Novel technologies to boost the shipyard industry

FIBRE4YARDS
SHIPYARD FOR THE FUTURE

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:

FIBRE4YARDS SHIPYARD FOR THE FUTURE

RESURGAM

MARI4YARD
MARI4ALLIANCE

30th and 31st May 2023, RTD Innovation Dock, Rotterdam

These projects have received funding from the European Union's Horizon 2020 research and innovation programme under grant agreements n° 101006860 (FIBRE4YARDS), n° 101007005 (RESURGAM), and n° 101006798 (Mari4_YARD).

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Novel technologies to boost the shipyard industry

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BUILDING FIBRE REINFORCED POLYMER SHIPS

AUTOMATIZATION PROCESSES
MODULAR CONSTRUCTION
DIGITALIZATION

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Context

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

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

FIBREYARDS SHIPYARD FOR THE FUTURE

Context

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

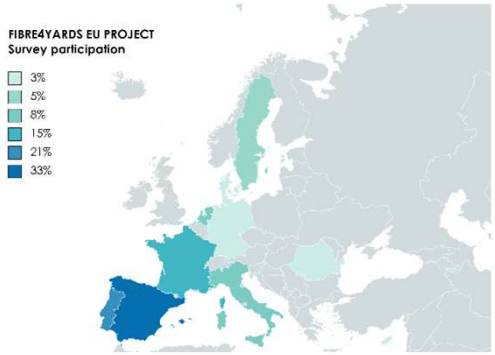
Some of the reasons that we have heard to explain this reasoning are:

- 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
- (…)

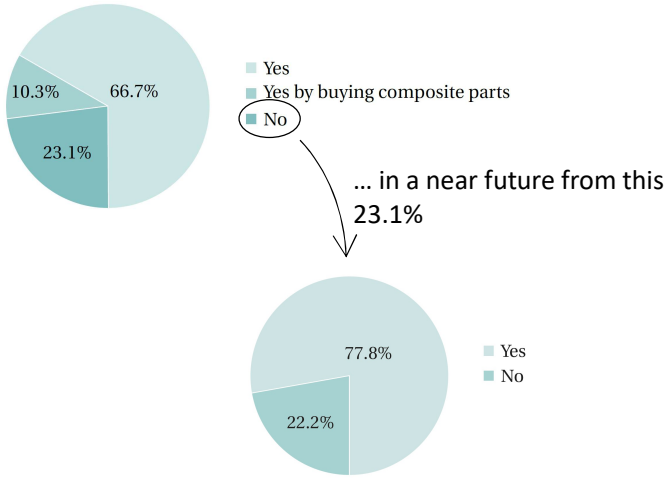
Context

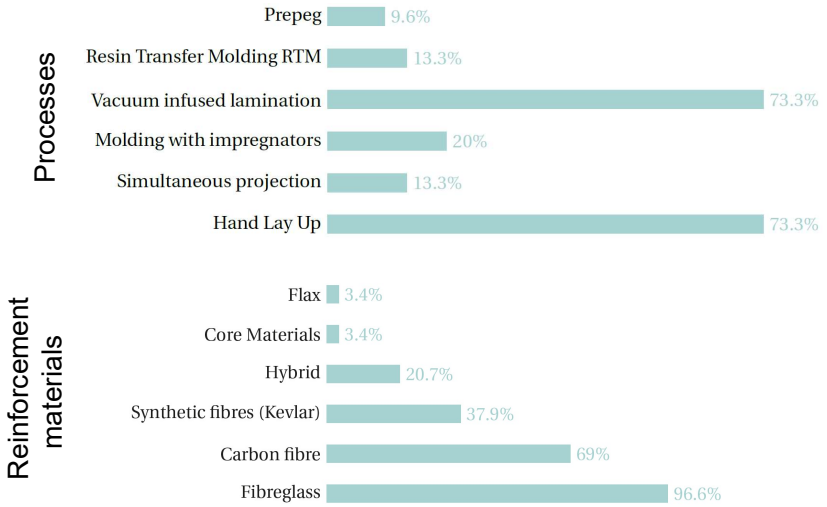
To assess this context, we have conducted a survey among EU shipyards

In this survey, we have find out:



Use of composites:

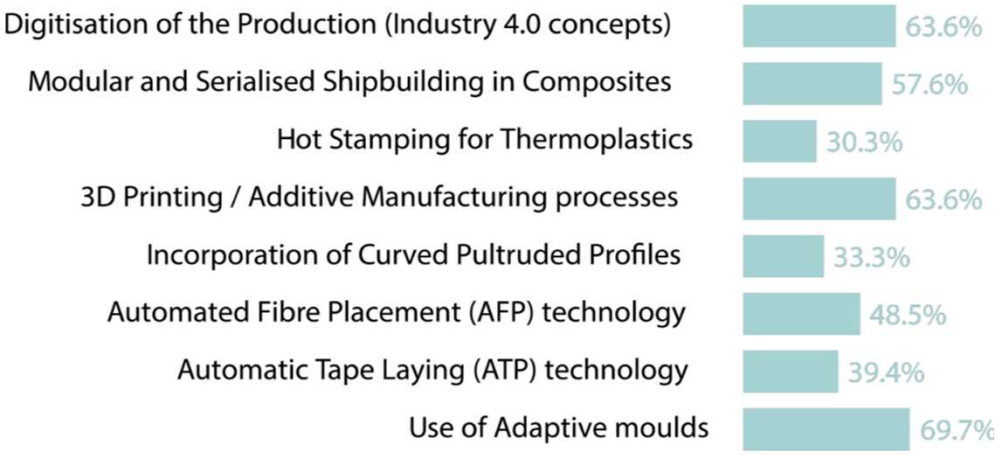




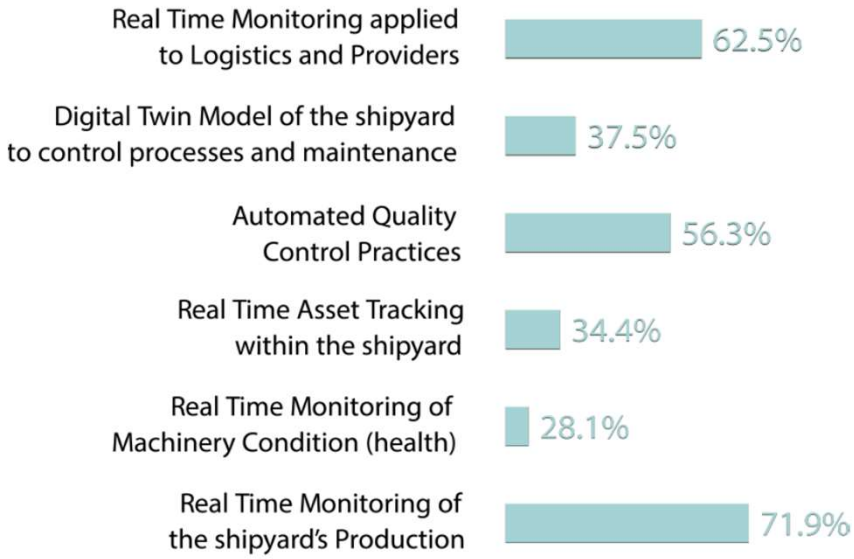
Context

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



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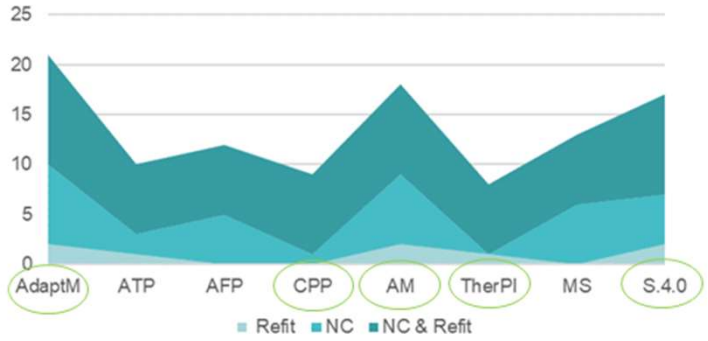
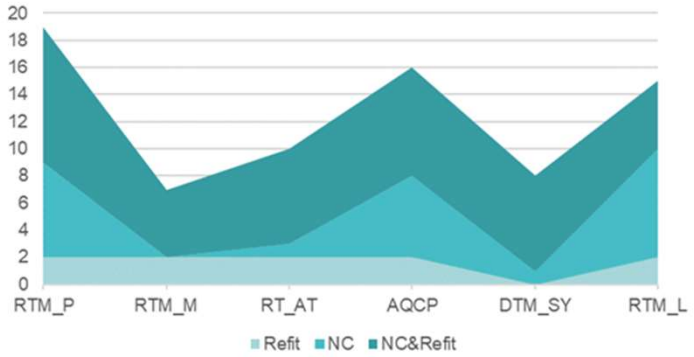


AdapM: AdaptiveMolds
ATP: Automatic Tape Placement
AFP: Automated Fibre Placement
CCP: Curved Pultruded Profiles
AM: Additive Manufacturing
ThermPl: Hot Stamping of Thermoplastics
MS: Modular and Serialized Shipbuilding
S.4.0: Digitalization of the production

