# REVIEW: ELLIOTT SUPERMAXI 100


PHOTO: TERRY FONG


# on Maximus


**IF YOU'RE GOING SAILING ON WHAT COULD TURN OUT TO BE THE FASTEST monohull in the world under 100ft, it pays to have some of the world's best sailors to run the systems.**

On board *Maximus*,the Greg Elliott supermaxi launched in Auckland 14 February, the crew included Team New Zealand weatherman Mike Quilter, grinder Rob Wardell, designer Clay Oliver, Olympic boardsailor Bruce Kendall, America's Cup sailor David Barnes and *Maximus*' sailing master George Hendy.

Along with other new supermaxis on the circuit, *Maximus* is actively sailed by her owners – no way are they there simply to sign the credit cards. Charles St Clair Brown was at the helm and Bill Buckley was overseeing the engineers in the main cabin as they tested and fine-tuned the heart of the boat's technology: the retracting canting keel, driven by a patented hydraulic system.

Representatives of Southern Spars, who built the rotating wing mast, a world first on a maxi yacht, were fine tuning the rig. Supported with PBO fibre shrouds, the 650cm wide mast has two spreaders with lower diamonds. The spreaders are aerodynamically, artistically shaped, resembling the flukes of a whale's tail.

The 330m² mainsail area is large owing to the low aspect rig allowed by the wing mast. The huge roach of the mainsail, from North Sails, may make it the largest 3DL Kevlar sail constructed for a racing yacht.

We left the Viaduct Harbour under tow, as the hydraulic propulsion system was yet to be installed. In the outer harbour, we executed slow circles to calibrate the B&G electronics which later marked the calibration as accept-

STORY BY **TED DIXON** ▮ ONBOARD PHOTOS BY **REBECCA HAYTER**

*Maximus*, the 100ft supermaxi, will sail under the New Zealand flag, including an attempt on the 24-hour record.
**THIS PAGE:** America's Cup grinder Rob Wardell powers into the hoist.
**TOP:** *Maximus*' rotating wing mast, probably the first on a supermaxi; a back stay block – the deck gear is the largest available off the shelf; the narrow waterline beam reduces wetted surface but houses the rams for the canting keel.
**FAR LEFT:** Owners Charles St Clair Brown, left, and Bill Buckley; during record attempts *Maximus* must be people-powered through her three coffee grinders; the base of the rotating wing mast.

able, but not perfect; calibrating under tow was not ideal.

Then, the grinders got to work to raise the mainsail. We dropped the tow and Buckley's team lowered the retracting keel, increasing our draft to six metres.

Under mainsail only and not even trying, we generated apparent wind of 12-14 knots at 70 degrees and a boat speed of 11.3 knots.

The professional sailors concentrated on their tasks: the trimmers directed their grinders. St Clair Brown was at the helm, adamant that clear communication be maintained throughout. "We have the helmstations well forward so we have excellent visibility and you are among the crew so you can communicate so much better than when back aft," says St Clair Brown. "Plus, it's like you're sailing a 65ft boat instead of a 100ft boat."

Even he is already amazed at Maximus' performance. "It absolutely blew me away," St Clair Brown says: "Twelve and a half knots upwind in 9 knots true wind with number three jib at 20 degree apparent. We were reaching at 14-15 knots with 8-9 knots true wind speed."

The main pedestal for the mainsheet has the Navtec controls and buttons for the keel system and canard trim.

We raised the number one jib and headed out of the harbour on a broad reach, the wind across our starboard quarter. *Maximus* responded to changes in the wind with rapid accelerations like a dinghy – except she is 100ft long. I kept well aft, clear of the frenzy of activity in the cockpit. The bow stretched out in the distance.

*Maximus*' acceleration in the wind gusts is so determined that it was confusing trying to follow the wind direction indicators, such is the apparent wind angle. We were now sailing 18 degrees off the wind at a boat speed of 14 knots in 16 knots of wind.

We cleared North Head, and prepared for a gybe: trimmers ready; grinders ready. St Clair Brown swung the stern through the wind – and the cockpit went wild: one set of grinders powering the mainsail into centre before the big ease; the second set of grinders hauling in the jib sheets. The trimmer on the leeward runner spun it free of its winch and the new runner was powered on.

