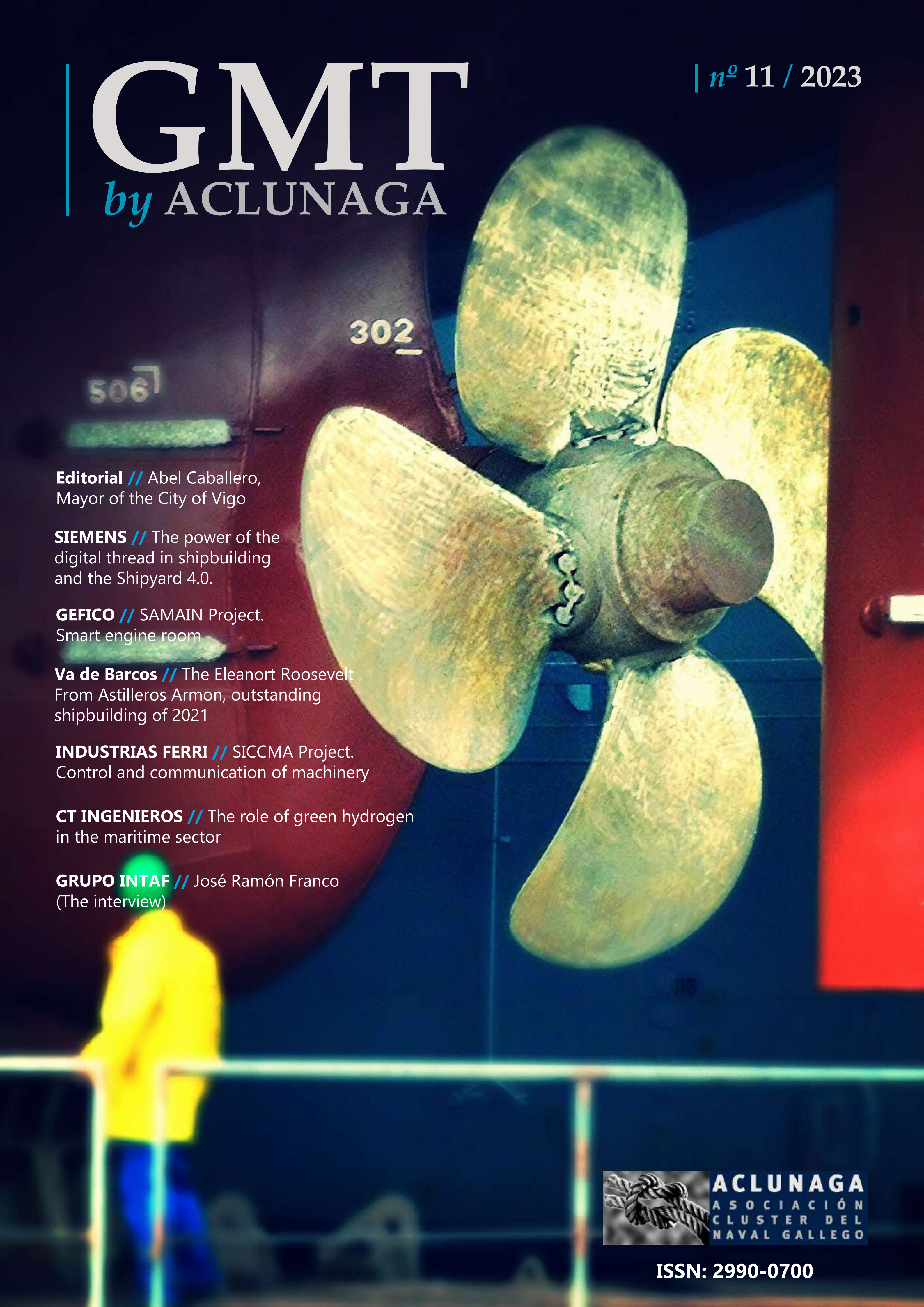
GMT by ACLUNAGA

nº 11 / 2023



ACLUNAGA
ASOCIACIÓN CLUSTER DEL NAVAL GALLEGO

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Galician Maritime Technologies

Editorial

The shipbuilding and repair industry of Vigo has demonstrated, throughout its successful history, that it brings together the best virtues that a key economic sector can possess: an enormous courage and a permanent capacity to adapt to new times and market demands; an enviable innovative spirit and an entrepreneurial soul, which allows them to face changes with courage and optimism. In short, our naval industry is the paradigm of resilience.

This background, together with a committed and increasingly well-trained workforce, has allowed it to gain a well-deserved reputation as a reliable economic actor. The road has not been easy, but the sector has been able to compete and rebuild itself without complexes or fears. Seeking outlets where others only saw closed doors. It has just done it again with the latest Barreras crisis.

The best vessels in the world have been and continue to be built in our estuary. If its origin goes back to fishing vessels, today the sector is prepared to face the most diverse challenges, from mega yachts to floating marine research centers. Thus, being a pioneer in the construction of oceanographic vessels, this summer we experienced a milestone with the launching of the largest vessel of this type in the Spanish fleet, commissioned by the IEO-CSIC to the Armón shipyard. And many more will come.

If the present is exciting, the future will be even more so. Because the approval by the Government - with the constant push of the City Council of the Strategic Project for Economic Recovery and Transformation (PERTE) will act as a formidable lever to transform and modernize a strategic economic activity and train more than 5,000 workers.

The Galician Shipbuilding industry needed this PERTE for many reasons, some of them of a strictly economic and industrial nature, but also others of an intangible nature. The sector demanded fair treatment from the administrations that responded to its real importance; so that it was not seen as a group of companies of smaller size and relevance. They demanded respect. The granting of this PERTE has contributed to strengthening the self-esteem of entrepreneurs who have given us plenty of reasons to trust them. And for this reason, I am also very proud to have contributed to the achievement of a plan that will be followed by others.

The administrations and institutions and all the economic and social actors have a commitment without expiration date to protect the shipbuilding and repair sector. Because to support this sector is to support Vigo, Galicia. Today we are facing a historic opportunity to protect the future of the sector and we are going to take advantage of it.

In Vigo we are clear about this support and we want to continue in the vanguard of the recovery, betting on innovation and talent. From this stand I express my absolute confidence in a naval that meets all the conditions to continue being one of the lighthouses that will illuminate the economy of Vigo and Galicia.

I cannot finish without highlighting my pride in Navalia, a biennial fair that has managed to become the first in Spain and the third in Europe in its sector, and that has not stopped growing and gaining prestige since its beginnings, gathering in its last edition more than 400 exhibitors from all over the world and 900 brands.

Abel Caballero

Mayor of Vigo

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The power of the digital thread in shipbuilding and the shipyard 4.0.

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Shipbuilding market is more global and demanding than ever. In the same way, our product, the ship, is more complex and its engineering, manufacturing and maintenance processes involve more and more actors, from the manufacturers themselves to suppliers or different subcontractors.

In this scenario, shipbuilders are taking steps towards the creation of the first truly digital shipyards, facing in the process the impulse that digitalization is giving to the sector with the creation of a standardized, unified, and coordinated infrastructure of engineering, manufacturing and maintenance of the ship.

Until now, the industry handled different technologies, often disconnected from each other and with limited capabilities, which forced the continuous sending of information between separate teams to reconcile changes, lengthening production times and increasing the chances of making mistakes.

The solution is the implementation of a digital thread that connects all product information throughout the entire engineering and construction process by means of an end-to-end PLM system that serves as a source of knowledge and truth, traceable and accessible to the last link in the supply chain. (Fig. 1).

Figure 1: Graphical example of data flow. Shows the flow of information in the digital thread.

Thus, any actor involved in the process can access in real time and in a synchronized manner data on designs and configurations, production status and schedules, materials and purchasing, suppliers and deliveries and, once the vessel is launched, its operating conditions, operating records and overall system status.

Thanks to this digital thread, every change or update, every improvement or problem can be synchronized in real time with all players in the ecosystem, ensuring that everyone is working with the most accurate and up-to-date information possible. This puts an end to rework resulting from the use of out-of-sync designs, and automatically results in reduced manufacturing lead times, more efficient maintenance, and improved performance of our production process. (Fig. 2).

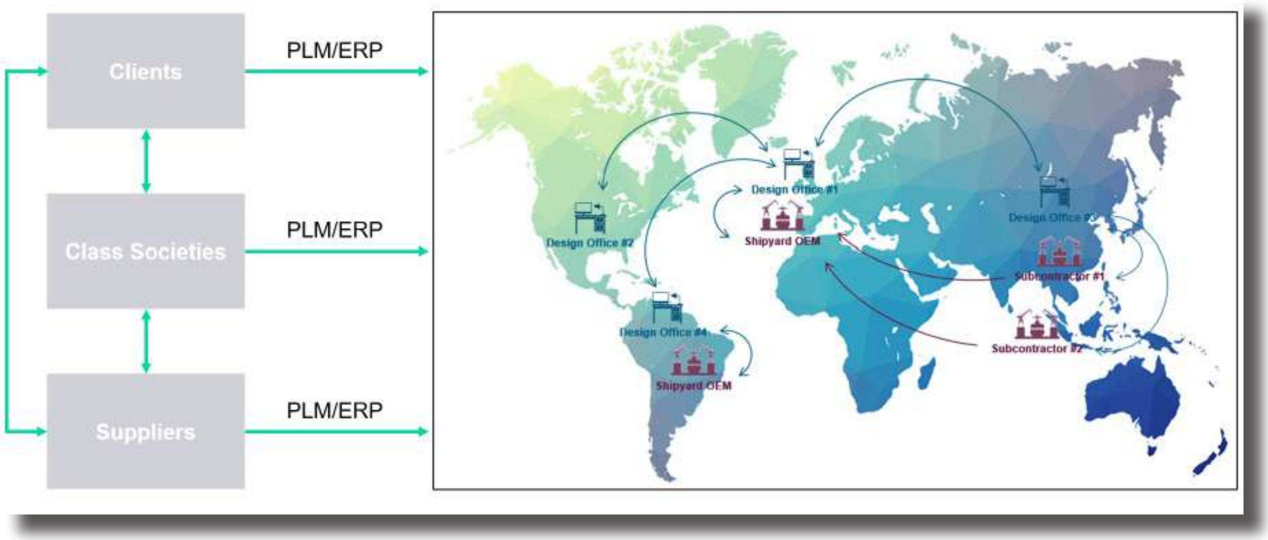

Figure 2: PLM as the basis of the digital thread can run locally on the company's servers or in the cloud, no special installation is required for this; the image shows the flow of information between the shipyard and the ecosystem.

PLM and the digital twin

As a synthesis industry, it is common for shipyards to manufacture their vessels with the help of dozens of local and global suppliers in different assembly and manufacturing sites. Despite this, it is necessary that all the actors involved in the production process have accurate and updated information on the design, characteristics, or modifications that the ship or each of the components that make it up.

The solution adopted is the sum of the digital model (3D model) and an advanced PLM software designed to keep everything aligned and updated throughout the supply chain. PLM allows everyone involved in the project to examine the documentation and model of each space and component, including piping and wiring requirements through a product structure tailored to the needs of shipbuilding that reflects its different disciplines (naval architecture, structures, mechanical engineering, etc.). (Fig.3).

Thanks to this we can, before the ship even exists, create a digital twin of the product on which to verify where equipment will be placed and determine the best installation plan or experiment with different features and functions for ship operation and test different ergonomic considerations for the future crew, thus optimizing operations, manufacturing, and maintenance tasks.

