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"DRONIZATION" OF THE SEA - SHIPS OF THE FUTURE

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ABSTRACT

Maritime areas cover 70% of the surface of the Planet, see the transit of 80% of world trade and accommodate submarine cables through which 99% of telecommunications pass. This carpet from the bottom of the oceans contributes to a wave of digitization of land, air and sea spaces, thus challenging human beings. The development of aerial drones and the autonomous car has largely inspired the industry of the maritime world. The smart shipping revolution is underway. Nothing seems to be able to prevent it as the expected benefits are numerous. Reducing the number of sailors on board ships will reduce the number of premises devoted to human presence, thus freeing up space for the goods transported, and will give naval architects freedom to design more hydrodynamic shapes adapted to the assignments. On this aspect, we are witnessing a transition from automation – which has already enabled significant crew reductions – to autonomy, which will amplify the phenomenon.

Keywords: robotics, drones, autonomy, artificial intelligence (AI), smart ships

1. INTRODUCTION

Could these men “who go to the sea” one day be no more? In common parlance, drones refer to flying machines. Paradoxically, the airspace was indeed the first to see itself invaded by machines implemented without a human presence on board, whereas its three dimensions are a priori more delicate to control than the only two of land and maritime spaces, at least for surface ships. Nevertheless, the latest experiments encountered by the maritime world in the field indicate that this delay could be made up for in the very near future, even prompting a maritime trade professional to ask himself the question of “a sea soon without sailors?".

The maritime industry is increasingly pursuing advanced integration of new technologies, aiming for even greater optimization of the volume of crews manning ships. The dronization and robotization of the seas are therefore well underway, even inevitable.

As in many other areas, it is above all the advent of artificial intelligence (AI) that suggests a real break in the strategy for the use of maritime spaces by humans. The latter should be able to reposition itself where it is best, i.e. where it can work more efficiently, in complete safety, without suffering the effects of heavy seas. Its gradual withdrawal from the maritime space is therefore not so much an abandonment as a way of optimizing the use of the oceans and developing one's knowledge of them, which is still very superficial.

Already well underway in the civilian maritime world, this shift in systems automation is pushing some states to develop military applications, as the duality of the latest technologies offers prospects likely to upset naval strategy.

The Navy has not remained on the sidelines of this development and has already programmed the use of drones for some of its missions. In view of what technology already allows, it is advisable to continue the reflection and to define as of now a policy of integration of dronization and the advent of AI in the navy of tomorrow while avoiding the trap of an arms race.

There is an acceleration in the digitization of all trades, from simple labor to the decision-making process. Many projects or experiments have already found concrete applications.

Safety will also be improved since approximately 95% of maritime accidents are caused by human factors. Finally, maritime traffic will be streamlined and improved to increase operating profitability, provided that the land segment (landing of containers, piggyback transport, etc.) follows the same developments.

2. THE CONCEPT OF AN UNMANNED VESSEL IN THE CONTEXT OF THE SHIPPING INDUSTRY

As soon as a project emerges in society, its development and its future will be subject to the context in which it is inserted. This context can be divided into two parts, on the one hand, the internal context which will be constituted by the project itself and its creative elements. On the other hand, the external context or the environment in which the project is immersed and which will greatly influence its development.

Although autonomous vehicles are no longer considered a novelty, autonomous navigation and the concept of unmanned vessels are real innovations for the shipping industry. No merchant ship is to date operated independently. Therefore, we are faced with a nascent project, which is taking its first steps in the maritime industry, and which will therefore be influenced by external factors. These factors will be political, economic, social, environmental, technological or even legal. It is necessary to analyze all the factors that are likely to influence the development of unmanned vessels, but also the impact that this type of vessel will have in return on its environment.

The concept of an autonomous ship as it is thought and developed by the maritime actors at the origin of its dazzling development will be considered in this article.

