

Novel technologies to boost the shipyard industry



FIBRE composite manufacturing technologies FOR the automation and modular construction in shipYARDS

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All Fibre4Yards consortium

ORGANIZED BY THE EU HORIZON 2020 PROJECTS:



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Novel technologies to boost the shipyard industry



Novel technologies to boost the shipyard industry



BUILDING FIBRE REINFORCED POLYMER SHIPS

AUTOMATIZATION PROCESSES
MODULAR CONSTRUCTION
DIGITALIZATION

Context



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

Context



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Russell James Hugh Wanhill. Carbon Fibre Polymer Matrix Structural Composites
DOI: 10.1007/978-981-10-2134-3_14

Context

THERE IS THE GENERAL BELIEVE THAT **SHIPYARDS CANNOT REACH THE LEVEL OF AUTOMATIZATION OF OTHER INDUSTRIAL SECTORS**

Some of the reasons that we have heard to explain this reasoning are:

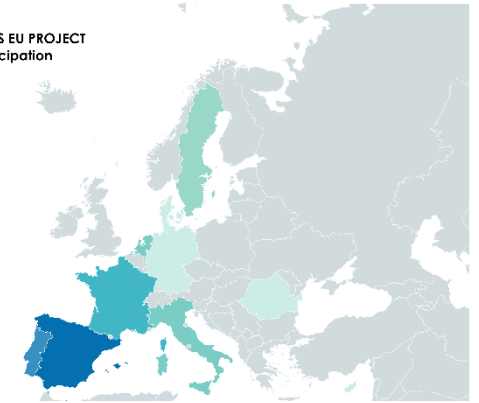
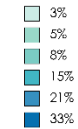
- The number of repeated units is low
- In small boats, there is no need for millimetric precision
- The investment required to automatize manufacturing procedures is too high
- (...)

Context

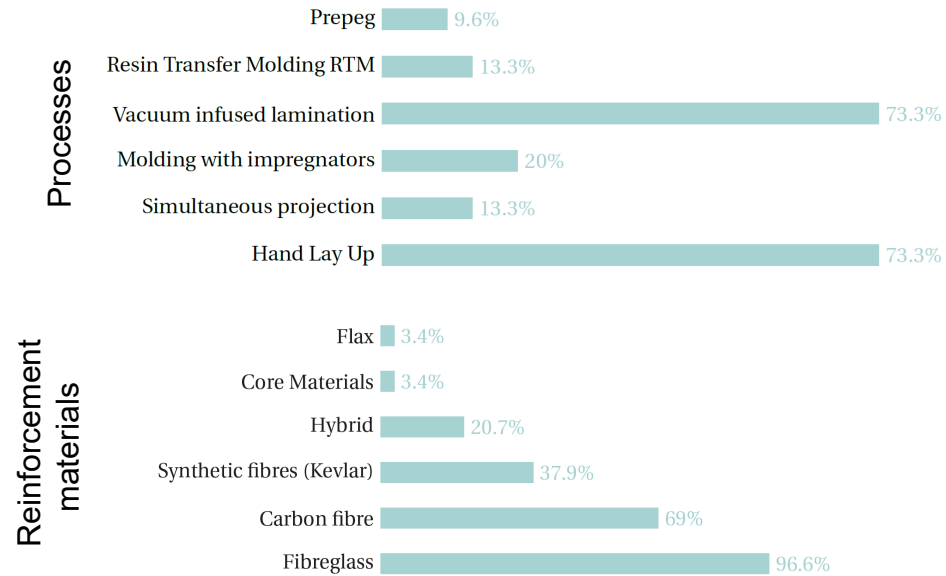
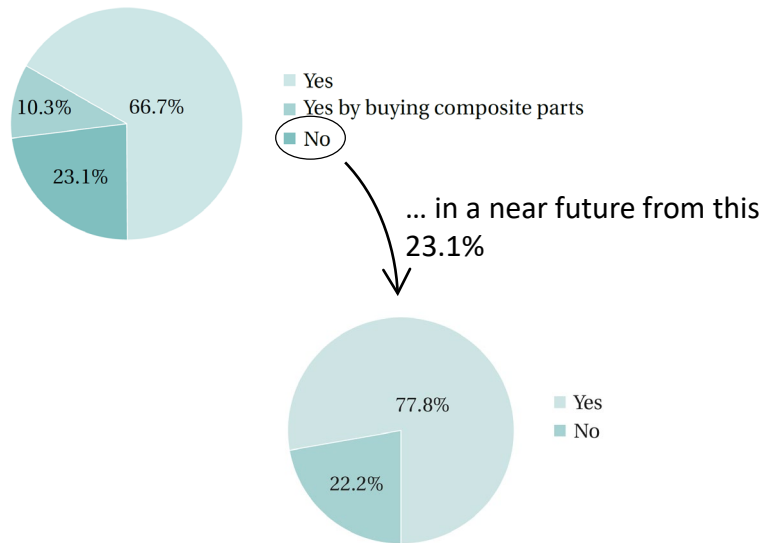
To assess this context, we have conducted a survey among EU shipyards

In this survey, we have find out:

FIBRE4YARDS EU PROJECT
Survey participation



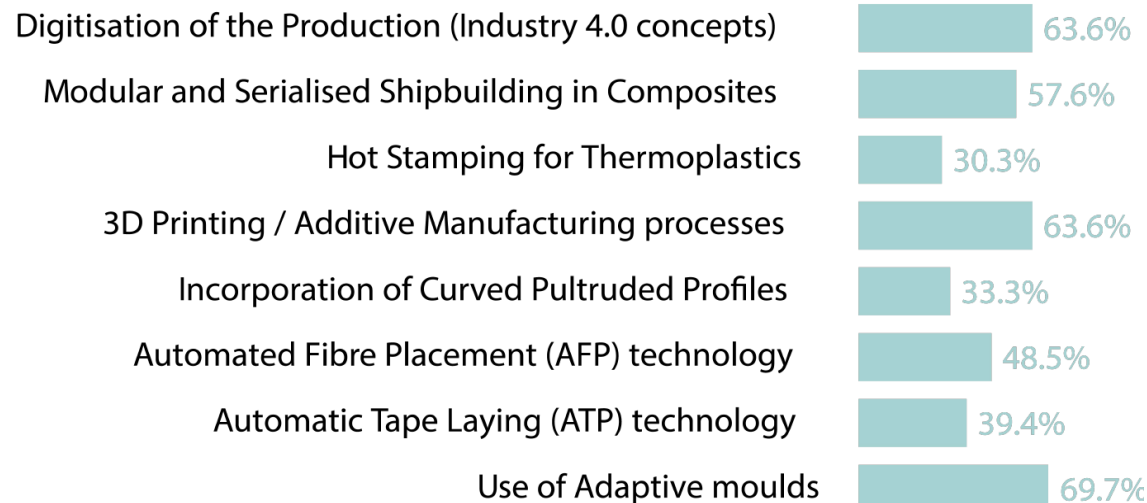
Use of composites:



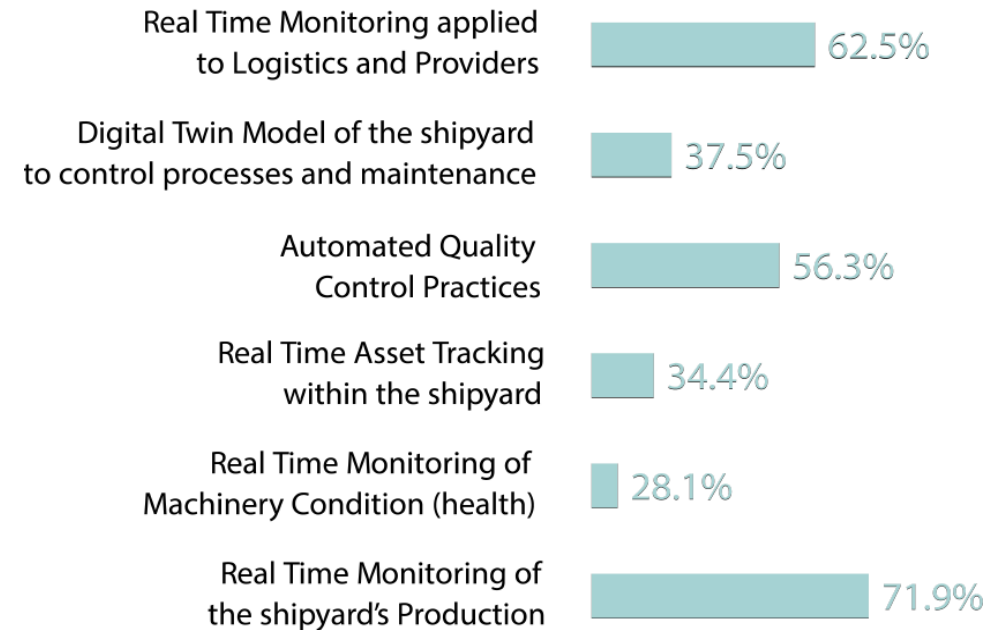
Context

But we have also seen that there is a real interest for new processes and shipyard improvements, such as digitalization:

Interest in new manufacturing procedures



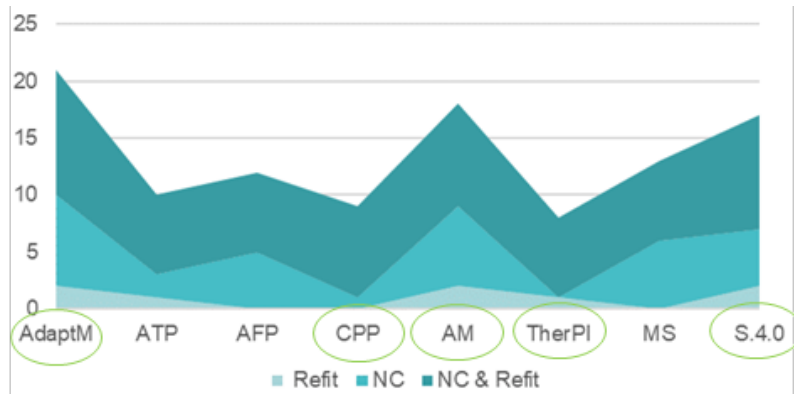
Interest in shipyard 4.0 concepts



Context

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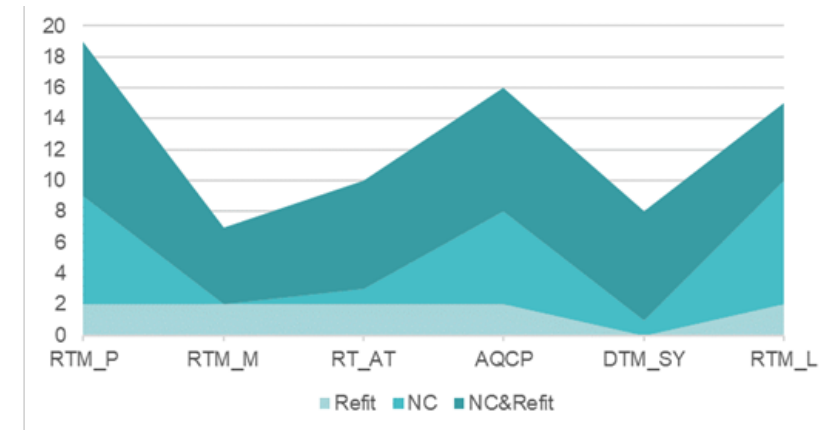
Interest in new manufacturing procedures



AdaptM: AdaptiveMolds
 ATP: Automatic Tape Placement
 AFP: Automated Fibre Placement
 CCP: Curved Pultruded Profiles

AM: Additive Manufacturing
 TherPI: Hot Stamping of Thermoplastics
 MS: Modular and Serialized Shipbuilding
 S.4.0: Digitalization of the production

Interest in shipyard 4.0 concepts



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

Objectives

The main objective of FIBRE4YARDS is to

- Develop the required technologies to increase the automatization and modular construction in shipbuilding,
- Digitalize the shipyard to improve the quality, its efficiency and maintenance
- Incorporate all these improvements, as well as sustainability aspects in the boat design.

And to prove that this can be done,

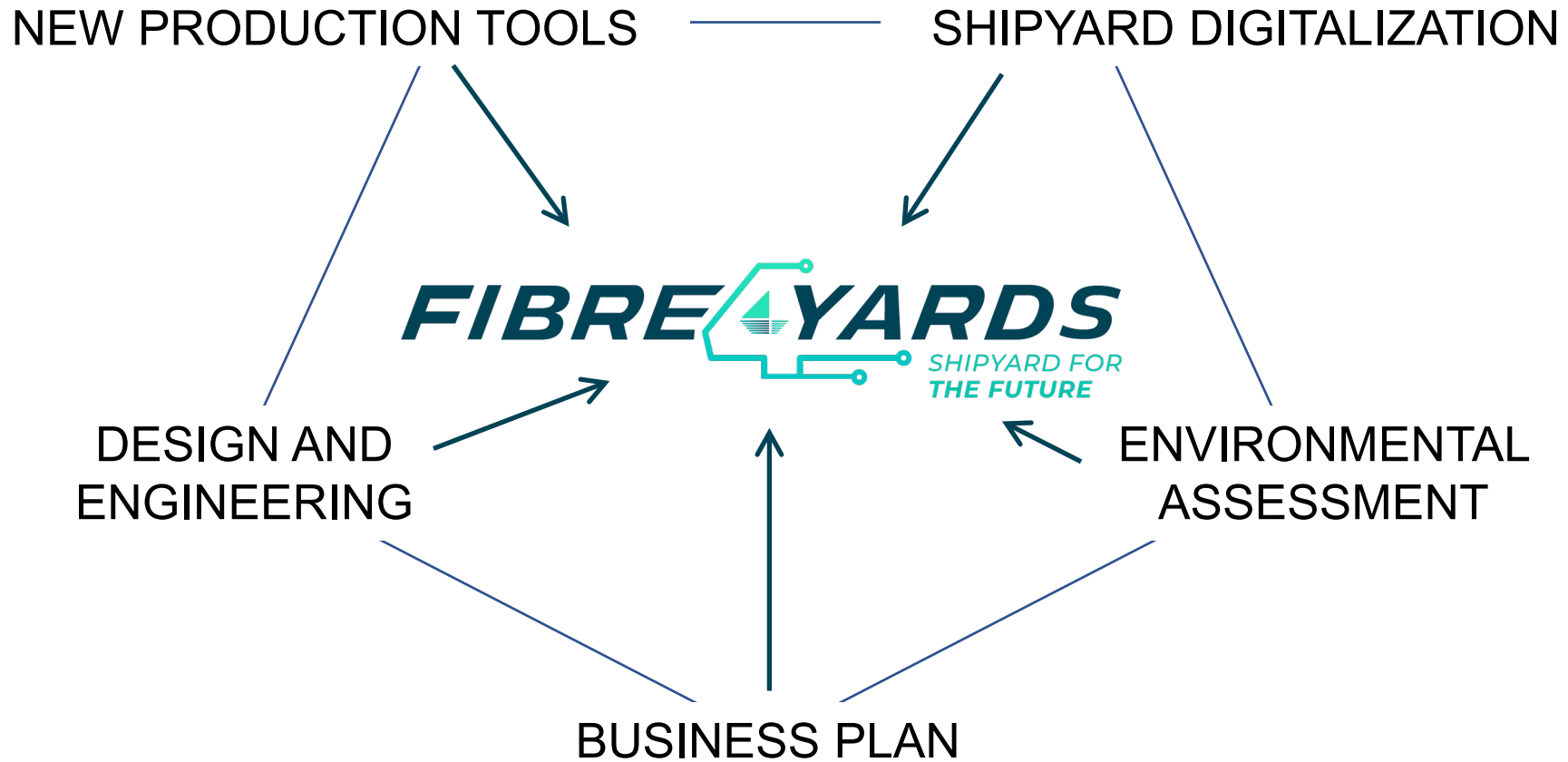
- Despite the number of repeated units is low
- Efficiently, despite the process does not require millimetric precision
- With an assumable cost for the shipyard

