Deep Ocean Materials

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Objectives

- Develop a measuring range at 3500 meters depth
- Maximize corrosion free endurance time (time between overhauls)
- Minimize maintenance time
- Minimize failure risk
- Respect budget constraints

Two Main Options

- Use market available products and design to improve system reliability
- Invest in material performance research aimed to design and develop a system as a complete prototype
- A cost effective compromise of above is to integrate market products into a customized system

Targets

- Withstand depth pressure with an acceptable flexural deformation
- Preserve the relative motion between moving parts without an excess of friction
- Preserve for long time the surface integrity avoiding corrosion
- Privilege non magnetic or even non conductive materials to avoid galvanic effects and influence compass related instrumentation

Titanium Alloys

- Excellent response to corrosion and fouling
- Non magnetic
- High mechanical strength
- Medium availability
- Its higher cost is largely compensated by the use of less material weight to obtain the same strength and by savings in maintenance cost

Titanium Alloys

- Its low density and high strength candidates it for the best material to make effective pressure vessels, but coupling connectors and joints of different material may cause galvanic problems to them.
- Welding Titanium alloys needs an expensive skilled procedure

Design Policy

- It is important to establish a design policy:

  - if the reference is Titanium alloy, any compulsory deviation from it must be considered as a case study

  - only Composite Technology may be associated to it with careful design of the joints due to the different elastic properties.

Composites Advantages

- Corrosion free
- Non magnetic
- Damage propagation very low
- Creative design due to the fact that the designer make its own production:

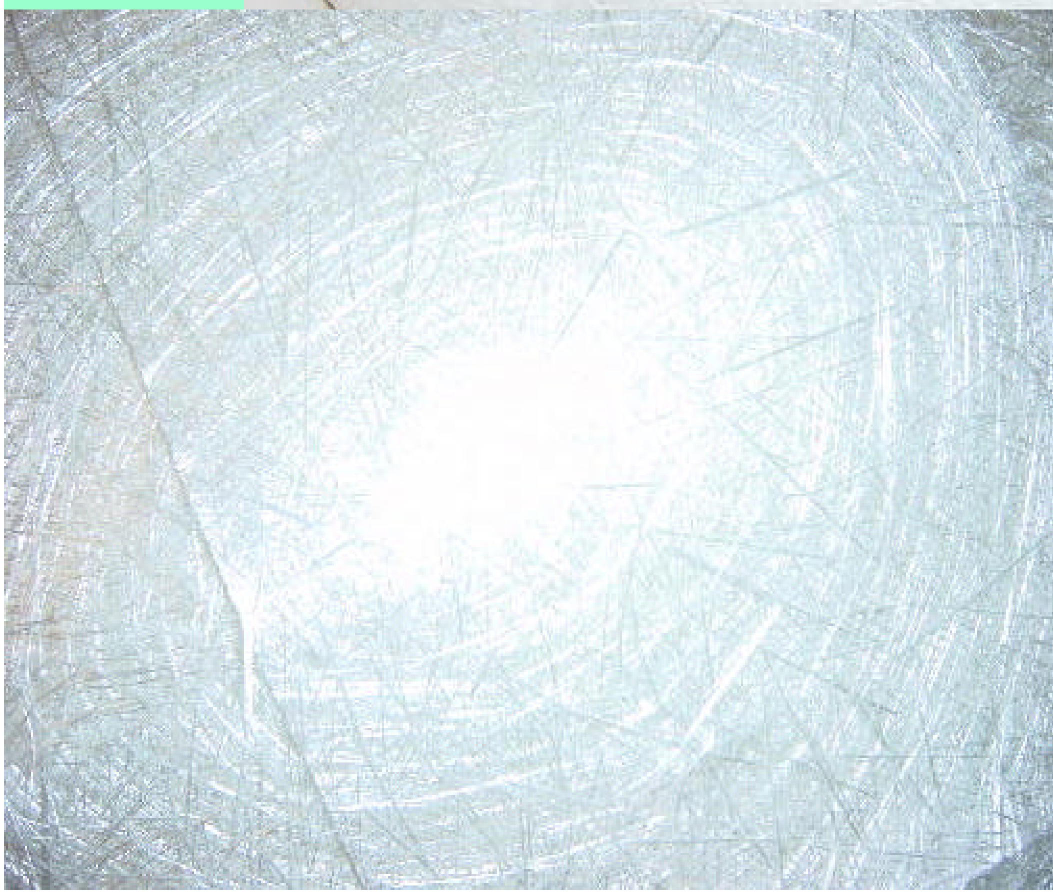
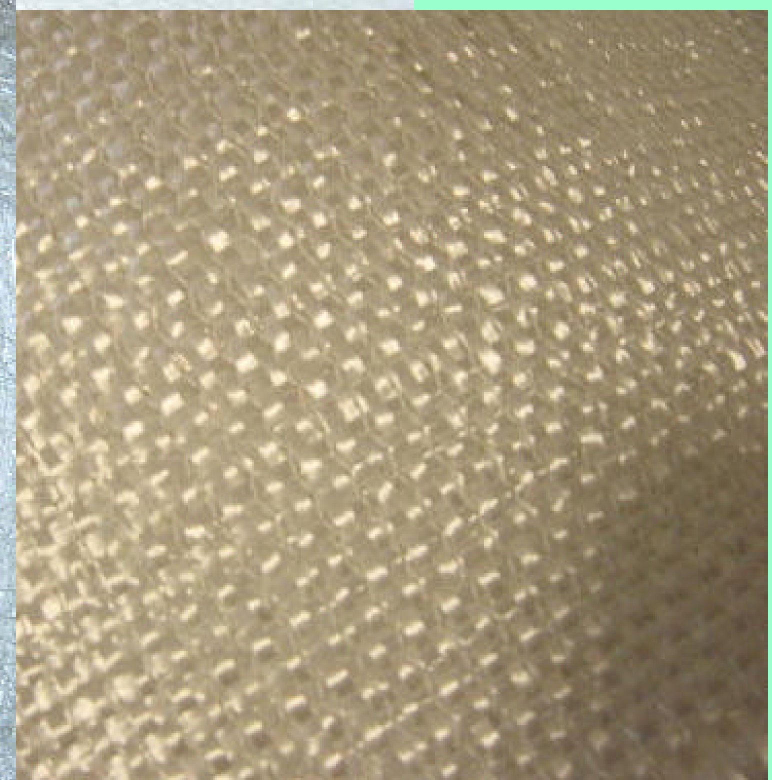
  - it is virtually possible to change material density and composition at any section