2.1 Autonomous navigation players

The thought of an autonomous robot developed with the advent of the computer and what can be called artificial intelligence. At that time, that is to say after the second half of the 20^{th} century, technological players began to consider the possibility of an autonomous robot capable of moving and adapting to its environment without external intervention. Empowerment technology took its first steps on land and then underwater in the 1980s with the development of autonomous public transport in particular. Today, many cities have acquired the technology of autonomous vehicles and are running unmanned, self-programmed metros in their underground.

Autonomous vehicle projects by private actors have developed considerably in recent years and we have thus been able to discover the Google driverless car projects or the Mercedes Benz project.

The technology that has been introduced in this driverless car concept is largely similar to that which unmanned ships are intended to be equipped with. In terms of autonomous vehicles, projects and applications in the air and land sectors are inspiring for the maritime sector, whether at the technological or regulatory level.

Although autonomous vehicles were widely developed in the first years of the 21st century, the idea of such autonomy applied in the field of commercial navigation, in consideration of the size of ships in particular, seemed inappropriate and risky.

The first attempt at autonomous unmanned navigation in the context of maritime transport was thought of in the 1980s in Japan.

A research project was then created to determine the feasibility of a ship without a crew on board. Naval architect Kai Levander had even imagined the silhouette of the ship without a crew. To do this, he had considered that the autonomous ship would be unmanned on board, guided by GPS systems and the only human presence would result from the more complex port entry and exit operations for which a pilot would be required to climb on board. Although this vision was similar to the projects emerging at the dawn of the 2020s, the technological level of the time did not allow the realization of such a concept.

Today, there are many projects and working groups studying the concept of autonomous ships. Some are focused on scientific and military uses and others project the concept of the unmanned vessel into the commercial realm.

This article focuses on commercial unmanned shipping, so we will look at unmanned container ship projects. In the Western world, and more specifically in Europe, two major projects have had a propellant impact. These are the MUNIN project led by the European Community and the AAWA project led with the support of the equipment manufacturer Rolls Royce.

3. THE MUNIN STUDY (Maritime Unmanned Navigation through Intelligence in Networks)

The study of unmanned navigation developed from 2012 to 2015 by the European Commission through the MUNIN Project sought to develop the concept of an unmanned ship from a theoretical point of view but also developed the NSE Technology Scheme.

Fig.1. MUNIN study

3.1. THE STUDY OF THE CONCEPT OF UNMANNED VESSEL BY MUNIN

In Europe, it is a European maritime cluster, the Waterborne TP, which will push the autonomous ship project. Publishing a research agenda for the development of the shipping industry mainly focused on the notions of safety and the environment, the cluster will introduce the development of an autonomous ship concept into the European agenda. However, the concept of the autonomous ship in the spirit of this cluster in 2007 aimed more specifically at increasing autonomy in navigation and improving the sensoriality of the sensors used in aiding navigation. Indeed, the Waterborne TP research agenda defines the autonomous ship as follows: "an autonomous ship is equipped with modular control systems and communication technology to enable wireless monitoring and control including advanced decision support systems and the capabilities for remote and autonomous operation"

This initiative was subsequently the starting point for a larger project still at European level: the MUNIN Program.

Under the impetus of the research agenda of the European maritime cluster and taking into consideration the development of vehicle autonomy, as well as its potential in a maritime application, in 2012 the European Commission launched the MUNIN project – "Maritime Unmanned Navigation through Intelligence in Networks".

Beyond the acronym, Munin refers in Nordic mythology to the name of one of the crows of the god Odin. Munin is sent by Odin every morning to fly over the world and bring back the information he has independently collected, before safely returning to his master. Like the crow Munin, the unmanned ship must act autonomously, while transmitting all the information it collects and safely reach its destination.

The project led by the European Commission aimed, thanks to all these intersectoral actors, to analyze the feasibility of autonomous ships during three years of study. The purpose of the MUNIN program was therefore to present a viable concept of an unmanned commercial vessel by studying a wide spectrum of factors, including technical, technological, economic and legal aspects. In the short term, the MUNIN project also aimed to apply to conventional ships, in order to improve their technological capabilities, thereby perfectly meeting the definition of an autonomous ship within the meaning of the Waterborne TP cluster.

