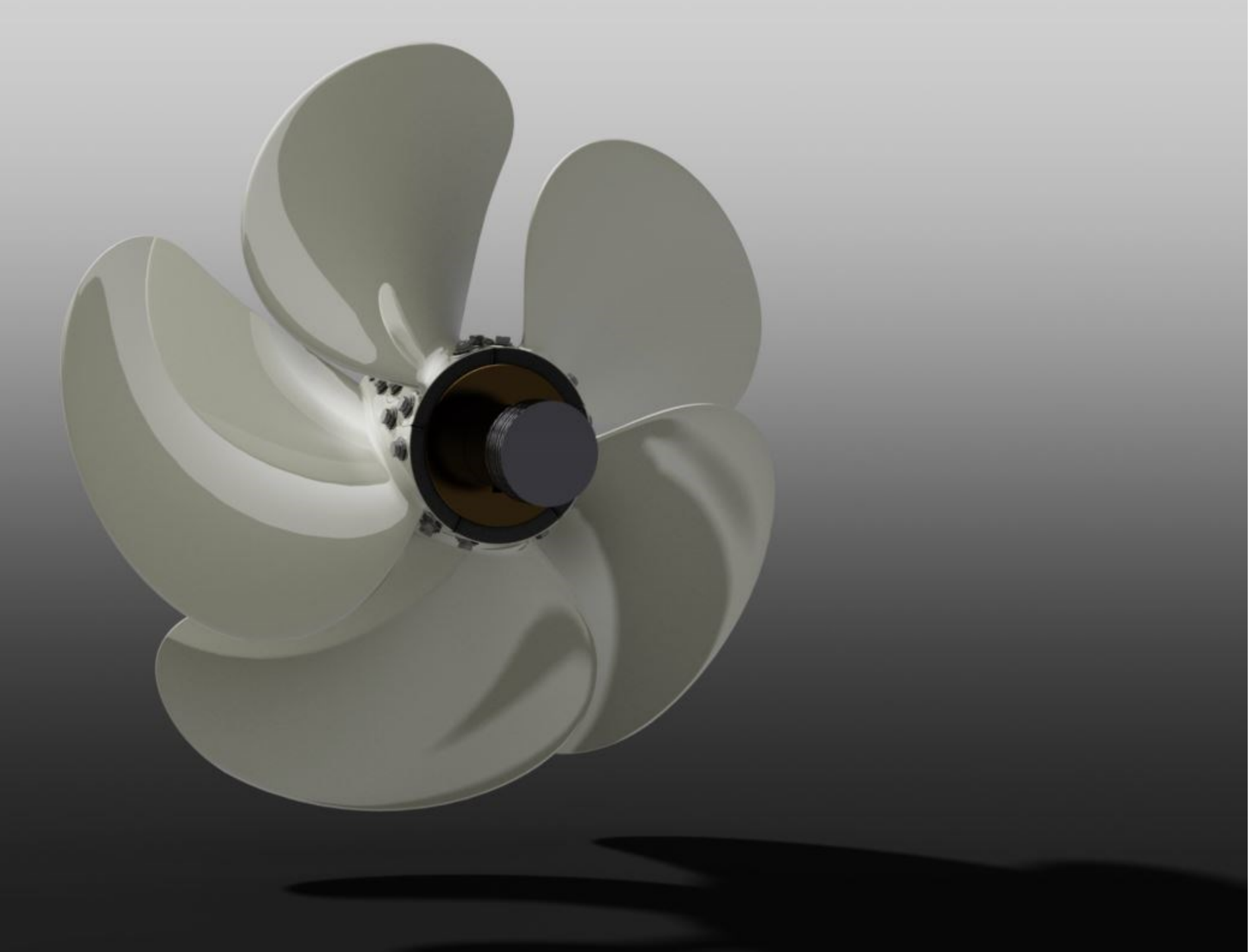


FABHELI

E-Lass Seminar Day
PORNICHET - 26/06/2018

Samuel DURAND,

CEO of the Innovative Design Office MECA

Pol MULLER

Head of Naval Platform Modelling department

SIREHNA – Naval Group

FABHELI

THE FILM (link)

ACTORS

PARTNERS

LOIRETECH (Leader)