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

FIBRE4YARDS SHIPYARD FOR THE FUTURE

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

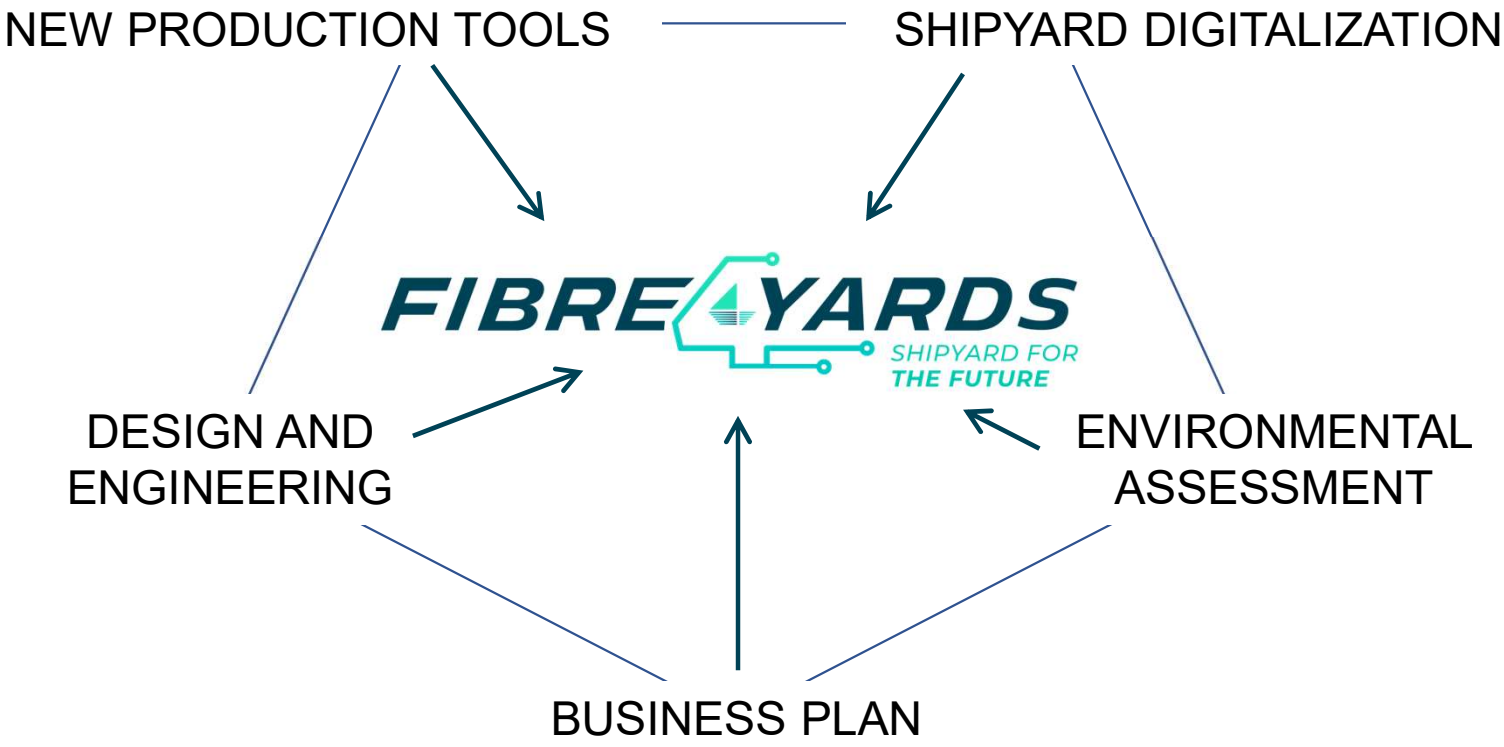
FIBRE4YARDS SHIPYARD FOR THE FUTURE

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 TOOLS
SHIPYARD DIGITALIZATION
FIBRE4YARDS
SHIPYARD FOR THE FUTURE
DESIGN AND ENGINEERING
ENVIRONMENTAL ASSESSMENT
BUSINESS PLAN

New production technologies

The new production technologies developed at FIBRE4YARDS will be

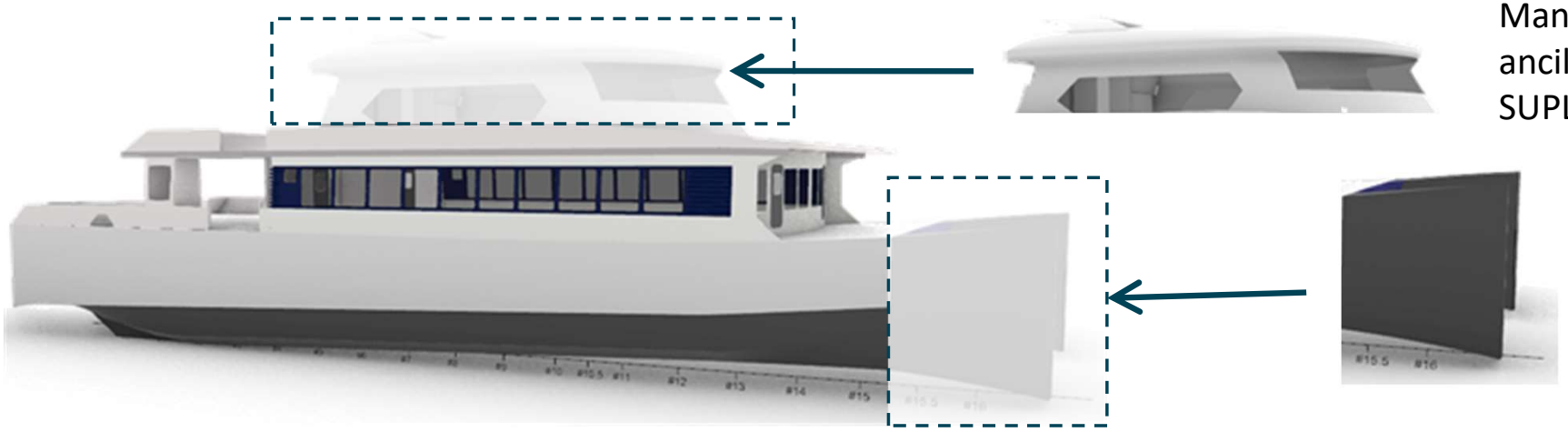
- Developed specifically for FIBRE4YARDS
- Adapted to the shipyard from other industrial sectors
- **MUST allow a modular construction**

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.