The program has chosen to focus on intercontinental dry bulk transport. The specificities of this type of transport agree particularly well with the benefits that autonomous navigation can bring. With unmanned navigation carried out on long voyages, mainly on high seas, slow steaming brings real benefits. Since we focus on the transport of dry bulk, perishable goods are discarded and the goods transported are not intended to suffer from an extended journey time. In addition, the supplementary employment costs of the crew due to a longer boarding time are erased by the very fact of autonomy. Finally, in the context of international voyages, the ship is required to sail mainly on high seas, far from congested areas where the risk of collision is greater. By focusing on dry bulk transport on high seas, the European program makes sure to get the best results from its study.

The MUNIN project defines the unmanned vessel as: "a vessel primarily guided by automated on-board decision systems but controlled by a remote operator in a shoreside control station". Through this definition, we note that the emphasis is on autonomous navigation, and not on a remote guidance system. The operator on land is only intended to intervene if necessary. This desire of Munin is part of the overall program and stems directly from the scope that was given to the study. Indeed, by focusing the study of autonomous navigation on a ship intended to travel mainly on high seas, autonomous navigation is more appropriate than remote navigation. The Munin project must take into consideration the weaknesses of the satellite coverage in certain areas, particularly on high seas, as well as the relatively high communication costs in certain areas which would remove any attractiveness of the autonomous ship project.

The Munin Study Project published all of its research at the end of 2015. The final results lead to the conclusion that the autonomous and unmanned navigation project is technically and technologically viable and feasible. However, while technology has evolved considerably, such is not the case with the regulatory context in which an unmanned vessel is intended to exist. This is one of the questions this paper examines in order to define the obstacles still in play when faced with the introduction of commercial autonomous navigation.

The Munin project is a purely European study, carried out by European actors according to a very Western point of view and background. But far without fail to estimate that Europe could be the cradle of this new revolution that is preparing the world of shipping transport. Indeed, in parallel with the Munin project, a similar study was carried out at the initiative of the Chinese Maritime Security Administration, the MSA, under the name of "Unmanned Multifunctional Maritime Ships research and development Project" with a view to exploring the potential for a future unmanned vessel.

3.2. AUTONOMOUS TECHNOLOGY ACCORDING TO MUNIN

The Munin project has developed a concept allowing the vessel to be operated autonomously by the onboard system. All the data collected by the sensors (Advanced sensor) will be transmitted to the autonomous navigation system (Deep sea Navigation system) which will plan the safest trajectory accordingly. The Shore Control Center will remain in constant contact with the ship, in order to be able to intervene if necessary thanks to the remote control systems (Remote Maneuvering Support System).

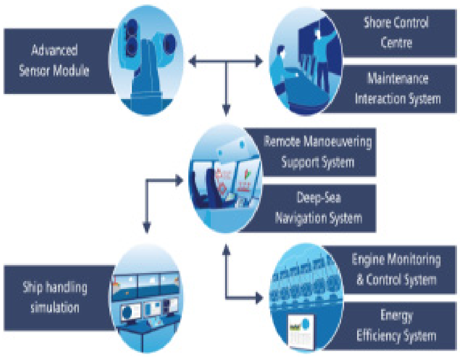

Fig.2. MUNIN concept

Situational Awareness Capability:

➢ <u>The Advanced Sensor Module</u>: this module will make it possible to relate all the data recorded by the sensors available to the ship. In the Munin project, there is no innovation with regard to sensors. All the existing technologies equip the ship. The ship will be equipped with radars, lidar, AIS, infrared cameras,etc. The range of sensors, the data of which will be linked and analyzed by the module, will make it possible to ensure a constant watch on board the ship, and to allow as much situational awareness as possible.