The grinders' toes executed occasional taps on the buttons to change the gears or to redirect the power to a different winch. There were three pairs of grinders and one person in each pair seemed to take the initiative, calling, "Change," as required – their arms did a quick forward-back to take a new gear and then worked the opposite direction. Grinding these boats is as much about brain as brawn.

Every action and reaction translated into sound, as the carbon fibre hull transmitted the tremendous loads on the blocks and rigging, and the hydraulics contributed an almost constant whirr.

Following the gybe, we pointed closer to the wind and the keel was canted to the windward side for the first time, the equivalent of placing 200 people on the windward rail. *Maximus* flattened out and her hull speed increased.

The apparent wind speed increased to 24 knots – *Maximus*' boat speed went to 13.6 knots then 14.6 knots; the wind angle was 22 degrees. Then: 19.5 knots at 23 degrees wind angle.

*Maximus* soared up Rangitoto Channel. The grinders rested following the flurry of each tack. Everyone enjoyed the ride upwind at 16-18 knots until we sailed into an area of low pressure. With less power in the sails, the canted keel leaned us weirdly to windward, the crew sheeted on to compensate but it still felt peculiar.

We bore away to reach up the channel, eating up the distance until nearly at Whangaparaoa Peninsula. We gybed again, another cockpit frenzy to sheet in and ease sails, and change the runners. We felt the loads take up again.

We sailed over toward Motutapu Island and prepared to tack back toward North Head, skating around the Hauraki Gulf as though it were a small pond. The keel was dropped back to its vertical position and we tacked onto port. The hydraulics canted the keel up to windward as we came out of the tack, close to the wind, at 12 knots. The boat flattened out and even the professional sailors couldn't resist leaning over the side of the boat to watch the white shadow of the bulb scooting along beside us. We were back to 16 knots boat speed.

As we approached North Head, hard on the wind, there was a teething problem: the hydraulics shut down, prevent-

