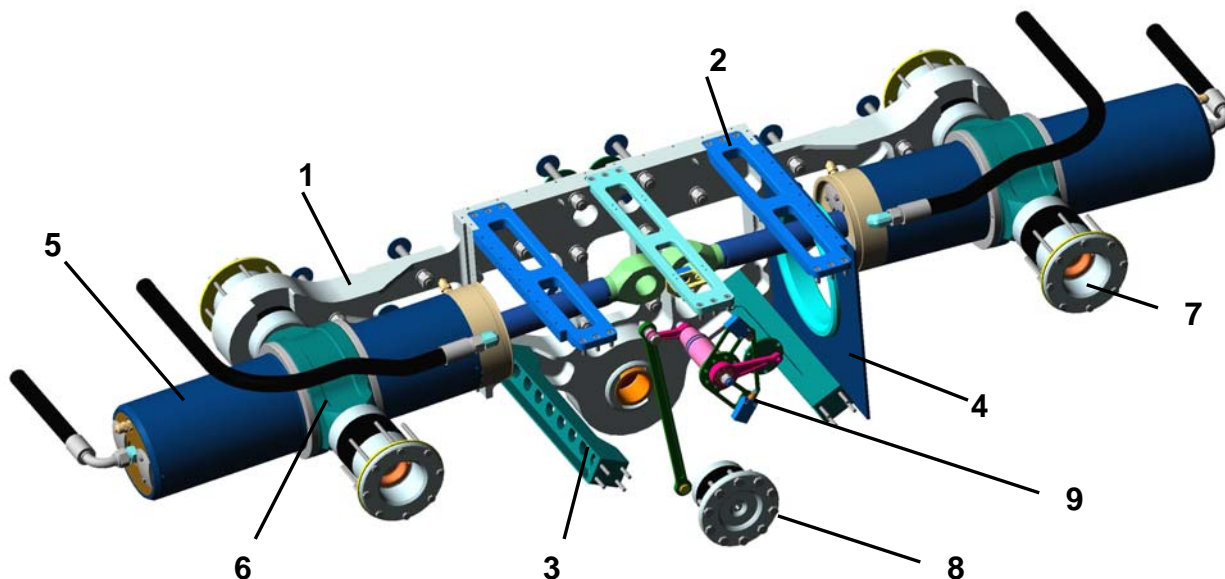
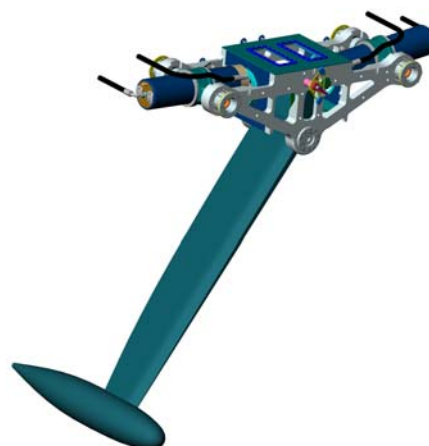


CANTING KEEL SYSTEMS

Cariboni's experience in canting keel systems dates back to 1996, when Junoplano was designed. Since then the concept has been continuously developed with different options (one or two cylinders) and additional features (canting and lifting systems). Special attention has been paid to reliability, serviceability and weight savings.

The most reliable configuration uses two double acting cylinders: in case of a cylinder failure, the system can continue to be operated using the other cylinder.

The aluminium transverse structure is designed to bear all the stresses generated by the cylinders, and to transfer to the boat structure only the righting moment through the bearings (#7 & #8, these are widely spaced to reduce forces to the minimum). The longitudinal beams (#2 & #3) are primarily to avoid the structure collapsing in case of grounding. Both the cylinder bearings (#7, 7075 aluminium alloy, or 17-4-PH SS, or Titanium) and the keel pin bearings (#8, 17-4-PH SS) are self-aligning, to allow for minimum misalignment or displacement during sailing.