➢ <u>The Engine Monitoring and Control System</u>: this system enriches the autonomous propulsion system and that of the engine room in order to predict possible breakdowns during the trip. By detecting the slightest flaw, whether it is an abnormal temperature, breakage or any other abnormality with regard to the ship's machinery, the system will be able to predict the consequences that could result from such a defect. The transmission of all these data and analyzes to the onshore control center will allow the onshore personnel to know in advance the risks of breakdowns or explosions and to plan the maintenance to be carried out.

➢ <u>The Energy Efficiency System</u>: autonomous and remotely controlled vessels offer many possibilities in terms of energy optimization. This system will optimize the ship's consumption according to the ship's needs in real-time.

The operational and decision-making organs:

➢ <u>The autonomous navigation system on the high seas (Deep Sea Navigation System):</u> this system will ensure that the ship follows the pre-programmed trajectory that will be ordered to the ship, taking into account the authorized deviations. The High Seas Navigation System makes it possible to take into account weather and traffic conditions in order to adjust the trajectory accordingly, notwithstanding the initial trajectory. The system, programmed in particular to analyze and act according to the road rules of the RIPAM regulations, will ensure secure navigation.

➢ <u>Remote maneuvering support</u>: this system is an auxiliary to other navigation systems that will come into action for more complex maneuvers. By predicting the safest trajectory operationally, it will help avoid collisions in congested waters or in ports.

➢ <u>The shore control center – (Shore Control System - SCC)</u>: the shore control center will intervene when the onboard systems are no longer able to manage a situation with sufficient security. If not necessary, the ship will not need to call on the intervention of the operator ashore since the onboard systems will operate the ship alone. The level of safety below, which the intervention of the center on land becomes necessary, has been determined according to the operational envelope which includes factors relating to weather, waves, traffic, or even visibility. In the event of an emergency, the vessel will activate the "fail to safe" mode and the navigation will be transmitted directly to the ONSE, the shore operator of the unmanned vessel from the Shore Control Center.

➢ <u>The interactive maintenance system – (maintenance interaction system)</u>: at present, maintenance is completely operated by the crew. Therefore, the MUNIN project had to develop a remote maintenance system, with the implementation of new processes to allow the ship to continue its journey, even in the event of a technical problem on board.

Maintenance will therefore be carried out by a "Safety Mode" technician on land from the control center, thanks to the interactive functions of the on-board system.

In the MUNIN concept, it is the ground staff acting from the SCC to manage complex situations. The systems on board are able to operate the vessel autonomously only within the limits of the pre-programmed situations.

The AAWA project uses the same scheme of technological autonomy but focuses on different navigation.

4. THE AAWA GROUP'S AUTONOMOUS SHIP CONCEPT

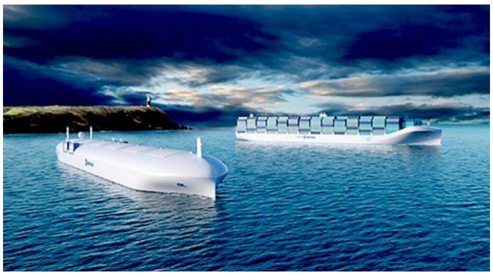

Fig.3. AAWA prototype

The study of unmanned navigation by the AAWA working group focused on analyzing the feasibility of the concept, in parallel with the development of its technological scheme and the design of the first prototypes.

4.1 THE AUTONOMOUS SHIP CONCEPT ACCORDING TO AAWA

This other study also played an important role in the advent of autonomous ships. The Rolls Royce company has expressed its very strong interest in autonomous maritime transport and plans to present its first autonomous ship by 2018 in order to carry out the first tests in Norwegian waters. Rolls Royce predicts the introduction of remotely controlled and autonomous vessels in coastal waters by 2025 and the operation of fully autonomous vessels in international waters by 2030.