ACTIONS

FIBRE4YARDS expects to achieve this objective with the following **ACTIONS**:

- Adapt **advanced manufacturing procedures** from other industries, **and develop new ones**, that can be used by shipyards
- Develop a software to create a **digital twin of the shipyard**, and define the sensors and measuring systems required to feed this digital twin
- Develop **numerical tools for ship design** that take into account the new production methods
- Evaluate the **environmental impact** of the new manufacturing procedures by conducting LCAs
- Elaborate **business plans** and cost benefit analysis to facilitate the implementation of these new technologies
- Develop **guidelines** that will help the implementation of all these developments

ACTIONS



New production technologies

The new production technologies developed at FIBRE4YARDS will be

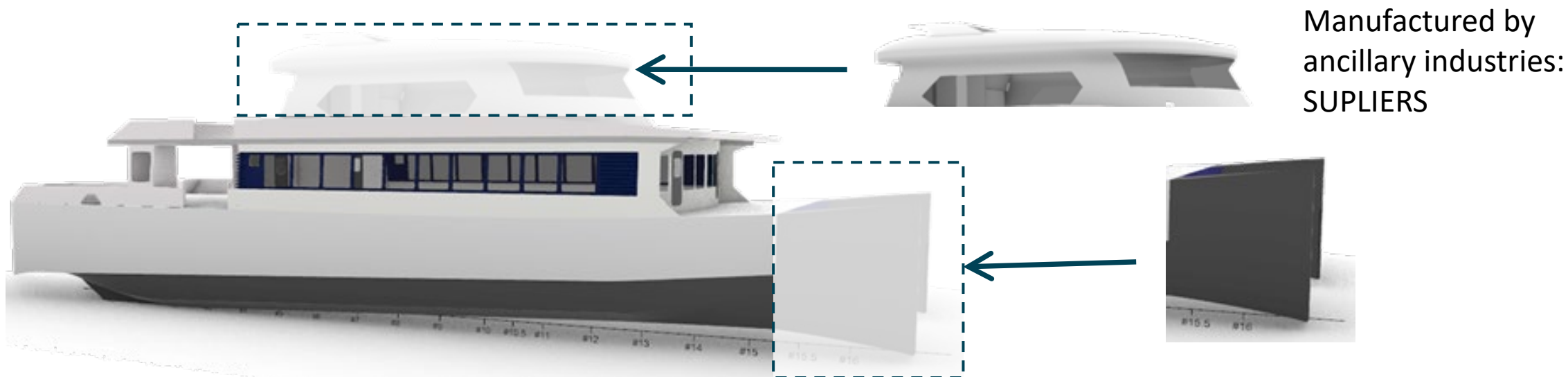
- Developed specifically for FIBRE4YARDS
- Adapted to the shipyard from other industrial sectors
- **MUST allow a modular construction**

They will be presented tomorrow

New production technologies: Modular construction

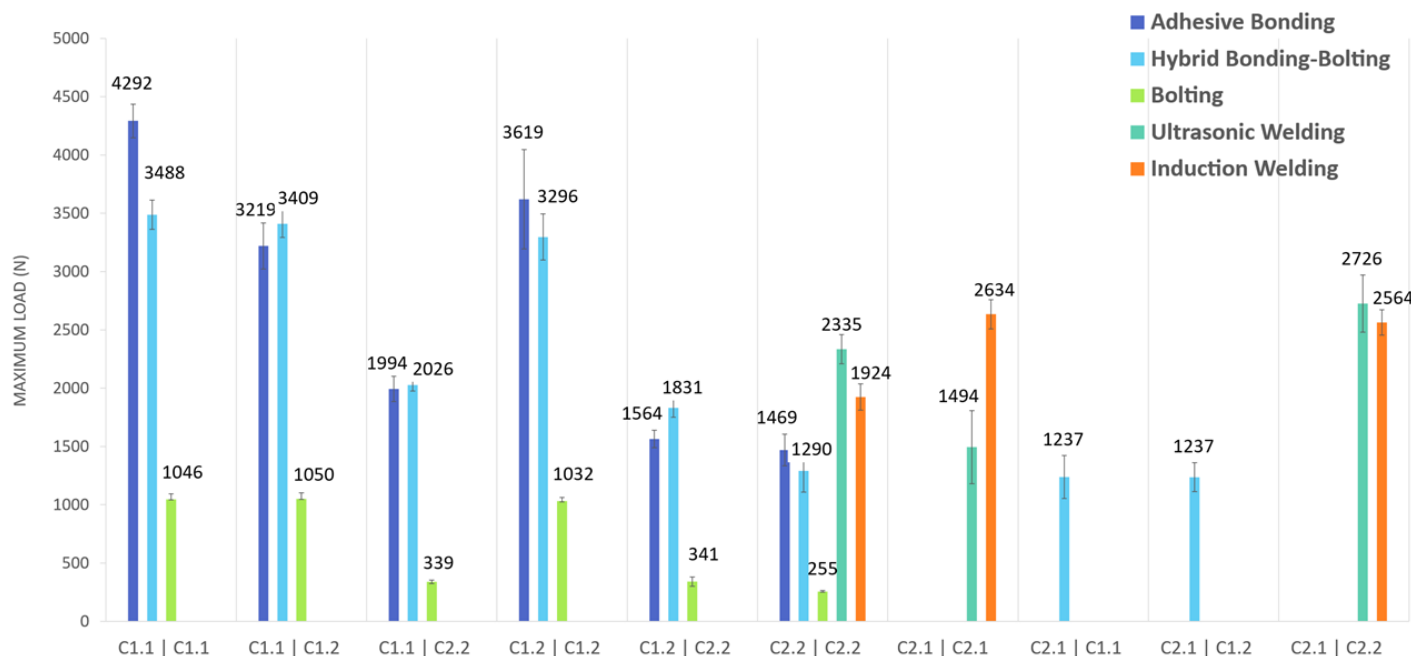
A modular construction will allow having ancillary industries, with specific automatized procedures, producing ship components.

This will reduce investment costs and will increase quality and efficiency.



New production technologies: Modular construction

To facilitate this approach, FIBRE4YARDS has evaluated different connection configurations, joining different materials



**C1.1: Photocurable acrylate matrix
Thermoset FRP Composite**

C1.2: Epoxy matrix Thermoset FRP Composite

C2.1: Hot-Stamped Thermoplastic FRP Composite

C2.2: 3D Printed Thermoplastic FRP Composite

Shipyard digitalization

- All new production processes have been fully analysed to define the best parameters to be measured for quality control
- Monitoring can be easily adapted to other production processes
- All monitoring data feeds a shipyard digital twin, facilitating
 - Quality control
 - Evaluation of production procedures
 - Assessment of production times
 - Predict consumable requirements
 - (...)