Manufactured by ancillary industries: SUPLIERS

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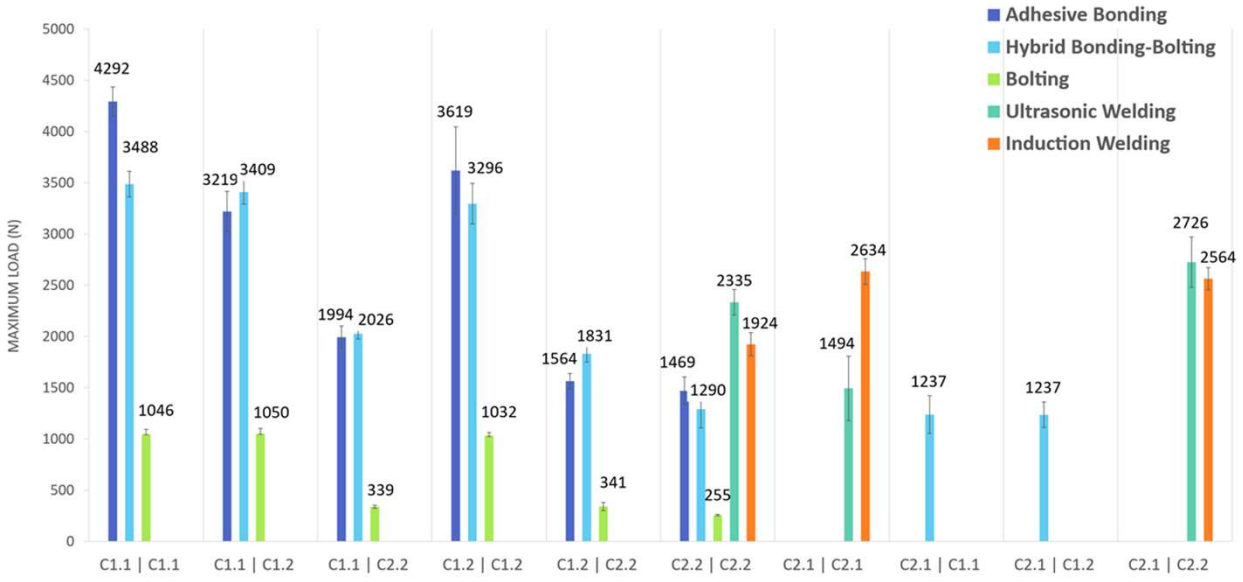
New production technologies: Modular construction

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

FIBRE4YARDS SHIPYARD FOR THE FUTURE

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
  - (…)