Most importantly, this technology allows all designs and changes to be synchronized with all suppliers and builders involved in the project, so that no time is lost, and no inconsistencies occur during construc-

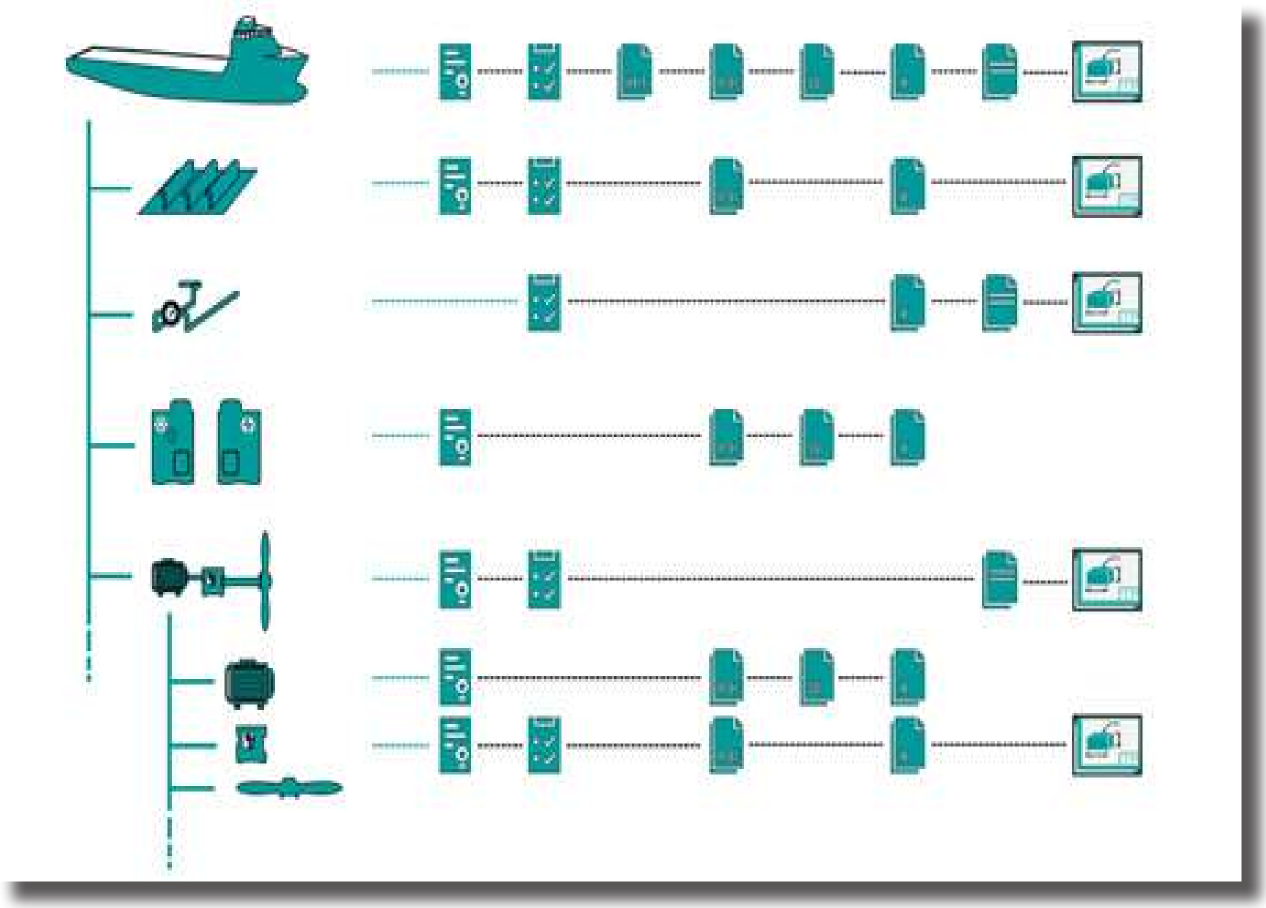

Figure 3: example of a list or scandals that allows to see the checks. In the image you can see how to subdivide the vessel into systems.

tion, which is a huge advantage during production.

In addition, PLM simplifies the management of the ship's bill of materials (BOM). Any changes to the design are automatically updated in the BOM as it is automatically generated from the 3D model from templates already created. By accessing the PLM, each department in the shipyard can use and modify the BOM for its own purpose.

Engineering uses it to track revisions and changes, meet planned costs and satisfy product requirements for performance, environmental compliance, serviceability, and safety. Production to plan manufacturing processes and assembly operations. Purchasing department uses it to procure the components that make up the vessel. And the repair and maintenance department uses it to plan maintenance operations and spare parts procurement.

Simulation and performance optimization

The digital thread allows us to use all the ship information collected in the PLM to improve our designs thanks to the different simulation tools. Naval architects and engineers have been experts for decades in crunching numbers to ensure that their designs will meet the performance requirements set by the shipowner, from speed to the ship's loading capacity.

Modern digital shipbuilders can, thanks to 3D modeling and augmented reality and predictive analytics technologies, simulate multiple scenarios to further improve design specifications using 1D simulation, finite element simulation or CFD simulation tools.

These technologies very practically increase efficiency in all phases of the ship's life cycle and allow designs to be validated more quickly and easily through checks at earlier stages of engineering. These checks greatly reduce the risk of failures and errors at critical stages of production, making manufacturing more efficient and sustainable (Fig. 4).

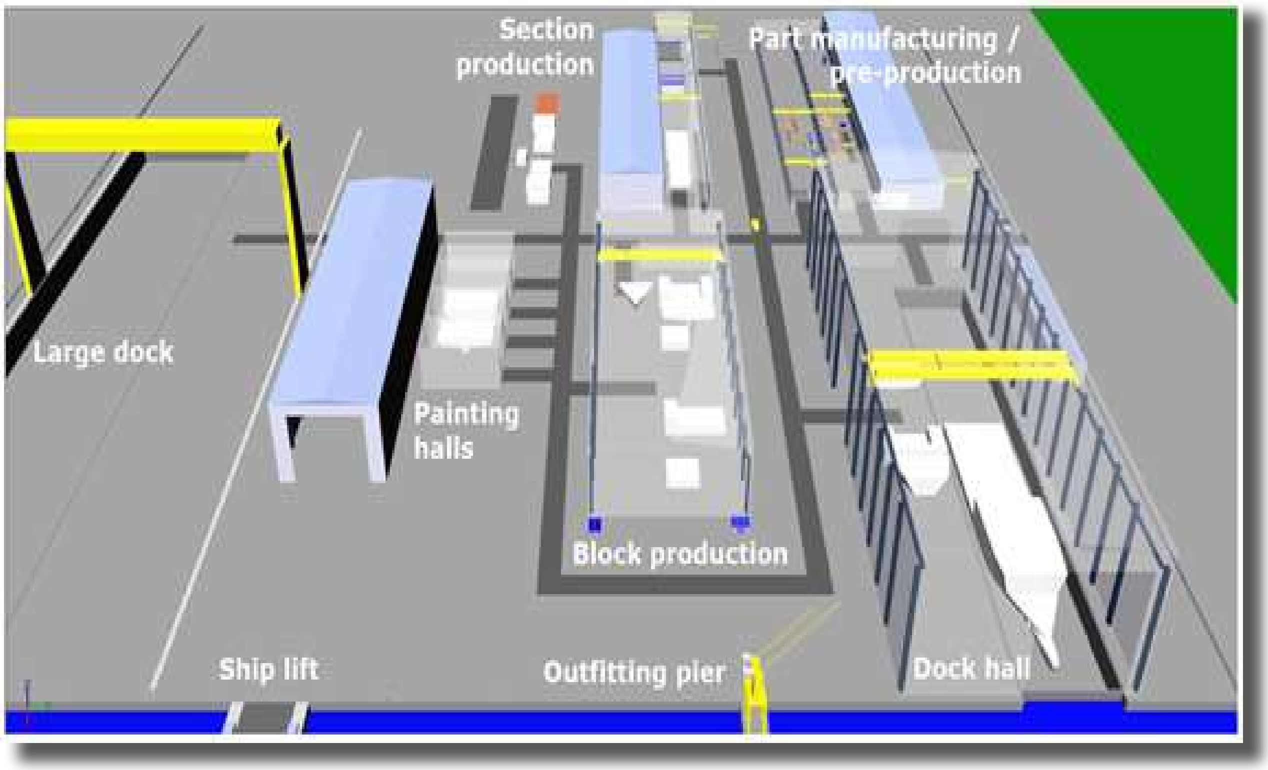

Figure 4: simulation of a dummy shipyard

Shipyards can create digital production twins of their facilities using plant and process simulation tools to simulate the entire manufacturing process step-by-step until an optimal production process is achieved.

Shipyard simulation tools can be used for plant planning, investment validation, strategic decision support or capacity and bottleneck analysis. But also, as support for planning and control, using them for verification of delivery schedules, validation of construction strategies or agile decision making in the face of changes in the project.

On the other hand, every component and every system of the ship can be inspected by the production teams using the 3D model and technologies such as virtual and augmented reality, and thus optimize the flow of materials through the shipyard, preassembly, and slipway construction.

Digital service and maintenance

As with all pre-launch work, maintaining all ship data on an integrated platform allows us to test and verify any future modifications to our vessel. The digital twin of the operation is key as vessels are modernized and refitted throughout their life.

Engineers and production teams can work on it to plot, test and simulate every step of future modifications, from installation to performance, to ensure the vessel will continue to function properly. This helps future-proof the vessel's operation, keeping it operational and up-to-date no matter how the world or technology changes.

As virtual versions of ships in operation, digital twins can also be employed to support a wide variety of tasks, from understanding the impact on ship performance of changes in operating conditions to enabling remote service technicians to help resolve serious ship breakdowns offshore. (Fig. 5).

The road to Shipyard 4.0

Establishing a digital thread that allows our ship's data to be integrated, updated and easily accessible to all stakeholders involved in the project is the key to making the leap to the digital shipyard or Shipyard 4.0. Only in this way will we be able to take full advantage of the different digital twins of each stage (product, manufacturing, and operation) to design and build our ships in an innovative, efficient and sustainable way, in short, so that the shipbuilding industry can meet its very high market demands on time and on budget.