Shipyard digitalization

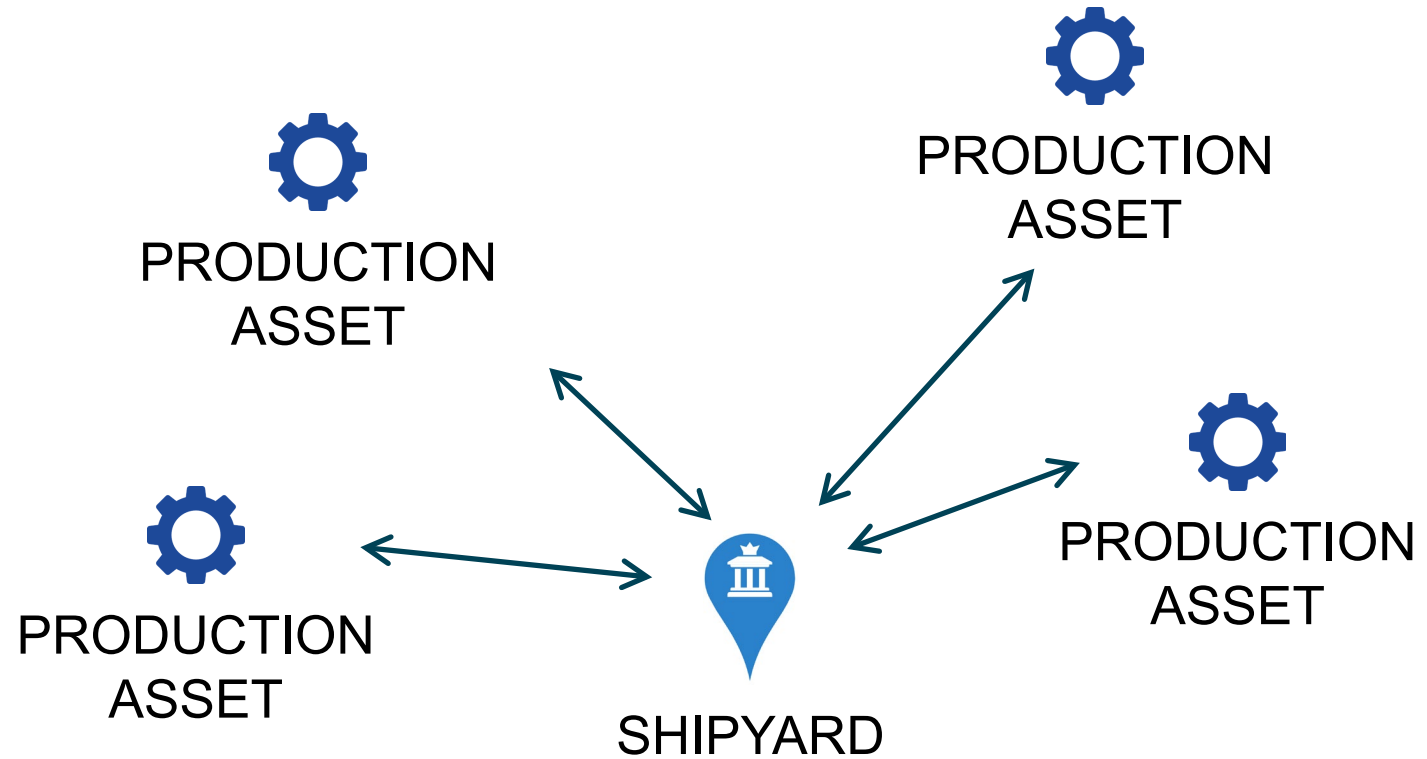
- All this data feeds the SHIPYARD DIGITAL TWIN



