FIBRE4YARDS
SHIPYARD FOR THE FUTURE

MARTECH 2022
6th International Conference on Maritime Technology and Engineering
24-26 May 2022, Lisbon - Portugal

FIBRE4YARDS

Fibre Composite Manufacturing Technologies for the Automation and Modular Construction in Shipyards

Xavier Martinez (CIMNE)
Daniel Sá (CompassIS)
João Silva (INEGI)
Santiago Alvarez-Buylla (TSI)

This project has received funding from Europan Union's Horizon 2020 research and innovation programme under grant agreement n° 101006860

WHAT IS FIBRE4YARDS

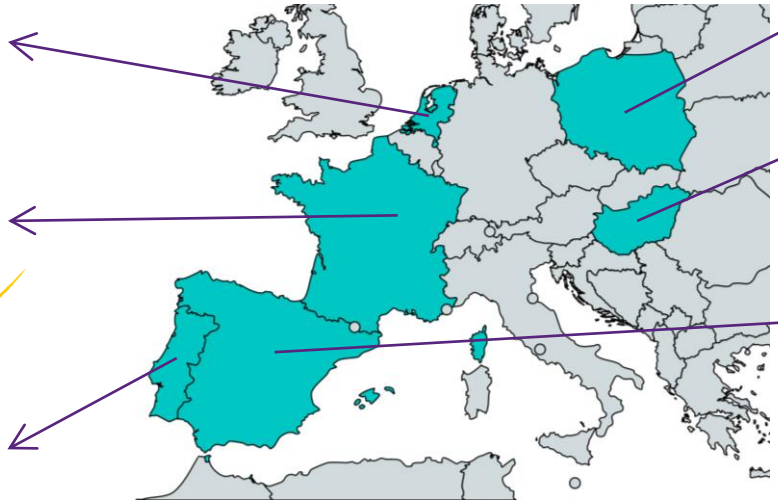
SHIPYARD FOR THE FUTURE

FIBRE4YARDS is a EU funded project which main objective is to maintain European global leadership in ship building and ship maintenance, through implementation of the Shipyard 4.0 concept in which advanced and innovative FRP manufacturing technologies are successfully introduced

IN A NUTSHELL

CONSORTIUM

To achieve these objectives, a consortium of 13 institutions from 6 European countries have gathered together



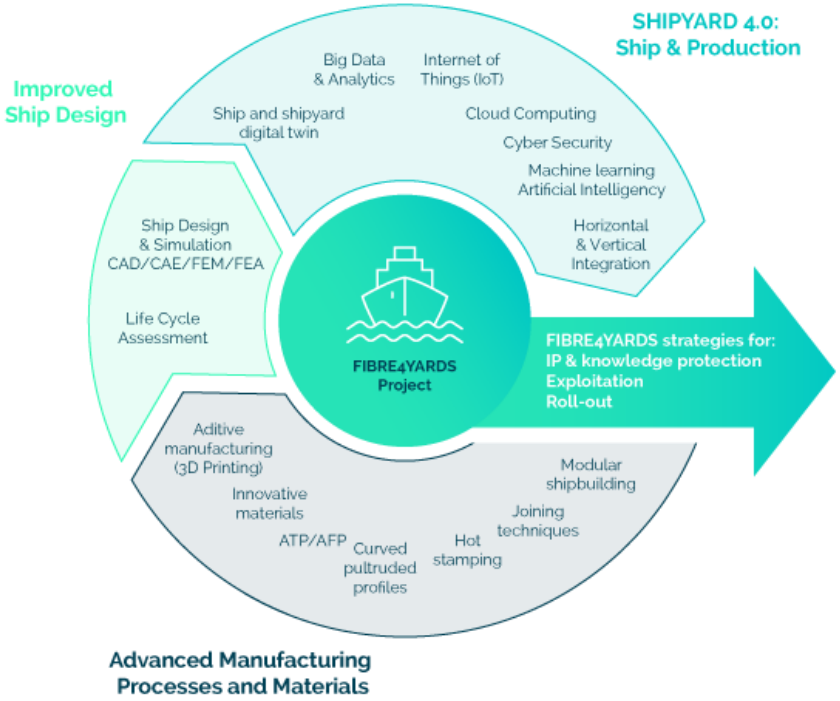
BACKGROUND

Today, Fibre-Reinforced Polymers (FRP) materials are extensively used for building lightweight hull structures of vessels with length up to about 50 meters, and most of the leisure crafts and sailing yachts, patrol and rescue vessels, and naval ships below 25 meters length are built in FRP materials.