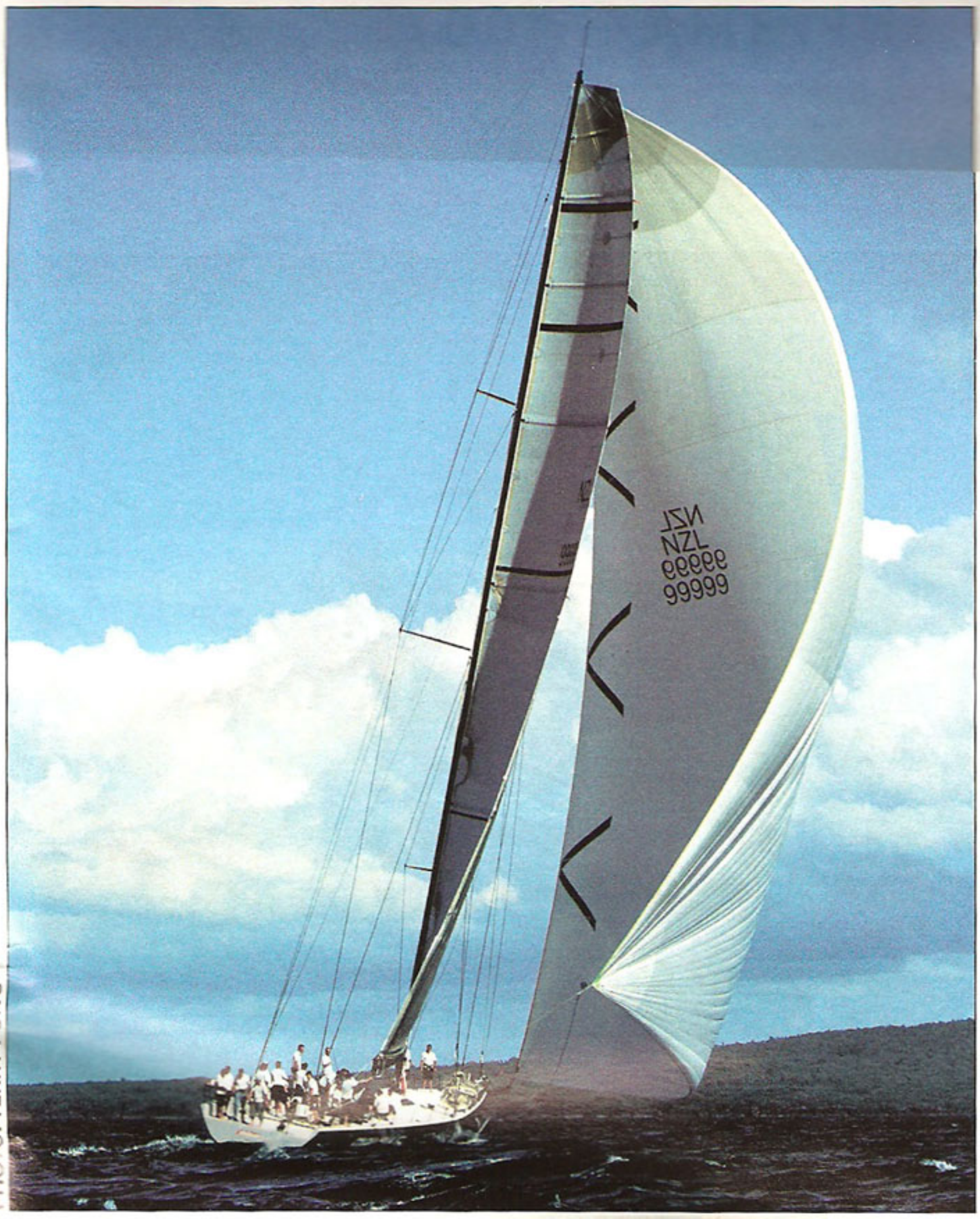



PHOTO: TERRY FONG

ing the keel from being canted back down to vertical, but that was of no interest to Takapuna Beach, approaching rapidly. Buckley and his team worked on the problem.

On deck, we did the nerves. Fully canted, the keel needs the sails sheeted in to counter balance it – but that meant being hard on the wind for Takapuna Beach. We needed the keel down to tack.

St Clair Brown instructed the crew to ease the sheets and the boat bore away to gain some sea room, but with less pressure on the sails and the keel still to windward, we heeled uncomfortably to windward.

OK, so what happens if the keel stays on the wrong side – will she knock down? Capsize?

The hydraulics buzzed back to life, problem solved. The keel is designed to cant to a maximum of 50 degrees but it had extended to 52 degrees and followed its designed safety check to shut down to stop any damage caused by over extending the keel. Buckley had to override it to start it up again. No big deal – just a minor adjustment to make back in the marina. We tacked back toward the city, on an angle of heel that felt more like normal.

Back in the harbour, we dropped the sails and picked up our tow, smiles all round. Adjustments during commissioning are expected and she is already outperforming her polars.

*Maximus* was to leave New Zealand on 18 March but a delayed shipping schedule means she will do the Auckland-Tauranga Race at Easter – allowing it to claim the debut of a New Zealand-built, world-class maxi.

**_Maximus'_ 850m² downwind sail area and 3m prod will power her attempt on the 24-hour record; the keel is always canted, to keep the boat flat.**

*See story: Technology on Maximus, page 28*

web www.supermaxi.co.nz

## SPECIFICATIONS

| | | |
|---|---|---|
| loa | | 30m |
| lwl | | 28m |
| boom | | 10m x .45m |
| SAILS: | | |
| | code zero | |
| | mainsail | 330m² |
| | upwind sails | 530m² |
| | downwind sail | 850m² |
| | prod | 3.5m |
| | gennakers | 3 |

PHOTO: IVOR WILKINS

# Technology on Maximus

BY **REBECCA HAYTER**

**"There's only one thing to do with righting moment," says *Maximus'* designer Greg Elliott: "increase it!"**

The pursuit of righting moment, without adding too much weight, was a primary strategy in designing the supermaxi, *Maximus*, to be the fastest monohull in the world under 100ft. Of course, that title has yet to be earned but it was top of the brief from her owners and Elliott proved his ability as part of the design team of the 140ft *Mari Cha IV* which broke the 24-hour record with 525 miles last year.