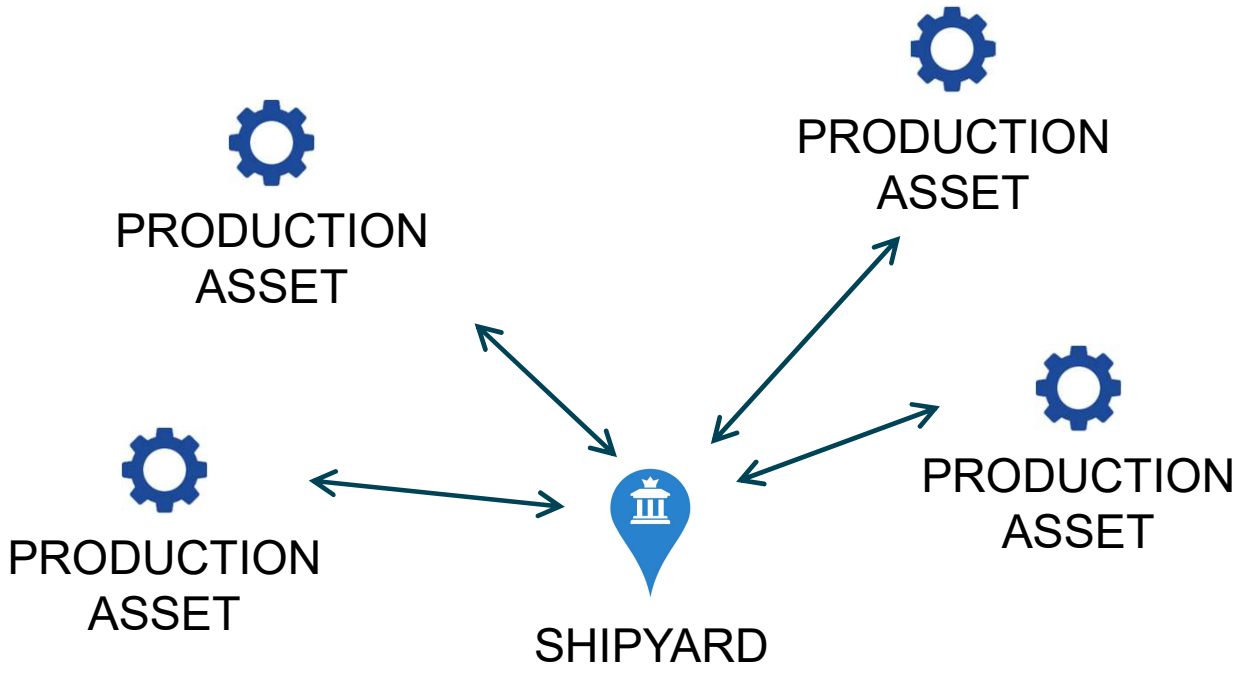
Shipyard digitalization

- All this data feeds the SHIPYARD DIGITAL TWIN

SHIPYARD

Shipyard digitalization

- All this data will feed the SHIPYARD DIGITAL TWIN



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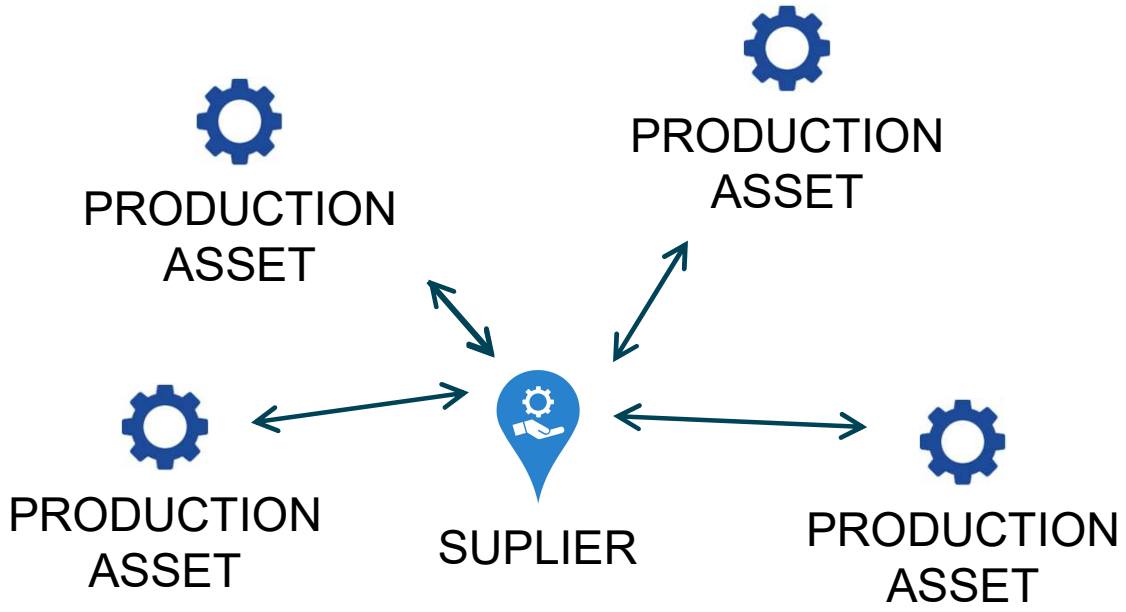

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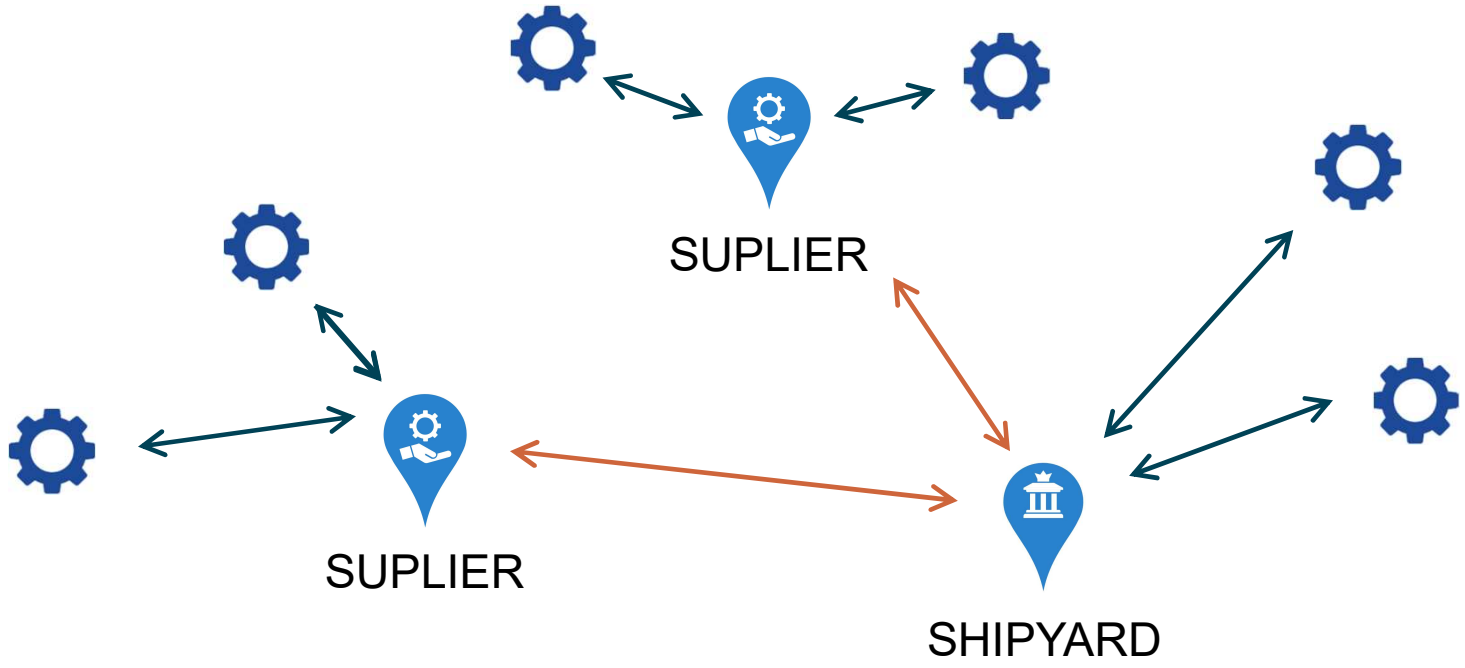