Composites Limits

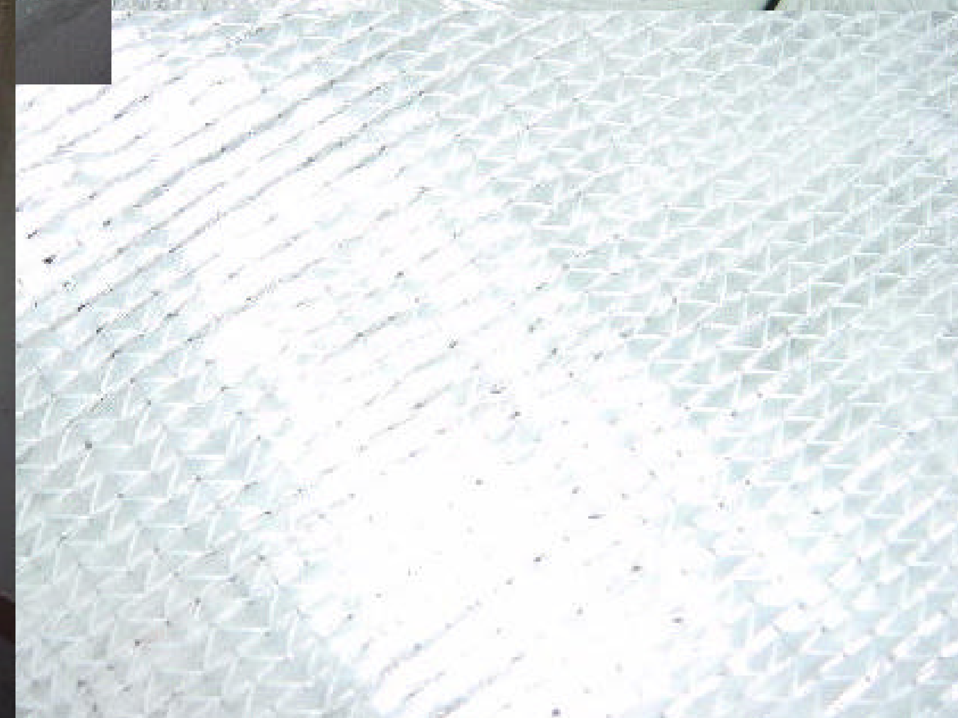
- A good quality assurance system is needed to avoid to transform a creative design in arbitrary solutions during production phase
- Normally an expensive set of models and moulds are needed for each component. Therefore this solution becomes cost effective after a large number of components per mould (with some exceptions)

Composites Optimization

- Standard lamination process with woven roving creates a part with maximum flexural strength in 0-90 degree directions, with minimum strength along -45 +45 directions.
- A special material woven along -45 +45 degree has been produced by reinforcement specialists to better hysotropy