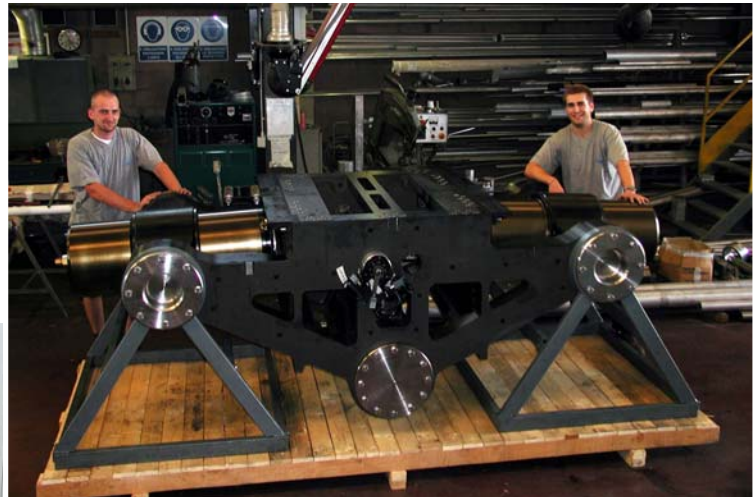
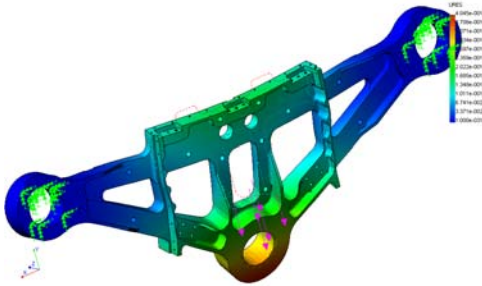


The cylinder tubes are usually made of 7075 Al alloy (Ergal), Titanium 6Al4V, 17-4-PH H900 stainless steel; the rods and terminals in 17-4-PH, Nitronic 50 SS, or Titanium 6Al4V. The system is watertight: the central part (where the keel head moves) is flooded, but the cylinders work in a dry area because the two longitudinal plates (#4) and two rubber bellows (between cylinder and plate) seal the central area. A top plate with inspection hatches seals the upper face.



CANTING KEEL SYSTEMS

Standard equipment includes a switchboard with electromechanical logic to control keel movement, a keel angle rotation indicator, the keel control manifold.



105' canting keel system
310 mm bore. Cylinder tube and components made of black hard coated aluminium (Ergal 7075), piston rod and terminal in 17-4-PH H900 SS. Bearings in 17-4-PH H900 SS.

60' canting keel system
160 mm bore. Cylinder tube and components made of black hard coated aluminium (Ergal 7075), piston rod and terminal in 17-4-PH H900 SS. Bearings in Ergal 7075 and 17-4-PH H900.



Buttons control panel



Keel manifold

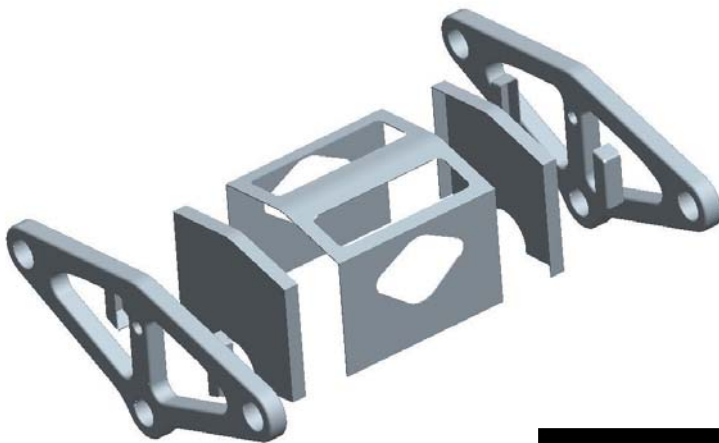
The largest experience on canting keel systems:

OPEN 60 (n° 2 yachts)	60' open	40° under construction	AORI	80'	40°
DELTA DORE	60' open	40° 1 cylinder	KAURIS III	105'	40°
ABN AMRO ONE	Volvo 70'	40° titanium cylinders	ONLY NOW	104'	40°
BRASIL 1	Volvo 70'	40° titanium cylinders	ANYWAY	64'	40°
ABN AMRO TWO	Volvo 70'	40° titanium cylinders	KRATOS	64'	40°
SHAKA	80'	40°	TIKETITOO	88'	40°
GENUINE RISK	90'	55°	WIND	50' open	38°
MARI-CHA IV	140'	40° 1 cylinder	JULIA	43'	40° CANTING + LIFTING
MAGNITUDE 80	80'	Cylinders supplying	TIKETITAN	88'	40°
DANGEROUS BUT FUN	80'	40°	FILA	60' open	45°
MAIDEN	115'	35° CANTING + LIFTING	JUNOPLANO	60'	55° 1 cylinder

Latest developments introduce an extensive use of composite elements:

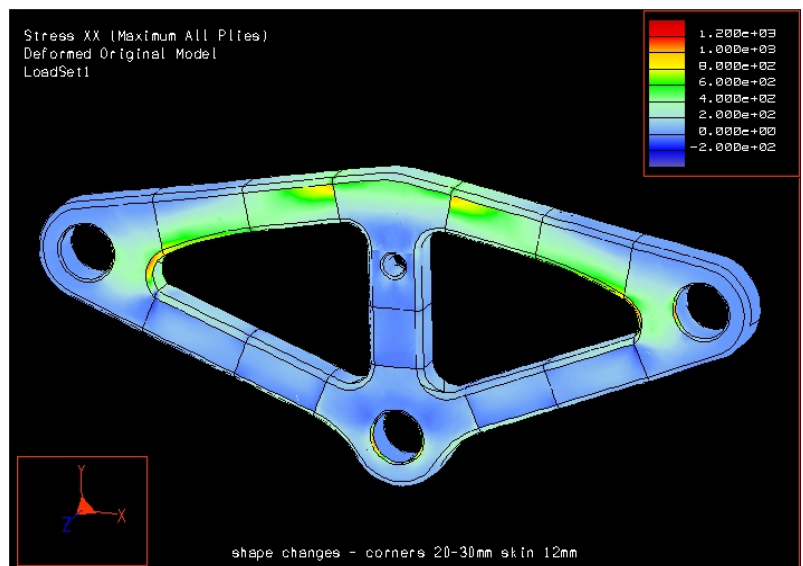
The typical twin frame concept remains the same. Two “A” shaped frames support the keel pivot pin, through two self aligning bearings, and the cylinders, through four self aligning bearings.

The advantages of the Cariboni “package” remain unchanged: easy installation, disassembling and servicing; but with the added benefits of the strength and weight savings of carbon fibre.

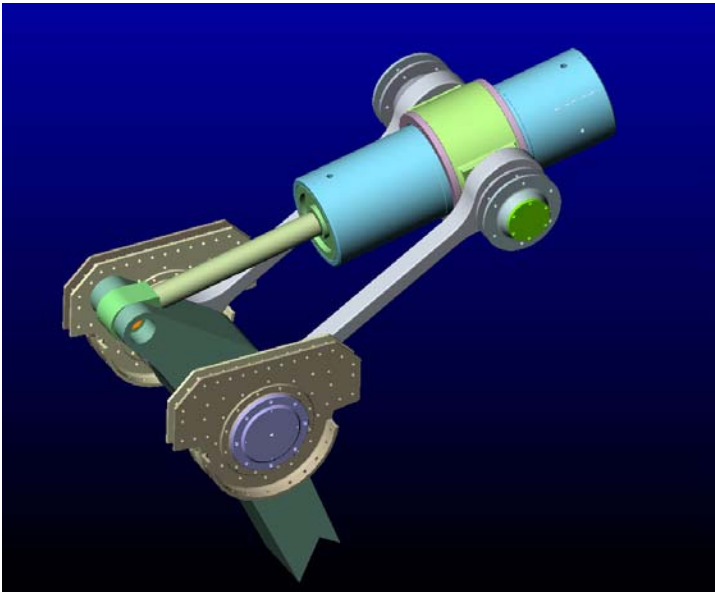


‘A’ frames with an integrated composite ‘box’.
All bonded (in this example)

Extensive Finite element analysis led to optimisation of the thickness - orientation of the fibres to “build” material properties to our specific needs.



The system includes a mechanical locking device to hold the keel fin in the central position in case of a complete failure of the hydraulic system. This device can be manually operated by the crew. The total height of the mechanism is kept as low as possible with a fine balance between keel lever arm and cylinder size (the longer the lever, the smaller the cylinder bore and the greater the stroke) to keep a lower centre of gravity and to allow a better crew accommodation on board.



The single cylinder configuration allows a bigger canting angle. In this arrangement the cylinder force is held by the two beams, and the boat structure (not shown in this picture), gets only the righting moment. An extremely precise composite design, machining and assembly process is indispensable for this configuration.

THE BIGGEST CANTING KEEL IN THE WORLD



Courtesy of Th. Martinez - Cherbourg



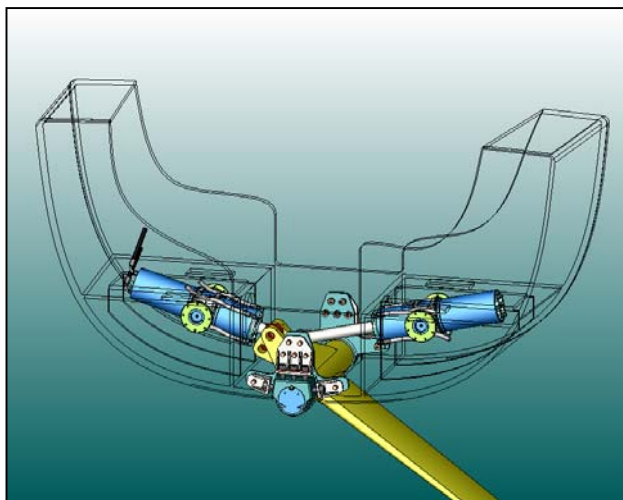
MARI-CHA IV canting keel cylinder onboard with the special asymmetrical bearing.

