FIBRE4YARDS
SHIPYARD FOR THE FUTURE

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FIBRE4YARDS

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

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OUTLINE

1. Fibre4Yards Project Presentation
2. Work made on
    1. WP2. Advanced FRP production and joining technologies
    2. WP3. Design and engineering for vessel production
    3. WP4. Smart manufacturing for Shipyard 4.0
3. Summary

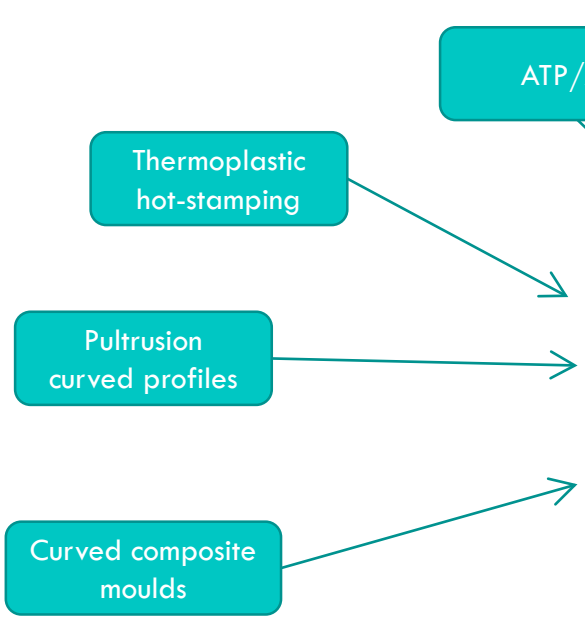
Fibre4Yards Project Presentation

Project presentation public video:

https://www.youtube.com/watch?v=uAk-fRj35UY

WP2. Advanced FRP production and joining technologies

Advanced FRP production and joining technologies
Technologies Assessment



2. Simplicity for Implementation / Adoption	Out of Die UV Cured Pultrusion for Curved Profiles	Hot Stamping of Thermoplastic Materials	Adaptive Moulds for Composite Panel Assemblies	Automatic Tape Placement (ATP)	Additive manufacturing: 3D Printing
		inegi	CURVE Works	10XL	10XL
Initial Investment	250000 €	500000 €	500000 €	400000 €	400000 €
Tooling Requirements	Medium: Two Simple Half-Moulds	Medium: Two Simple Half-Moulds	Low: One Open Mould	Low: One Open Mould	N.A
Additional Attached Systems	Yes: Robot arm, Grippers, Pump	Yes: Pneumatic Compressor, Thermoregulator	Yes: Vacuum Pump	Yes: Filament / Fibre transport system, Moulds, Rotational Axis, Closed Loop System	Yes: Granulate drying system, Granulate transportation system, Infra-red imaging, Air compressor
Need for Skilled Manpower	Yes	Yes	Yes	Yes	Yes
Flexibility	Medium to High	Low to Medium	High	Medium to High	High
Required Shop Floor Area	32 m^2 (Lab Scale)	35 m^2	50 m^2	80 m^2	80 m^2