Laminate Porosity

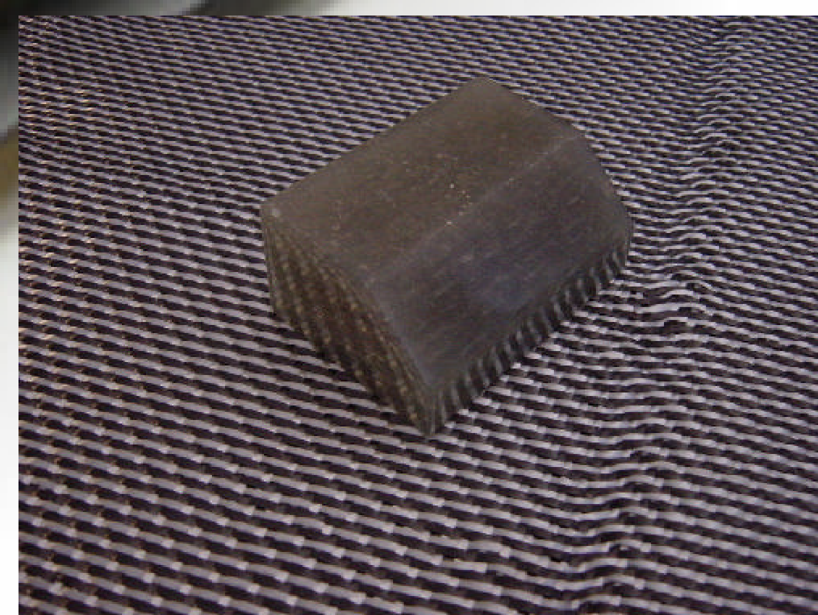
- Quality Assurance Problem
- Rigorous test of construction materials
- High quality polyester isoftalic resin
- Avoid any contamination of the resin with undue fillings

