Autonomous ships

Autonomous ships are a much-discussed topic in the industry, but how realistic is this technology and how soon should we expect it?

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Defining autonomy

The term 'autonomous ship' is mainly used to depict a self-sailing crewless vessel, but there are actually various degrees of autonomy. It is first important to distinguish between these levels of autonomy before commenting on when and why these vessels could start to become a reality.

Lloyd's Register has defined seven levels of autonomy (from AL 0 to AL 6 see box on page 3), which we have grouped as follows for simplicity:

- Manned ship – traditional crewed vessel with a human operator making decisions
- Remote ship – controlled by a human operator ashore
- Automated ship – running pre-programmed software and can only operate within the scope of the algorithm
- Fully autonomous ship – operating system can calculate consequences and risks, and make decisions by itself.

We are likely to see a steady transition from manned (AL 0), through the intermediate stages, to fully autonomous (AL 6) ships happening whilst the technology is tested and algorithms are improved through machine learning.

What types of ship will become autonomous first?

In our opinion the most likely initial applications for an autonomous ship will be in simple inland or coastal liner trades – mainly bulk carrier, passenger or roro ships. A good example would be a roro ferry operating across a Norwegian fjord. The waters are relatively calm and traffic-free, and the route is simple.

When will autonomous ships become a reality?

To use the most publicised example, the *Yara Birkeland* (an inland electric container ship) is expected start trading remotely in 2020 and fully autonomously by 2022, with the shipbuilding contract just recently signed. So, we are likely to see the technology in action within the next few years. However, the timeframe will vary hugely depending on the type of trade, trading pattern and, crucially, the level of autonomy being referred to.

What are the advantages?

The advantages of autonomous ships are plentiful. They eliminate human error, reduce crewing costs, increase the safety of life, and allow for more efficient use of space in ship design and efficient use of fuel. A three-year research project by MUNIN (Maritime Unmanned Navigation through Intelligence in Networks) predicted a saving of over $7m over a 25-year period per autonomous vessel in fuel consumption and crew supplies and salaries.

What are the disadvantages?

Despite the operational savings, there will be a large capital expenditure in initially investing in the technology, especially in the early stages of its development. This is not just for the ship itself, but also the setting-up of onshore operations to monitor fleet movements. There may also be incompatibilities between the current marine infrastructure and an unmanned vessel.

Further, the lack of crew will make maintenance of moving parts incredibly difficult on long voyages and breakdowns could result in significant delays.

Conclusion

In our opinion, there is no viable economic benefit for a completely autonomous (AL6) ocean-going ship in the immediate future. Despite a belief in the technology, there will always be value in a human presence on board overseeing operations, the safety of the ship and the safety of the cargo. There will definitely be an application with small inland and coastal craft, but in a 20,000 TEU trans-Atlantic container ship we are only likely to see the lower levels of autonomy to aid the crew in navigation.

What are the regulatory barriers to autonomous ships?

Autonomous ships are becoming a reality. How will the regulatory and legal systems adapt?

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Whilst the high investment in onshore and offshore infrastructure is undoubtedly a hurdle to autonomous technology being broadly adopted in the shipping industry, perhaps a more daunting obstacle is the unreadiness of the regulatory and legal systems which keep the shipping industry in check. The predicted degrees of ship automation and the timeframes to implementation can vary dramatically, but the simple fact is that the current legal framework lacks the basic language required to account for autonomous ships in any capacity.

COLREGS

The COLREGS, for example, outline the 'rules of the road', providing navigation instructions for ships to follow to prevent collisions at sea. But they specifically only apply when 'one ship can be observed visually from the other'. Rule 5 (Look-out) insists above all on perception and judgement to assess the 'special circumstances' and to make a full appraisal of the risk of collision. Whilst it is feasible that a ship remotely operated or monitored from ashore could satisfy these conditions, it is difficult to see how a fully autonomous ship ever could. Not least because the UN Convention on the Law of the Sea 1982 requires (under Article 94) that each ship must have a master who is 'in charge' at all times.

SOLAS

From a human perspective, we must consider SOLAS. SOLAS sets minimum standards of safety at sea and includes an obligation for masters to assist a ship or person in distress. Regulation V/33 explicitly requires masters to deviate to save life. In some cases, autonomous ships may be better at responding to distress signals, but sometimes there can be no substitute for visual identification.

Other conventions

Theoretically, there needs to be a complete overhaul of the current framework by which the shipping industry operates, which will include the rewording of civil liability conventions (ie Salvage, Nairobi Wreck Removal, CLCs for oil pollution), the UNCLOS 1982 and all domestic shipping legislation (eg the Merchant Shipping Act in the UK).

P&I cover

There is work to be done from a P&I perspective too. Is an autonomous ship poolable? Should a remotely operated ship, controlled from on shore, be considered equivalent to an ROV operated from aboard a traditional ship and therefore excluded from pooling? Our view is that autonomous ships would not fall outside the definition of 'eligible vessels' for pooling purposes, nor would they be distinguishable from conventional manned ships for the purposes of the risks and liabilities excluded from cover.

Conclusion

There is no doubt that such amendments will take a considerable amount of time and effort, and with the *Yara Birkeland* on the brink of full autonomy, we must start soon. According to the UN, the Law of the Sea Convention 1982 was implemented as an update to the centuries old freedom-of-the-seas doctrine in order to account for 'the technological changes that had altered man's relationship to the oceans'. Now is the time to re-evaluate our relationship once again.

	Autonomy Level (AL)	Description
AL 0	Manual	No autonomous function. All action and decision-making performed manually (n.b. systems may have level of autonomy, with human in/on the loop.), i.e. human controls all actions.
AL 1	On-board decision support	All actions taken by human operator, but decision support tool can present option or otherwise influence the actions chosen. Data is provided by systems on board.
AL 2	On & off board decision support	All actions taken by human operator, but decision support tool can present options or otherwise influence the actions chosen. Data may be provided by systems on or off-board.
AL 3	Active human in the loop	Decisions and actions are performed with human supervision. Data may be provided by systems on or off-board.
AL 4	Human on the loop, operator/supervisory	Decisions and actions are performed autonomously with human supervision. High impact decisions are implemented in a way to give human operators the opportunity to intercede and over-ride.
AL 5	Fully autonomous	Rarely supervised operation where decisions are entirely made and actioned by the system.
AL 6	Fully autonomous	Unsupervised operation where decisions are entirely made and actioned by the system during the mission.

Lloyd's Register seven levels of autonomy