SHIPYARD

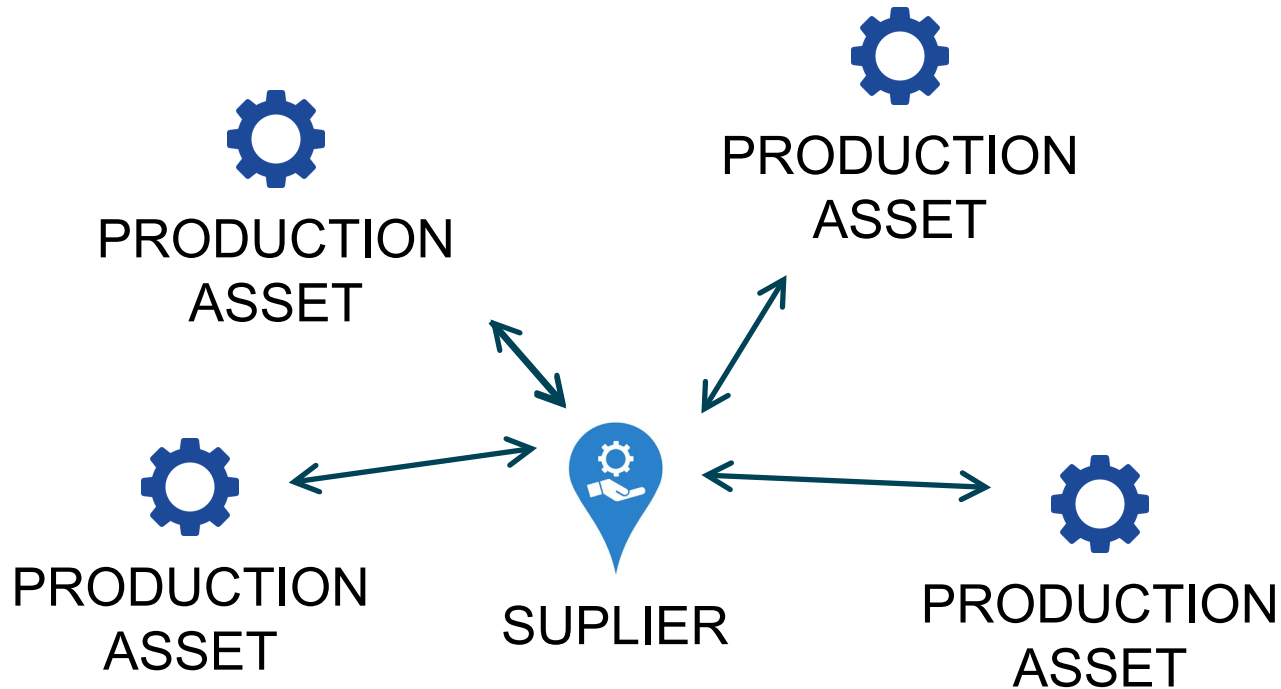
Shipyard digitalization

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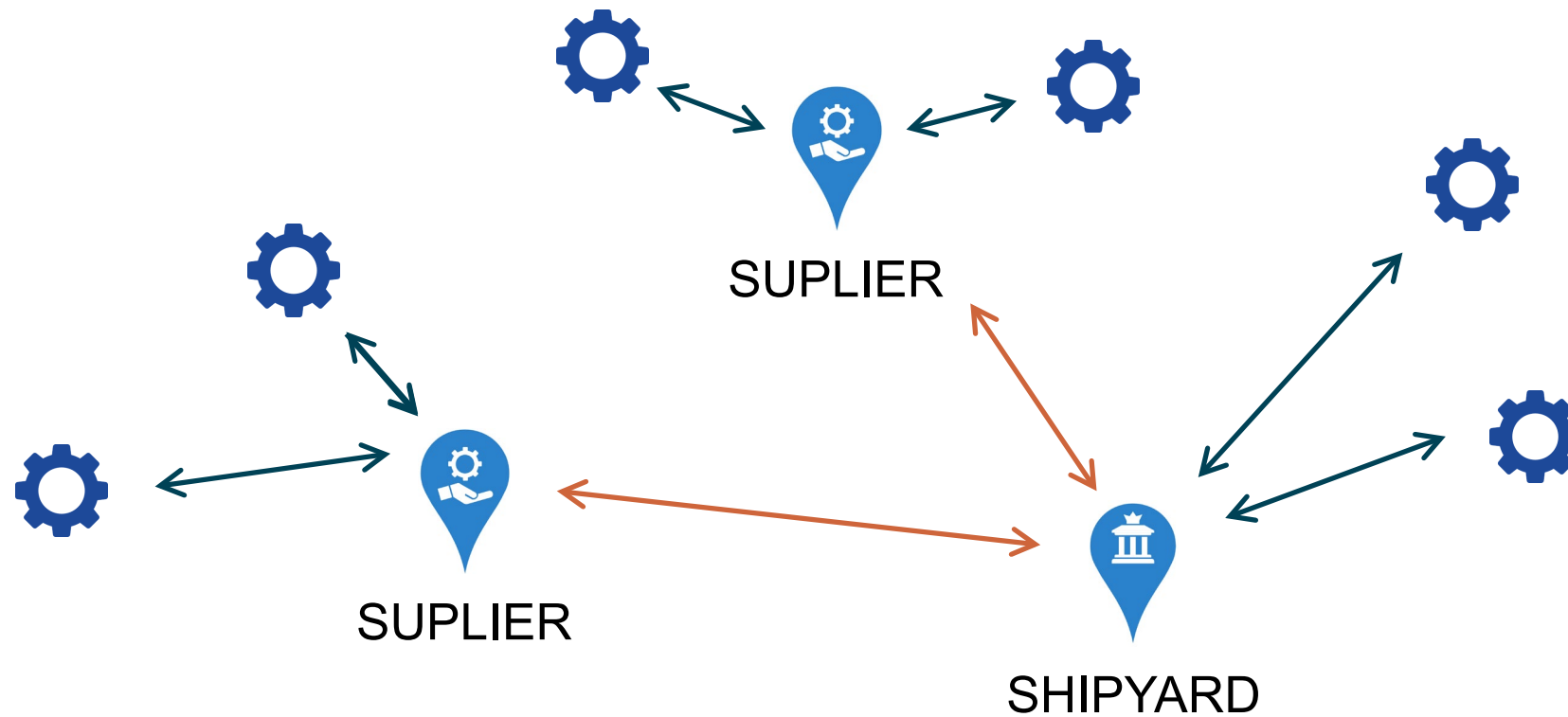
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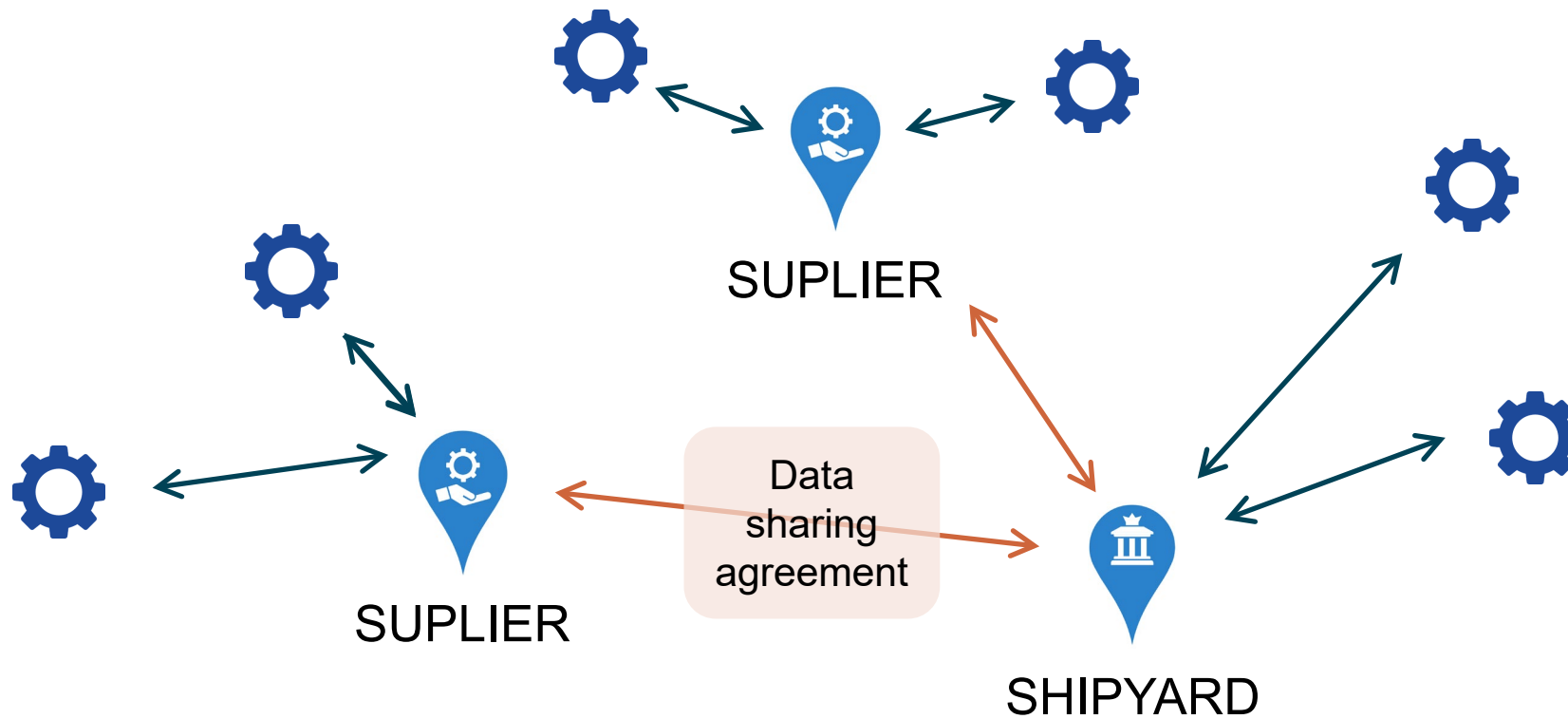
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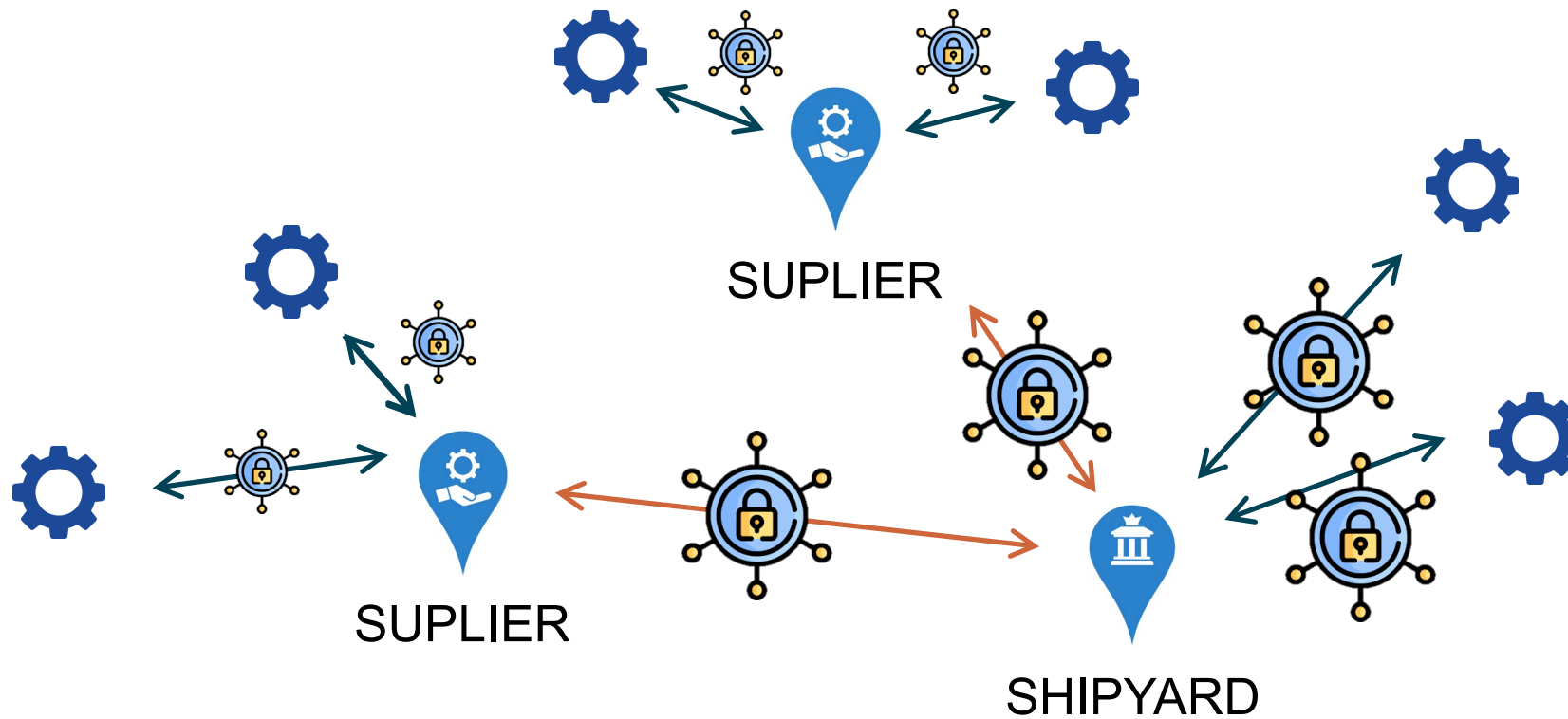
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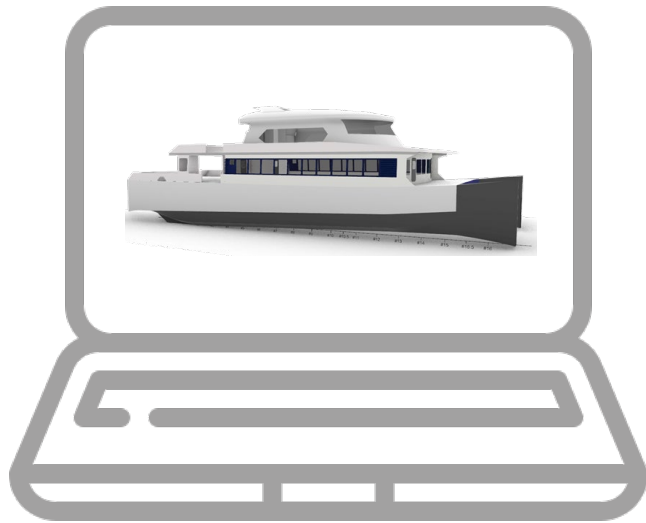
Shipyard digitalization - CYBERSECURITY