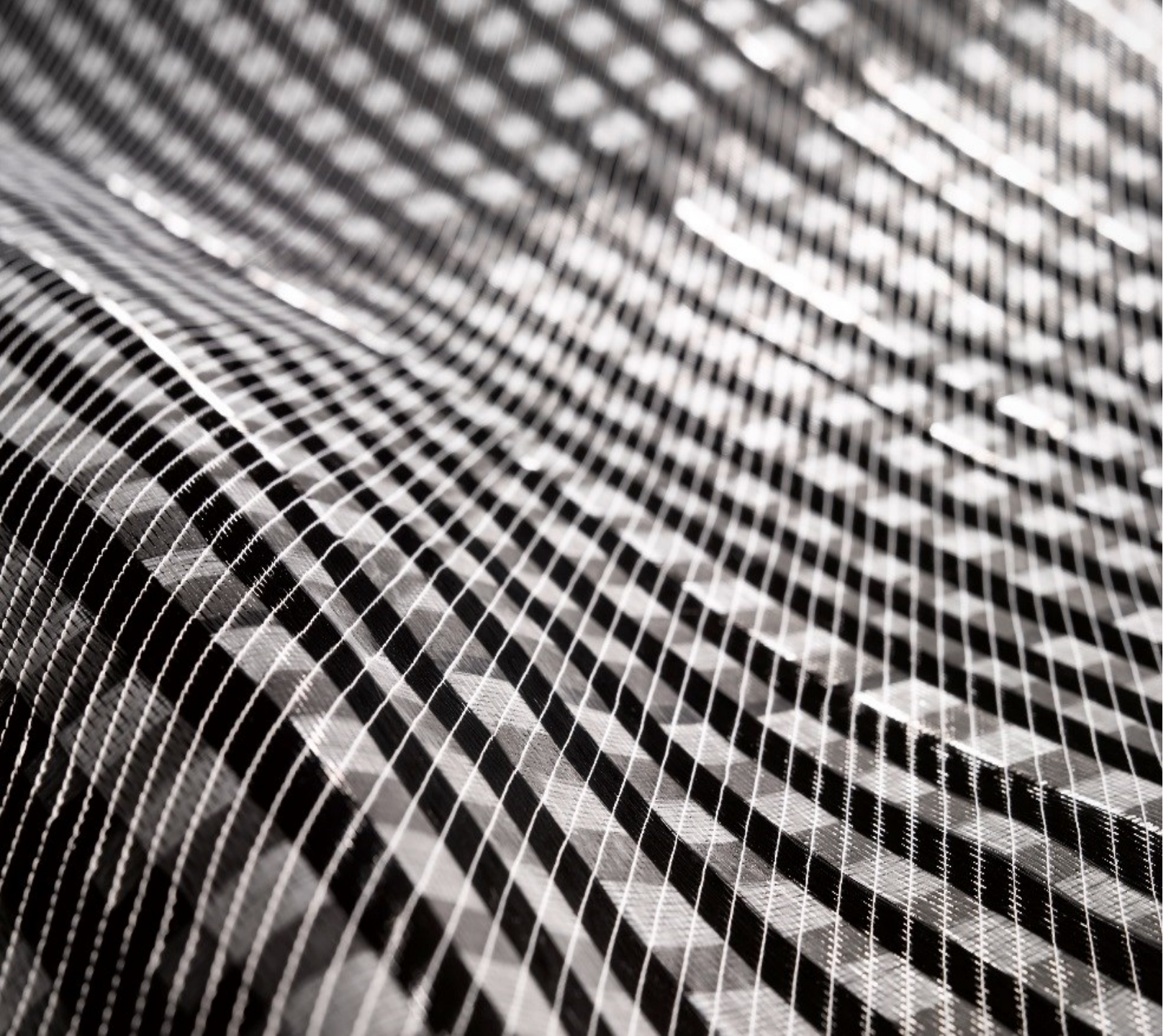
MECA

NAVAL GROUP

CONTRIBUTORS

Bureau Veritas

AML



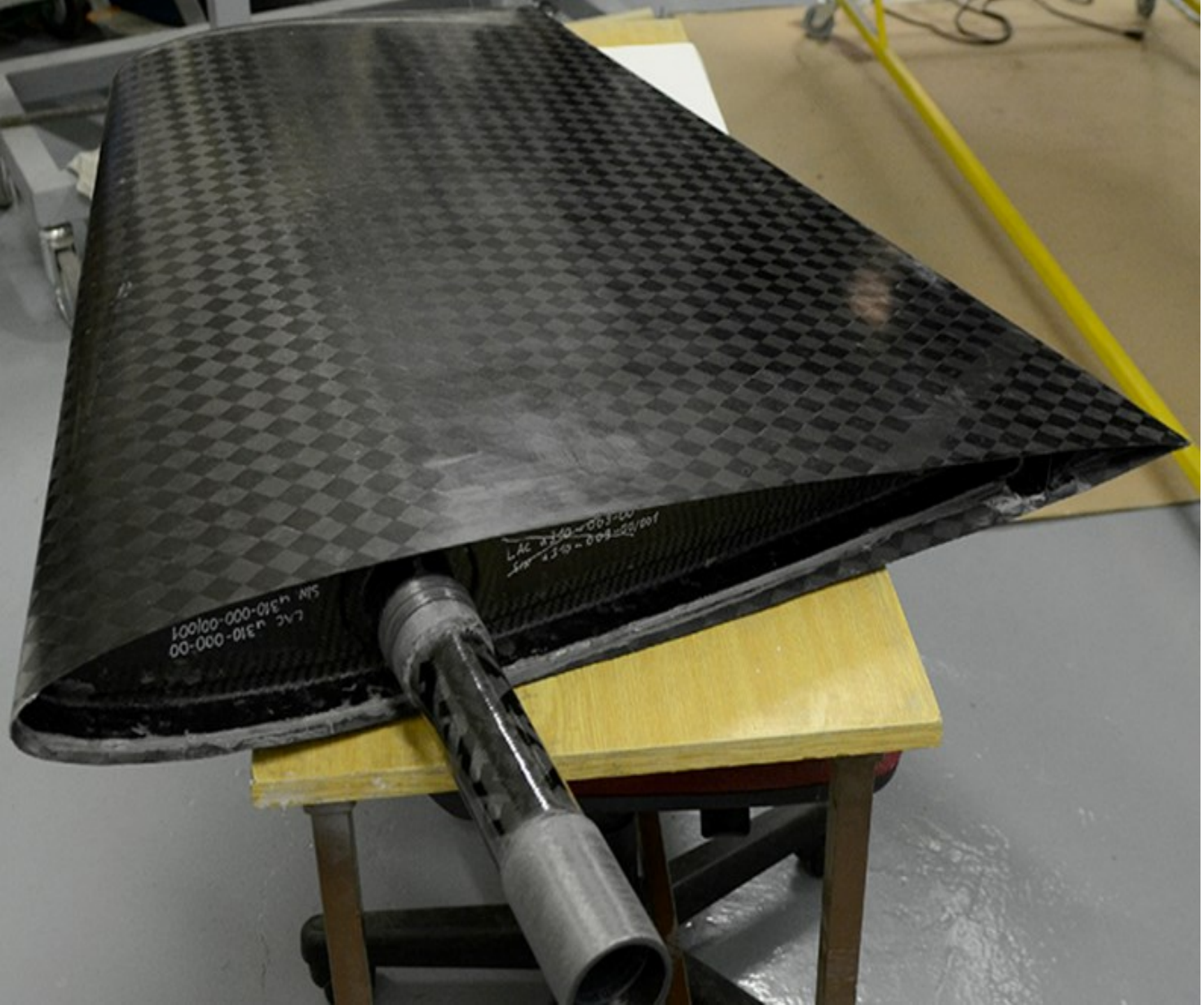
COMPOSITE MATERIALS ?

mélange de fibres ou renforts et de résine

polymérisation de la résine

densité faible

procédé de fabrication utilisant un outillage ou moule



GENESIS

Composite propellers or composite blades are classically manufactured using pre-preg technology.

- High cost,

- Weakness of the junction between profiles

THE PROJECT

Collaborative Research Program - DGA Rapid

Objectives :

To design,

To manufacture in an industrial way,

And to test in real conditions,

A propeller made of composite materials.