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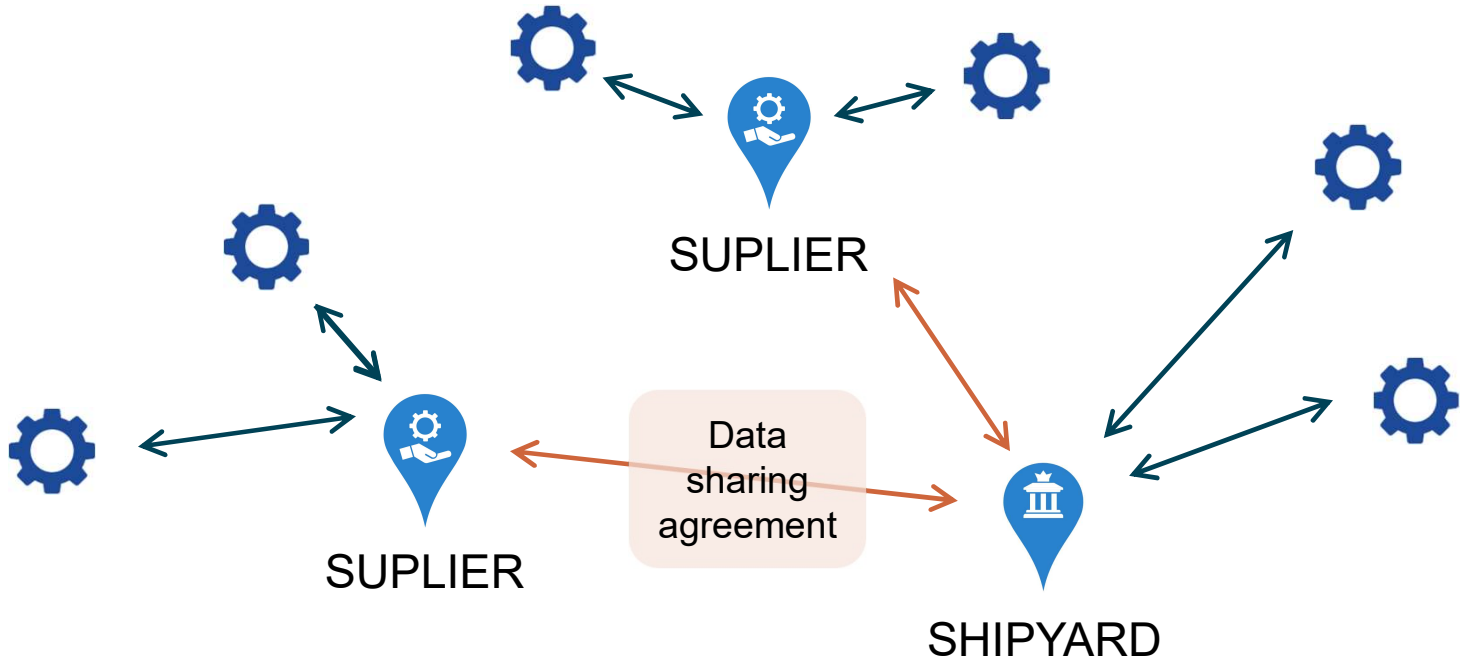
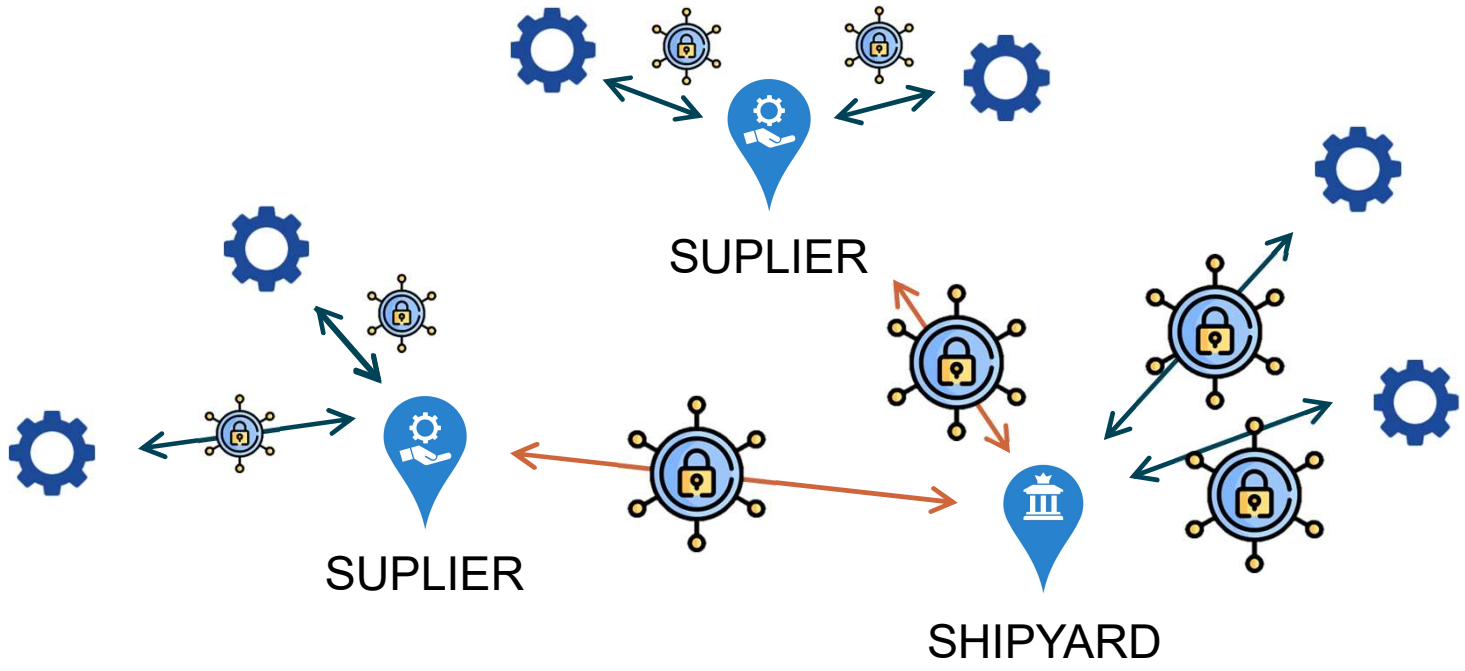


Shipyard digitalization - CYBERSECURITY

- 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

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FIBRE4YARDS SHIPYARD FOR THE FUTURE