Rolls Royce has partnered with many maritime stakeholders, such as classification societies, academics, designers and equipment manufacturers, to lead and lead the Finnish AAWA – Advanced Autonomous Waterborne Applications project. This project, funded by TEKES, the Finnish Research Agency for Technology and Innovation, examined the current context of the maritime industry. This project revolves around the study of the next generation of ships, with regard to technological, legal and economic aspects. The results of this study aim to reveal the specificities of autonomous navigation and to present the first designs and prototypes of autonomous commercial vessels.

The scope of the AAWA project initially focuses on coastal operations, as it believes that the technology will be relevant in the short sea segment, until the international legal framework has been adapted to international autonomy navigation. The AAWA project drew heavily on the aviation industry which has already experienced the autonomous navigation revolution, although academics working on the study acknowledge that the challenges in the marine environment are much broader than those that arose in the air sector.

Rolls Royce is working on the design of an autonomous ship and plans to have a fully autonomous vessel sailing in the Baltic Sea within a decade.

The other partners of the AAWA project are also actively working on the design of these vessels.

Fig.4. ReVolt project

This is the case of the Finnish classification society DNV GL. The classification society, which introduced the Revolt project in 2013, recently presented its first prototype of an autonomous ship. The ReVolt project aimed to develop a ship approximately 60m long, capable of sailing without a crew on board and without gas emissions thanks to its battery systems.

Also, Yara and Kongsberg provided a perfect example of the use of the unmanned ship concept in the future. YARA and Kongsberg's project is to deploy the first fully autonomous and electric vessel at the start of 2018. The vessel named Yara Birkeland will begin sailing with a crew on board. The functions and responsibilities of the crew will be gradually transferred to the onboard system with a view to achieving remotely operated navigation in 2019, then fully autonomous in 2020.

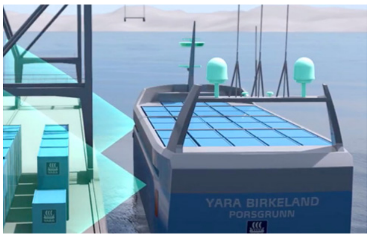

Fig.5. Yara Birkeland prototype

Although its scope of operation is relatively limited, involving only operation in the Norwegian fjords along a defined route, it will make it possible to open up the way to larger container ships and to carry out the first tests of the technology developed for the unmanned ship.

Fig.6. The Yara Birkeland prototype, launched in February 2020 in Romania

4.2 AUTONOMOUS TECHNOLOGY DEVELOPED BY THE AAWA PROJECT

The AAWA project has developed a comprehensive empowerment system, building on existing empowerment technologies.

The main question on which the project focused was to define the best technological combination in order to achieve the level of performance and safety necessary for the operation of a commercial vessel while maintaining a cost of reasonable investment and operation.

The AAWA concept is based on linking systems for situational awareness, collision avoidance, trajectory planning and ship status. All of the data that will be collected by the various sensors and systems will be analyzed by the autonomous navigation system (ANS), itself in conjunction with Rolls Royce's dynamic positioning system, in order to allow the ship to define the best trajectory and to have the widest possible knowledge of the environment in which it evolves.

Fig.7. AAWA concept

Kinematic and dynamic data analysis systems:

➢ <u>The "Route planning" trajectory planning module</u>: this RP module will make it possible to define the trajectory of the trip from the starting point to its point of arrival, thanks to waypoints. This module is the technological equivalent of the voyage plan established by the crew of a traditional ship. The RP module will determine the trajectory, the heading, as well as the speed of the trip.

➢ <u>The collision avoidance module – CA</u> – will ensure the safety of the trip by avoiding obstacles and the risk of collision. Based on the RP trajectory planning module, the CA module will be able to deviate from the predefined trajectory according to the risks of collisions that it detects. The two main functionalities of this module are on the one hand to assess the risks of collision and on the other hand to allow the ship to navigate in complete safety, both in congested areas and on the high seas.

- The situational awareness module - the SA module, still linked to all the sensors, is more global in its functionality. Its role will be to collect all the data provided by the ship's sensors, link them and extract the information determining the environment in which the ship is operating. In the technology of autonomous ships, this module is undoubtedly the most important because it is what will make it possible to make a synthesis and to draw information useful for the intelligent navigation of the ship.