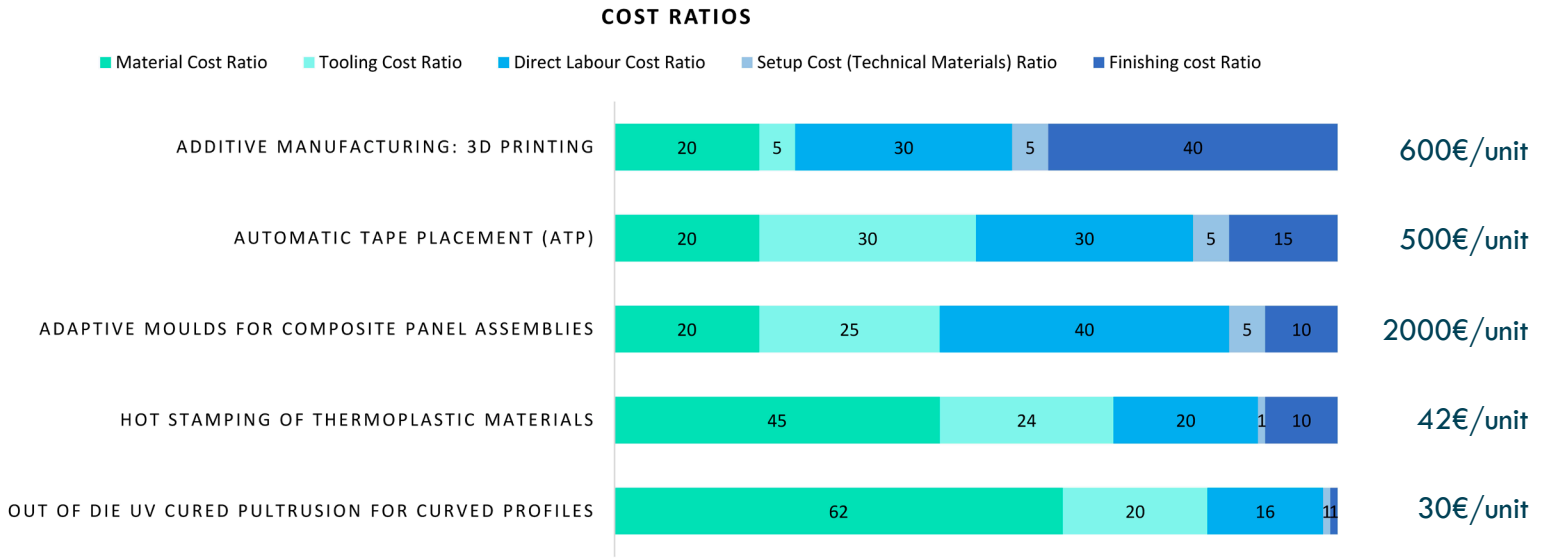
Advanced FRP production and joining technologies
Technologies Assessment

Several tables have been developed comparing the different technologies in terms of:

1. Feasibility, in terms of type of composites that can be produced (materials, geometry, etc.)
2. Implementation requirements (initial cost, tooling, shop floor area, etc.)
3. Worker health impact
4. Costs (material, tooling, equipment, etc.)
5. Process performance (times, post-processing, part reject rate, etc.)
6. Process control and inspection
7. Environmental impact
8. Geometry accuracy and geometries that can be manufactured

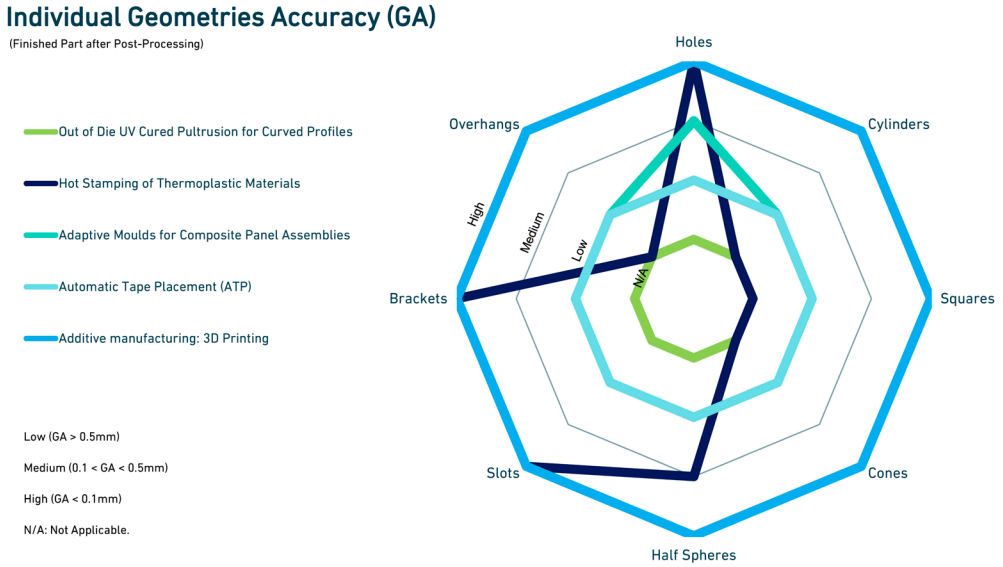
Advanced FRP production and joining technologies
Technologies Assessment

Regarding costs, the comparison shows for each technology how it is distributed the cost per unit part manufactured:



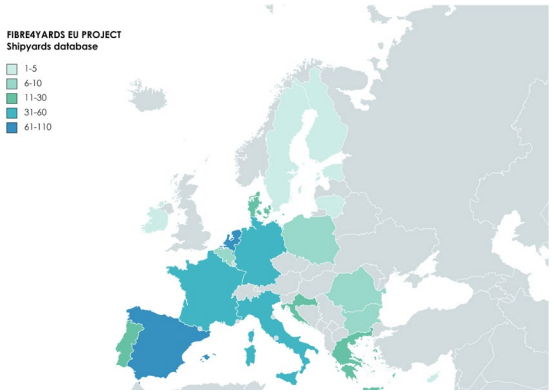
Advanced FRP production and joining technologies
Technologies Assessment