A SHORT TIME

KOM
04/16

End of specifications
10/16

Draft
mock-up
01/17

Mock-up and foils
manuf. 06/17

Tests
prototype
10/17

12/17

Pool test
01/18

03/18

End Project
04/18

2016

2017

2018

Design and
certification methods
09/16

Material
Samples
01/17

Optimized
propeller
design
03/17

12/17

Tooling
manuf.
10/17

Propeller manuf.
11/17

02/18

Sea trials
03/18

STRONG OBJECTIVES

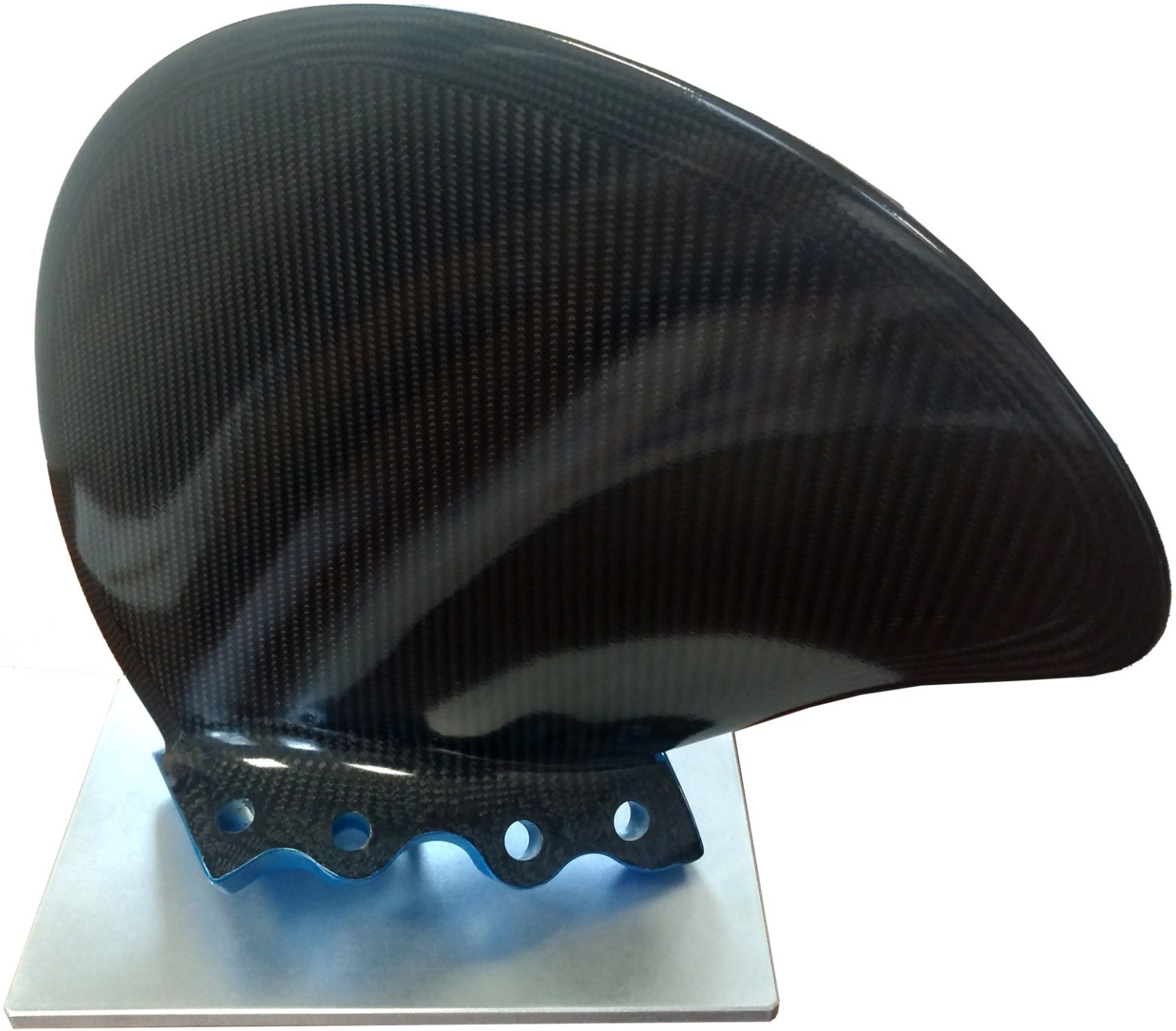
To replace a metallical propeller on a twin-propeller vessel

Diameter 1.1m

the PALAIS, a passenger ship 30 meters long and 84 tons with two engines of 1100 hp

To design removable propellers

NAVIX
La compagnie des îles et du golfe du Morbihan



LOCKS

Main

Development of the RTM manufacturing process,

Make "one shot" blades, without finishing operations,

Control of composite propeller costs,

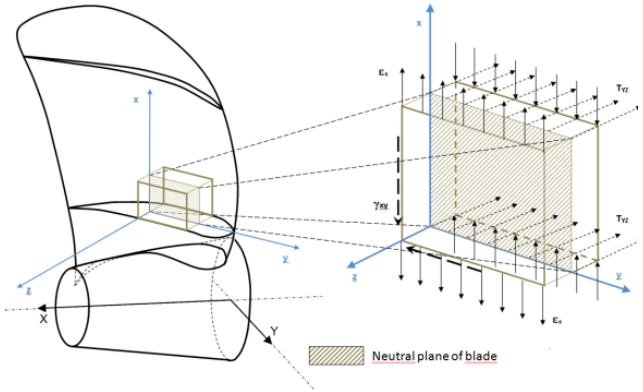
Robust blade / hub connection,

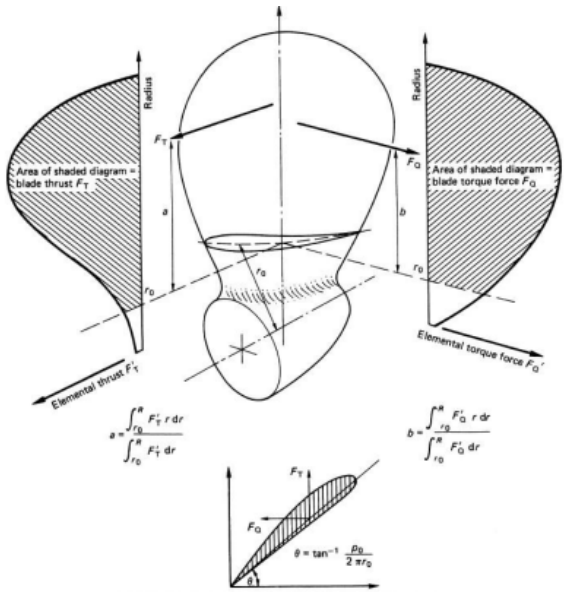
Impact performance at the leading edge,

Propeller performance,

Normative framework or rules to build,

RULES OR STANDARDS

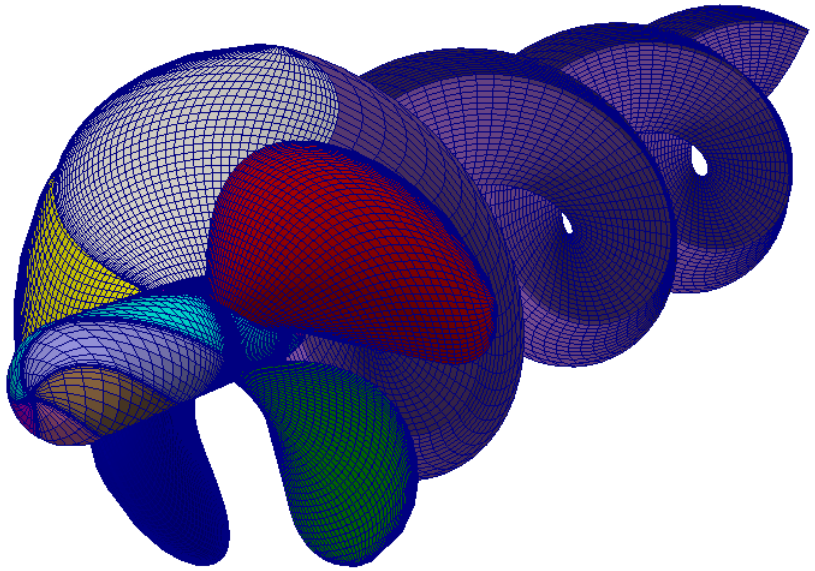




The partners called on Bureau Veritas, which oversaw the design of the propeller, preparing for future certification.

Fundamental work to go back to the origin of the dimensioning of the metal propellers, then to apply it to the composite propeller.