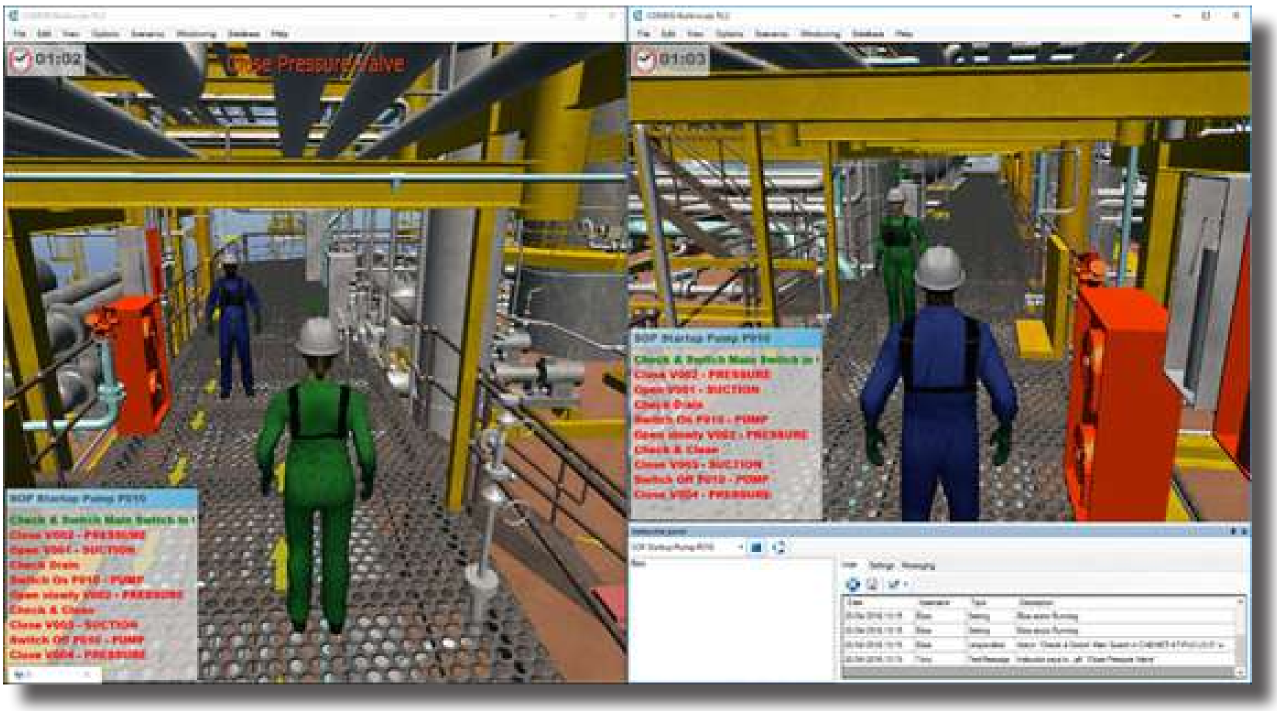

Figure 5: all information can be stored locally or in the cloud in PLM

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SAMAIN Project. Smart engine room.

Marta Herva // Gefico Enterprise, S.L.
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The naval sector, and particularly the fishing sector, has not developed at the same rate as the industrial sector in terms of the so called 4.0 technologies, due to its particular characteristics. The difficulty of accessing communications and the need to have especially robust equipment have slowed down its evolution towards what is now a reality in the industry on land.

However, the steps being taken towards full automation and even the creation of digital twins are beginning to be visible. These are large projects that make this evolution visible and that, at the same time, serve as a driving force for this philosophy to spread in the sector.

On the other hand, in a context in which qualified labor willing to sail is increasingly scarce, shipowners bear large costs derived from poor operational control of equipment and the lack of provision for adequate maintenance. Being able to control these processes remotely would facilitate these tasks, and automation will allow optimization of the process.

However, it is necessary to break down the technical barriers that currently prevent turning a ship's engine room into an intelligent one, as is the overall objective of this project. On the one hand, a philosophy tending to the automation of the auxiliary equipment that makes up the ship's engine rooms must be established and, on the other hand, mechanisms must be provided that allow all this information to be compiled in an orderly, graphic and useful manner. Finally, it is also necessary to advance in ship-shore communication strategies, which, although they have improved (for example, Internet connection via satellite), are still too expensive to consider continuous communication.

The results of the project presented in this article will allow progress towards the achievement of the final objective of designing a Smart Engine Room, which allows the automation of many of the operations for which it is already difficult to find qualified labor nowadays.

This general objective that states the philosophy of the SAMAIN project has materialized through the following general objectives:

1) Development of a remote monitoring system for its application in the auxiliary equipment of a ship, which can be accessed by inspectors and technicians from the shipowner from land, as well as technicians and engineers from the companies of the auxiliary equipment and facilities.

2) Creation of a platform that allows the storage and management of the information collected through the monitoring system. Through an artificial intelligence program, future failure scenarios can be foreseen once they have occurred in the past.

3) stablishment of the documentary, technical and audiovisual bases to provide naval equipment with easy access to installation information during maintenance tasks.

The result of the fulfillment of these 3 objectives is the design of a platform in which all kinds of information related to the equipment will be available (see Figure 1). This information can be managed locally and will also have the possibility of remote access.

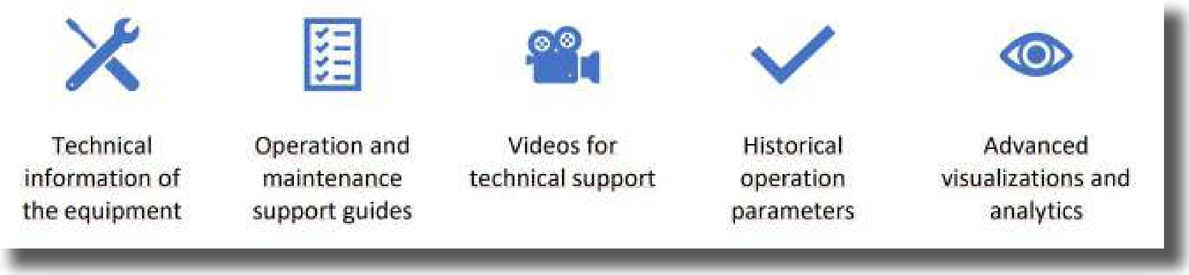

Figure 1. Information available in the platform

Consortium

The SAMAIN (Smart Engine Room) Project is a collaborative project of ACLUNAGA, GEFICO and Muutech Monitoring Solutions. The participation of the 3 entities has been key to advancing the proposed objectives, since each of them has contributed with their expert knowledge in the different technological fields involved.

Gefico, the leading company and promoter of the project, has more than 40 years of experience in the manufacture of machinery for the naval sector, mainly for water treatment (reverse osmosis desalination equipment, evaporators, purification systems, etc.). All these years, the company has maintained a close relationship with shipowners and end users; therefore, it is perfectly aware of the needs that are being detected in the sector. Although the idea initially arises to incorporate the proposed solutions to the equipment manufactured by Gefico, the proposed developments can be perfectly extrapolated to any auxiliary machine installed on a ship where the control and monitoring are intended to be centralized.

Muutech Monitoring Solutions, a startup specialized in monitoring and analyzing industrial and communications data, provides its experience in the complete life cycle of data, from its capture to its visualization and conversion into information, through advanced analytics and establishment of alarms, always focused on personalization and the different users of the information. With extensive experience in projects in sectors as competitive as the automotive, metal and food sectors, he manages to provide the necessary technological and communications component in the face of the innovative challenge posed by the SAMAIN project.

Finally, Aclunaga, as the association that gathers all the stakeholders that operate in the sector, is the agent of the project that allows unifying the demands of the sector, represented through its members, trying to incorporate these needs as points of improvement of the technological and productive capacity of the Auxiliary Industry.

Work methodology

During the development of the project, different types of equipment from those included in the Gefico catalog have been considered. One of the case studies has been a type of freshwater generator by reverse osmosis, which will be used in this article as an example of the solutions implemented.

As derived from the general objectives of the project, its development has been approached from the different perspectives necessary for its achievement. In this sense, we can talk about three main areas of work:

1.- Production of technical and audiovisual documentation.

When new equipment to be installed in an engine room is purchased, frequently the technical documentation is not available or easily accessible in the installation itself. Also, sometimes the operation and maintenance manuals are very exhaustive, and it may be complicate to locate the concrete information needed by a technician when an urgent intervention needs to be conducted.

In response to these needs, one of the tasks that has been carried out in this project was the development of simple technical and audiovisual documentation, related to the most common operations of the equipment, which may be available on a platform hosted on a local server in the ship itself, and

which can also be accessed remotely for updating when connectivity is available. These are the so-called operation and maintenance support guides referred in Figure 2. In this way, the operator will be able to easily access all the available information. One of the simplest and most immediate ways to do so is to use the QR code that will be available on the equipment itself through a mobile device. Within this information, you can also find the more traditional documents, which are usually supplied with the sale of the equipment and that are part of the manual. In this way, the operator will be able to immediately access the P&ID or the electrical diagram to be able to make any verification about the installation and the equipment, or the parts list and the list of spare parts if components are needed to be ordered in case of breakdown or planned maintenance. Figure 2 shows a summary of the different types of documents that could be consulted.

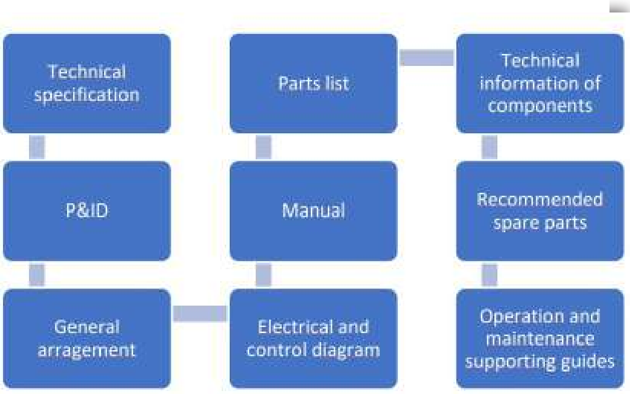

Figura 2. Documentación técnica del equipo accesible local y remotamente.

The operation and maintenance support guides will be available both in text format accompanied by images, and in audiovisual format. In both cases, the operations that need to be carried out for a specific maintenance task or verification of correct operation of the equipment are shown step by step in a detailed and simple manner. As an example, Figure 3 shows a series of extracts from different moments of a video, which shows how to disassemble and assemble the high-pressure pump that is usually mounted on reverse osmosis freshwater generators.

ASSEMBLY AND DISSASEMBLY OF DANFOSS PUMP

1. Remove the 4 flange bolts

5. Remove the spring, spring guide and pistons

13. Install the new mechanical seal and seal on the flange

Extract from explanatory video frame sequence on how to assemble and disassemble the high pressure pump.

2.- Monitoring and tracking of key parameters that allow proper monitoring of its operation and failure prediction.

One of the key aspects of the project has been to identify the key parameters that affect the operation and analysis of problems of the equipment studied. Subsequently, the instrumentation that allows the adequate monitoring of these parameters and the reading by the data storage platform has been selected.

In general terms, the most relevant parameters that are interesting to know in a typical reverse osmosis installation are:

- Discharge pressure on the feed pump.
- Pressure drops between filtration stages.
- Pressure drop in the membranes.
- Feed water flow.
- Flow of permeate generated.
- Conductivity (directly related to salinity) of the permeate.

Therefore, there are 3 types of parameters to be measured in the installation: pressure, flow and conductivity.

One of the most sensitive components to incorrect operating operations are the reverse osmosis membranes, in which the separation of the salts from the feed water occurs, a process through which fresh water is generated that will later be treated before its consumption. Among the most common problems that are usually found associated with this element are the soiling of these or an increase in salinity in the system. Among the parameters whose monitoring has been proposed, the following can provide useful information in this case:

Permeate flow. This is a key parameter to know if the process is being carried out correctly, together with other parameters with which it is related. The measured value must be checked against the design parameters.

Permeate conductivity (salinity). The conductivity is representative of the general state of the process and is particularly influenced by the state of the membranes. If the rest of the parameters remain constant, an increase in conductivity will indicate a deterioration in the state of the membranes that will imply making a stop to clean or replace them.