- FIBRE4YARDS is defining cybersecurity protocols to ensure that the network is safe

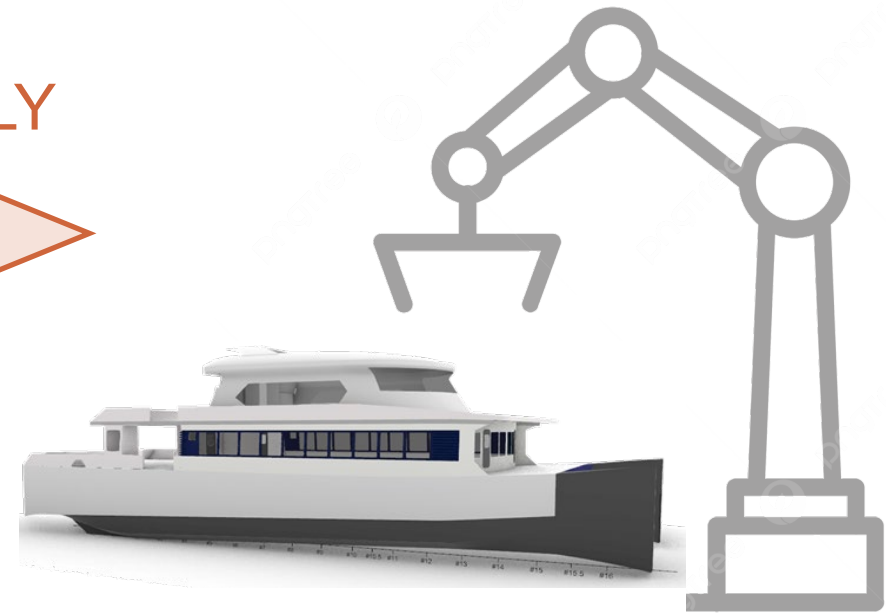


Design and engineering

- To reach full potential of the new production methods developed, these must be incorporated in the ship design process