FLUID-STRUCTURE COUPLING



Development of an automated fluid structure coupling

Flow solver PROCAL 2.309

- 3D Boundary Element Method (BEM) based on potential flow theory
- blades, hub and blade wakes are meshed using quadrilateral panels

Structure solver ABAQUS 6.13 distributed by "Dassault Systèmes".

STRUCTURE SOLVER

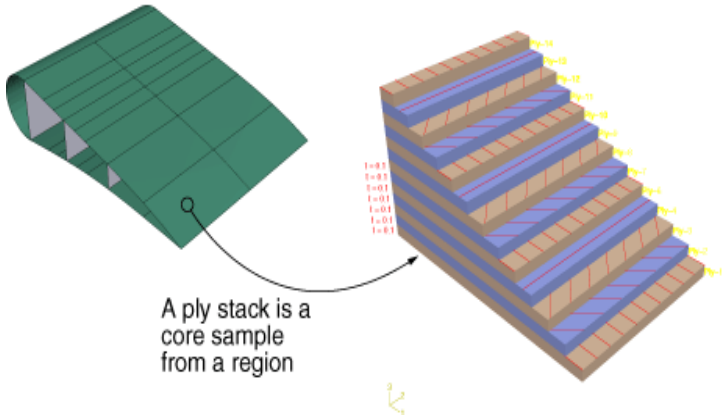
Type of elements

Volume elements	Thick shells	Shells
☺ High order elements ☺ Accurate representation of the geometry (structure and shape) ☹ Elements must have the same thickness as the plies ⇒ too small	☺ Low computer resources needed ☺ Accurate representation of the geometry ☹ Adapt the description of the ply stack for each element	☺ Low computer resources needed ☺ Accurate description of the ply stack (specific to ABAQUS) ☹ Loss of accuracy of the outer shape
Meshing and computing issues	Ply description issue	Pressure and displacement transfer issues

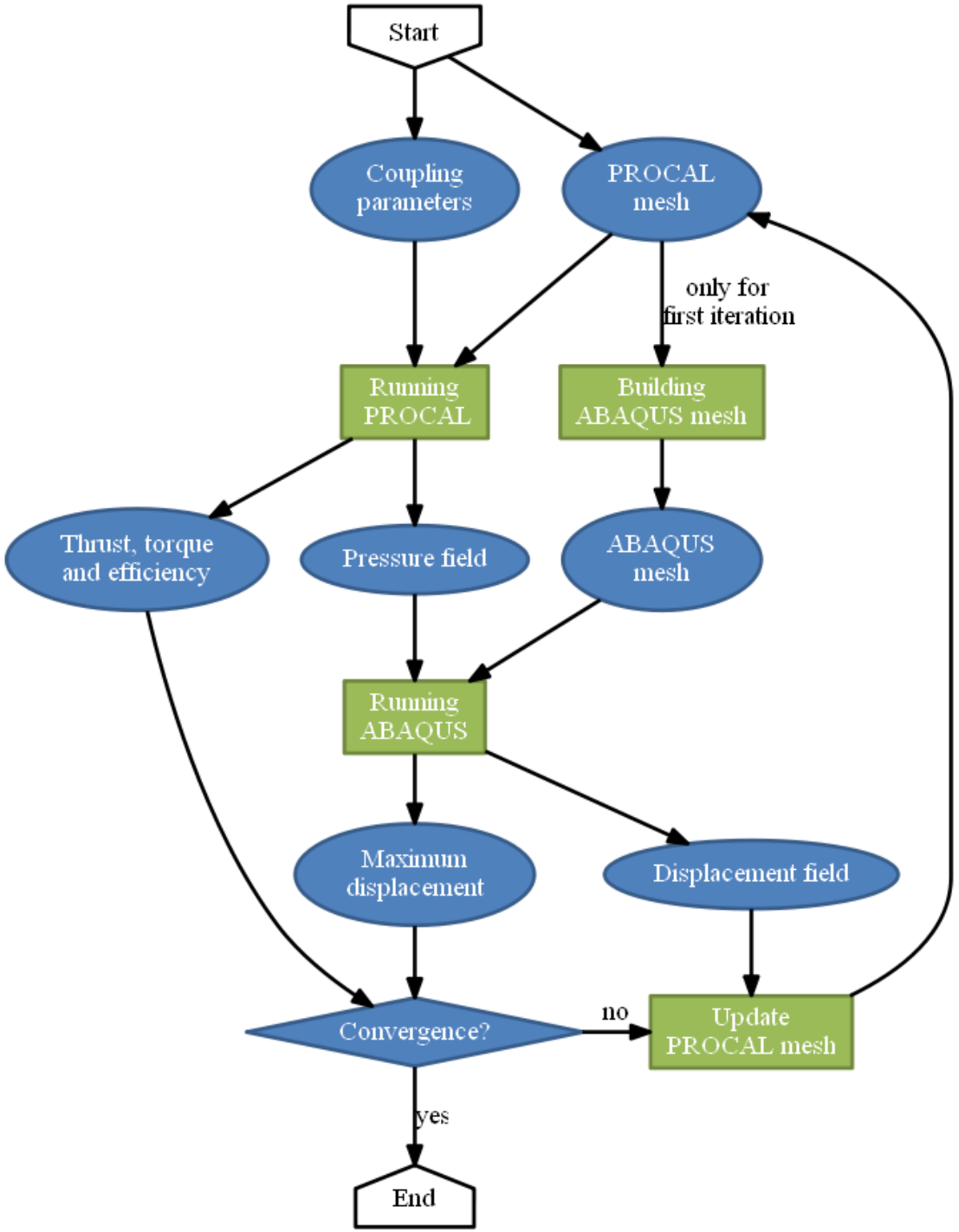
These issues can be tackled with variable difficulty level

The ply description issue can be solved and automated easily

Thick shell elements have been chosen



COUPLING ALGORITHM



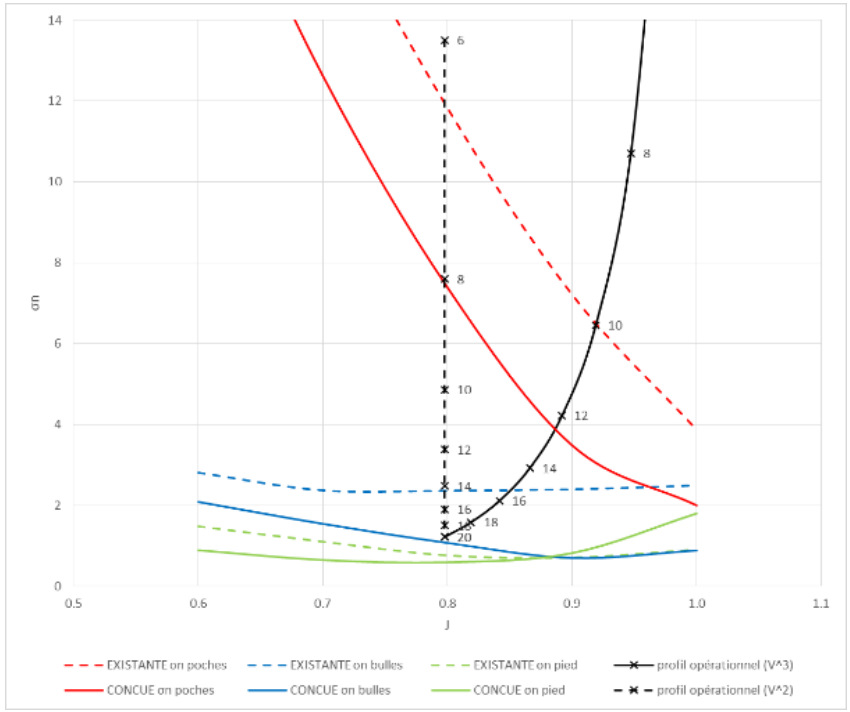
Based on iterations overs pressure and displacements until convergence