Pressure drop in membranes. The difference in pressure between the inlet and outlet of the membranes is a direct indicator of the possible existence of fouling. Therefore, proper monitoring of this value will allow knowing the evolution in the degree of soiling and anticipating proper maintenance, thus avoiding incurring unnecessary costs.

3.- Creation of a platform for the storage and management of the collected information.

The last step is to create a platform in which to host all the information developed and collected in the previous points. In addition to accessing technical documentation and support guides, it will be possible to access the parameter display boards, such as those shown in Figure 5. From here, it will be possible to establish the alarms or warnings that are considered necessary.

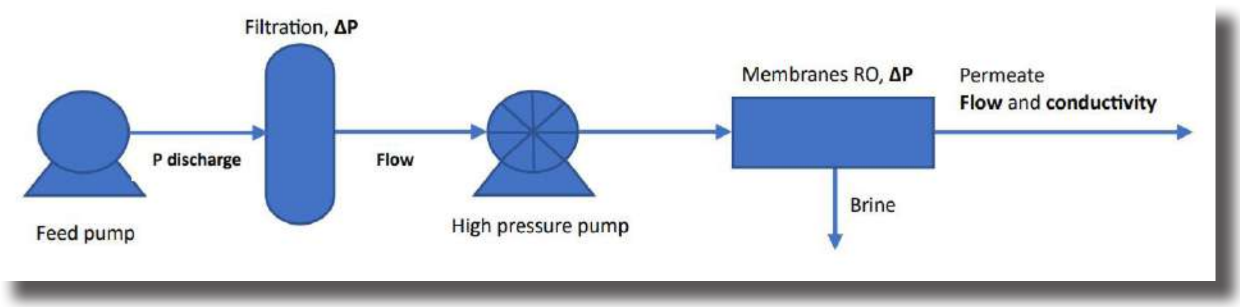

Figure 4. Simplified scheme of a typical reverse osmosis installation.

Figure 5. Data visualization dashboard example.

One of the main challenges of this phase of the project lies in communication difficulties. In industrial monitoring projects there is normally a stable network and connectivity, and in any case, it is always assumed that in the event of a loss of connectivity, data collection will stop, which is not usually a problem because nowadays it is not rare that it implies a stop of the line due to not being able to collect the traceability. But on a ship, all this changes. In recent years, satellite connectivity combined with coastal mobile connectivity has undoubtedly found its way among ships of all types and for equally varied applications: from telemedicine to allowing sailors to watch Netflix. The case that concerns us, that of telemetry, is not very widespread when assuming that there will be cuts in communications or that the delay is too high, therefore not being able to depend on an application in the cloud.

For this reason, an architecture shown in Figure 6 has been designed that allows local collection and visualization, being always available locally, but in continuous synchronization with the cloud platform. Whenever possible, the data will be updated on the cloud platform for use by shipowners and other agents, being able to extract value from the added information of their fleet and remotely, including the history of performance and providing help in predictive maintenance and analytics more computationally complex allowed by the powerful platform.

Communication is also bidirectional, allowing documentation to be updated with new processes, etc. from the cloud. This architecture will even allow ships that do not have connectivity to collect the data and synchronize it by having mobile coverage close to the coast or in port, avoiding technicians collecting data with USBs, etc.

Conclusions

The results of the SAMAIN project have laid the foundations for the development of the smart engine room on a ship. It has been seen that it is necessary to work in two main areas. On the one hand, practical, simplified, and visual information must be generated regarding the most common operation and maintenance actions of the ship's auxiliary equipment (or any other equipment to be integrated into the system), which will be available to the technicians on board to facilitate and guide the interventions that need to be performed on the equipment. On the other hand, remote monitoring and failure prediction is only possible if the equipment has the necessary monitoring. In this way, the effective application of this methodology must necessarily go through the digitization of the equipment's sensors, at least regarding the parameters identified as critical for each equipment.

With respect to the additional difficulty of limiting access to the network connectivity that exists on a ship, especially in those that make longer campaigns, an architecture has been defined that allows overcoming this problem. In this way, the information will always be available in a local host, for the operators on board. By being in continuous synchronization with the cloud platform, as soon as connectivity is available, the data update will be done in a bidirectional way.

In summary, the implementation of the concept of the smart engine room will facilitate the work of the personnel on board, as well as the monitoring of shipowners and other agents of interest from land, thus contributing to a more remotely controlled management, planning of maintenance actions and ordering of spare parts and, ultimately, the reduction of operating costs.

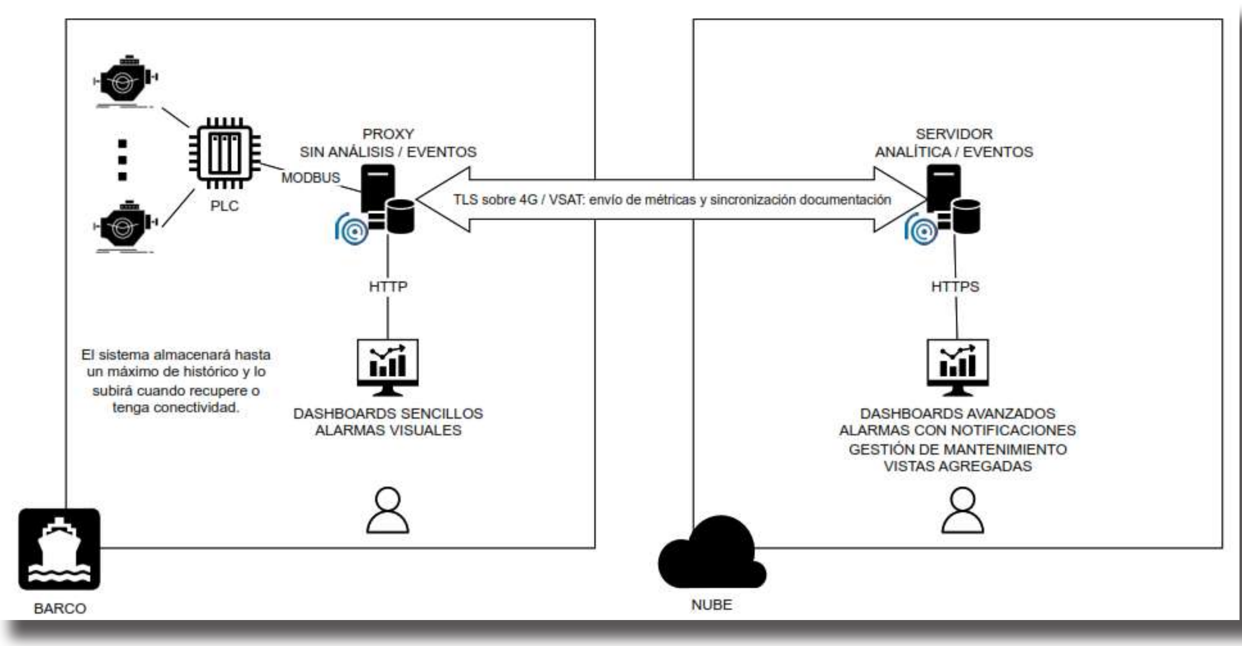

Figure 6. Architecture and connectivity.

The Eleanor Roosevelt from Astilleros Armon, outstanding shipbuilding of the year 2021 in Spain

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The world's longest fast ferry catamaran, the Eleanor Roosevelt built by Astilleros Armon in Gijón for Baleària, was chosen by the readers of the website www.ingenierosnavales.com as Outstanding Shipbuilding of the year 2021 in Spain. Delivered by the Asociación and the Colegio Oficial de Ingenieros Navales since 2010, the award is given by popular vote on the web, being the first time that this group of shipyards is the winner. The Eleanor Roosevelt takes the place of the frigate Sea Cloud Spirit in the list of winners after beating the other two finalists, the replenishment oiler HMAS Stalwart built by Navantia and the tuna fishing vessel Monteraiola built by Freire Shipyards.

The latest vessel in Baleària's fleet is, with 123 meters entirely built in aluminum, the longest fast ferry catamaran in the world, allowing it to carry up to 1,200 passengers and 500 linear meters of trucks and 250 cars, or alternatively, 450 cars. Built at the Armon Shipyard in Gijón between 2018 and 2021 after an investment of 90 million euros, the Eleanor Roosevelt came into operation on May 1st 2021, linking Denia with the Balearic Islands. The incorpora-

tion of this vessel allowed Baleària to increase by 60% the supply of high-speed passenger seats and double the number of vehicles on this route.

The Armon Group's shipyard in Gijón, in addition to the construction of the vessel itself, oversaw the project coordination and the execution of the mechanical engineering, with the support of the Valencian engineering company Cotenaval. The design of the Eleanor Roosevelt was the work of the Australians Incat Crowther, while the engines, propulsion system and gas plant were manufactured by the Finnish company Wärtsilä. The architectural and interior design is the responsibility of Oliver Design and interior designer Jorge Belloch.

The Eleanor Roosevelt is the seventh Baleària vessel running with natural gas. The Valencian shipping company already has 9 ships that can operate with this fuel, which considerably reduces emissions (CO_2 emissions up to 30%, NOx emissions by 85%, and eliminates sulfur emissions and particles) and noise pollution. The Eleanor Roosevelt's four dual GN/GO engines, each with an output of 8,800 kW, enable it to reach a service speed of 35 knots (with a top speed more than 40 knots). The two LNG tanks give the ship a range of 400 nautical miles in gas navigation (1,900 nautical miles in the case of combined gas/diesel).

Measurement equipment has been installed on board the vessel to monitor fuel consumption in real time, as well as to calculate engine efficiency. Other sensors will provide information that will allow the vessel to navigate efficiently, as well as adjust speed and course to increase comfort according to the sea conditions or make decisions on preventive maintenance using big data. This is the third vessel of the shipping company that has this monitoring system, and is part of Baleària's control

tower project, which will use big data to make agile and efficient decisions in the areas of safety, preventive maintenance, commercial efficiency, and emissions.

The Eleanor Roosevelt gains the adjective smart ship thanks to these and other technological innovations, such as passenger access via QR code, internet service throughout the journey, the free digital entertainment platform accessible from the cell phone or the possibility of seeing their pets through webcams installed in the holds. The ship's interiors are spacious and bright, which together with the elastically floating superstructure and the installation of high-tech insulation reduce both vibrations and noise, ensuring a comfortable crossing for passengers.

The ship's name pays tribute to the writer, gender equality activist and advocate for the civil rights of African and Asian Americans and World War II refugees Eleanor Roosevelt, who was the first chairwoman of the United Nations Human Rights Commission and one of the driving forces behind the Universal Declaration of Human Rights. This is the sixth ship of the shipping line that pays tribute to pioneering women in their respective disciplines, in line with its commitment to one of the Sustainable Development Goals: equality and empowerment of women.

The success of the Eleanor Roosevelt has led Baleària to build a second fast ferry at the Armon shipyard in Gijón, named in honor of pioneering biochemist Margarita Salas and scheduled to begin operations in 2024. The new vessel will combine the most competitive performance of the Eleanor Roosevelt with several new design and engineering features to elevate the customer experience. Maintaining the dimensions of the original vessel, the Margarita Salas will feature a second deck with a lounge seating area in the bow and double the aft deck area with an outdoor bar service, as well as 10% more power thanks to the installation of four dual 9,600 kW Wärtsilä natural gas engines.