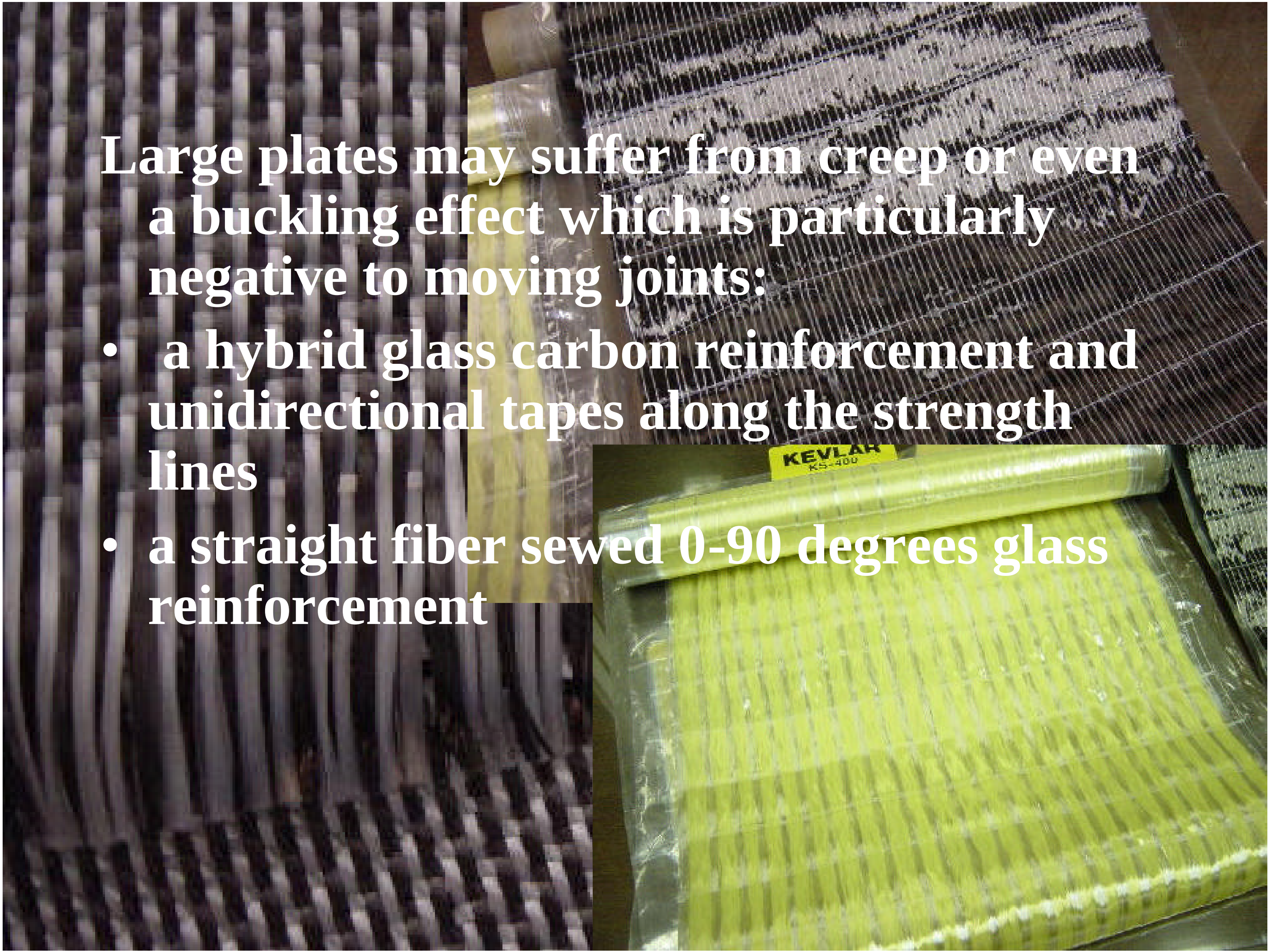
Lamination Data Sheets

- Design the appropriate sequence
- Avoid to make joints with surfaces subject to cure on the mould because the joint will be weak.
- Use insert on the mould to accommodate particular shape
- do not insert metallic part in the sheets to avoid interlaminar shear effect

Deep Water Resins

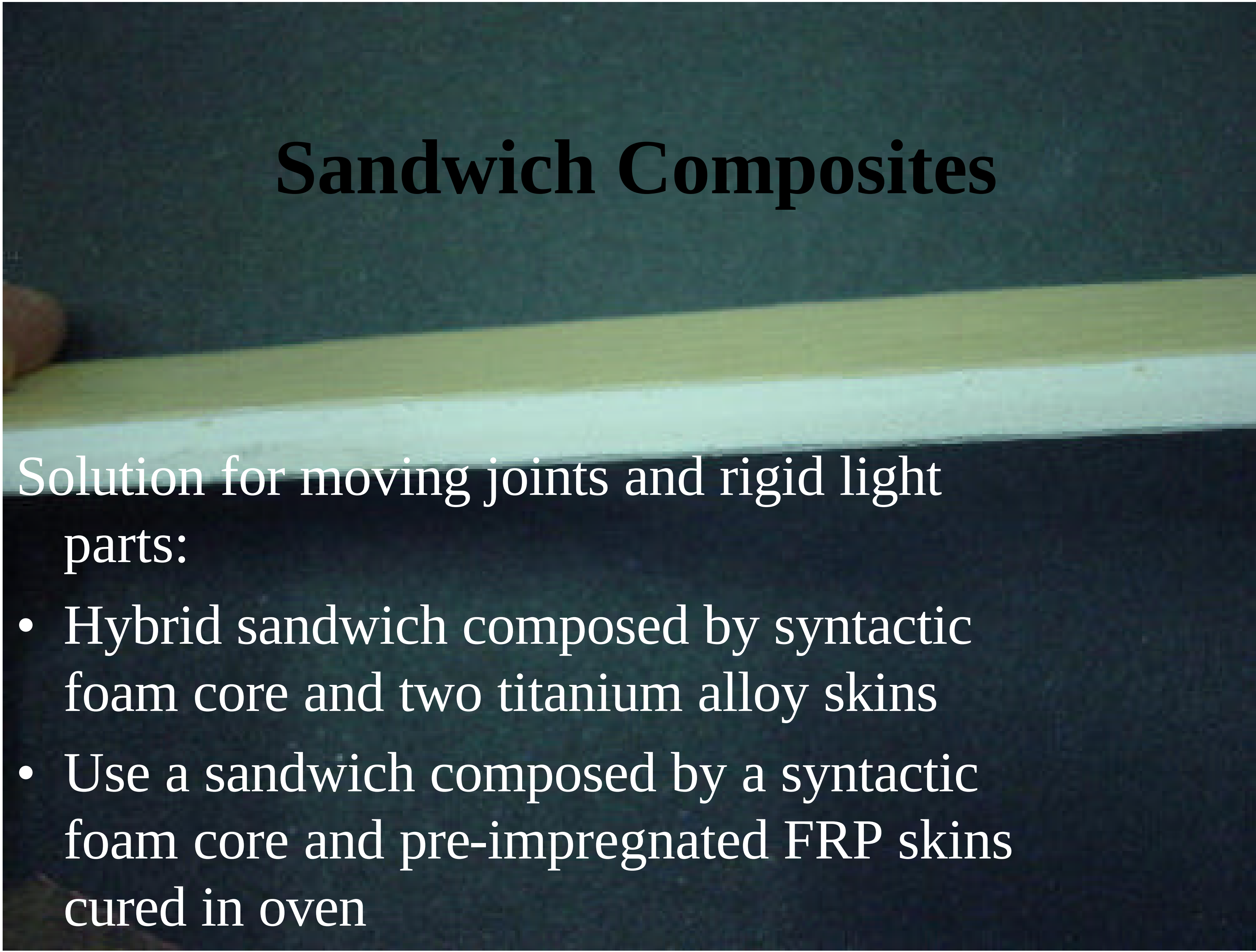
- **Syntactic foam to encompass electronic boards with the associated wiring and underwater connector**





Large plates may suffer from creep or even a buckling effect which is particularly negative to moving joints:

- a hybrid glass carbon reinforcement and unidirectional tapes along the strength lines
- a straight fiber sewed 0-90 degrees glass reinforcement



Sandwich Composites

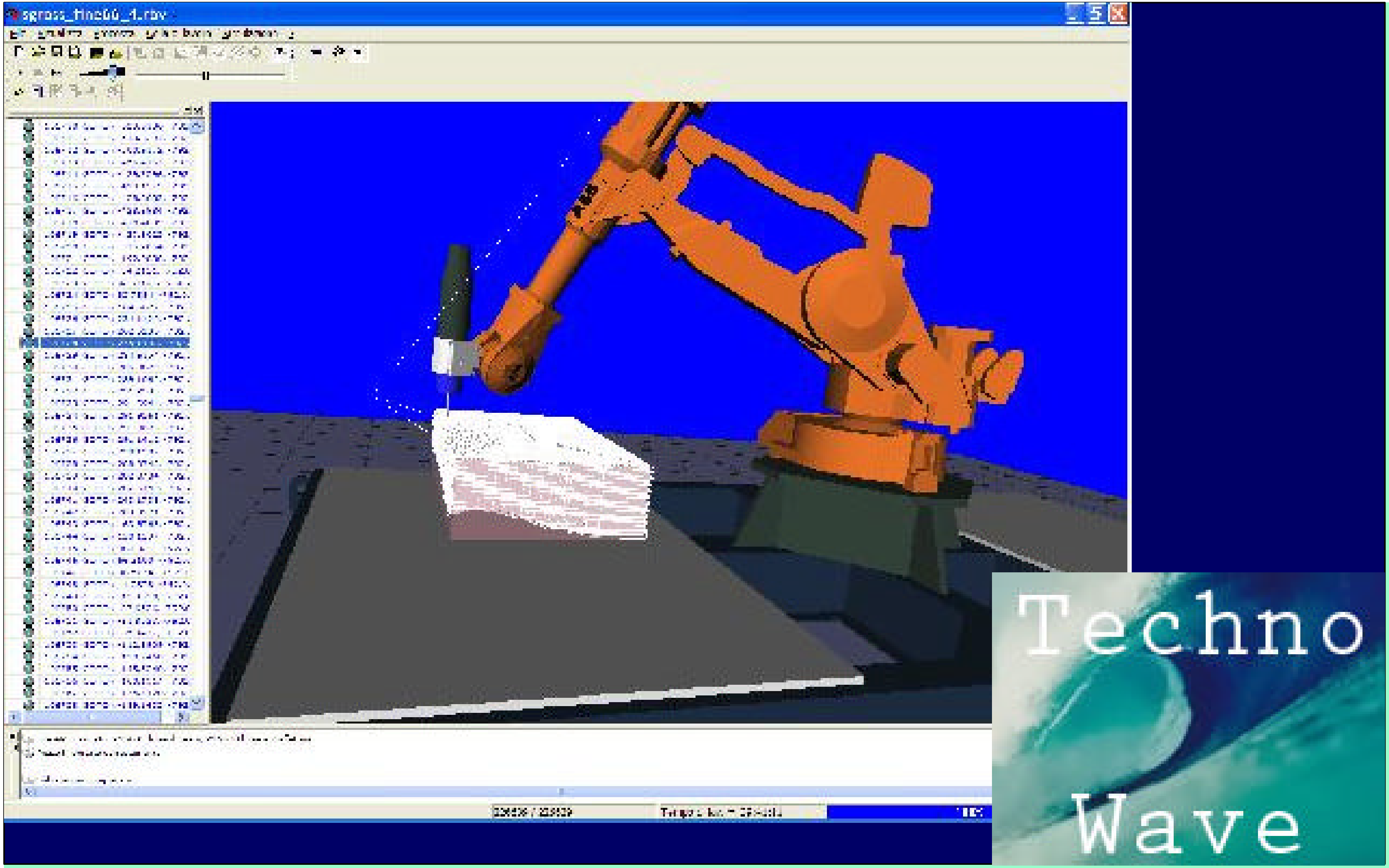
Solution for moving joints and rigid light parts:

- Hybrid sandwich composed by syntactic foam core and two titanium alloy skins
- Use a sandwich composed by a syntactic foam core and pre-impregnated FRP skins cured in oven

