# Maritime Autonomy – A Way Ahead?




**Maritime autonomy allegedly holds out the potential for significant economic gain, should anyone be able to crack all of the problems that would make a scalable business. Nick Tudor explains why it is not currently possible to make such a business and proposes a way ahead that could be seen as radical by some, necessary by others.**

## Full Autonomy

Currently, we treat autonomous vessels as if they were 2-year old children; we don't trust them to do things on their own. We give the child a task and we watch them like a hawk and we don't let them anywhere near sharps knives, fires, etc. We need to change this so that we treat them, more like, and I accept that the analogy might break down here, teenagers. In this scenario, the chances are that they are capable of doing the job asked of them unsupervised, to a reasonable/acceptable standard and when they have finished or if they are unable to do so, then they will report back. The focus here will be on what I am going to refer to as 'full autonomy' which I am going to define as follows: The vessel is given a task, it goes and does it unsupervised and it only reports to a human if something has stopped it from doing so, or it has completed the task; a teenager at least!

> **"We treat autonomous vessels as if they were 2-year old children; we don't trust them to do things on their own"**

## The Law

Without going into specifics, I am not a lawyer, let alone a maritime lawyer, international law requires that every vessel shall have a Master. In conversations with maritime lawyers, Class Societies, insurers and others, this is so that there is someone to blame when it has all gone wrong. This might be a bit cynical, but it appears to be not far from the truth. The role of a Master is to be the final arbiter, the ultimate decision maker on all matters at sea. For autonomous vessels of any size, this role is still required by law and therefore the regulation that enables compliance to that law means that some aspects of autonomous vessel design operation and deployments have to adopt some human based practices. However, there is no-one on board the vessel.

## Master of all they Survey?



In a number of circumstances, what exactly can a Master do? For example, the 'Officer-of-the-Watch' also known as the 'Operator' in a facility called a Remote Operation Centre (ROC), while supervising the autonomous vessel (they're only allowed to supervise one at a time), notices that the communications have failed.

Such problems have to be raised to the Master who maybe anywhere else in the world. They are woken up, arrive on the bridge/arrive in the ROC/phone in to be briefed that the Operator cannot communicate with the vessel.

Questions is: what exactly are they supposed to do about it; there are no communications? (There are similar other such issues for which it is probably not right to assume functions will be available for an autonomous vessel that are analogous to a crewed vessel; a list can be provided!) To repeat, there is no-one on board.

> ***"it does not make sense for there to be a role of Master for an autonomous vessel in the same way that one is required for a crewed vessel"***

This means that the vessel has to behave as though there were humans on board even though there aren't and this has to be apparent, as far as is reasonably practicable, to other maritime traffic. I argue that it does not make sense for there to be a role of Master for an autonomous vessel in the same way that one is required for a crewed vessel.

Removing the requirement for a Master would require international agreement to change the law, but we need changes to international and national laws to enable scalable use of autonomous vessels anyway, so this is a difference that makes no difference. So, who is going to be the one in the dock when it all goes wrong? I'll come back to that, shortly.

## Class

Another big issue is Class. The problem as I see it is that the mantra currently adopted is that autonomous vessels have to be 'as safe as crewed vessels'. The Class determines what functions a vessel has from many perspectives, especially safety. However, it appears that there is no objective definition of what constitutes 'safe'. Arthur Dent in *The Hitchhikers Guide to the Galaxy* [1] had the same problem when Ford Prefect enlightened him to his predicament and told him he was 'safe' on the Vogon constructor ship[1].

Currently, it appears that good practice has evolved since at least Nelson was a boy and an assessment is undertaken by Class Societies. Opinion varies as to which of these Societies is best; another level of subjectivity, and one needs to define 'best'! These vessels have no-one on board, I may have mentioned this before, so why do we need to classify them in the same way as crewed vessels?

There will be many arguments why this should be so, but historical precedent is not necessarily relevant in this case. Let's turn the question round and rephrase to 'why not have a different class'? We can still adopt a swathe of good practice but stop where it does not make sense. This would allow a number which defines what we mean by 'safe' (enough) as is the case in most other sectors ranging from aerospace, automotive, rail and industrial plant. As a result, lots of problems can be solved.