Design and engineering

- This has been done by developing new formulations and numerical procedures that take into account the performance of the structure based on the production method.
- These new formulations have been incorporated in software design tools

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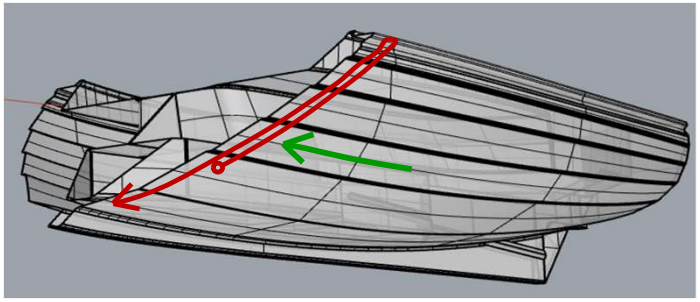
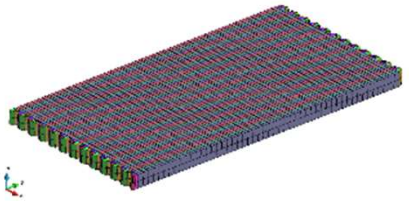
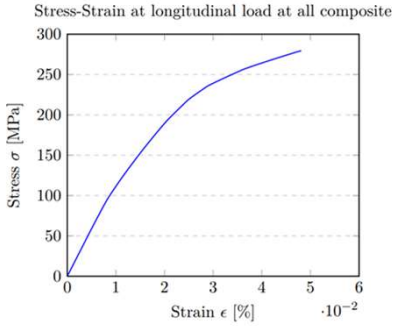
Failure criteria for 3d printed materials that takes into account the anisotropy produced by the printing direction







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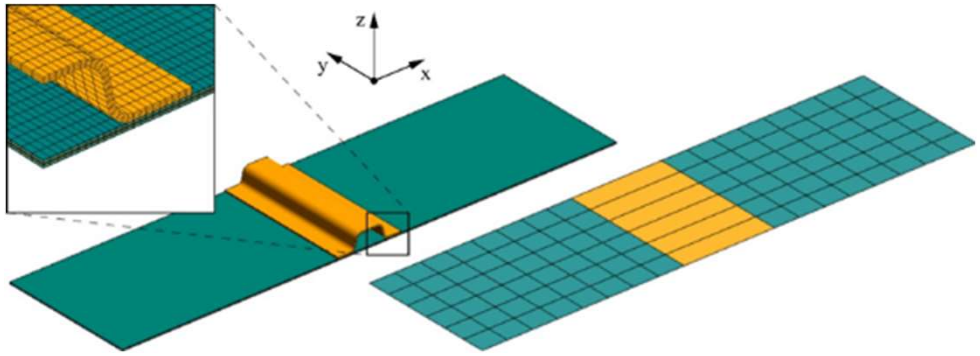
Incorporation of stiffness and strength of connection members or stiffeners in the shell formulation