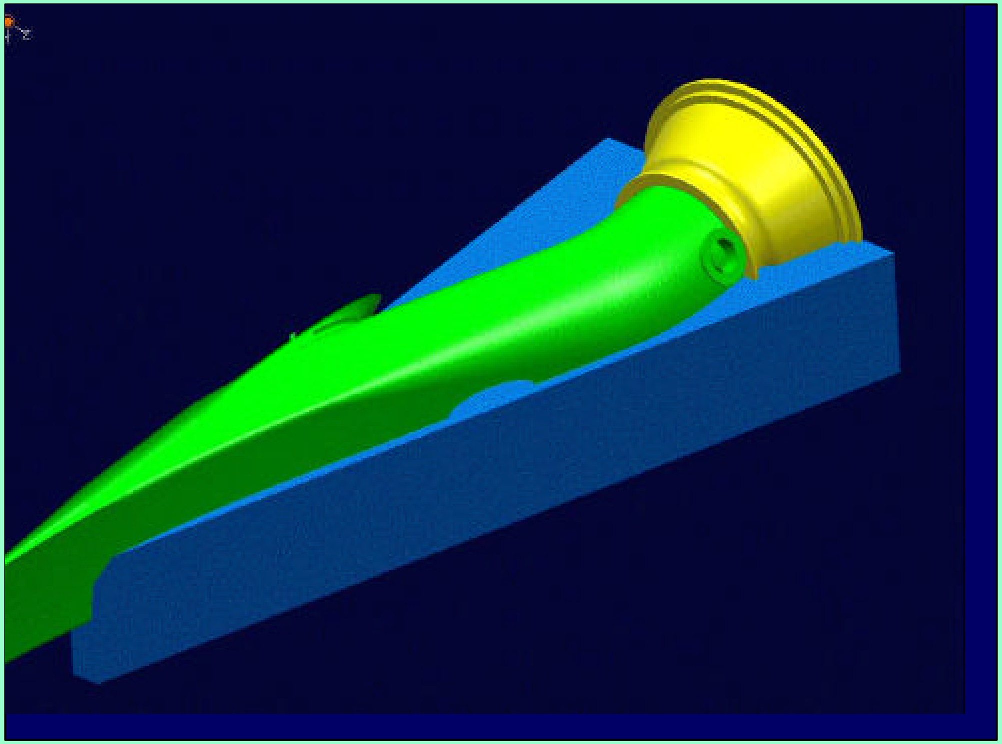
CAD CAM Models

Novel procedure to make inexpensive moulds:

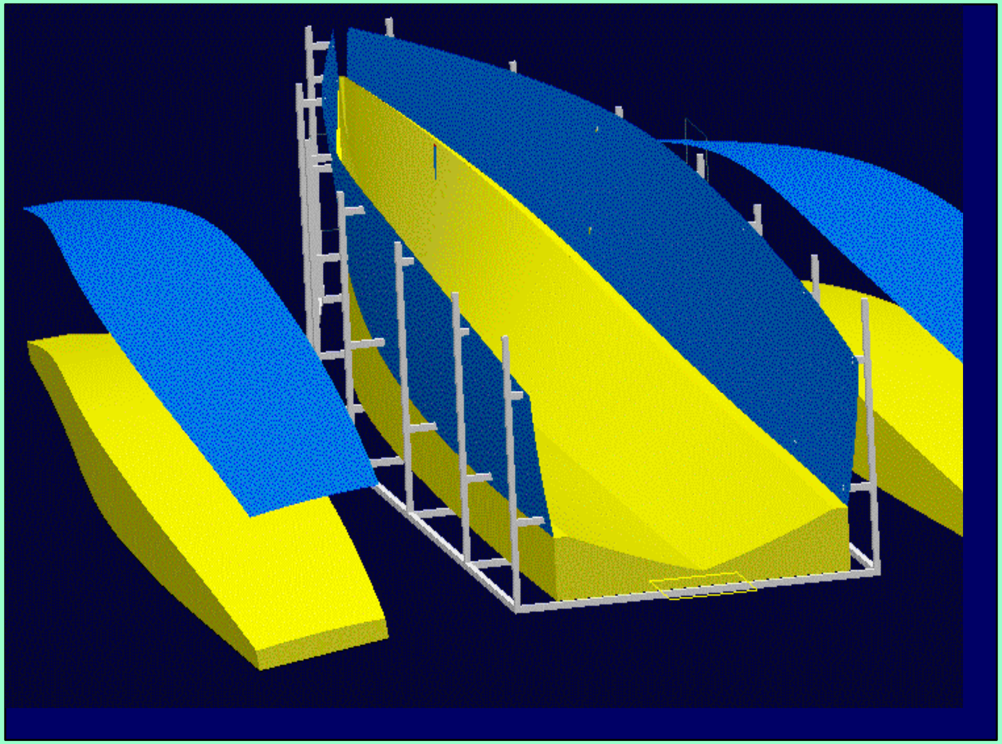
- CAD drawing of the model
- CAM file of the working sequence
- a 7 axis robot machines the CAD model
- lamination of the mould on the model
- production of FRP parts out of the mould