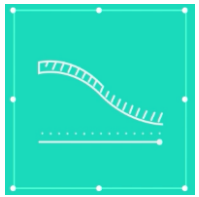
However, the **production capacity** in numbers of FRP ships **is not achieving its full potential** due to high total production costs. One of the main reasons for this limitation is the **lack of automated procedures**, and the current semi-artisanal methods used in FRP shipbuilding

https://www.boats.com/on-the-water/boat-building-construction-resin-fiberglass-cores/

CONCEPT AND UNDERPINNING TECHNOLOGIES



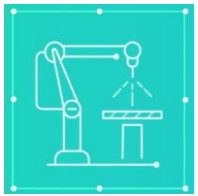
1. Advanced Manufacturing Processes and Materials



Curved composite moulds

Pultrusion curved profiles

Thermoplastic hot-stamping

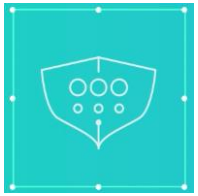


ATP/AFP

New connection technologies

3D Printing

AUTOMATED MODULAR SHIP CONSTRUCTION



Acoustic Black Holes

2. Improved Ship Design

In order to boost the benefits provided by the new technologies, new ship-design tools will be developed. Among them

NEW NUMERICAL METHODS FOR SHIP ANALYSIS:

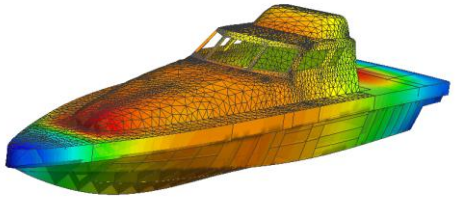
1. Beam elements for the analysis of curved pultruded profiles
2. Reduced models to account for connections, in terms of stiffness and strength
3. Plastic laws to characterize thermoplastic materials
4. Special failure models to account for the anisotropy existing in Additive Manufacturing materials

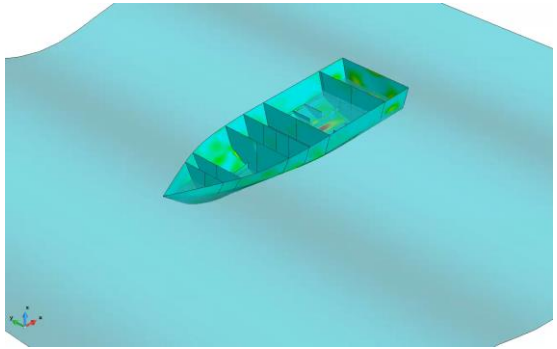
2. Improved Ship Design

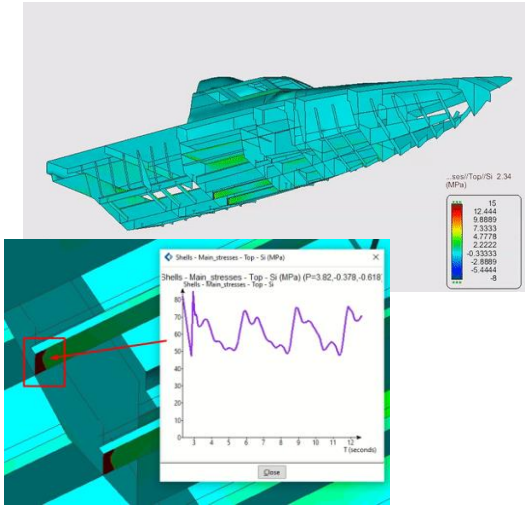
SPECIFIC NUMERICAL SOFTWARE FOR SHIP DESIGN:

Two different vessels will be designed with the new software to evaluate its capabilities and performance

PATROL BOAT





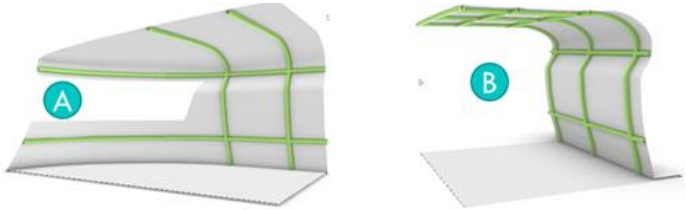


2. Improved Ship Design

SPECIFIC NUMERICAL SOFTWARE FOR SHIP DESIGN:

Two different vessels will be designed with the new software to evaluate its capabilities and performance