Regarding the geometries that can be produced, the comparison has allow to prepare graphs such as the following one:

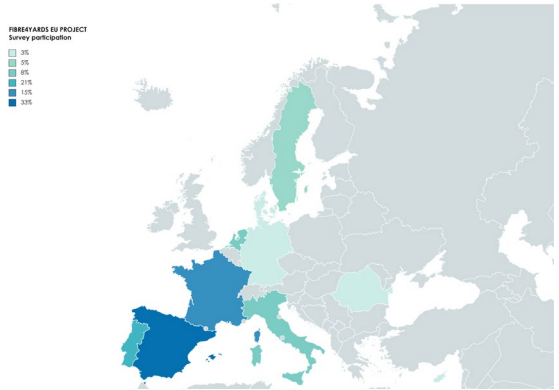


Advanced FRP production and joining technologies
SHIPYARD SURVEY

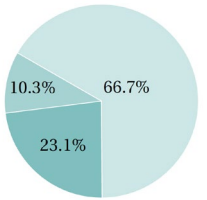
426 shipyards of the European Union have been contacted for a survey in order to know they actual production technology, and their interest on the different technologies that will be developed by the project.

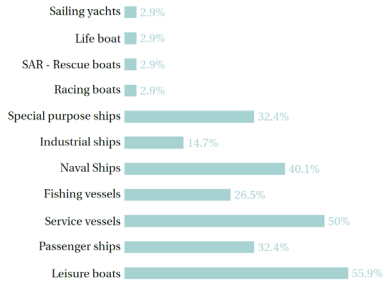


A total of **39** shipyards (9.2%) have participated in the survey.



Use of composites

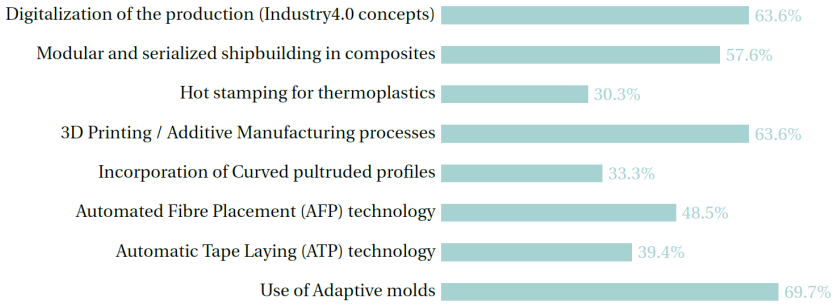




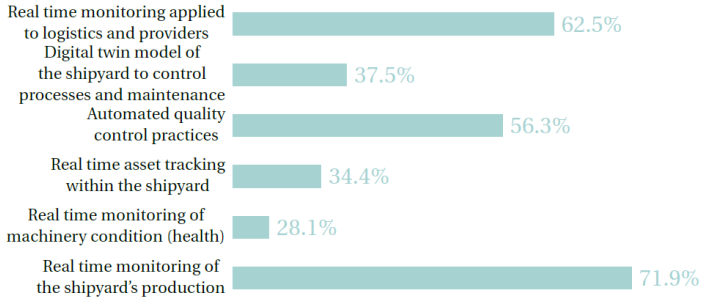
Advanced FRP production and joining technologies
SHIPYARD SURVEY

Interest of the Shipyards in the project results

Technologies of interest



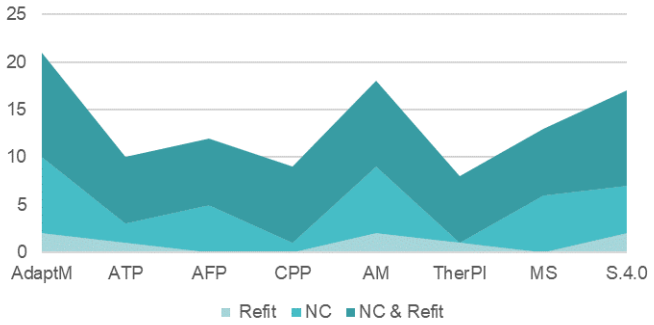
Shipyard 4.0



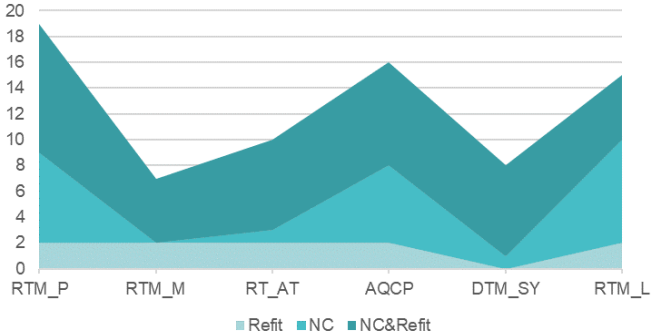
Advanced FRP production and joining technologies
SHIPYARD SURVEY