## Safety Argumentation & Evidence

If we have an objective safety target to meet, then argumentation can be put in place to show that any aspect of the vessel has been assessed from a design perspective. We therefore show that we understand the contribution to the safety of the vessel through the mitigation of hazards. By doing so, evidence can be produced to show that the claims have been met, or otherwise. Without an objective safety target, subjectivity leads to non-standardised vessels and consequent questionable safety; depending on your criteria for 'best' with regard to the Class Society used.

## Insurance

Insurers are all about the numbers; they love them! Give them such an understanding of the risk and they can then properly cost that risk; what's not to like in this regard?

[1] Arthur: If I asked you where the hell we were, would I regret it?
Ford: We're safe.
Arthur: Oh good.
Ford: We're in a small galley cabin in one of the spaceships of the Vogon Constructor Fleet.
Arthur: Ah, this is obviously some strange use of the word *safe* that I wasn't previously aware of.
— **Douglas Adams, The Hitchhiker's Guide to the Galaxy**

## Software

The maritime world has no sector specific software standard and that's great; the world doesn't need any more of them. Software systems are not necessarily a one-for-one replacement of electrical or mechanical systems. Development of software in aircraft has been carefully developed to meet an internationally agreed standard which is 'goal' based and aligns well with safety argumentation.

Other sectors have developed software standards but these tend to be technique oriented which can lead to a tick-box approach to assurance of the software system. Given that sensor systems can be built to detect on-board and off board issues, that there is a sufficiency of them (spectrum coverage and redundancy) set in a systems architecture, then there merely needs to be some software that makes decisions, high integrity decisions. This software cannot be artificial intelligence (AI), the safety of the vessel depends on it and AI is a bet.

The software has to be shown to play its part in the mitigation of hazards, so deploying robust techniques to build this are required. Sounds expensive? Well, so is losing the vessel! Nevertheless, while other approaches are available, check out the techniques deployed by D-RisQ which can save a considerable amount of time/cost while providing evidence to support the safety case.

## Other Sectors

Interestingly, a few years ago, Volvo declared that if (when?) they produced an autonomous car, they would accept liability for any accidents; it's apparently still 'when'. In the air industry, the aircraft manufacturer is liable, same for most other products. However, like all such products, they may decide that the issue was not caused by them but their supplier and hence the next lawsuit is raised and lawyers make their money.

## Maritime Autonomy & Liability; A Suggestion

By removing the role of Master, liability can shift to the vessel producer. So long as the vessel is operated within the defined context of use (defined in the safety case), then any issues can be pinned on the vessel designer; if it's out of the context of use, the operator /service provider becomes liable. Proving this should not be difficult. Someone is still likely to be liable, which should satisfy the lawyers!

## The Market




Should there be a market for autonomous surface vessels, it is not going to be sufficiently addressed by having one person supervising one vessel; it's not a scalable business model. Given that the high integrity software can ensure that the vessel behaves at least as well as a 'teenager' then there is no real reason for a one-to-one relationship. The service has to be reliable and should be able to continue in the vast majority of cases without supervision. One might decide that higher risk areas (eg around harbours) there has to be closer supervision. This would make the market viable through being scalable. Note that the operator still has to operate the vessel in accordance with the design specification and the design specification has to be maintained in accordance with the manufacturer's requirements, in the same way that aircraft and cars are required to do every year or so.

## Conclusion

"The significant problems we face cannot be solved by the same level of thinking that created them": Albert Einstein. If we remove the role of Master, have a completely different class of vessels, build them such that it can be argued to be adequately safe against a design safety target, then there is a chance that a market could be made and addressed. Demonstrating this approach might cost a few quid, and cause some changes to international agreements and the odd law here and there, but then away anchors!

***"The significant problems we face cannot be solved by the same level of thinking that created them": Albert Einstein***

## References

[1] The_Hitchhiker's_Guide_to_the_Galaxy, https://en.wikipedia.org/wiki/The_Hitchhiker's_Guide_to_the_Galaxy_(novel)

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Following a full career as an RAF Officer Engineer, Nick has been working in software and high integrity systems for the past two decades. As co-Founder of D-RisQ, he has worked in multiple sectors including aerospace, defence, automotive, rail, autonomous systems in air, land, sea, nuclear decommissioning and cyber-security. Perhaps the only claim to fame he might have is as one of the key authors of DO-333, the Formal Methods Supplement to DO-178C (the aerospace software standard).