In order to guarantee an optimal perception of situational awareness, the AAWA project compiles all the sensor technologies available: radars, high-definition cameras, thermal imaging, and lidars.

Operational and decision-making systems:

- The Autonomous Navigation System. (Autonomous system navigation): the autonomous navigation system or ANS takes into account different data in order to develop a complete navigation architecture. The ANS will combine dynamic positioning, route planning, collision avoidance and situational awareness systems. The highest levels of ANS relate and analyze all of this data in order to determine the situation of the vessel. The situation of the ship will make it possible to automatically determine the operational mode to which the ship will be subjected between the autonomous, remotely controlled modes, or the safety mode ("fail-to-safe").
- The dynamic positioning system "Dynamic positioning" DP - the dynamic positioning system will allow the vessel to automatically maintain its course or position by automatically adjusting its thrusters and rudders. Combined with data relating to the real-time positioning of the ship from the global navigation satellite system, and with the help of wind sensors, the ship will be able to maintain its position even in bad weather conditions. The modern DP system such as that developed by Rolls Royce also allows the ship to maintain a reduced speed. This is welcomed in the autonomous navigation project since slow steaming is part of the challenges of autonomous navigation as we will see in the second title of this part. By collecting data relating to the maneuverability of the vessel, the DP will be able to determine the projected route of the vessel. In addition, the data relating to the dynamic stresses experienced by the ship will be transmitted to the collision prevention module in order to allow the development of the safest possible trajectory.
- Ground Control Center - Rolls Royce recently released plans for a Ground Control Center. Within this center, Rolls Royce estimates that 7 to 14 people will be sufficient to manage the monitoring, control and maintenance of the autonomous ships that will sail around the globe. The presented control center provides shore operators with interactive screens, voice recognition systems, holograms and surveillance drones to monitor the environment of ships. Such a concept somewhat resembles the latest sci-fi movie posters, but this project is going to become reality.

5. THE AUTONOMOUS BOAT IS SEARCHING FOR ITS COURSE

As much as inland transport, the empowerment of boats is marked by the search for a balance between technological advances, safety concerns, environmental impact, trade facilitation, costs for the industry and the consequences for employment. Both in the maritime transport sector and in that of river transport, the autonomous boat appears today as an innovation, ticking many boxes but having to face contrary currents. What are the current projects and promises, but also what are the constraints and obstacles to its development?

Focusing on the transport of goods, MUNIN was able to demonstrate the technical feasibility of unmanned navigation. But the major obstacle to commercial development has proven to be international regulations, which now prohibit unmanned boats.

Possible uses in all fields - boat empowerment has long permeated many industries. This is particularly the case for the oil and gas industry, with, for example, the French group Bourbon, a fervent user in the offshore oil industry. For its part, scientific research uses maritime drones to carry out oceanographic surveys. The military field is not to be outdone, with in particular the launch, in 2016, of the Sea Hunter boat, a US Navy submarine hunter.

It is in the maritime and river transport of passengers and goods that autonomy is more recent, with a long lead in the maritime sector due to the presence of large shipowners, unlike the river which is more an environment of craftsmen. We can mention a multitude of autonomous boat projects for tourist cruises and the transport of goods: barges on the canals, river shuttles, ferries on lakes and fjords, and even the autonomous cruise liner imagined by the company American Buffalo Automation, in the United States. As for the river transport of goods, it is currently experiencing renewed interest from local authorities in France, which have a river or access to the sea. The autonomous barge is an opportunity for innovation and modal transfer to a less polluting and more economical mode. Its development will also require a technological evolution of the river infrastructure (locks, ports).

MIT and the Advanced Metropolitan Solutions (AMS) Institute in Amsterdam are collaborating on a project called RoBoat. The initial goal, in 2016, was to create a system of autonomous boats that could serve as water taxis in a city where there is more than 100 km of canals, but the project now faces a problem of acceptability by tourists and sailors. The designers approached, in vain, other cities and then looked for other uses, in the form of a movable bridge or for transporting waste.