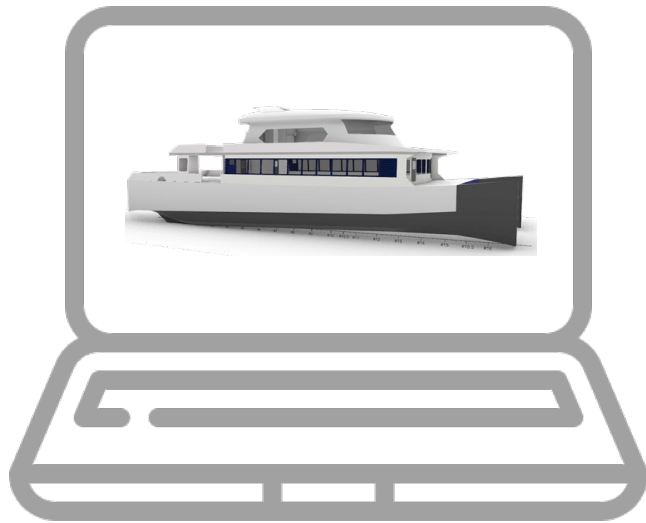


TRADITIONALLY

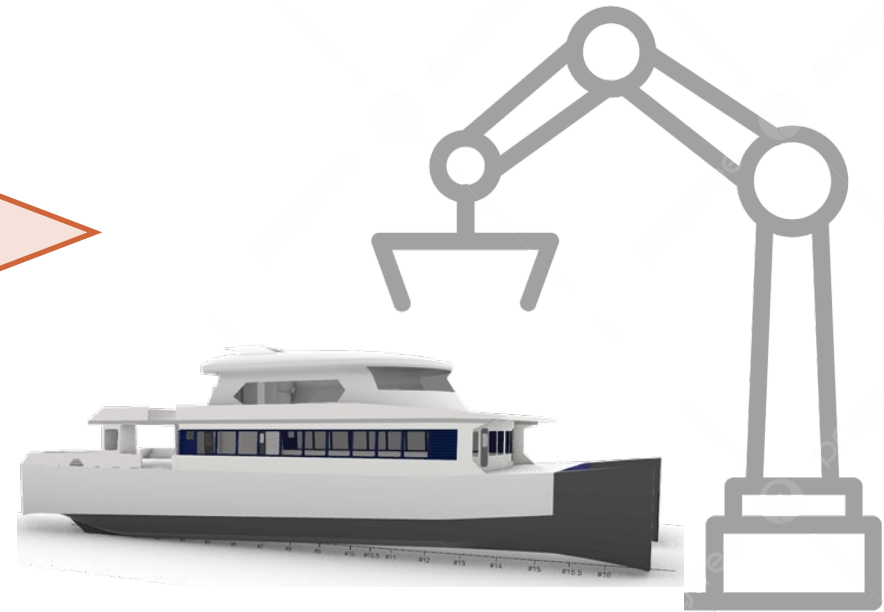


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NEW REQUIRED
APPROACH



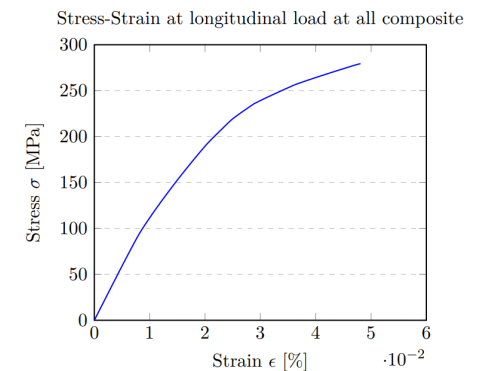
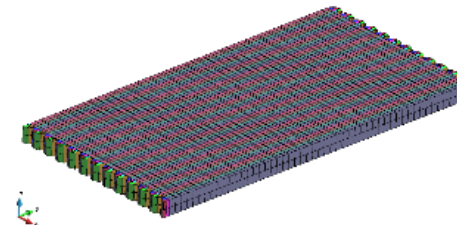
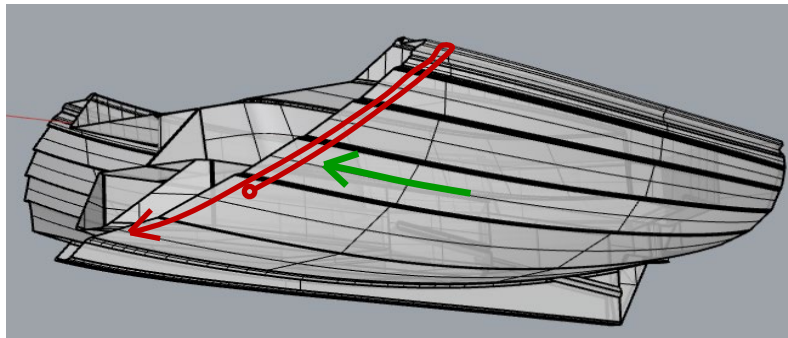
Design and engineering

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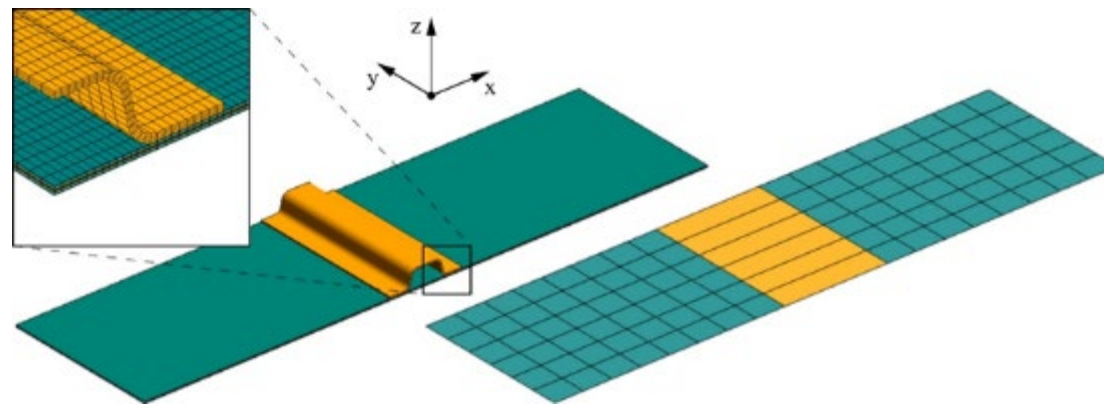
Failure criteria for 3d printed materials that takes into account the anisotropy produced by the printing direction



Design and engineering

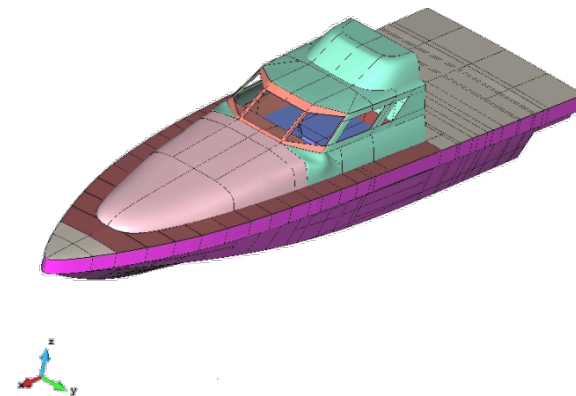
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Incorporation of stiffness and strength of connection members or stiffeners in the shell formulation

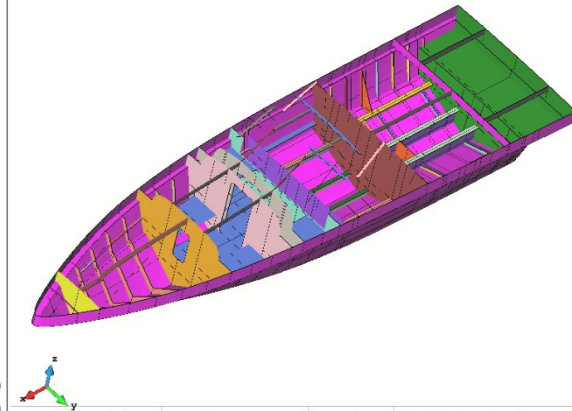


Design and engineering

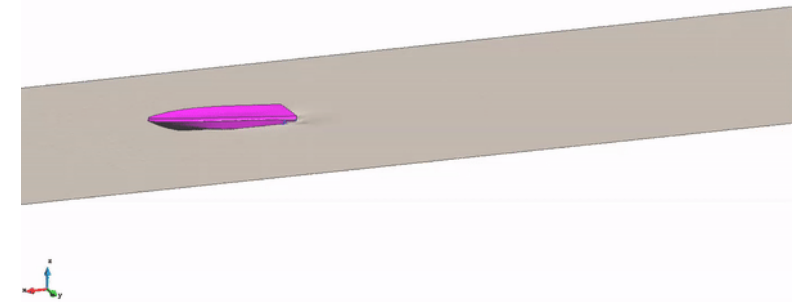
- All these new analysis models have been incorporated in a FEM analysis software and two ships are being design to show its full potential



- HL1 (2)
- HL2 (2)
- HL3 (2)
- HL4 (2)
- HL5 (0)
- HL6 (0)
- HL7 (2)
- HL8 (2)
- HL9 (4)
- HL10 (2)
- HL11 (4)
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- HL13 (8)
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- HL15 (2)
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- HL16 (0)
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- HL19 (28)
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- HTs_1_4 (40)
- HTs_5_6 (16)
- HTs_14_15 (10)
- HULL_P110_fondo (480)
- P112_nucleo_15mm (30)
- P112_nucleo_20mm (10)
- P112_nucleo_35mm (4)
- P112_nucleo_40mm (42)
- P114_cabin_horizontal (24)
- P114_cabin_vertical (16)
- P115_interiores_habit (38)
- STERN_P110_espejo (30)



