Building a Successful Maritime Autonomy Ecosystem

Findings from a Maritime Autonomy Workshop

Introduction

The Centre for Assuring Autonomy (CfAA) at the University of York ran a workshop for the maritime sector in March 2024 focusing on the challenges for successfully introducing maritime autonomy and strategies for addressing these challenges. It also identified actions that the CfAA can take to assist the maritime community as it moves towards the introduction of autonomous functions and vessels, and remote operations. The workshop was attended by a wide range of stakeholders including shipbuilders and equipment suppliers; regulators, class societies; pilots; insurers; academics, learned institutions, lighthouse services and consultants.

The workshop included presentations on the perceived challenges in introducing maritime autonomy, particularly in the areas of safety and assurance, the assurance frameworks developed in York, and four autonomy use cases which were used as the basis for group discussions. Participants discussed the four use cases, identifying design and assurance issues, and outlining solution approaches. The workshop also included an interactive session to identify the attendees' perceptions of the main issues facing the sector as it moves towards the wider introduction of autonomous capabilities.

The purpose of this report is to summarise the findings and recommendations from the workshop, starting with an overview of discussions centred around four use cases, as these give a valuable perspective of the issues being faced by the sector.

Use Cases

The workshop attendees split into four groups and each considered one use case. Considerations included- why the capability was desirable (the business case), what the safety implications were, and what assurance looked like?

Some of the key conclusions from the use cases were:

Periodically Unattended Bridge: perceived benefits relate to crew welfare and crew utilisation; technical issues include achieving situational awareness (SA) especially if crew return to the bridge to respond to alerts; safety concerns particularly relate to SA, understanding of alerts and the latency of response; assurance concerns include verification and validation processes and obtaining sufficient coverage, through simulation, of situations requiring manual intervention so that the handover between technology and the human can be evaluated and agreed by all stakeholders.

Pilotage of an Autonomous or Remotely Piloted Vessel: the operating concept (ConOps) needs to consider pilots operating from a remote operations centre (ROC) and how this would satisfy the safety, legal and environmental protection requirements of the Port Authorities; acceptability of and trust in remote pilotage; key safety concerns are establishing and maintaining SA and handling emergencies, e.g. loss of connectivity or abandonment of the ROC, resulting in a loss of the thrust or steering functions; there is also a need to consider risks of the vessel itself, its fuel and its cargo. Where a pilot is requested to take control of a MASS, e.g. transitioning to remote operation to enter a port, the potential legal implications in terms of change in responsibility or liability need to be considered.

Emergency Response for a Vessel at Anchor: anchor handling is very challenging, especially when dealing with situations where there are potential hazards that could impact safety, e.g. the anchor cannot be recovered, and the anchor starts dragging on the seabed. Alternative solutions *in lieu* of anchoring were considered, including the use of dynamic positioning systems or 'fall-back' states that require external assistance. The use case also considered autonomy isolation to ensure safety of the salvors, e.g. so that the collision avoidance systems don't increase the risk of boarding a vessel, or machinery taking autonomous action, e.g. motors re-starting, without warning the people on board.

Change of Voyage Plan: safety principles for conventional ships still apply, however, a change of voyage will need to be evaluated to ensure the agreed 'fall-back' states remain applicable and to prevent an intolerable risk from arising e.g. external assistance may no longer be available in the new port, or the autonomous vessel may not be accepted in some ports, and this might impact the business case; the human has to be "in the loop" - the controlling mind making decisions about voyage changes.

Findings

The discussion of the use cases showed that introducing autonomy into the maritime sector is complex with technical, human centred design, social and legal aspects all requiring consideration. Based on these discussions and the interactive session, the principal findings are:

- The three critical enablers to maritime autonomy are credible safety assurance, effective regulatory processes and establishment of a compelling business case.
- The maritime community has concerns about the current state of standards and regulations, and would like to see more rapid progress on workable regulations, both internationally and at national level.
- Regulatory development, with government support, is seen as crucial to enable the successful introduction of autonomy.
- The concept of operations (ConOps) needs to be considered carefully, and simply automating current practices is unlikely to be successful without this.
- Context is crucial and it is necessary to consider a vessel as part of the overall maritime autonomous infrastructure (MAI), not in isolation.
- Human-system teaming, including handover of control, needs to be considered during design and analysis, and addressed in safety assurance.
- The legal position in terms of liability for (accidents involving) autonomous vessels is unclear and may vary internationally, which could give rise to the need for a dynamic safety assurance approach to acceptance.
- Considerable stakeholder engagement is needed, e.g. education and training for all stakeholders, and support to culture change.
- Demonstrators which show the effectiveness of maritime autonomy and how the systems can be assured are needed to enable effective engagement between industry, class societies and the regulatory community.