From a technological point of view, we find the same types of sensors as for the autonomous car (Lidars, ultrasounds, HD cameras, 4 or 5G, GNSS, etc.) and, in addition, sonars to detect obstacles under the water. The size of the boat then determines the number of sensors required. The latter feeds deterministic algorithms today and tomorrow artificial intelligence systems (pattern recognition, data fusion, etc.) that are increasingly powerful.

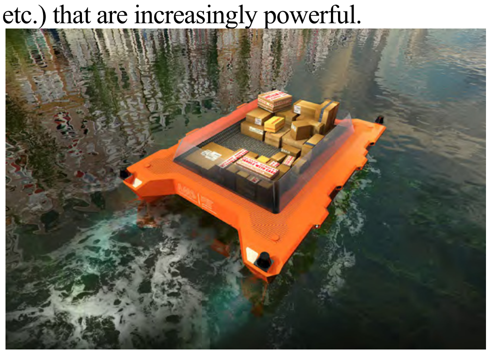

Fig.8. River solution for automated parcel transport designed by Roboat

Fig.9. Autonomous river transport imagined by Roboat on the canals of Amsterdam

The autonomous boat benefits from technology transfers from the automotive industry, with however adaptations to the specificities of the maritime world. For example, the boat must navigate on a moving surface, which complicates the maneuvers and requires more complex trajectory calculation algorithms than those used for the road; this is particularly the case for mooring manoeuvres. However, since the speed is lower than on the road, remote control from the command center is less demanding in terms of communication latency. In addition, the boat is not confined to a predefined route, which allows greater flexibility in avoidance operations.

Moreover, we find the same debates as for the autonomous car on the issues of cybersecurity, liability in the event of a collision and the response of insurers, as well as the certification of autonomous boats, including on-board computer systems. The question of acceptability also arises for passenger transport vessels and to a lesser extent for freight vessels. The impact on employment is also a major concern for carriers. Professions are changing towards high value-added digital, modifying the traditional professions of sailor and boatman. We are witnessing a crisis of vocations and the autonomous boat can be seen, in the long term, as a solution to partially compensate for this lack of personnel.

With increasing autonomy, the entire architecture of the boat must be redesigned to reduce its environmental impact. Thanks to the space saving due to the reduction, or even the elimination of the crew on board and the equipment intended for them, a model of an autonomous freighter or barge can be designed by optimizing the hydrodynamics of the hulls in order to reduce the energy consumption. Clean, electric or LNG-powered engines can complete the design of the boat of the future.

The interest is also economic. On the one hand, the use of an autonomous boat makes it possible to reduce the expenses related to the crew, which represents approximately 30% of the operating costs (a traditional barge making Le Havre-Gennevilliers in 20 hours requires a crew minimum of three people).

On the other hand, its design allows an increase in payload and therefore greater margins. It must nevertheless take into account the higher investment cost than for a conventional boat in the calculation of economic profitability. The improvement in safety is another positive point, considering that, according to the insurer Allianz, 85% of incidents are due to human error. However, it seems that all the experiments have been carried out so far in favorable weather conditions, leaving uncertainty about the level of safety in bad weather conditions.

6. CONCLUDING REMARKS

Ultimately, the general concept of an unmanned ship revolves around three main components:

- A set of sensors recording a wide range of data on the environment of the ship,
- Autonomous navigation and analysis systems capable of linking all the collected data and calculating the best trajectory,
- An onboard/shore communication system.

Above all, we note that the various projects are based on existing technologies. There are no major technological innovations, the real challenge of the autonomous ship is based on how to connect all of these existing technologies, in order to allow perfect and complete autonomy.

The conclusion of this study of the autonomous ship concept as developed by the main players is therefore that, technologically, the unmanned ship is already a reality. The next steps will be to delimit and determine the context in which the unmanned vessel will be implemented.

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