CATAMARAN



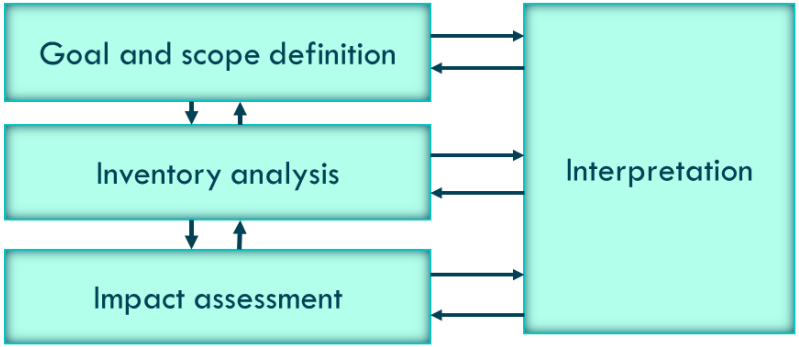
The superstructure of the catamaran will be used as a demonstrator of the different technologies targeted by the project.

2. Improved Ship Design

LIFE-CYCLE ASSESSMENT OF ALL PROCESSES AND MATERIALS:

The life-cycle assessment of processes and materials will be taken into account at the design phase of the ship.

STAGES OF A LCA



ISO 14040:2006
Environmental management.
Life cycle assessment.
Principles and framework

ISO 14044:2006
Environmental management.
Life cycle assessment.
Requirements and guidelines

Environmental Model: IPCC 2021 GWP 100
ReCiPe 2016

3. SHIPYARD 4.0. Ship and Production

The project aims to define a new automatized Shipyard. This will be achieved by:

1. Develop monitoring strategies to obtain required data for continuous quality control and factory maintenance.
2. Develop a monitoring system based on shipyard 4.0 and IoT technologies for the control of the different production processes in a shipyard (Digital Twin Model) and assess the best maintenance plan, making possible the reduction of shipbuilding costs.
3. Develop cyber-security protocols to ensure the production and data safety.

3. SHIPYARD 4.0. Ship and Production

A first analysis has been already conducted of the different parameters that must be monitored for the different technologies:

- Pressure: in the US welding pneumatic actuators.
- Air flux (overall): Ultrasound welding module system
- Electric consumption: of the hot-plate press system.
- Electric consumption: of the infrared heaters.
- Vibrations: on the hydraulic pump (stamping press), the auxiliary chiller and the hydraulic pump (hot-plate press).

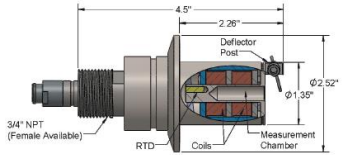
- Resin temperature in the plies
- Polymerization in the plies
- Resin detection in the plies
- Air presence in the resin inlet
- Vibrations in the vacuum pump

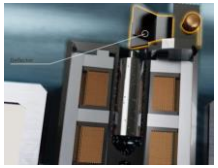
- Geometrical accuracy (to be checked if this is possible and at what cost)
- Power consumption (UV source)
- Power consumption (Robot arm)
- (If possible) Temperature at the exit of the mould.
- Resin level

- Vibrations in electric motors (AM & AFP)
- Levelling of the printing bed to check for possible undesired curvatures and deformations (AM & AFP). (AM & AFP)
- Temperature in the area of the ribbon immediately after putting in place (AFP).
- Roller pressure (AFP).
- Pellet moisture (AM).
- Powder density in the Hopper loader.

3. SHIPYARD 4.0. Ship and Production

Example of monitoring strategies:





- **Geometrical accuracy** of the finished part
- **Electrical power** consumption of the UV sources
- **Temperature** at the exit of the mould
- Resin **viscosity** and **Tª**
- **Vibrations** on the recirculation pump
- Ambient **temperature** and **humidity**