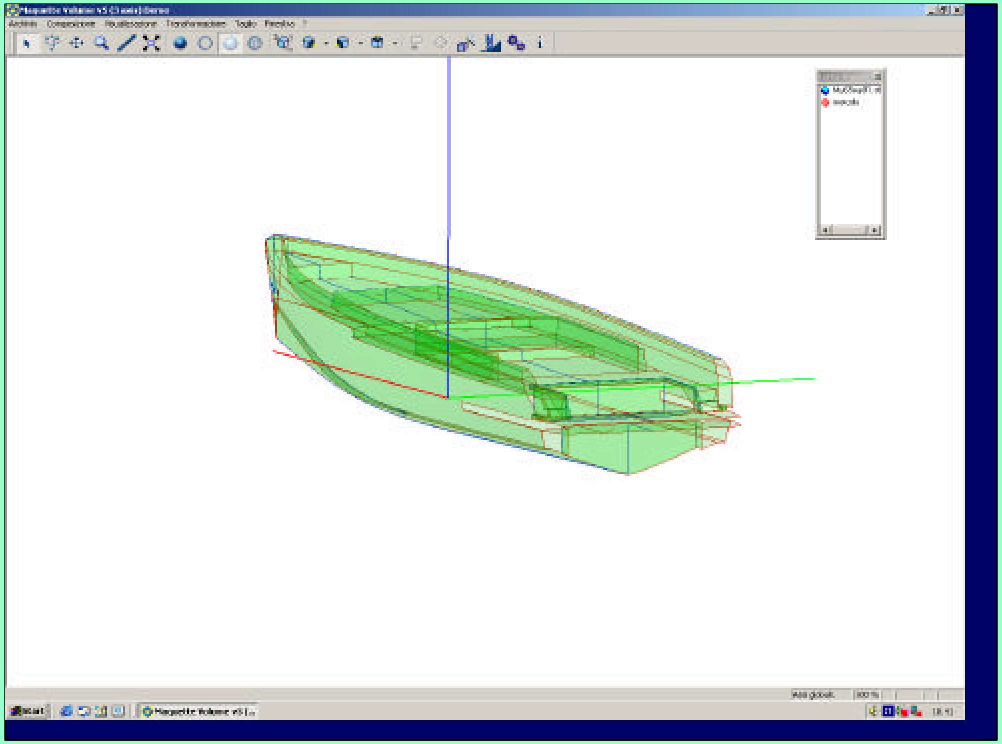
Innovative composites technology for marine environment