To prevent interpolations: the surface mesh is the same for the structure and flow solver

PERFORMANCE

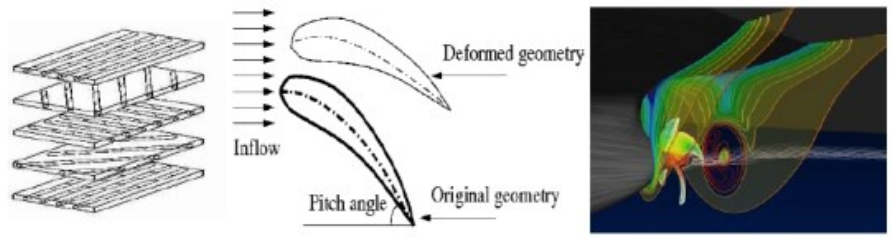
Résultats à 20 nœuds

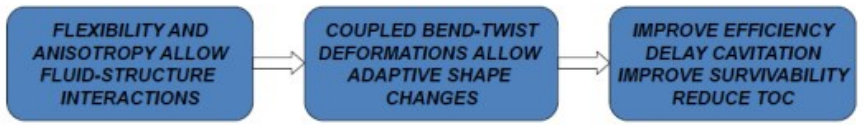
Grandeur	Unité	Hélice existante	Hélice conçue	Variation
Vitesse de rotation	RPM	731.1	730.1	-0.1%
Puissance au frein	kW	969.0	934.1	-3.6%
Puissance délivrée	kW	741.3	714.6	-3.6%
Couple	kN.m	9.7	9.4	-3.4%
$10K_Q$	-	0.4037	0.3912	-3.1%
J_0	-	0.796	0.798	+0.1%
K_T	-	0.2054	0.2049	-0.3%
Poussée	kN	45.0	45.0	-
J_S	-	0.771	0.772	+0.1%
Rendement	-	0.645	0.665	+3.1%



À 20 nœuds, l'hélice conçue est plus performante que l'hélice existante sur le plan du rendement et de la cavitation (réduction du risque de cavitation).

L'hélice composite est plus flexible, ce qui peut être mis à profit pour améliorer son rendement (variation de pas avec la déformation).





LEADING EDGES

Reinforcement of the leading edges to improve the resistance to impact without complicating the manufacturing process.