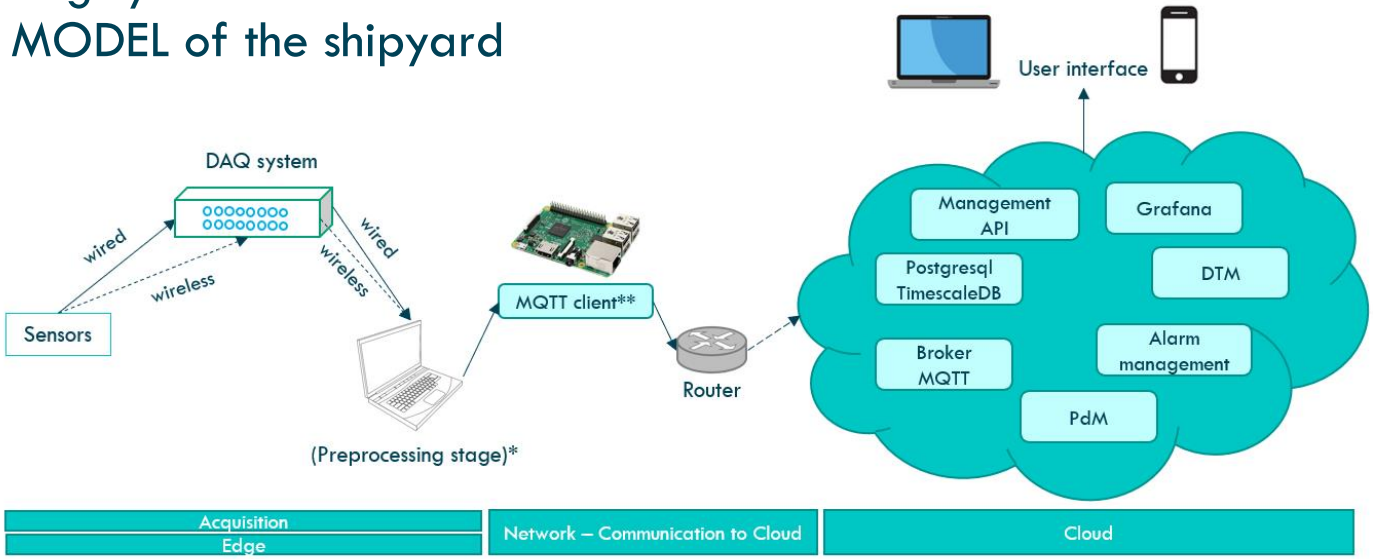
Viscometer
Process control
100-2000 cP

Accelerometer
Eq. maintenance
Important requirements into DAQ selection

Wireless p&h sensor
Certification and traceability
LoRaWAN communications

3. SHIPYARD 4.0. Ship and Production

Conceptual definition of the monitoring system and the DIGITAL TWIN MODEL of the shipyard

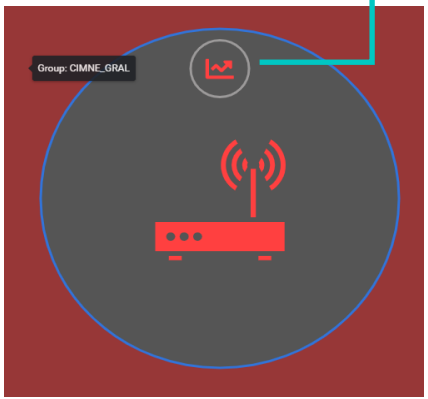


*This stage may not be needed if DAQ allows post-processing
** MQTT client could be located in preprocessing stage

We need a PC-like device (PC, RasPi, etc) either to postprocess data, to act as an MQTT client or as both tasks.

3. SHIPYARD 4.0. Ship and Production

DIGITAL TWIN MODEL of the shipyard



Link to the corresponding Grafana dashbord

Grafana

When an alert is triggered the platform detect in real time the geolocation of the group and device with problems.

SUMMARY

Fibre4Yards project aims to redefine the shipyard. New shipyards must be more automatized, based on a modular construction.

All processes must be monitored and connected to a digital twin of the shipyard for quality control and maintenance.

Ships must be redesigned, considering the new environment. This will improve their quality and performance, as well as the efficiency and productivity of the shipyard is improved.

The approach proposed by Fibre4Yards does not only affect the shipyard, but also its ancillary industries, as all of them will be interconnected and work under the same environment, to reach the same goals.

SUMMARY

Besides the tasks defined in detail in this presentation, the project will also:

1. Construct several demonstrators to prove the feasibility of the developments made
2. Develop new guidelines for materials and advanced production methods
3. Conduct a cost benefit analysis and develop a business model for the technologies developed and the shipyard 4.0 environment
4. Continue disseminating the results obtained, in order to reach a broader audience that can benefit from them

FIBRE4YARDS
SHIPYARD FOR THE FUTURE

MARTECH 2022
6th International Conference on Maritime Technology and Engineering
24-26 May 2022, Lisbon - Portugal

Thank you for your attention

https://www.fibre4yards.eu/

contact@fibre4yards.eu

xmartinez@cimne.upc.edu

This project has received funding from Europan Union's Horizon 2020 research and innovation programme under grant agreement n° 101006860