General characteristics

Length: 123 metres
Beam: 28 metres
Passengers: 1.200 people
Capacity:: 450 cars
Installed power: 35,2 MW
Cruising speed: 35 knots

SICCMA Project. Control and communication of machinery

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Introduction

In industry, remote controls are frequently used for the operation of machinery which, because of their size or the risk involved, it is advisable to operate them from a safe distance from the equipment. In other applications it is important that the operator is very close to the object being controlled.

These controls generally consist of portable control boxes that have a cable of a certain length that somehow "moves" the control panel a certain distance. This system is also used using radio communication instead of a cable.

The purpose of this project is to design a wireless communication and machinery control system for our machines and so that they can be used for any other application, emphasizing the push towards the digital transformation of the Spanish naval industry and towards an Industry 4.0 model that allows the interconnection of machines, the connection of machines to the cloud and the centralization of metrics. All this will result in more efficient maintenance, smarter manufacturing and cost reduction with a consequent increase in productivity.

Motivation

The use in harsh conditions that our users give to the wireless controllers leads us in many occasions to breakdowns that require urgent repair, because the user needs to operate the machine. This causes serious problems for our after-sales service, which is forced to do the only thing it can do, send the controller for repair. The repair time is not under our control.

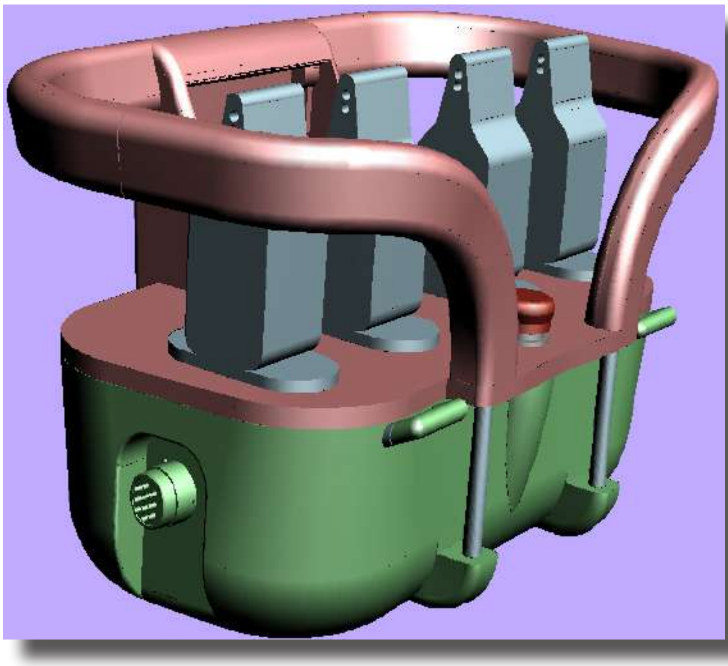

Figure 1. Case design

On the other hand, due to model changes and suppliers' stock outages, sometimes the times are longer than would be desirable, it can even be said that sometimes they are extremely long. Added to these inconveniences is the fact of the high cost, both of the command and of the repair and of urgent shipments.

In addition, our technicians have to go to the customer's home or wherever the damaged machine is, just to check that the remote control does not work.

In general, these remote controls are not standard, but are specially configured for the application for which they have been purchased. This does not mean that each remote control is totally different, but it may have a different number of pushbuttons or control levers.

This point also delays the procurement of a spare part from the supplier and makes it impossible for Ferri to have a spare control in stock for each machine.

The fact that through this experimental system it is possible to have the operating data of the machine in the cloud, will allow to know in advance the problem that is occurring in the machine and will enable its remote solution or at least make the maintenance technician go prepared to the repair.

General description of the experimental prototype

The system we have designed consists of a small computer receiving the remote control signals and the design of the remote control itself.

The receiver transfers the control signals to the control PLC and, in the case of small machines, can receive the remote commands and control the machine directly.

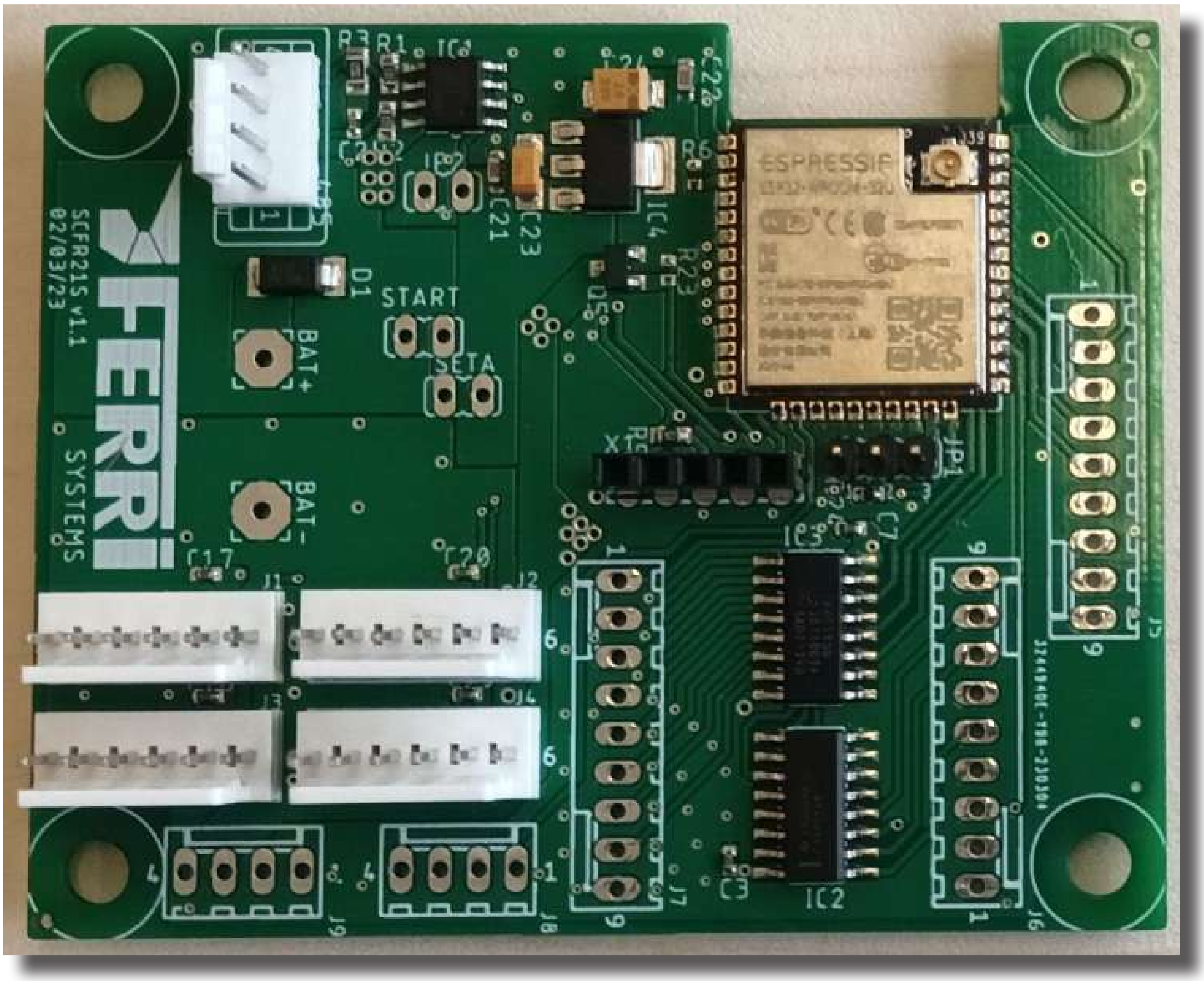

Figure 2. Transmitter electronics

Figure 3. Receiver electronics

On the other hand, it has a small archive system that allows you to store the historic of alarms and other events that you consider interesting. The generated archive can be transmitted via wifi to a cell phone or to a server on the internet if it can be connected to the appropriate network.

In addition, thanks to the receiving computer, the machine itself is loaded with the manuals and plans that are considered, all this can be consulted from the mobile, of course you must have the appropriate app and the correct username and password.

In the case of having several machines equipped with this system and that can be connected to the Internet, the historical records of each machine, operating hours, etc., can be monitored from a central computer. With this information, in a second phase, it will be possible to start with perdictive maintenance.

The electronic circuits for the receiver and transmitter have been designed and also the ergonomic casing to contain the transmitter with its batteries and controls, the casing can be 3D printed but is designed so that an injection mold can be made.

Due to the operation in the 2.4 GHz band and using standard protocols, an app on Android can be used to temporarily replace a broken remote control.

Each receiver-transmitter set must be configured for each application, indicating the number of controls it has and what type they are and the machine identifier. In addition, each analogical control must be calibrated. All this operation is done from a web page, (computer or mobile), the receiver raises a wifi network to which the technical staff connects for configuration and adjustment. At any time this operation can be performed by a qualifie technician.

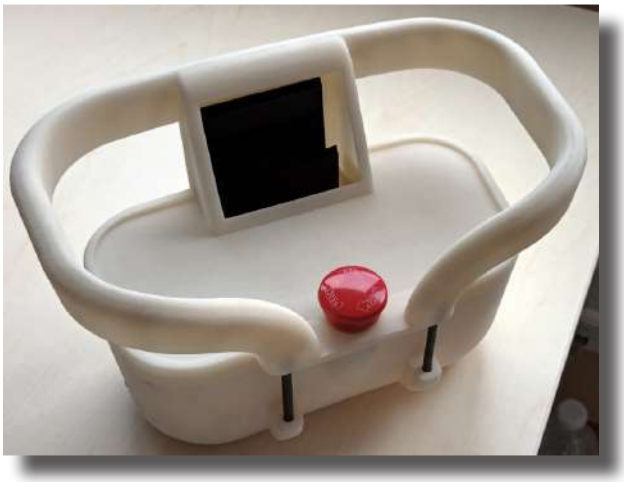

Figure 4. Casing prototype

SOLUCIÓN INTELIGENTE DE CONTROL Y COMUNICACIÓN DE MAQUINARIA. SICCMA

El objetivo principal de SICCMA es contribuir a la transformación digital de las PYMES, especialmente las del sector naval, mediante el desarrollo experimental por parte del consorcio de una solución innovadora de prestaciones de comunicación y control avanzado, que posibilite el control inteligente de equipos sencillos

AEI-010500-2022b-250

Este proyecto ha sido apoyado por el Ministerio de Industria, Comercio y Turismo.

Orden de bases: ICT/1117/2021, de 09 de octubre, modificada por la Orden ICT/474/2022, de 20 de mayo, por la que se establecen las bases reguladoras de ayudas de apoyo a agrupaciones empresariales innovadoras con objeto de mejorar la competitividad de las pequeñas y medianas empresas.

Convocatoria: Orden de 25 de junio de 2022, por la que se efectúa la convocatoria correspondiente a 2022 de las ayudas establecidas para el apoyo a Agrupaciones Empresariales Innovadoras, correspondientes en el marco del Plan de Recuperación, Transformación y Resiliencia.

The role of green hydrogen in the maritime sector

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CT ENGINEERING DRIVEN PEOPLE

1. Introduction

Hydrogen is destined to be the element that leads the decarbonization not only of the maritime sector but the industry in general.

The recent efforts made by administrations, companies and researchers towards a goal of zero emissions have led recent years in an environmental revolution in the search for productive, profitable and green sectors, using hydrogen as a common point.