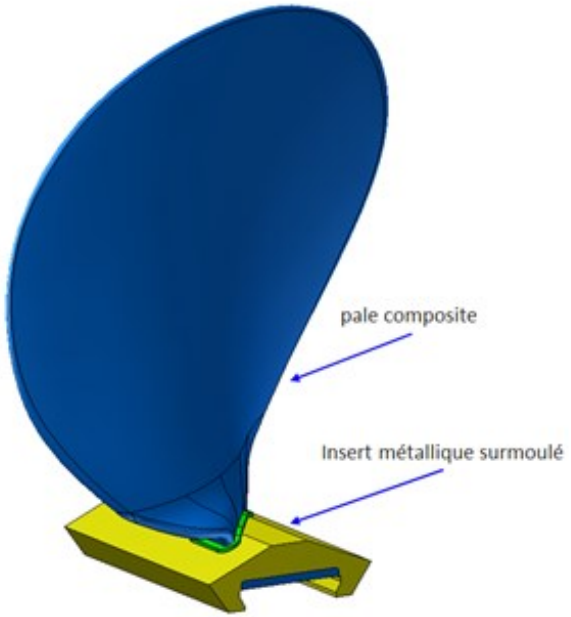
COATING

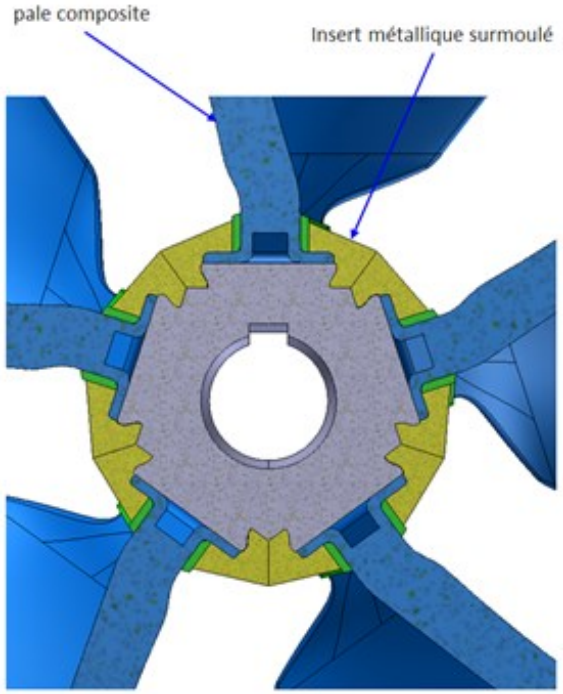
Application of a coating

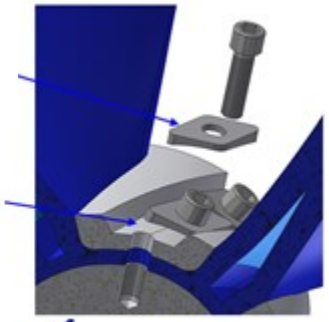
Improved hydrodynamic performance

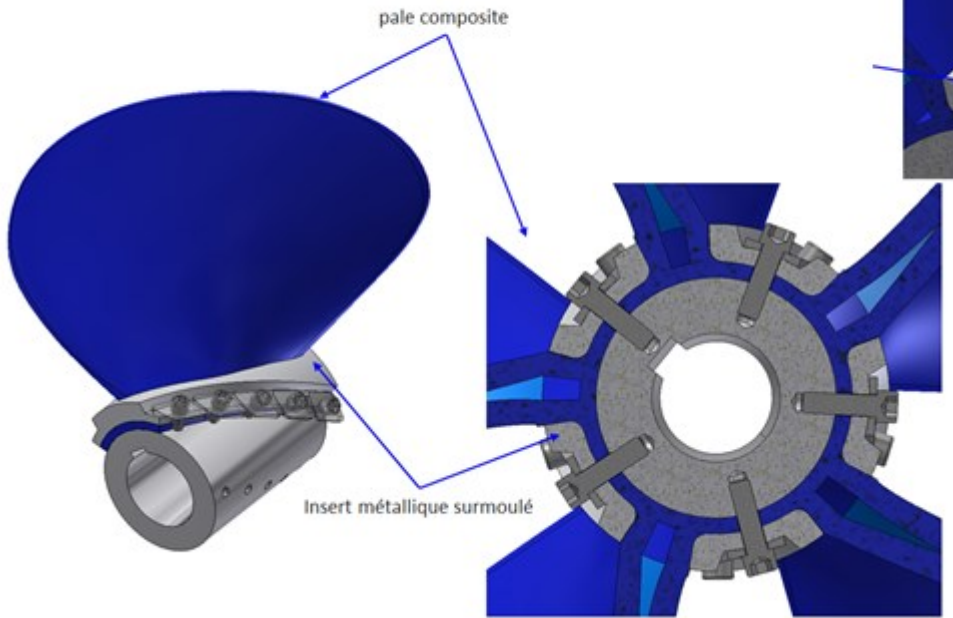
Improvement of resistance to cavitation

BLADE/HUB JUNCTION









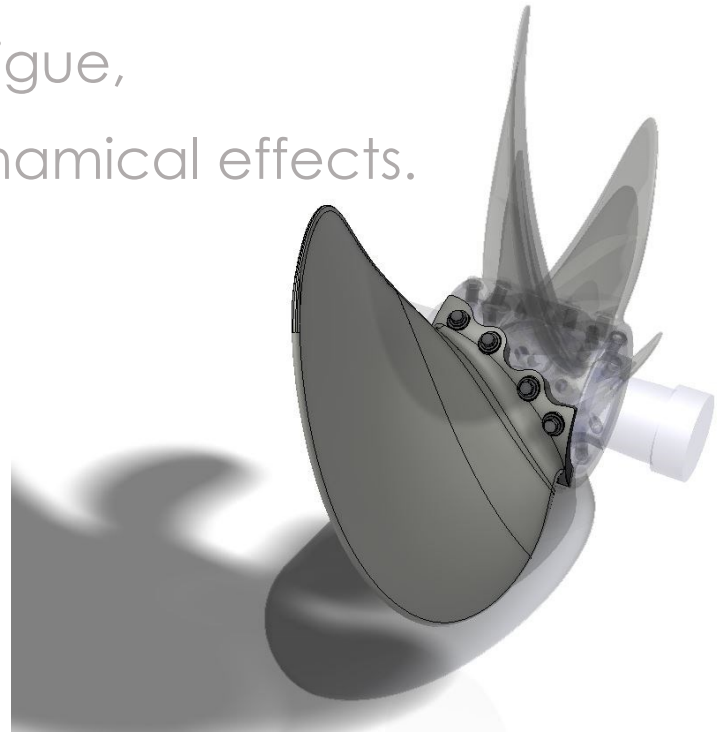
Search of mechanically reliable solutions, while ensuring disassembly.

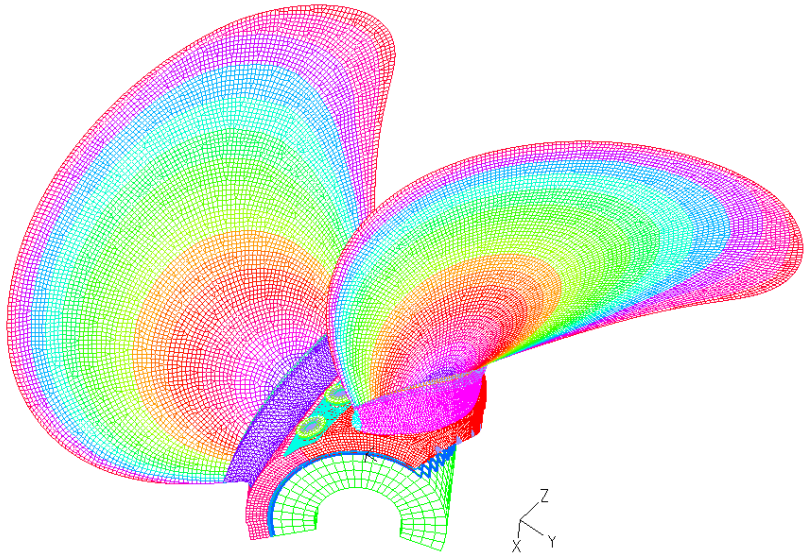
Max torque motor,

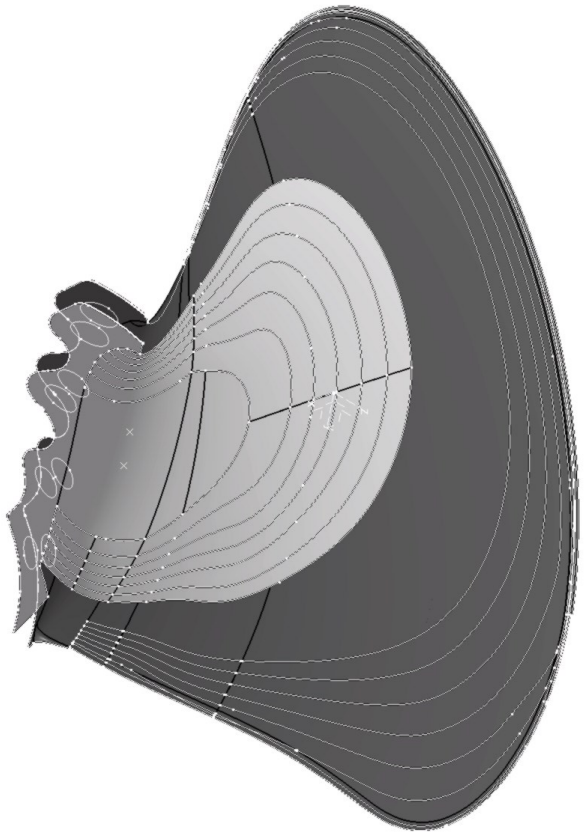
Clamping,

Fatigue,

Dynamical effects.