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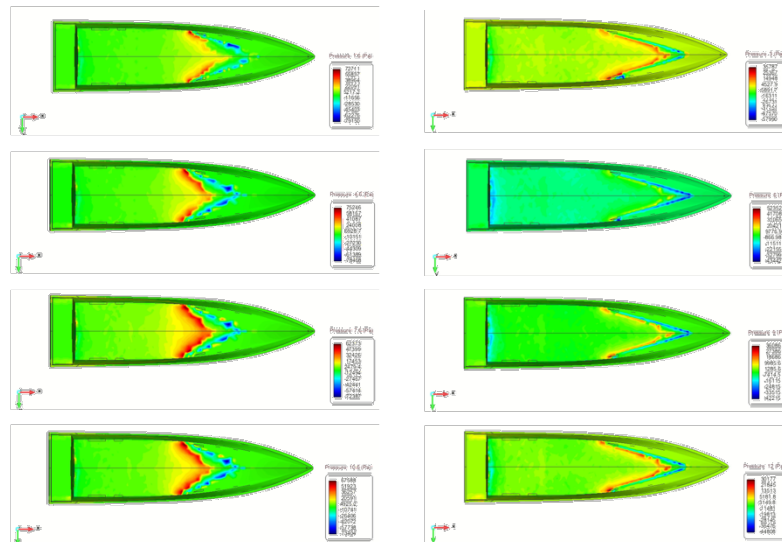


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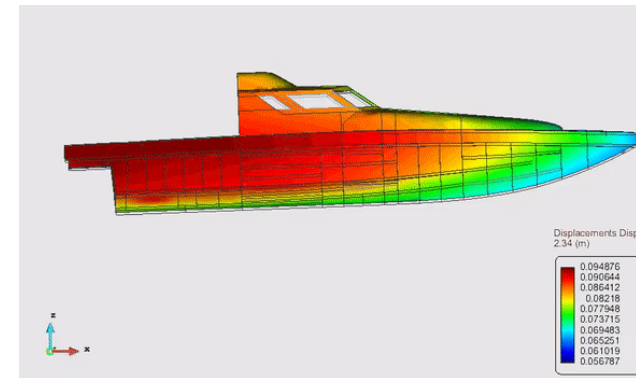
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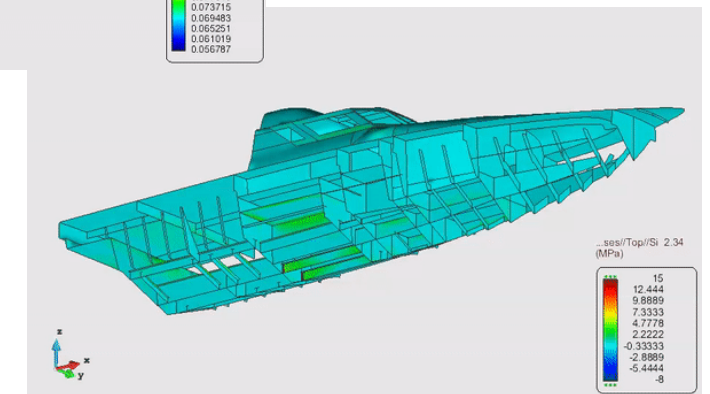
Evolution of hydrodynamic pressures in the hull



Displacements



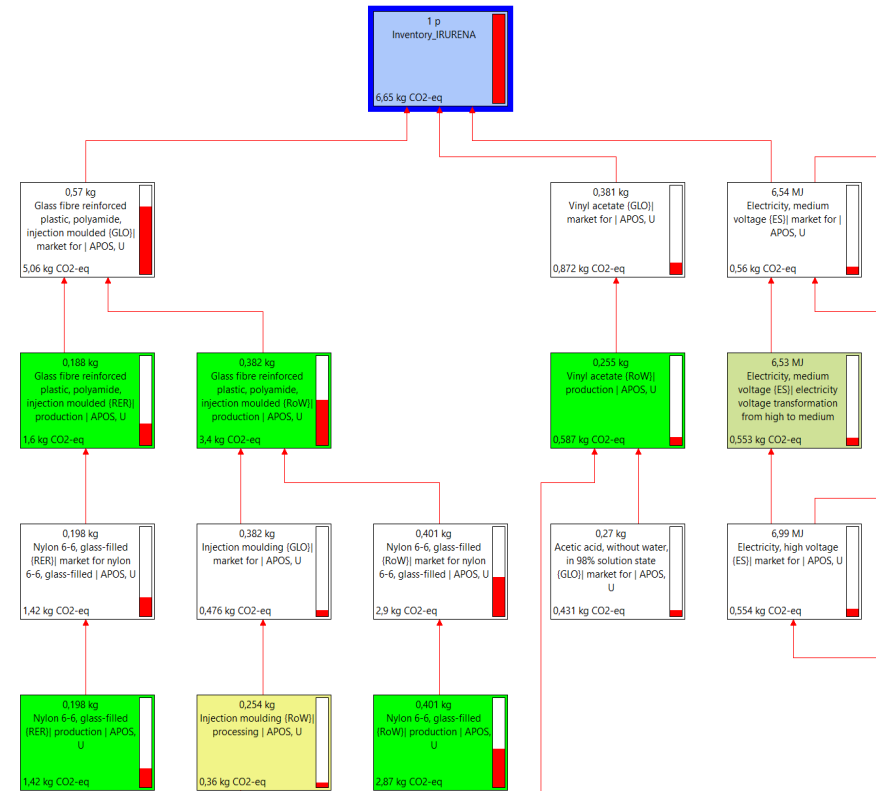
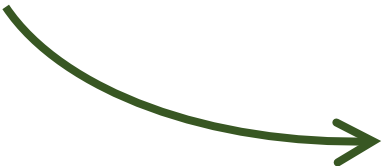
Stresses



Environmental assessment

- **We, ALL, must build ships taking into account their environmental impact:**
During production, in service and when the ship reaches its end life
- We have conducted a Life Cycle Assessment (LCA) of all new production methods developed in FIBRE4YARDS

Contribution of individual materials used to manufacture a curved pultruded profile in CO2 emission equivalent



Environmental assessment

- First results of the LCA analysis have shown that materials are the main contributors of the CO2 equivalent emission
- A responsible selection of the manufacturing material can lead to a major reduction on the environmental impact of the ship component
- The optimization and efficiency improvement of production methods can also help to minimize the impact of shipbuilding

Business Plan

- In FIBRE4YARDS we have defined different business models and plans for the different technologies developed. From production methods, to software development.
- All technologies and developments of the project have one or several business models associated, which proves that they do have possibilities to be merged into the industrial network
- Right now we are conducting a cost benefit analysis study to evaluate the advantages provided by the technologies proposed in FIBRE4YARDS

SUMMARY

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USING AUTOMATED PROCESSES

IN A DIGITALIZED SHIPYARD

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USING AUTOMATED PROCESSES
IN A DIGITALIZED SHIPYARD**

With this approach, we will

**IMPROVE QUALITY
BUILD MORE SUSTAINABLE SHIPS
REDUCE COSTS**

Having defined the framework, we have to continue working, enthusiastically, to reach this goal



THANKS FOR YOUR ATTENTION

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