Interest of the Shipyards in the project results

Technologies of interest based on type of shipyard



Shipyard 4.0 technologies based on type of shipyard



RTM_P: Real time monitoring production
RTM_M: Real Time monitoring Machinery
RT_AT: Real Time Asset Tracking
AQCP: Automated quality control practices
DTM_SY: Digital Twin Model
RTM_L: Real time monitoring logistics

WP3. Design and engineering for vessel production

Design and engineering for vessel production
New Numerical Methods

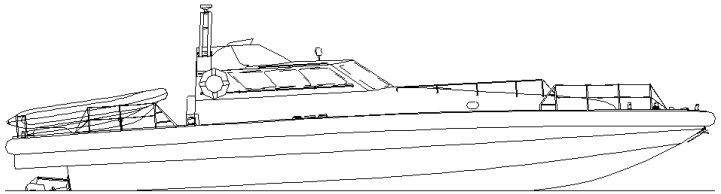
New numerical methods will be developed for the design of composite vessels manufactured with the technologies developed. Among them:

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

Design and engineering for vessel production
New vessel design

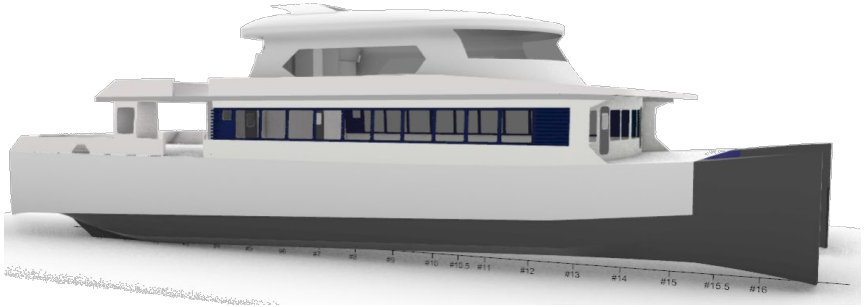
Two different vessels will be re-designed and re-engineered in order to be produced with the new technologies developed in the project.

1. Patrol boat



Copyright by Nautatec S.L.