But, can the maritime sector really stop depending on fossil fuels thanks to hydrogen?

2. Hydrogen types

Hydrogen is the lightest chemical element that exists and is abundantly found in a gaseous state in the air, being also tasteless, odorless and colorless, properties that water inherits after its union with oxygen [1].

Hydrogen follows a color classification system according to the methods used to obtain it, and it´s possible to classify it in three groups:

- Hydrogen obtained with polluting emissions
- Hydrogen obtained with low polluting emissions.
- Hydrogen obtained with zero polluting emissions.

2.1. Hydrogen obtained with polluting emissions

According to the IRENA (International Renewable Energy Agency) report, before COVID and the hydrogen boom, more than 95% of the hydrogen generated was produced from fossil fuels such as coal, oil or natural gas [2].

Within this category would be gray, brown and black hydrogen:

- **Grey**: It´s commonly associated with hydrogen obtained from natural gas through the reforming technique, being, within fossil fuels, the least polluting. It is the cheapest hydrogen to produce today. Since the publication of the IRENA report to date, the situation of being the most consumed hydrogen has not changed, and it is currently the most widely used [3].

- **Black**: In the case of black hydrogen, bituminous coal is used, a substance similar to tar and obtained as a product of petroleum refining [4].

- **Brown**: Unlike gray hydrogen, brown hydrogen is obtained from coals such as lignite or directly from petroleum [4].

2.2. Hydrogen obtained with low polluting emissions

The hydrogens in this category are mainly defined in two types:

- **Blue**: These hydrogens are obtained with polluting emissions but these emissions are trapped with the use of CO2 capture technologies. Hydrogen is obtained by emitting polluting emissions that are captured and stored or reused for, for example, the creation of other fuels [3]. Within this category it is necessary to highlight the role of turquoise hydrogen, which is a type of blue hydrogen.

Turquoise hydrogen is generated by pyrolysis of molten metal using natural gas. The gas is passed through molten metals, releasing hydrogen and carbon in solid form, thus avoiding emissions into the atmosphere.

• **Pink**: It is the hydrogen that is obtained through the use of nuclear energy. With it, different methods of obtaining hydrogen are used and, thus, different types of hydrogen, the pink one is the one obtained by hydrolysis (a process in which the water bonds are broken) [3]. Within this category, it is worth highlighting the **red** hydrogen (obtained using the thermolysis process, taking advantage of the heat generated from the nuclear reaction to obtain hydrogen) and **purple** (it uses the electricity generated by nuclear energy in electrolysis processes).

Hydrogens of this type do not generate polluting emissions, however, they do generate radioactive waste.

2.3. Hydrogen obtained with zero polluting emissions

The hydrogens in this category, as their name suggests, are those that do not generate pollutant emissions into the atmosphere or waste of any kind. Within this category, the following stand out:

• **Yellow**: Similar to green, but uses solar energy to obtain electricity for the electrolysis process [3].

• **Green**: It is obtained from water by using energy from renewable sources, mainly wind power, for the electrolysis process [3].

• **White**: It is nature's hydrogen; it is present in gas form and can sometimes be found in underground deposits [3].

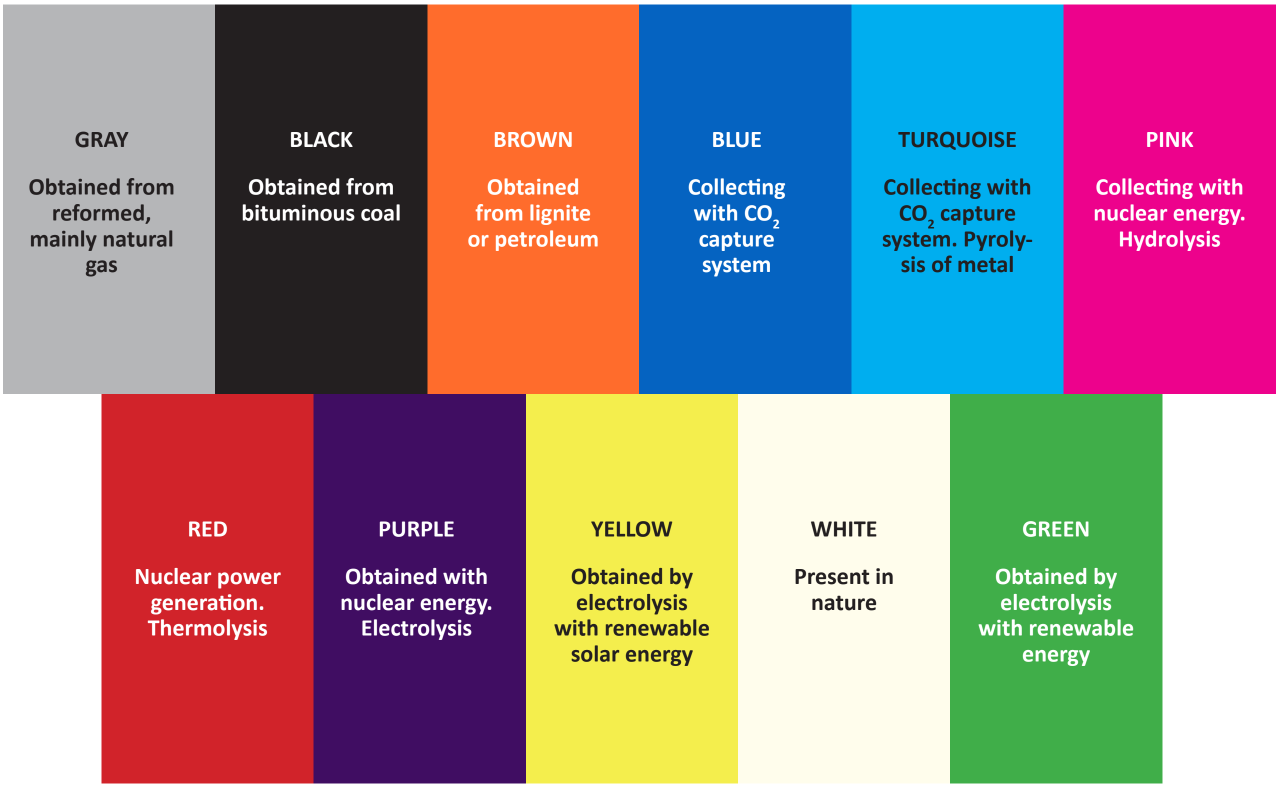


Figure 1. Hydrogen color classification. Own elaboration

3. Ways of obtaining hydrogen

There are different ways of obtaining hydrogen depending on the resource, as shown in Table 1.

Natural Gas	Crude oil	Coal	Biomass	Water
Reformed	Gasification	Gasification	Pyrolysis	Electrolysis
	Pyrolysis		Gasification	
			Combustion	
Partial oxidation	Partial oxidation	Combustion	Liquefaction	Thermolysis
			Fermentation	
Autothermal reforming	Autothermal reforming	Liquefaction	Photofermentation	Photolysis
			Biophotolysis	

Table 1. Methods of obtaining hydrogen depending on the type of resource

- **Reformed**: Currently it is the most widely used hydrogen production method. To obtain hydrogen, a reaction between methane and water vapor is produced, obtaining hydrogen and carbon monoxide.

- **Partial oxidation**: This is a process in which methane combustion occurs in the presence of oxygen, thereby producing carbon monoxide, carbon and hydrogen.

- **Autothermal reforming**: Combination of the reforming and partial oxidation processes. Process in which hydrogen and carbon monoxide are obtained by partial oxidation of the hydrocarbon with oxygen and steam and its subsequent catalytic reforming.

- **Gasification**: This is a process that consists in passing air currents through oil or coal heated to a high temperature. Later, the air is replaced by steam and then it is treated.

- **Pyrolysis**: Consists on the degradation of a substance in the absence of oxygen with the addition of heat. As a result, gases are obtained whose basic components are carbon monoxide, carbon dioxide, hydrogen, methane and more volatile compounds.

- **Combustion**: Coal or biomass is burned in the presence of oxygen to obtain, among other components, hydrogen. This process is similar to pyrolisis or gasification.

- **Liquefaction**: Consists of the liquefaction of the gases generated in previous procedures.

- **Fermentation**: It consists of obtaining methane gas from which hydrogen is then extracted by fermenting organic matter. The hydrogen obtained through this process, as well as all those related to organic matter, is known as biohydrogen. If this biohydrogen is used in the generation of fuels, it is understood to be biofuels.

- **Photofermentation**: This procedure lies between Fermentation and Biophotolysis procedures, employing sunlight as a catalyst.

- **Biophotolysis**: This procedure allows hydrogen to be obtained from the hydrolysis of water by photosynthesis. It is analogous to hydrogen production by water electrolysis using sunlight instead of renewable energy as a catalyst for the reaction, and the use of autotrophic microorganisms instead of electrodes.

- **Thermolysis**: Consists on the decomposition of water molecules by thermal processes using high temperatures. The main problem with this technology is, precisely, the energy input required to break down the molecules, so chemical cycles are used to lower the temperature.

- **Photolysis**: Unlike the previous system, in this case the aim is to break the water molecule through sunlight. Te main problem with this system is that it depends on the materials used as conductors and their properties.

- **Electrolysis**: Electrolysis is a chemical process in which a body immersed in a substance and on which an electric current is applied disintegrates. This type of process is used in fuel cells to obtain energy.

4. Obtaining green hydrogen by electrolysis

Of the types of hydrogen explained previously, as well as the different techniques that exist for obtaining it, green hydrogen obtained by electrolysis is the predominant demand that has set international policies. Not only because of the positions taken by national and international administrations, but also because of the maturity in the degree of development of these technologies as a result.

This is the most environmentally friendly way of obtaining hydrogen and the one that offers the greatest guarantees of development and low emissions to date.

The following three types can be classified as hydrogen production depending on the electrolyte applied in the electrolysis: Alkaline Electrolyzer (AE or AEL, Alkaline Electrolysis), Proton Conducting Solid Polymer Electrolyzer (PEMEL or PEM, Proton Exchange Membrane Electrolysis) and Solid Oxide Electrolyzers (SOEL, Solid Oxide Electrolysis) [5].

The Direct Electrolysis of Seawater (DES) could be added due to the notable impact that the use of seawater has, since seawater is one of the most abundant resources on the planet and, electrolysis from seawater under appropriate conditions, it produces hydrogen and dioxygen with 100% faradaic efficiency, however the technology is not sufficiently developed currently, although it is being further developed.

The main characteristic of alkaline electrolysis (AE) is that its electrolyte is a 25-35% KOH aqueous solution, which has a working temperature of between 70-90 ºC and a pressure below 3.2 MPa.

The efficiency of these systems allows a specific energy consumption between 4.5-5.5 kWh/Nm3 and a lifetime of over 30 years. In addition, as it is a highly studied technology and has relatively low development and implementation costs, it is classified as the most appropriate technology to produce green hydrogen on a large scale compared to other types of electrolysis.

In the case of PEM technology, the main problem for implementation is the cost of both catalysts and membranes, which makes large-scale development very complicated and, in the case of SOEL technology, due to the complexity chemistry that it presents, it is developed in small-scale modules, that is, below the MW.