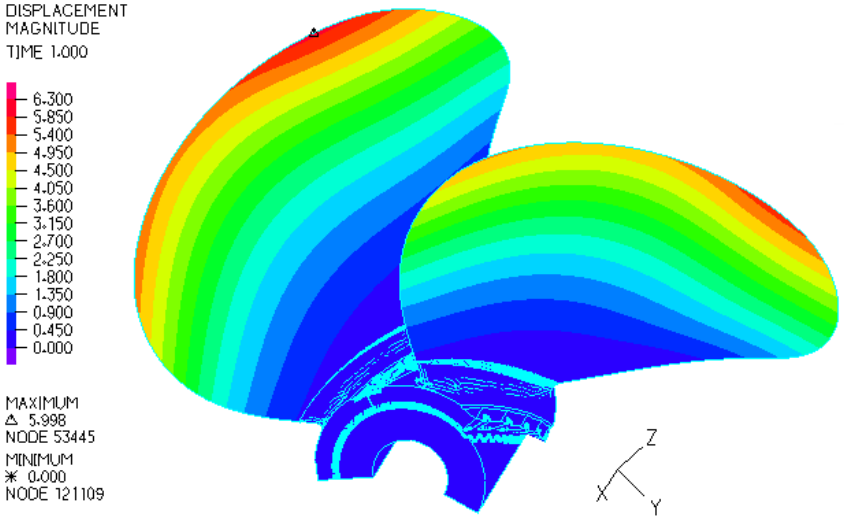


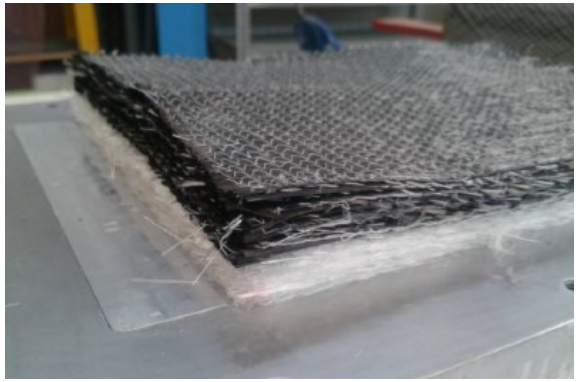
COSTS UNDER CONTROL

Optimization by mechanical calculations of the composite:

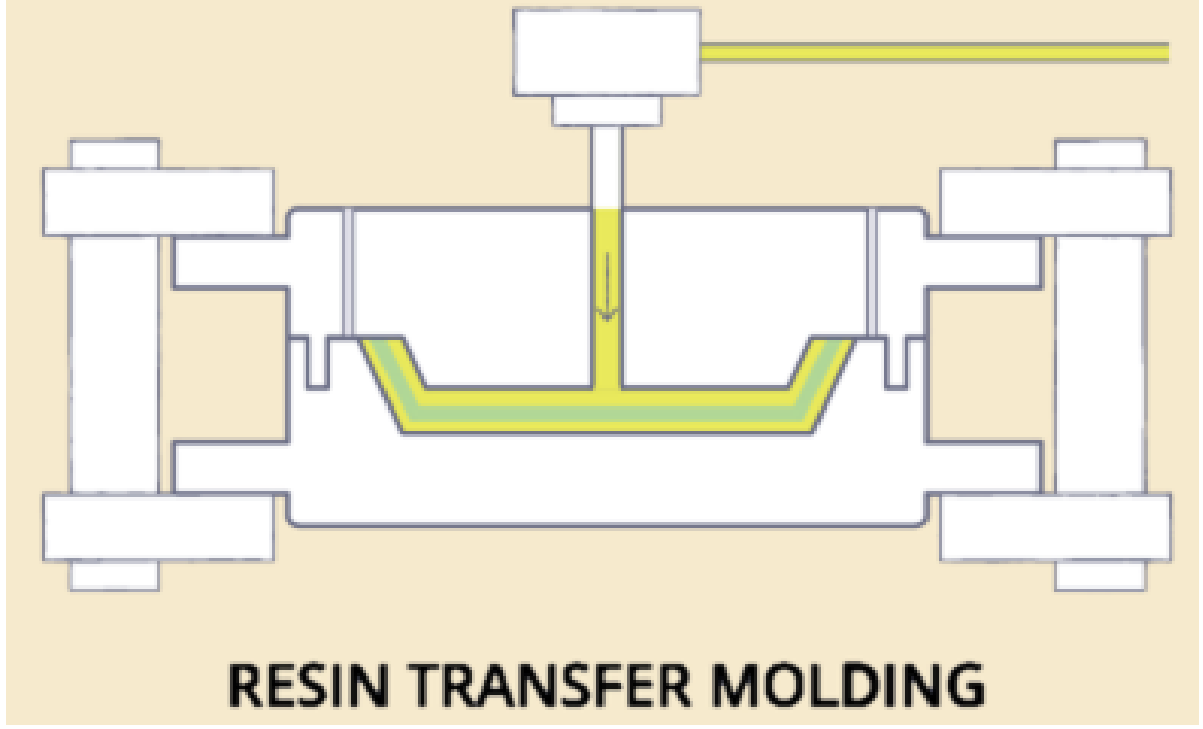
- put carbon fibers where it is needed

- orient the reinforcements in the direction of the loading.





In connection with the manufacturing process.



DEVELOPMENT OF THE MANUFACTURING PROCESS

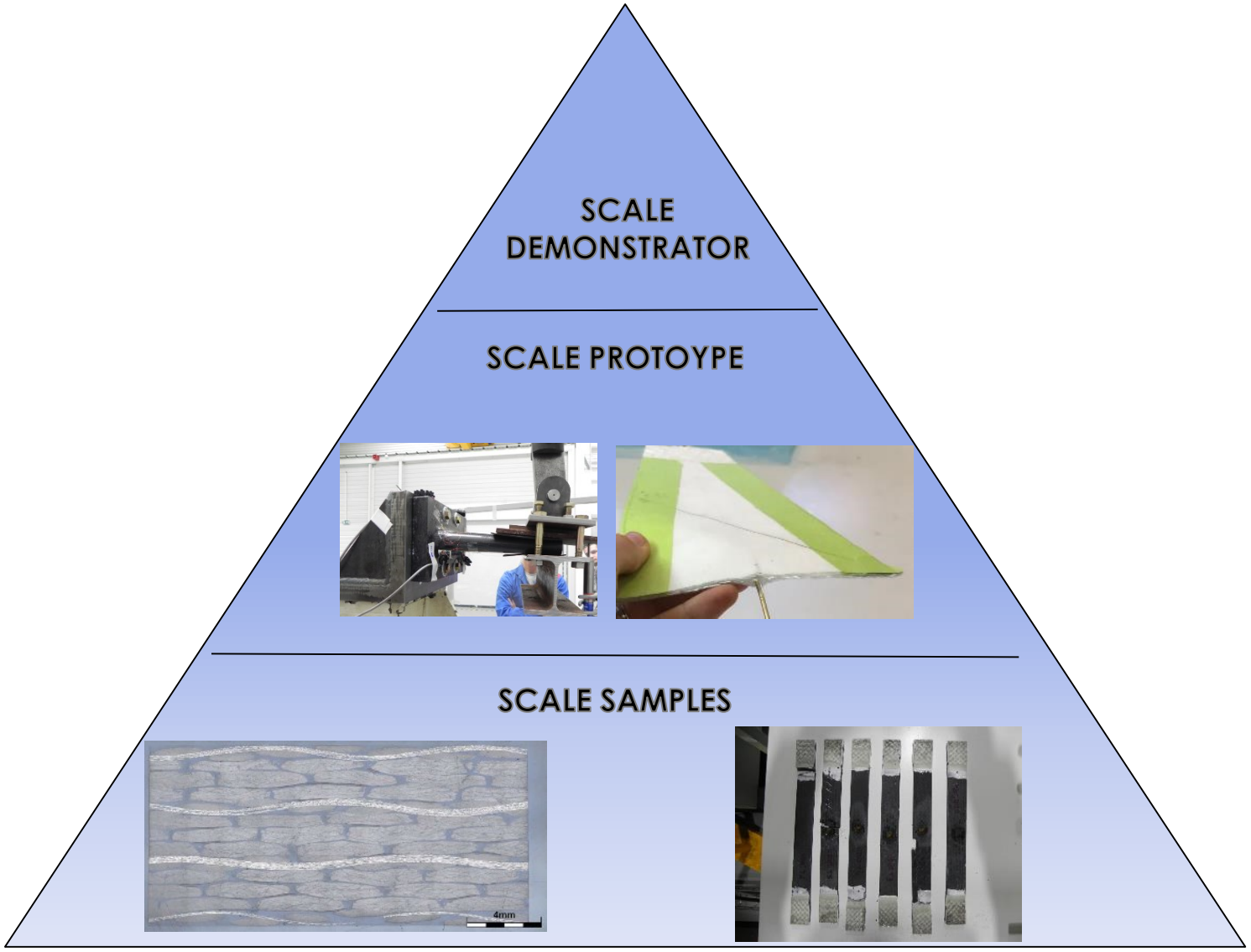
Development of the manufacturing routing