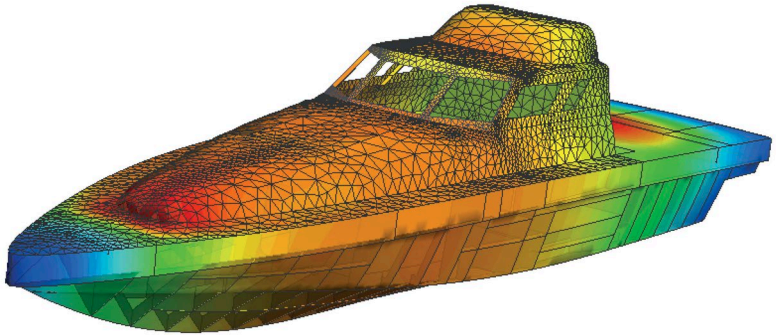
2. Catamaran

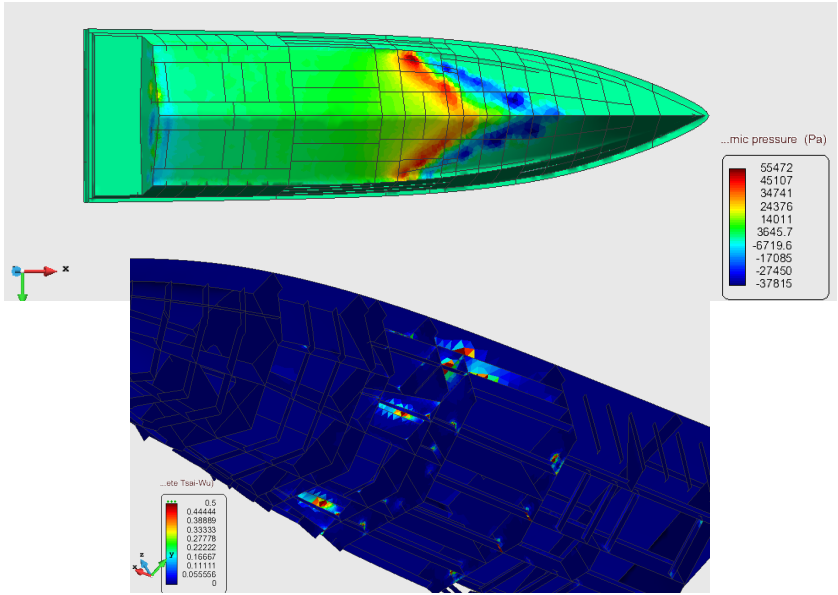


Copyrights by TSI and Gondan Shipbuilders. Final design based on a previous vessel structure designed by Gondan Shipbuilders.

Design and engineering for vessel production
New vessel design

Finite element models will be developed to evaluate the vessel performance and to decide the best elements in which the new production technologies can be applied.





WP4. Smart manufacturing for Shipyard 4.0

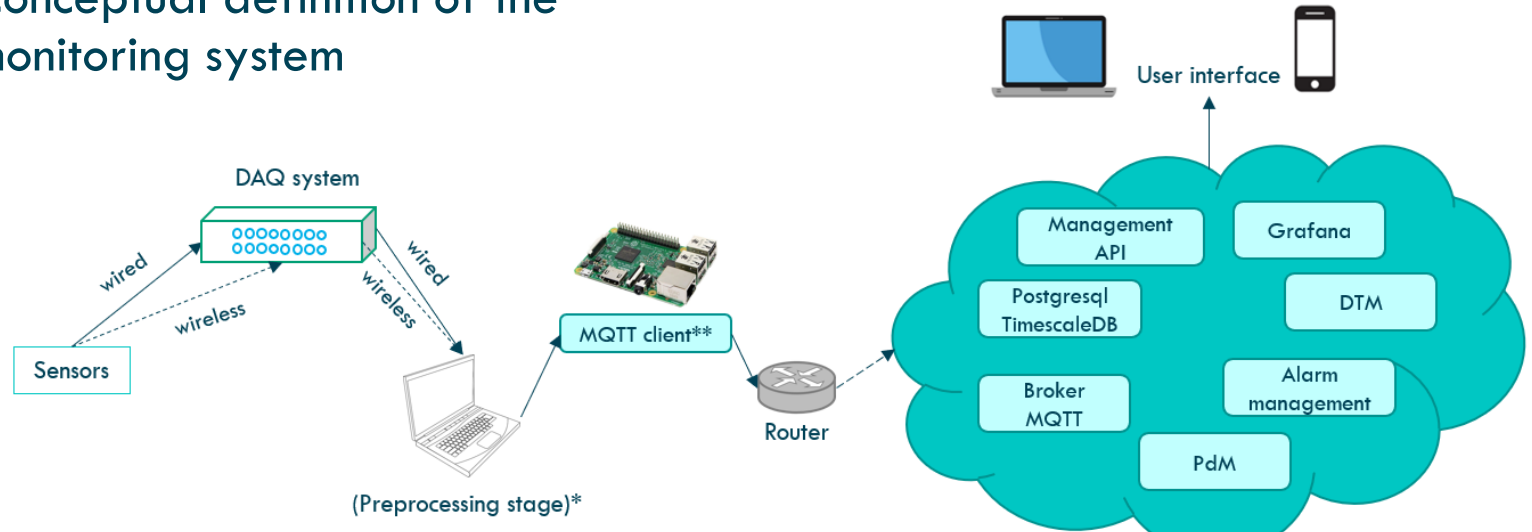
Smart manufacturing for Shipyard 4.0

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.

Smart manufacturing for Shipyard 4.0

Conceptual definition of the monitoring system



*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.

Smart manufacturing for Shipyard 4.0

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.

SUMMARY

Fibre4Yards project has reached a steady pace in order to define a new shipyard concept, more automatized, more connected and more efficient.

Besides the tasks defined, which will continue, the project will also:

1. Conduct a life cycle assessment of the processes and materials to improve the sustainability of the shipyard
2. Conduct a cost benefit analysis and develop a business model
3. Construct several demonstrators to prove the feasibility of the developments made
4. Continue disseminating the results obtained, in order to reach a broader audience that can benefit from them

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Thank you !

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