Interview with Hans-Christoph Burmeister, Head of the Department Sea Traffic and Nautical Solutions of the Fraunhofer Center for Maritime Logistics and Services

Trust in software

by Przemysław Myszka

Autonomous shipping will, in all probability, profoundly change the maritime business, also the land side of it. We are talking with Fraunhofer CML's Hans-Christoph Burmeister about what has already been achieved in making crewless ships a reality and what developments need to take place to further the process. These include, among others, factoring in weather, harmonising different technologies, and building 'trust' between humans and machines.

■ ***Let us start with the nuts and bolts of autonomous shipping. What are the developments thanks to which we already have real-life projects with an autonomous container ship, domestic ferry, and dredgers?***

It is a result of the general automation trend, also when it comes to transportation modes. The maritime industry has already had some experience with sensor and tracking technologies designed for specific control tasks. It has been now combined with advances made in automated decision-making and sensor fusion systems, all very much driven by the automotive sector, which, in turn, should take credit for showing that self-driving vehicles can become a reality.

There are also differences, and not all concepts and solutions developed for the automotive can be used by the maritime industry. Or, at least, not in a copy and paste style. While both use sensors, the particular technologies differ. For instance, ships don't need accuracy measured in single millimetres. Another example would be lidars, which aren't particularly suited for marine navigation. On the other hand, though, the maritime industry can learn a lot about sensor fusion and redundancy from other segments. There is currently a certain lack of cross-sensor value checking, being up to the officer on watch to determine whether data that comes from the radar matches the one coming from the automatic identification system.

Ships also operate in an altogether different environment than cars. It has its set of pros and cons. Decision-making doesn't have to be that fast, but at the same time it needs to look more into the future. Still, since vessels are large physical objects, the decision you or the algorithm takes now will take time to execute, will last longer, and will be more difficult to alter rapidly. As such, the decision-making forecast is extended over a longer period. We are talking about seconds or even less in cars – to dozens of minutes for ships.

Computational power is yet another issue. Creating a representation of the surroundings, hence situational awareness, isn't so difficult in the open sea. The situation changes when much more is happening, think of in-port activities, or when raw data must be extracted and analysed, especially from additional sources like high-end cameras. They will give you extra input for precise operations, but at the expense of installing strong enough computers.

■ ***How important is weather, particularly accounting for bad or even extreme conditions, in developing solutions for autonomous shipping?***

Weather needs to be taken into account as well, as it adds streams of data and impacts the performance of the sensing equipment. Truth be told, although the existence of the topic is acknowledged, it is also somewhat neglected. Autonomous shipping projects currently focus on collision avoidance and anti-grounding. Weather should be very much factored in because it is one of the leading causes of accidents, with incidents that come to pass by floundering far exceeding those that result from ships colliding with each other. Better weather routing can help to a certain degree, increasing the likelihood of avoiding bad conditions in the first place. As things stand today, we will have the so-called operational envelopes, determining under what conditions algorithms can take over, leaving operations in harsh weather in human hands. Yet, moving forward towards fully unmanned shipping, we will have to make sure ships can ride out the storm.

■ ***Can we imagine a situation when there is a conflict arising between what the algorithm would do and what the officer in charge would opt for?***

It is maybe not a matter of two decision-making centres fighting over the next best move but understanding why the software gives particular advice. In other words, algorithms behind autonomous shipping cannot function as black boxes that spit out answers. The people in the loop need to understand the reasoning behind this-and-that decision. For want of a better word, let us call it "trust," in the sense that officers can trust the software that it won't put them in harm's way.

It may as well not be a matter of conflicting decisions, but the sequence. The officer would take a specific action now, while the algorithms would suggest a different one at a later point of time; still, the outcome would be the same in both cases, namely safe operations. Or when the software is actually doing something but not communicating it, prompting the officer to step in and take over control.

In a way, it is funny because a lot of what constitutes navigation consists of monitoring. It isn't that the officer on duty constantly tells everybody on deck what they are doing. Nevertheless, revealing the inner life of algorithms is what's needed for building that 'trust in software.'

■ ***Shipping is as broad of a term as they get – from inland waterways coal barges to sailing mega-hotels, from liner to tramp traffic, and from vessels that sail the open seas to those having to navigate through near-miss archipelagos and fairways. What ship types are a perfect match for making their operations autonomous, which are so-so, and which won't become crewless in the foreseeable future?***

If by "autonomous" we understand supportive systems helping with monitoring or decision-making, then all ship types would benefit. Again, think of the air industry where the autopilot takes care of much of the flight. In contrast, if we talk about vessels without onboard crew, there are certain limitations. Cruise ships or long-distance ferries, particularly those covering overnight crossings, aren't the most suitable ones for unmanned operations and thus highly unlikely to be automated. While it is technically doable, airline passengers are against flying without a crew, so it's very much a 'psychological issue,' so to say. On the other hand, domestic ferries that serve shorter routes would be a good match, similar to automated trains taking care of airport traffic. Here you could even envisage a 'travel on demand' service. The tug market also looks promising. It is a taxing job, potentially very hazardous, too, so making it remote-operated or fully unmanned would secure the availability of this service in the future. It is also a cut-throat market nowadays, so ports and terminals would

undoubtedly benefit from ensuring the capacity to handle the traffic around the clock.
In general, fixed-route services are promising, including inland waterways, not only because the operational environment stays pretty much the same but also because you can put technology on the infrastructure, such as aids to navigation. That way, you don't have to rely just on the equipment with which the ship is furnished. Moreover, multiple vessels can use that tech-enhanced infrastructure, so the investment cost on the shipowner's side can be lowered.
In turn, it might take some worldwide standardisation agreement to see unmanned vessels in tramp trade, the core of which is the ability to sail globally.