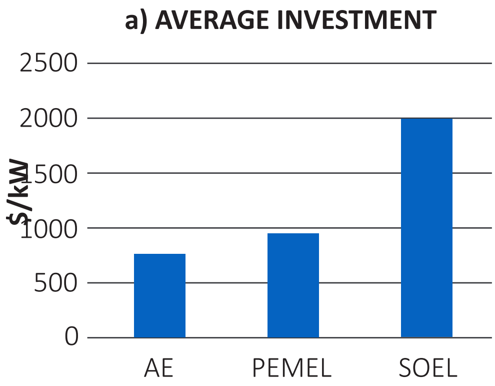
A comparative summary of the characteristics of these types of electrolysis is given in Table 2 and expanded in the graphs in Figure 2.

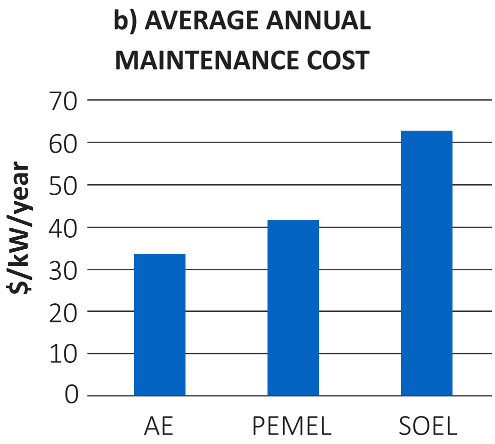
AE has the lowest average investment and maintenance costs of the three types of electrolysis. In addition, it has one of the longest service lives along with the PEM system and, although it does not have an energy requirement as low as the SOEL system, it is second only to the SOEL system.

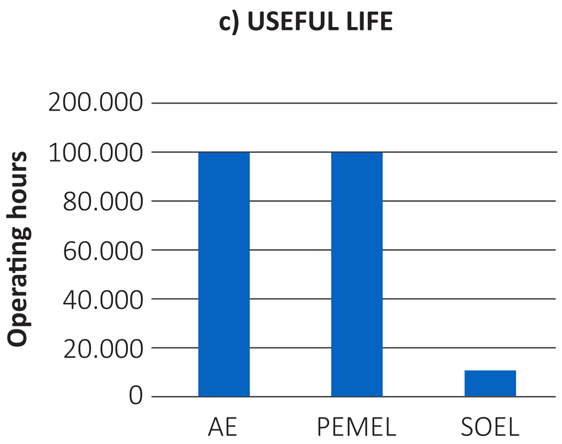
Coupled with the fact that the hazard of this system is moderate, AE technology is considered the most cost-effective and safest method of green hydrogen production to date.

Characteristics	AE	PEM	SOEL
Investment ($/kW)	500-1000	600-1300	>2000
Average investment($/kW)	750	950	2000
Maintenance cost ($/kW year)	10-60	18-65	>65
Useful life (hours)	100.000	100.000	100.000
Energy requirement (MJ/kg)	170	170	135
Hazard / Risk	Medium	Very Low	Medium

Table 2. Characteristics of electrolysis technologie







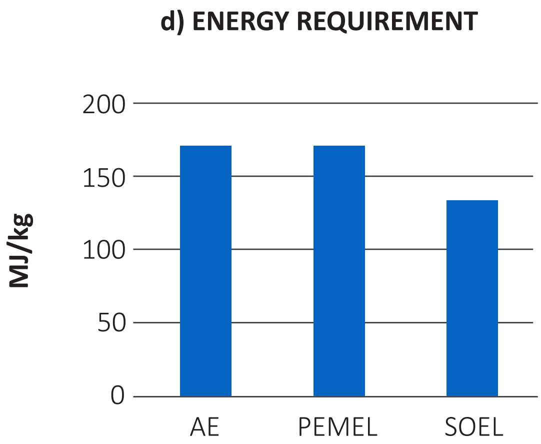


Figure. 2 Average investment for each electrolysis process (a), average annual maintenance cost for each electrolysis process (b), useful life (c) and energy requirement for each electrolysis process (d).

5. The situation of hydrogen in the maritime sector

Hydrogen can be used in different ways on board a ship:

a) As fuel in combustion engines.

b) As fuel for batteries or fuel cells.

c) As part of another fuel.

However, it does present several problems that, nowadays, within the maritime sector, entail technical and legislative challenges that have not yet been solved.

First of all, it is necessary to address the storage on board.

While natural gas can be stored in liquid form at -163 ºC as Liquefied Natural Gas (LNG), currently the safest way to carry hydrogen on board is in tanks on deck and in gas form, which makes storage capacity smaller.

The temperature of liquefied hydrogen at atmospheric pressure is 90 °C lower than that of LNG, which means that the fuel service system will be subjected to strong thermal variations, even greater than those of an LNG system, reaching variations of around 270 ºC, when in LNG systems it is around 180 ºC.

Also, the embrittlement due to hydrogen low temperatures can lead to changes in the performance of the steel and the materials used to store it, with a higher risk of leaks in liquefied hydrogen than in LNG facilities. To correct this, better materials, more research and, therefore, more investment will be needed.

Another fact to be taken into account in the hydrogen storage chain is that hydrogen is only liquid between -240 ºC and -253 ºC, which will require very advanced systems to prevent the heating of the load both by heat transfer during storage and during loading/unloading operations, which would cause problems in the management of the boil-off gas (BOG) generated.

In addition, if liquid hydrogen is stored, it is necessary to evaluate its sloshing phenomenon. With an ignition energy of less than 0.02 MJ, and the electrostatic charges generated by the load balance, cases of autoignition in storage tanks may occur, with this energy required by LNG being 0.28 MJ, much higher than that of hydrogen.

Furthermore, and according to laboratory experiments, it has been obtained that the speed of hydrogen flame propagation is much higher than that of methane, in fact, it has been quantified that this increase in speed is 10 times faster than any other hydrocarbon.

Secondly, there is no maritime regulation to be taken as a reference on hydrogen as a fuel. There are some extensions of requirements due to the similarities with natural gas, but there is no regulation as such to serve as a reference for shipowners and technicians when establishing this type of fuel on board. This would allow to generate legal certainty, not only at a technical level, but also at the time of contracting, for example, insurance policies.

There is also no training as such for seafarers operating on ships with hydrogen as fuel on board, as they will require a high level of education and training due to the high safety standards that such equipment would require.

Thirdly and finally, the availability of hydrogen is very limited both due to the lack of infrastructure and the definitive development of water electrolysis, which requires technological maturity that will foreseeably reach optimal technological maturity in 2030. In addition, the maritime industry would have to fight against the need for an extensive supply network on a global scale that is currently practically non-existent and that today, as a fuel, cannot compete against LNG.

For this reason, the role that hydrogen would have during this energy transition in the marine sector would be as a support element for synthetic biofuels, such as biomethanol, biodiesel, etc. and its use in navigations of the *short sea shipping* type with the use of fuel cells or small-scale combustion engines, mainly due to the limitation of fuel storage, but it is discarded on large commercial routes and on board merchant ships.

Despite these common limitations within the sector, one of the projects related to hydrogen in which we have worked, among others, from CT Ingenieros in its Ferrol Site, is the preparation of the feasibility plan for a tugboat with hydrogen propulsion.

This project, led by Nodosa Shipyard within the H2Tug consortium, of which we are part, is currently under evaluation by the Ministry of Industry, Trade and Tourism within the PERTE Naval.

With this we aspire not only to delve into the technology of hydrogen implementation in the framework of small ships, but also to improve the design and operation of propulsion plants with the aim of making hydrogen as a fuel viable in certain sectors of maritime transport, being pioneers in the development of this technology in Galicia.

6. Conclusion

The implementation of hydrogen as a fuel in the maritime sector in the medium term is quite complex, as there are technical and legal challenges that must be overcome in order to ensure the viability of this type of technology on board, offering full guarantees not only for shipowners and operators in the sector, but also for crews.

Hydrogen plays a prominent role as an essential element in the new generation of biofuels that are currently being developed, and its implementation would allow further decarbonization and the objectives set by the International Maritime Organization to reduce polluting emissions.

It is necessary to develop not only the legal and technical aspects of hydrogen in the maritime industry, but also the necessary infrastructures to guarantee the supply chain to ports and the industry that operates in their areas of influence.

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ACLUNAGA will participate with its own booth at the fairs:

Expomaritt (Istambul):
October 11-14, 2023

Europort (Rotterdam):
November 7-10, 2023

International Workboat Show (New Orleans):
Nov 29 - Dec 01, 2023

The interview:

José Ramón Franco
Managing Director of INTAF Group

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With more than 80 years of history and nearly 200 workers, the parent company of a family nature integrates the subsidiaries Neodyn, Intaf Promecan, Tecman, Sincromecanica, Evolventia, and Cogaltra, the latter two with the participation of external partners. This industrial and services group is characterized by its great capacity for innovation, high diversification, adaptation to the market, and customer service culture.

The history of INTAF is a reflection of the link and evolution between a family and a company with a territory, Narón. Its business model has constantly adapted to the needs of its customers and the evolution of the market to provide a comprehensive service in the metal-mechanical field, through continuous investment in infrastructure, machinery, organization, and permanent innovation and always counting on a versatile, flexible, professional and committed staff.

Its strategy focuses on maintaining diversification, specialization, and expansion of the value chain in the product and service provided, which allows it to have a multidisciplinary and multisectoral capacity.

• **Would you say that the way of competing today has changed, and in what sense? In both the national and international markets, do you consider that there has been any significant change in the way of doing business, or winning contracts?**

The intensive globalization model has given rise to patterns and strategies, mainly on the part of large companies and corporations, which have resulted in a greater concentration of purchasing processes, the contracting of larger work packages in most cases, and the obligatory need for companies supplying products and services to adapt to this new reality. All this, added in many cases to the centralization of management and purchasing decisions, has led to a lack of direct contact and relationship between clients, suppliers, and local collaborators; and to a distancing and lack of common objectives between the demanding areas (production, maintenance, etc.) and the purchasing areas, which by extension affects the financial areas.

On the other hand, in many cases, hiring scales prevail that don´t consider the real value provided by SMEs: close and committed. Perhaps at this time, and after the recent events derived from the COVID pandemic and the war in Ukraine, this purchasing strategy is changing, bearing local suppliers in mind and betting on a local value chain that is closer to the need.

• What are the particularities and challenges of the shipbuilding sector from your point of view, and what type of customers do we need to attract?

We start from a position of certain advantage, one that entails a naval industry that has also been adapting to the different stages of the naval and industrial evolution in the region of Ferrol for 300 years. For example, with the manufacture and repair of ships for different uses and services both in the civil and military area, with the constructions for the oil and gas sector, or the manufacture of components for the conventional and renewable energy sector; and at this specific moment the intense activity in the facilities of Navantia Fene for offshore wind power in collaboration with Windar and under the strategy of the Navantia Seanergies business line. As a result of this trajectory, we have accumulated knowledge that allows us to face any challenge with optimism, being in a position to overcome them. We must continue to improve, and this involves multiple factors as improvements in the internal organization of each company and the coordination of the entire value chain, from the offer phase of the tractor customer itself, in which the complementary industry should already be involved, to the maintenance program itself until the end of the useful life.

Evidently, at any given moment, we must target customers, sectors, and opportunities that allow us to exploit our knowledge and available resources to the maximum without losing sight of newly emerging or traditional lines of activity that, with the suitable investments and the availability of human capital, we can develop with solvency and profitability.