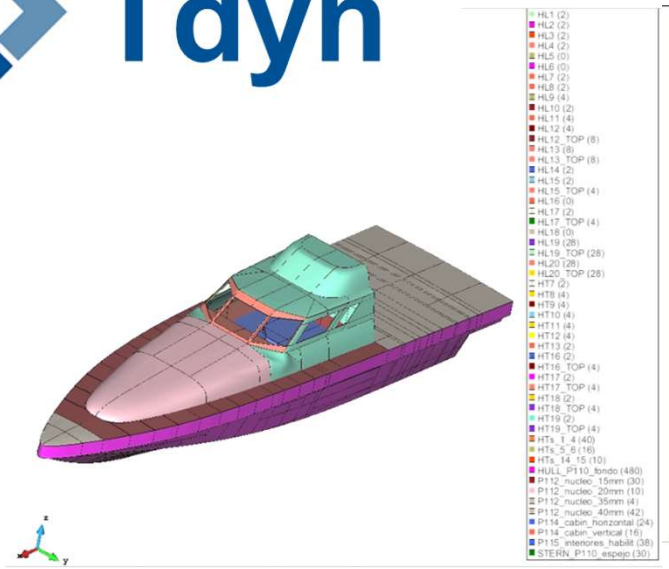


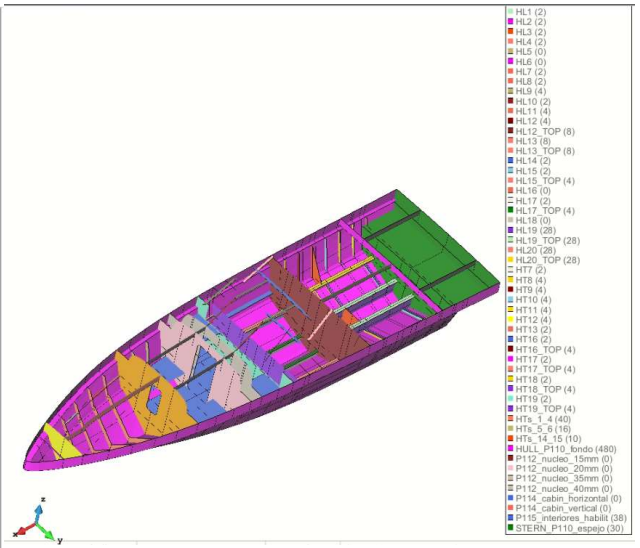
FIBREYARDS SHIPYARD FOR THE FUTURE

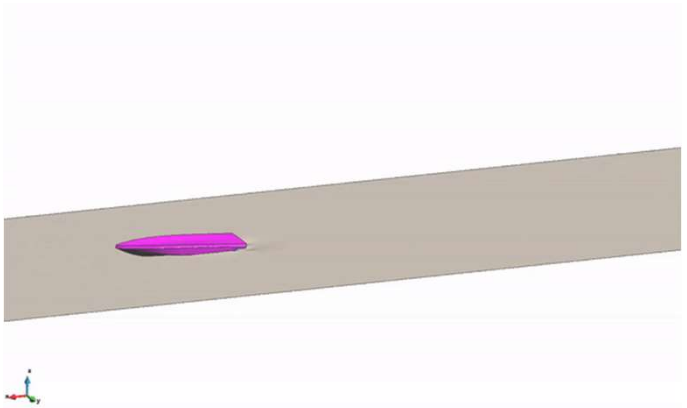
Design and engineering

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

Tdyn







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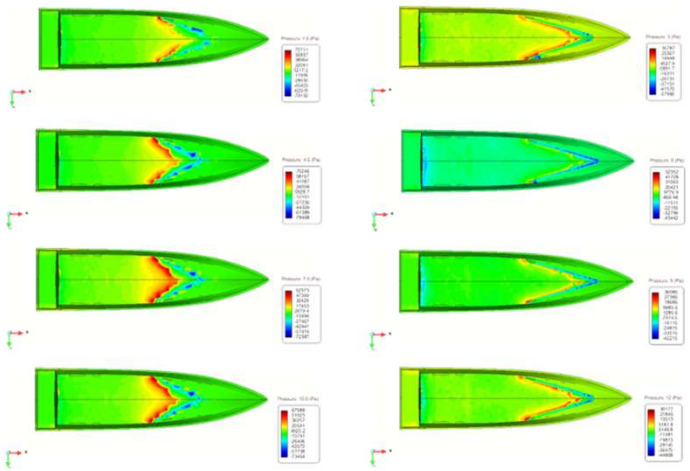
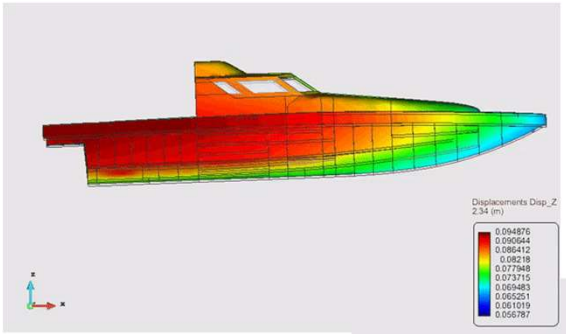
Tdyn

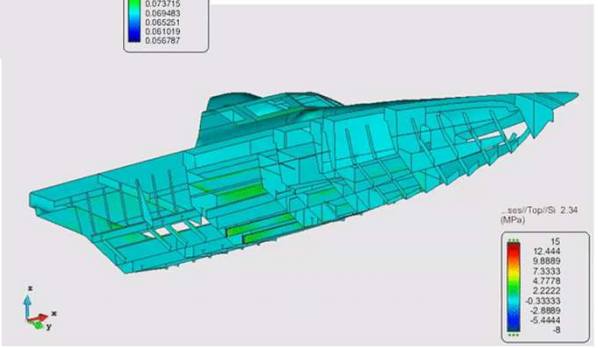
Evolution of hydrodynamic pressures in the hull



Displacements



Stresses



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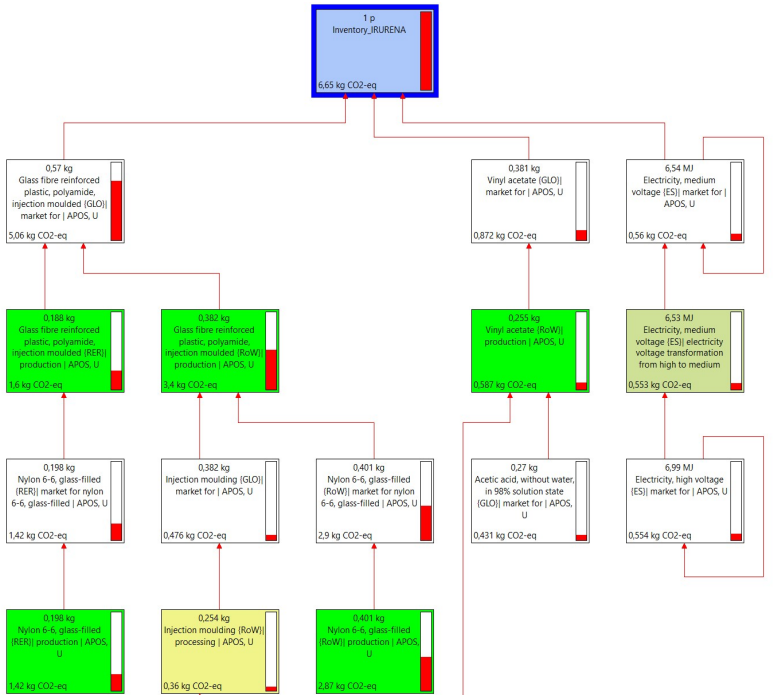
Environmental assessment

- **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



FIBRE4YARDS SHIPYARD FOR THE FUTURE

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 the 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

We do believe that it is possible to build ships with

- **A MODULAR CONSTRUCTION**
- **USING AUTOMATED PROCESSES**
- **IN A DIGITALIZED SHIPYARD**

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SUMMARY

We do believe that it is possible to build ships with

- **A MODULAR CONSTRUCTION**
- **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

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SHIPYARD FOR THE FUTURE

THANKS FOR YOUR ATTENTION

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