Definition of process parameters and injection strategy

Process adjustments

Verification of process repeatability (deviation) and influencing parameters

CONTROLS, TESTS



Tests on hub/blade connection mock-up

Foils mock-up

Mechanical tests on samples

Samples, specimen and Material Controls and NDT, SEM, US

Impact tests on leading edges

Coating tests

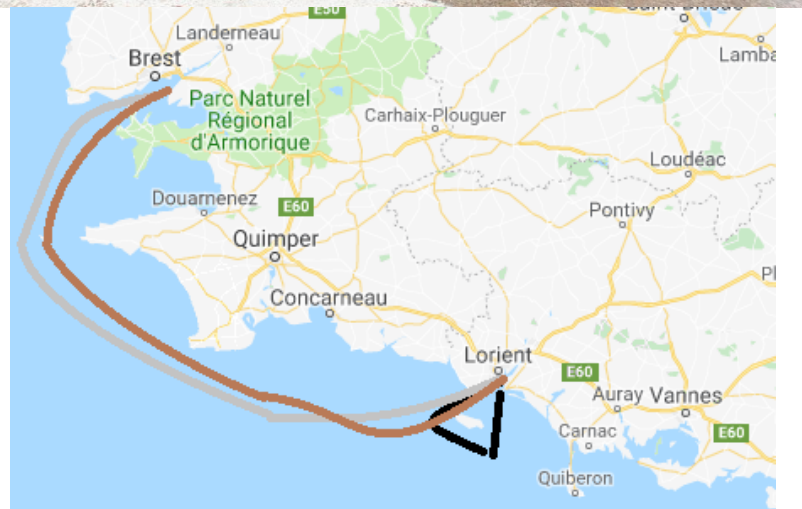
TOOLS FOR MANUFACTURING PROCESS

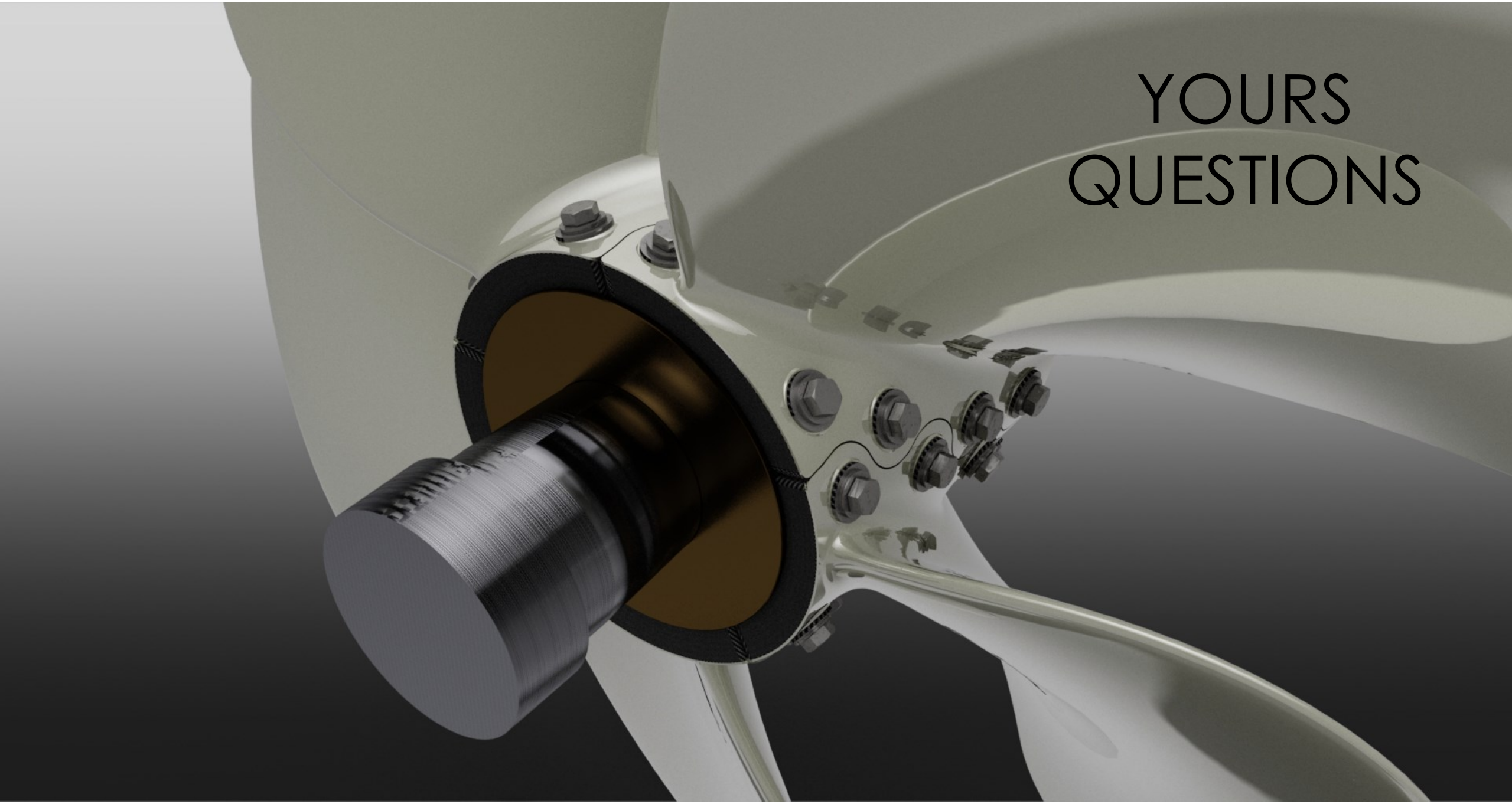
Manufacture of blade tools

Fabrication of preforming tools

MOUNTING

SEA TRIALS


Landerneau
Brest
Parc Naturel Régional d'Armorique
Carhaix-Plouguer
Loudéac
Douarnenez
E60
Pontivy
Quimper
Concarneau
Lorient
E60
Auray
Vannes
Carnac
E60
Quiberon


YOURS
QUESTIONS