-based technology. Since a ship requires only 'lite' data collection and transmission hardware the burden on ship operators and crew is reduced because no expensive equipment is needed either onboard or in company offices. Current usage of includes the Ship Emergency Response Service, which uses contingency planning and intelligent modelling for casualty ships alongside other resources from master mariners, engineers and naval Architects. Some major ship operators have Fleet Control Centres with live feed from their fleet ship systems, enabling them to contact a ship to raise questions arising from unexpected or erroneous data received from the ship.

Machine Learning has predominated recent Artificial Intelligence development. But one drawback is that AI is only effective for a given task. This restricted application classifies this usage as 'Narrow AI' rather than true Artificial Intelligence. Deck officers onboard are currently using Narrow AI systems to give them sensor readouts of options from which to make informed decisions. A common use of this type of AI is route optimisation for regular coastal routes with large Ro/Ro passenger ships

that have fast turnaround times and few route options. These optimisation decisions have traditionally been based on the experience of the master and officers onboard, but systems are currently in development that use data points collected throughout a vessel's lifetime to optimise routes based on the vessel's recorded performance in all types of wind, sea and weather. This technology can now be applied to spot market voyages. Predicted fuel savings can make substantial economies and consequently Narrow AI is very attractive to vessel owners. The question this application poses, however, is about the role of shipmasters' skill and authority to make routing decisions, a concern explored below.

We can report progress in security systems for high-risk maritime areas. These systems have advanced sensors for object detection, assessment, identification and early warning to the ship. AI identifies an object through sensors and monitors its behaviour. It detects and recognises threats and initiates automated communication with a shore control centre, feeding back live information and deploying a non-lethal deterrent on the target. Benefits of such systems include uninterrupted surveillance at multiple points, as opposed to constant human watch. The system, has multiple feeds from around the ship and does not tire. Consequently, threats can be detected earlier enabling a faster response time. AI records information photographically and of behaviour for crew debrief and further machine learning. Object recognition and classification is a subset of Machine Learning rapidly developed for non-marine uses so requires little adaptation for deployment at sea, offering vessel owners greater economy in its acquisition.

Currently, shipboard systems can receive multiple inputs before displaying information prior to the OOW taking an informed decision. AI is able to go further by recognising the 'intention' of the OOW and improving the quality of recommendations. Because lack of Situational Awareness is often a key cause of incidents at sea, 'intelligent' systems afford additional safety and reduce the risk of key information going unnoticed by the OOW. Current areas of development include mapping of environmental areas to prevent mistakes such as opening a wrong valve or permission to dispose of garbage or ballast water leading to environmental damage.

Other sectors of transport, from outer space to self-driving cars, have embraced AI development. The aviation sector has trialled self-landing aircraft with only push button intervention. Ships, being the largest transport machines in size and capacity and motive power, without effective combination of human reason and AI present occasional unmanageable risks.

Most current ML methods are broadly classification models. As an example, a computer might be trained to determine that a table is a table, or a dog is a dog. A human can distinguish between a table and a dog and if a pink panther is in the room react accordingly. 'Intelligent' machines have limited capability to react correctly when unexpected data is encountered, but they can augment a human's capacity to process data speedily and access the value that data holds. A human, however, can think in the abstract, interrogate thought and emotions and can reason by experience and either lead or work in a team. Nevertheless, though the maritime industry has been slow to invest in new technologies which are commonplace in other sectors, methods and learning models best suited to our sector are belatedly being adapted for us. Narrow AI is already here and onboard ship in the form of advanced early warnings for collision avoidance, security and route optimisation. It clearly assists deck officers with ship operation.

The Honourable Company of Master Mariners Young Officers Committee (YOC) feels that further investigation is needed to make AI acceptable and beneficial on ship:

1] **Approval to a standard recognised by all maritime states of Cyber and Computer Product Systems that utilise ML or AI.** The maritime industry has embraced electronic equipment, but now needs recognised standards maintained in the operation and life cycle of the systems.

2] **Training and development for officers who use these types of equipment.** Humans will continue to be in command of ships that represent risk at sea. They should have proper training. Revised training under STCW should reflect cyber security and increasingly intelligent computer systems. STCW should supervise, validate and approve this training with a certificate of competency or endorsement covering the use of cyber and computer systems. A manufacturing company holding flag state approval can provide type-specific training for ship systems. Future recruitment of officers will seek 'digital natives' who enter the industry with applied knowledge of computing and who have an ability to work quickly and easily with shore-based experts.

3] **Cyber security concerns over criminal and political activity disruptive of maritime operations, such as virus attacks and electronic jamming.** Criminal and political attacks make ship systems redundant and put them in danger. An additional concern is the lack of back up systems or those that continue to operate at reduced capacity through independent readings and manual inputs. Though some of these concerns can be allayed through greater cyber-awareness, design of foolproof systems should be a priority.

4] **A master's overriding authority for operations to be included in any safety management system and recognised internationally to avoid unfair disciplinary action and conviction.** A seaworthy ship is part of a contract of carriage and the master and officers are best placed to make appropriate decisions. The vast amounts of data fed ashore can lead to unfair questioning and misguided expectations by shore parties lacking knowledge or understanding of realities at sea. There is a fear that 'intelligent' computer systems once onboard may be used to aid the crew but yet be uncertified or fail to provide data protection for an individual.

Merchant fleets are created for commercial reasons by supplying international economies. Ship size continues to increase while crew numbers decrease. Ships convey increasingly dangerous cargoes, sometimes to environmentally sensitive areas and politically unstable countries. Ships' masters face growing challenge from shore operators and flag states regarding ship operations. To mitigate these concerns AI based technology needs proper development and approval and be operated onboard ship by officers trained with its use. AI is focused on automation of navigation and security, but it could perhaps be adapted for cargo operations leading to better utilisation of an officer's time and could be transferred between ship types in the owner's fleet. This would benefit the ship owner by retaining trained crew and aid the sale and purchase of fleet types more suitable to commercial patterns. AI systems have undoubted maritime uses and as we progress towards true General AI, the possibilities become limitless.

Ships cannot operate with proposed manning levels. Additional staffing requirements can be assisted by AI systems to combat fatigue and work pressures by removing unnecessary tasks. Deck officers can then focus on navigation and the preparation of and operation of the cargo system, releasing the ship's master to focus on responsibility for overall charge and taking the best-informed decisions. Human agency onboard ship, *supported by AI*, can lead to safer navigation and greater cargo care, crew safety and security.

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