■ ***What would be your best-case scenario for the uptake of this technology? Then again, what would shelve the entire thing altogether? In-between, what is your take on how autonomous shipping will progress in the nearest years?***

Seeing one of the pioneering projects having an accident has a high disillusionment potential. It doesn't have to be a Hindenburg-like incident. Still, I'm pretty sure the news would be full of autonomous-ship-went-wrong headlines, underlining that it was a crewless ship even if the accident wasn't the fault of technology, to begin with.
That is probably why the initial trials are carried out in-house, with the party in charge having oversight on both the vessel and cargo. It wouldn't derail the entire venture altogether; the automation trend is, it appears, robust enough to shoulder such mishaps. Still, it would force the next party to think twice before waving the look-at-us-we-are-launching-an-autonomous-vessel flag. Then again, we had accidents introducing radars or AIS because of these technologies, but we managed to get past and refine the solutions to the point that they have become bread and butter.
The best-case scenario would, in turn, be autonomous shipping catalysing the change from economies of scale to genuinely streamlined and synchronised logistics chains. Instead of ordering the next TEU record-holders, which would then call to even fewer ports than today, we would have unmanned fleets of smaller ships but ones that do sail according to schedule, making the vessel call optimisation topic more or less redundant. Couple that with automated terminals, truck platooning, and autonomous trains, and you could see the benefits trickling down the entire value chain. I am more than looking forward to seeing the concept validated in real life, perhaps in a region with a well-established short sea shipping network and good cross-country collaboration. This endeavour will require many parties jointly working towards a common goal. There are some promising initiatives in the Benelux involving inland waterways transportation. However, the most significant push will come when one of the largest logistics service providers decides to automate its multimodal global logistics chain. If they succeed, others will in all probability follow suit, automating transport, on- and offshore. Shipyards would surely also capitalise, as it makes much more sense to design and build a fully unmanned vessel from scratch than having a retrofit. There is also a chance that automation brings more standardisation to ship manufacturing. In all probability, it will never resemble car production, but reaching the airlines level is feasible. Shipowners could then opt for designs that are 'mass-produced,' hence cheaper if you understand by it a model that comes in higher numbers than in today's series of a dozen units at best – and which also differ from company to company. A feeder or short sea shipping company operating a fleet of ten, 20, or 50 identical autonomous vessels? Perhaps that is the future we will have the opportunity to witness with our very eyes.

■ ***When discussing autonomous shipping, it is often brought up that 'the technology is already there; what is lacking are regulations.' Is that the case? And if yes, then why and what is needed to catch up legal-wise?***

That was, indeed, the argument for a long time – that legal issues will be the main blocker for the uptake of autonomous shipping, at least in international traffic. Interestingly, it wasn't brought up by lawyers. In fact, they are the ones looking forward to establishing new rules because it will open a new field in which they can operate. It was more of a general criticism that, it appears, pops up whenever a new concept starts making it to the top of the agenda.
Over the past four of five years, we witnessed a very open discussion, also on the International Maritime Organization level, about autonomous shipping coming to fruition. Rules and regulations are yet to be fully ironed out, but it is more of ticking it off rather than some grand legal battle that will once and for all decide upon the fate of unmanned vessels. The countries pioneering autonomous shipping are already amending their laws to clear the way, leastwise regionally. In an ideal world, we would already have global regulations, but we can calmly settle for second best and proceed with the works, even in waters that are sort of charted only.
What would help accelerate the entire thing is harmonising the different technologies

that are developed for autonomous shipping. From a global uptake perspective, it simply wouldn't make sense to have separate interfaces, say, for autonomous shipping in Germany, Poland, or Sweden. Naturally, more funding, especially seed, would be more than welcome to lower the financial risk of investing in mass autonomous shipping.

■ ***Leaving aside autonomous shipping, what are the other technological developments that, in your opinion, have the biggest chance to change the industry?***

Developing sustainable technologies has been a critical driver of innovation for a few years, be they auxiliary engines, main propulsion or other projects that aim to disrupt the maritime business, like alternative fuels. Unlike digitalisation, where our industry can learn from others, the green fuel part is, it seems, something we have to discover ourselves. Sure, there are electric cars, and some manufacturers have been experimenting with hydrogen for decades now. Still, a seagoing vessel that must take cargo, e.g., from the Nordics to Spain and go back, is a widely different pair of shoes in terms of the needed battery capacity or hydrogen bunkering needs. The answer might as well be liquefied natural gas, liquid biogas, e-fuels, heavy-duty wind assistance, ammonia, fuel cells, electricity – or probably all of them depending on the shipowner's requirements and market specifics. However, what is needed across the board is a sound alternative for heavy fuel oil, hence also new engine types. ■