• Do you detect difficulties regarding the development of your activity: infrastructures, transport, logistics, environmental regulations, etc. Could you tell us the advantages and disadvantages, strengths and weaknesses of the region?

On the basis that the businessman should not be conformist, we see that there is a lot of room for improvement, but if we look back, we have progressed a lot in all aspects, although we are now living through complex times. Certainly, it is necessary to improve the transport of goods and passengers by rail, to improve accessibility to ports and airports, and to be able to maintain transport infrastructures in an adequate state.

I consider that we must be able as people, companies, and administration to obtain a better performance of everything we already have, there is a lot of room for improvement. It is necessary to reduce and improve the public administrative bureaucracy, neither the processes nor the times are adequate for the current dynamics in which the speed of development of the economy has nothing to do with the situation of previous decades.

I believe that Galicia is today a growing community and has a business fabric we have never had before, with leading companies in sectors such as steel, naval, automotive, aeronautics, fishing, textiles, pharmaceuticals, ICT, etc.; therefore, we have a great business strength. What we need is to gain greater visibility both in Galicia and abroad and to be able to make the leap from small to medium-sized companies in a natural and well-managed way.

From my point of view, the greatest weaknesses are the excessive bureaucracy and the administrative burden that companies suffer daily; digitalization has been a great step forward, but it also has been hampered by a continuous increase in procedures and obligations that entail additional costs and the lack of application of existing and available technologies.

• In your opinion, what are the weak points of shipbuilding in Galicia?

The loss of qualified and highly experienced human resources over the years; the slow progress in management and organization systems that allow the different parts of the value chain to plan and execute actions in a more optimized way; and the lack of interest by a large part of the youth in the professional disciplines that operate in the shipbuilding industry are intensively weighing down the evolution of this sector.

If the above is already serious and decisive in terms of the future expectations of this sector, is also serious when considering new investments, capacity expansion, and market extension. Especially if these require high participation of skilled labor since it would make little or no sense to embark on projects whose viability depends precisely on the availability of professionals in adequate numbers and training.

• What distinguishes INTAF from its competitors in terms of specific products and services?

We have grown slowly throughout all these years, accumulating knowledge, investing, and innovating to complete our capabilities and be able to offer customized solutions in the metal-mechanical field that may consist of engineering development, equipment, and components manufacturing, steel heat treatment, or maintenance and repair, among others. One of the advantages is that we can serve each customer with great flexibility and availability, adapting to a specific demand for a product or offering the service comprehensively.

• How do you plan to develop and expand the business? What are your objectives for 2024?

The first objective is to maintain the permanent consolidation of the value chain we have complemented with the steel heat treatment plant.

In addition, we intend to continue gaining market share in the renewable energy sector, specifically in the wind energy sector, both onshore and offshore.

In the naval sector itself, we are already collaborating with Navantia in the development of components for the F-110 frigates, also intensively with the Repairs area and in the offshore wind power area in two specific lines, on the one hand, collaborating in the development of improvements in the production lines, and on the other, in R&D&I programs in the manufacture of components for the support structures.

In addition, and in line with what we have been doing for more than ten years, we will continue to collaborate with other companies in the development of industrial plans and investments aimed at jointly acquiring capacities in which we are deficient in Galicia and which form part of the strategic value chain of Galician companies. Two examples of this policy are Evolventia in the manufacture of gears and Cogaltra in the heat treatment of steels.

• Innovation mention as one of the pillars of the current development of companies. To what extent has R&D&I been important in INTAF's trajectory? And how far has it taken you? Is a company like INTAF ready to tackle this digital transformation?

Innovation is key in any company, and means adapting to the continuous change of the environment; we have worked steadily and uninterruptedly in this area through investment in technologically advanced machinery and participation in collaborative projects, meanly dedicated to the research of materials and robotization of processes, all accompanied by continuous training.

Regarding the word digital transformation, we do not believe so much in disruption as in daily and continuous progress; in this sense, for years we have had an integrated business management model supported by a central platform that covers all the Group's companies, operating transversally and covering all phases of the process, and in addition, a series of peripheral solutions that interact with the central system in those management areas that require a high degree of customization, either to provide internal coverage or to provide a better service to our customers.

We are now moving towards greater robotization of some activities such as welding and connectivity between the different systems in the plant.

• Another challenge we´re dealing with is the renewal of the workforce. Why are younger people not attracted to the sector? How can companies attract young talent?, Do you have this problem/ difficulty in INTAF? Why do you think it is?

The shipbuilding sector tends to be cyclical in terms of activity and, as a consequence does not generate stable jobs, which has resulted in a part of the personnel that has been trained over the years moving to other sectors and even to other places mainly looking for stability in jobs that this sector could not offer.

We have to work together to make shipbuilding a more attractive sector to capture the interest of the workers. It is necessary to improve the regulation of working conditions to generate real expectations of maintaining the job and develop permanent and adequate training plans for real, current, and future needs, and of course both in direct trade positions through Vocational Training and at the university level.

In the case of Ferrolterra, and specifically in Navantia, a lack of permanent and sequenced renewal of retiring personnel has given rise, on the one hand, to the fact that for years there have not been calls for positions that gradually were incorporated into the workforce and consequently these people took over, losing the accumulated knowledge; on the other hand, in that now intensive calls for vacancies are being made in the public shipyard mostly being covered with personnel from the nearest industry. Something that is affecting many companies losing skilled labor in which we have invested for years in some cases.

At INTAF, precisely to avoid these peaks, we follow a strategy of diversification of both sectors and clients, allowing us to offer high job stability, and achieve a minimum turnover. But we cannot ignore the situation, and it is indeed necessary for a generational replacement that is often very difficult, especially taking into account that in some engineering degrees or vocational training few students enroll, and many fewer finish.

• Productivity rates in Spain are still relatively low compared to the European average. How is this problem related to the training of professionals?

We have gone from apprenticeship schools with magnificent results to a stage in which there was hardly any in-company training; however, now with dual vocational training this situation can be reversed, and from what we are seeing, the university is betting on a similar model.

With the perspective that comes from experience, I would like to encourage young people to choose studies related to this industry, which is one of the engines of the welfare society, and which, moreover, we are sure will enable them to have an adequate standard of living.

It should be noted that not in all cases the possible lack of productivity is linked exclusively to the education or training factor; proof of this is that professionals who leave this sector and many others in different geographical locations tend to be highly valued both in Spain and in other countries. Productivity is a consequence of many other factors that require more detailed analysis in each case.

• Environmental protection is one of the challenges that the industry is facing. Do you think that measures taken in this regard affect you negatively? How could it be improved?

It is a reality that in the past the environment was not an absolute priority in the development of many activities, among them also the shipbuilding sector, however, today is unthinkable that this factor is not determining the strategy of the sector and all its activities. It is an issue that we can see even in the orientation of the business lines; proof of this is Navantia *Seanergies* and the offshore wind power line of activity.

In any case, the sector and the agents involved in it, from the shipyards to the auxiliary industry, must set as a priority to make the development of the activity compatible with total respect and protection of the environment.

• At a time like the present, what measures do you consider urgent/necessary to strengthen and protect the sector?

An agile and adequate execution of the naval PERTE can represent a big opportunity for improvement; increasing public-private collaboration, planning investments in a coordinated manner, and actively seeking new markets are fundamental pillars.

In the case of Ferrolterra and Navantia, greater integration of the auxiliary industry and adequate, rigorous, and stable labor regulation. Investments that allow providing the sector with adequate operational capacities, among others: a new dry dock, the renewal of the machinery, productive and auxiliary means, the external crane fleet, and, of course, a permanent training plan to accompany the also permanent and sequenced incorporation of personnel to both the main and support industries.

• The presence of women is scarce in the shipbuilding sector. Is their participation being encouraged?

It is one of the problems we have historically faced the lack of women in the metal-mechanical sector. In this sense, I believe that we are all open and willing to see greater participation of women, who can choose a training related to the sector, and sure that it will allow them to have a wide range of job opportunities. Companies must also assume the development of the necessary actions to facilitate this integration in the widest possible range of positions.

I would like to take this opportunity to highlight the role of women in the sector who, although limited in terms of number and type of positions, in our business group and in most of the companies I know, have developed and develop their responsibilities with the utmost efficiency and commitment.

• Does the shipbuilding sector work together? How is it perceived from the point of view of an auxiliary company?

As I have already pointed out, I consider this to be one of the great challenges with room for improvement, for cooperating, investing in a coordinated manner, providing integrated solutions by several companies, and facilitating the tractor industry in the execution of its projects are, among others, some of the lines to be developed and improved.

• What has been your recipe for staying viable and competitive for so many years, and how has the demand for your services evolved recently?

The ingredients have been: hard work, effort, commitment, reliability, and innovation. With this, we have managed to build customer loyalty, which we have accompanied almost since our inception, and we have achieved to have qualified and committed human resources.

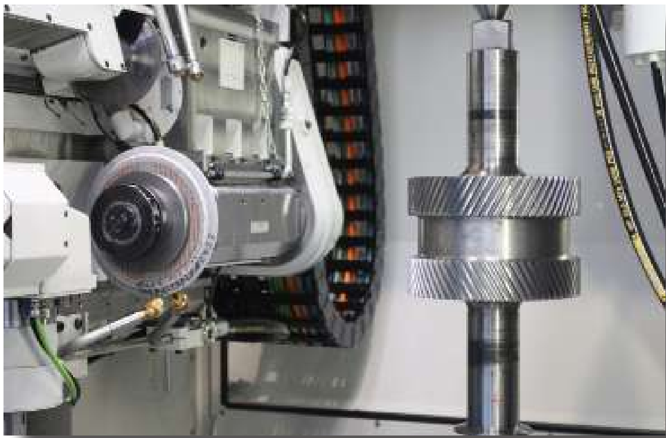
From there, from our core business, we have adapted to the demand with an incremental service, in which we have gone from delivering parts or components according to the customer's drawings to designing complete solutions for a product, manufacturing it, assembling it in their facilities, maintaining it and, when necessary, uninstalling it.

• Have you had to change your strategy or plans for the future as a result of the economic situation with the recent pandemic and the situation resulting from the war in Ukraine?

I believe that, like all companies and sectors, we have suffered an increase in raw material and energy prices, as well as shortages at certain times. But we have gained the confidence of the sector and our customers. Although it has meant a large effort, we have been managing the situation as well as possible, agreeing on prices with our customers and suppliers, and assuming the challenge of overcoming this crisis since the start.

• Given the challenges ahead, are you optimistic about the future?

I assumed the challenge of the succession of a small family business at the age of 16 (1972), with the exceptional collaboration of my father and my mother, in this case, as a clear example of a hard-working and committed woman. Over time, my wife has joined us, and today, two of my sons integrate into the company. The vocation of a family business, committed and with vitality is in our blood, thus we are not short of optimism.



We try to convey to our families, staff, collaborators, suppliers, customers, etc., our vocation of permanence and optimism, even in a very complex moment in which it seems that businessmen, freelancers, liberal professionals, etc., do not enjoy a reasonable appreciation by some political options with high capacity of influence, and that is resulting in the creation of a social climate tending to negatively value this group and the majority condition that we represent and profess, which is based on work, effort, commitment, and wealth creation. Hopefully, those having responsibilities in this area will realize this and resume the right path to prevent the gradual abandonment of those who we are at this moment; and something more important, to stimulate the culture of entrepreneurship and business creation.

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