Many detailed observations were made in relation to the use cases, but the above were common themes across most, if not all, of the discussions.

Recommendations and Actions

The key recommendation is that the maritime community needs to work together to address the challenges of safe, scalable and cost- effective introduction of autonomy - no single stakeholder can do this by themselves. This requires action by multiple stakeholders, but the CfAA can support the community by taking the lead on issues where its independence and knowledge are key enablers:

1. Seeking greater government investment in maritime autonomy, reflective of the levels seen in autonomous driving.

2. Seeking funding for a “demonstrator” project showing how to assure particular autonomy concepts, engaging as wide a range of stakeholders as possible.
3. Consulting with professional bodies, e.g. IMarEST, and trade bodies, e.g. SMI, to identify areas where the CfAA could facilitate agreement and developments in the international maritime community.
4. Following on from 3., working with the maritime community to develop a shared understanding of key issues, e.g. on regulatory principles and practices and how they have been dealt with in other sectors, reflecting the need to cover the whole MAI, not just vessels and ROCs.

All of these, particularly the second action, are urgent. Ideally, the demonstrator should parallel the development of the IMO MASS Code both to help validate it, and to provide feedback so it can be refined before it progresses from voluntary to mandatory status.

Conclusions

It was clear from the workshop that safe and beneficial introduction of maritime autonomy is a highly complex subject, needing the involvement of many different stakeholders. We hope that, by convening such a wide group of stakeholders and senior decision- makers, the CfAA has contributed to the understanding of the issues. We will follow through on the recommendations and actions and will inform the workshop attendees and the invitees who were unable to attend of progress, likely organising a follow-up workshop in due course.

Resources

Centre for Assuring Autonomy (CfAA)

Safety of autonomous systems in Complex Environments (SACE)

Assurance of Machine Learning in Autonomous Systems (AMLAS)

Attendees and Affiliations

Person	**Organisation**
Lydia Hyde, Principal Systems Engineer, Research & Development Directorate	General Lighthouse Authorities of the UK & Ireland
Peter Sheppard, Head of Technical and Policy	Institute of Marine Engineering Science and Technology
Mike Knott CBE, Maritime Capabilities Advisor	BAE Systems Maritime & Land
Eshan Rajabally, Maritime Autonomy Technology Lead	BMT
Justin Buck, Principal Robotics Engineer	National Oceanography Centre
Erik Tvedt, Naval Architect	
Mark D R Darley, Chief Operations Officer	Lloyd's Register
Baris Soyer, The Director of the Institute of International Shipping and Trade Law	Swansea University
Claire Pekcan, Director	Safe Marine Ltd / Liverpool John Moores University
Clare Green, Innovation Partner	Defence and Security Accelerator (DASA)
Dorthea Vatn, Research Scientist	SINTEF Digital
Tobias Rye Torben, Senior Autonomy Engineer	Zeabuz
John Shimell, Chief Engineer Autonomy	QinetiQ
Thor Myklebust, Senior Researcher	SINTEF
Jan Przydatek, Director of Technologies	Lloyd's Register Foundation
Sam Dadd, PR and Communications Manager	Lloyd's Register Foundation
Maria Lagoumidou, R&D Manager, Innovation	Tokio Marine Kiln
Chris Balls, Principal Surveyor	Maritime Authority of the Cayman Islands
Stephen Perry, Naval Authority Certification Officer	Naval Authority & Technology Group, UK Ministry of Defence
Karan Kheta, Naval Authority Reviewing Officer	Naval Authority & Technology Group, UK Ministry of Defence
Charles McHardy, Deputy Commissioner of Maritime Affairs	Republic of the Marshall Islands
Chief Executive	Society of Maritime Industries