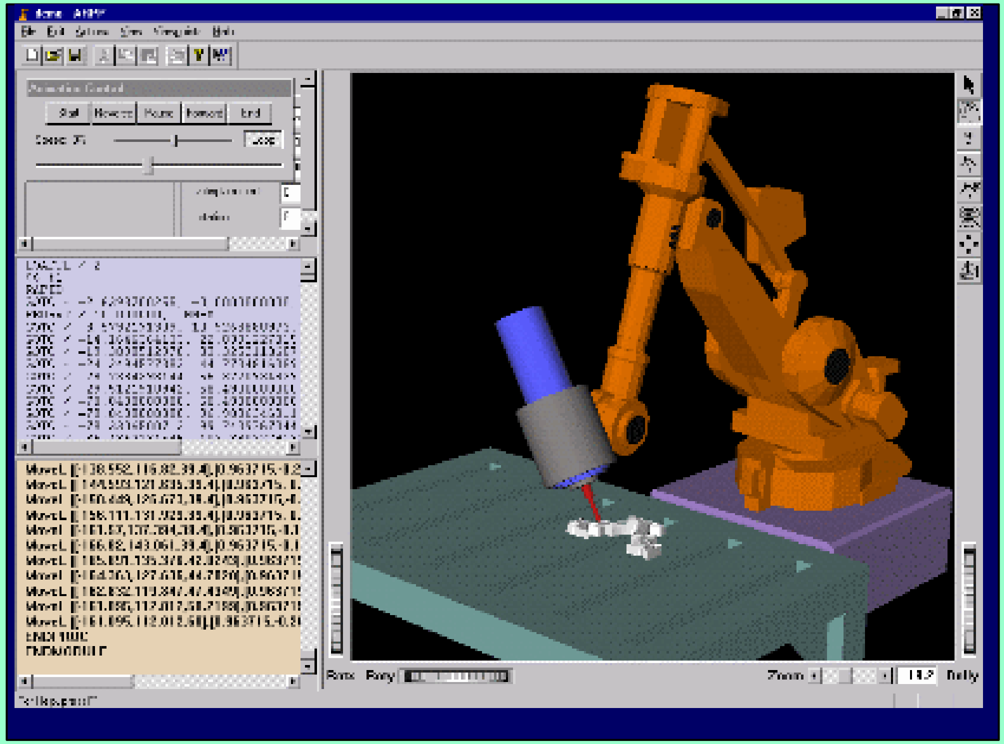
3D CAD Design



Model disassembly



CAM Path



Tool Path Simulation

Robot machining

Robot machining

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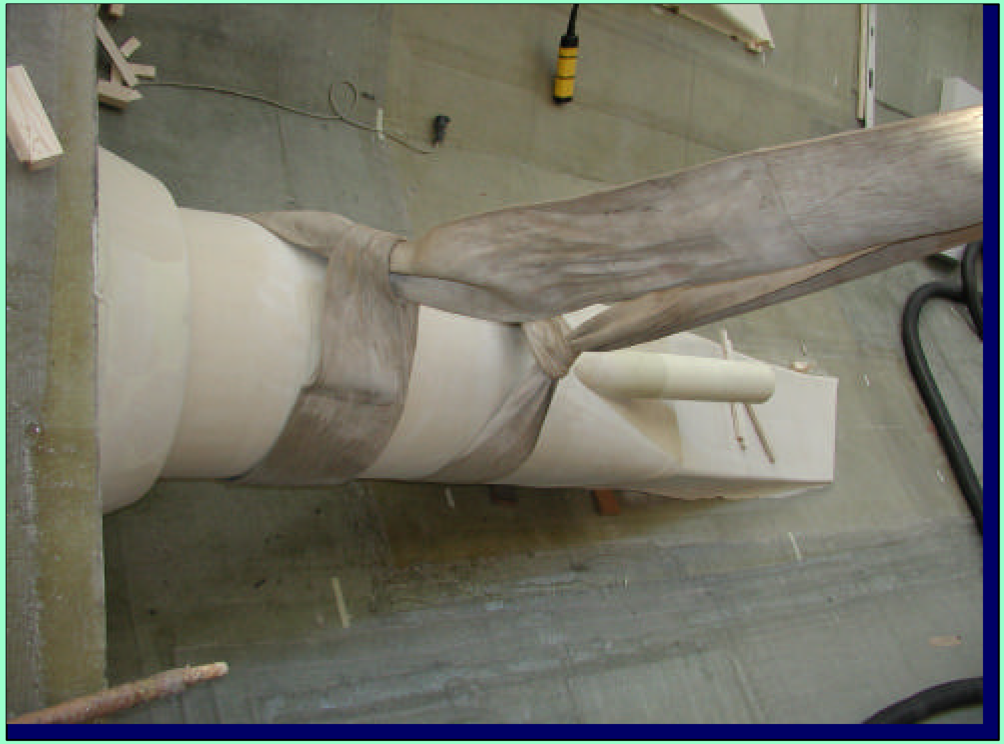
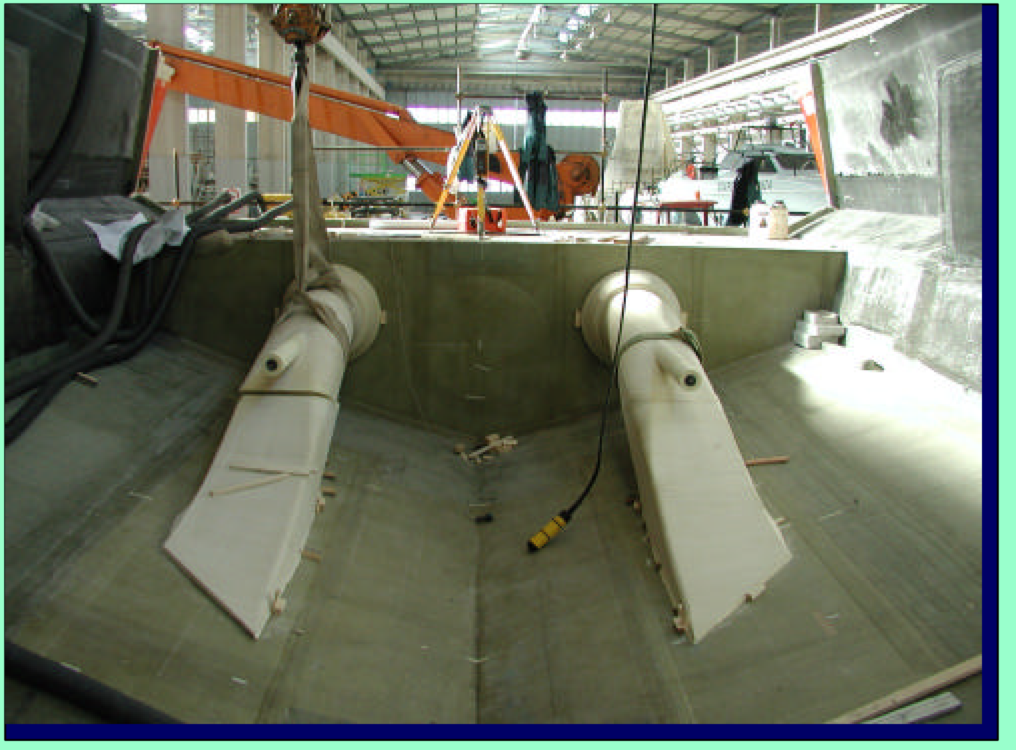


Model pre-assembly



Model pre-assembly

Model Finishing

Other models

Machining a sonar dome model