MARI-CHA IV canting keel cylinder: 380 mm bore, 1280 mm stroke, 17-4-PH stainless steel.
358 tons working load at 350 bar
(... can lift a loaded Boeing 747!)
1ST SERVICE AFTER 25000 nm.





90° *GENUINE RISK*:
55° canting keel system with twin cylinders.



KEEL JIG

All our canting systems supplied include a CNC machined jig of the structure of the canting keel. This simplifies the procedure for correct alignment of the bulkheads and installation of the canting keel mechanism.



Bulkheads with keel jig during assembling with the hull



APPROXIMATE MAIN DIMENSIONS AND WEIGHTS OF COMPLETE SYSTEM

Model		60'	88' / 80'Racing	105'
Max canting angle		40°	40°	40°
Bulb weight	kg	3500	11000	24000
Keel fin weight	kg	980	3000	2500
Distance from bulb CG to rotation centre	mm	3300	3100	3000
Distance from keel fin CG to rotation centre	mm	1580	980	1500
Frame + cylinders dim. (LxWxH)	mm	550x2200x460	750x2600x570	1350x3290x830
Frame + cylinders weight	kg	250	633 / 497	2.100



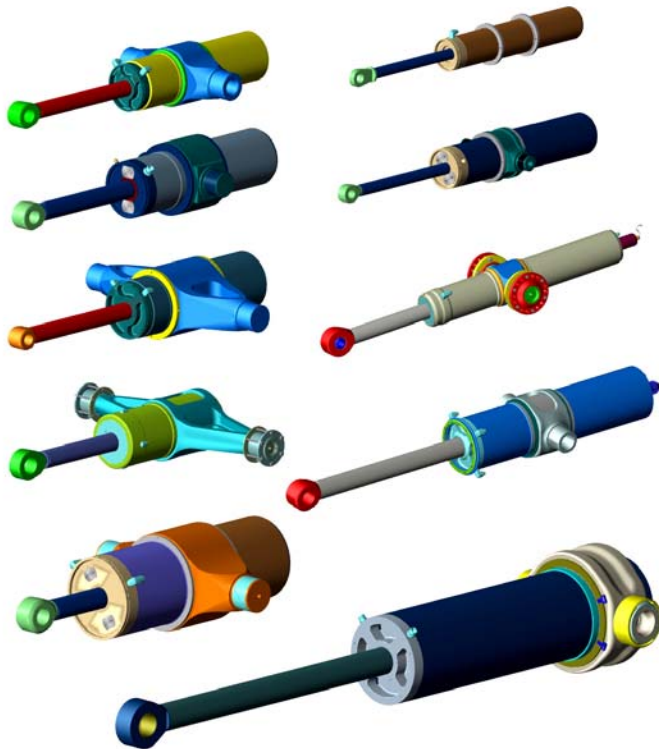
CYLINDERS

Many standard double acting cylinders for canting keel systems.

Hi-tech materials and advanced design for top performance, reliability and lightweight. Black hard coated aluminium (Ergal 7075), Titanium 6Al4V, 17-4-PH H900 stainless steel.

Integrated linear transducer available.

From 100 mm to 380 mm bore diameter, from 150 to 350 bar working pressure (2000÷5000 psi).



60' KRATOS

THE FASTEST KEEL IN THE WORLD

90' *GENUINE RISK*: only 6.5 seconds for a complete keel tacking from -55° to $+55^{\circ}$!!



TITANIUM DOUBLE ACTING CYLINDER

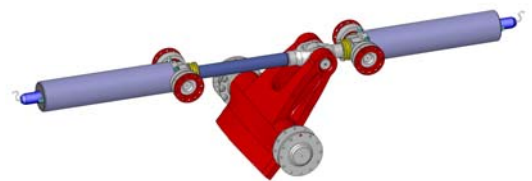
These Titanium double acting cylinders have been developed specifically for 70' **VOLVO OCEAN RACE 2005-2006 edition**.

All the parts of the cylinders are made in Titanium 6 AL 4V T6. The result is a light and strong cylinder, perfectly suited for moving a racing boat canting keel with the maximum of the speed and force.

**3 DIFFERENT SYSTEMS, 3 OUTSTANDING RESULTS,
ONE PHILOSOPHY FOR THE HIGHEST RELIABILITY.**



ABN AMRO ONE
Winner



BRASIL 1
3rd place



ABN AMRO TWO
4th place
24h speed record 563 nm