Let's get *Mari Cha IV* out of the way: like *Maximus*, she's built in carbon, and has a canting keel. Unlike *Maximus*, she has two masts – both of which are non-rotating, water ballast and a different racing programme. They are, says Elliott, quite different concepts; *Maximus* is not a baby *Mari Cha IV*.

*Maximus* hit the water on February 14 having begun, as many boats before her, over a beer between two mates – Auckland businessmen/ocean yachtsmen Charles St Clair Brown and Bill Buckley.

Their brief to Elliott encapsulates what he loves to do: design for speed rather than to a rating rule. He blames rating rules for slowing the development of monohull technology while multihulls, racing on the basis of length, have been free to explore it. He welcomed the announcement from Sydney Hobart Race organisers that they will accept entries from yachts up to 100ft, with more open stability requirements, in this year's race. Across the Tasman, ocean racers Neville Crichton, Bob Oatley and Grant Wharrington welcomed it too – all have canting-keel supermaxis in build or rebuild. The 2005 Sydney Hobart promises great battles.

Largely freed up from stability rules, monohull designers are seeking greater righting moments and, this year, that means canting keels. Simply, a conventional fixed bulb keel has the weight down low to counteract the force of the wind in the sails. This counteracting force is called righting moment. The heavier the bulb, the greater the righting moment, and the more sail area the yacht can carry – up to a point.

A canting keel, however, can swing its bulb out to windward, using the lever effect to increase the righting moment, allowing the boat to carry more sail area. Mini Transat yachts and Open 60 yachts have had canting keels since the early 1990s, but they are relatively new on other ocean racing yachts. Canting keels can provide some interesting moments:

**TOP:** The hull was built over a male mould, pictured; the owners have retained the moulds, hoping to sell sisterships to *Maximus*.

The deck was built over a female mould, using CNC technology. When joined to the male mould, there was a tolerance of less than 2mm between the two.

they need to be canted to the new windward side when the boat tacks or gybes – get the timing wrong, and the boat will lean at decidedly odd angles. You don't want to even think about a crash gybe.

They also exert tremendous loads on the boat, which is where modern, structural engineering technology comes in.

Elliott's not revealing the exact righting moment, usually expressed in tonnes, but *Maximus'* keel has 12 tonnes of lead in its bulb, which is on a six-metre keel fin which cants to 50 degrees off vertical. The keel of Australian racer, *Skandia*, canted to fewer than 35 degrees but this was due to racing rules, then effective. *Maximus* is probably the first supermaxi with a keel that cants to 50 degrees.

St Clair Brown and Buckley wanted their boat to win major offshore races – the Sydney-Hobart, the trans-Atlantic challenge and its 100-year record, the Fastnet – and inshore races, such as Antigua Race Week and the Rolex series in Europe. It's difficult to design for inshore and offshore, Elliott says, as offshore racers have smaller rigs, more back-up systems and accommodation which disadvantages them against inshore racers.

In regattas, *Maximus* will power her winches hydraulically, but when competing for ocean records, the rules dictate she must be people-powered. One of those is the 24-hour record. "We have a strong chance," says Elliott. "I just want to do better than 525 miles; 526 is fine by me." He intends being onboard for all races.

He received the brief just four months before construction was due to begin. "It's a massive project," he says. "I was working on it, thinking about it, 24 hours a day." That included extensive research at the wind testing tunnel at the University of Auckland and VPP work

(Velocity Prediction Programme) by Team New Zealand designer Clay Oliver.

Starting at the maximum length allowed, 100ft, Elliott explored many options, including a canting, rotating rig, to eventually establish the optimum beam for the length, given the driving force: ie, the rig, and the available power: ie, the stability.

Other supermaxis have avoided the technical challenge of a canting keel and a rotating rig in the same boat. Elliott says simply, "Someone has to be first."

"I wouldn't say it's a big rig, it's a moderate rig for the size of the boat – it could certainly be bigger but that's determined by how much righting moment you have so there's a limit. If you're an inshore boat you could potentially have a bigger rig for the same horsepower because you're not having to put up with extreme weather.

"It's all very well trying to be the fastest in the world but if you don't finish… With Maximus, I think we're very close to the mark but we haven't overstepped the mark."

The aerodynamics of the Southern Spars-built wing mast will sail the boat at 4-5 knots under bare poles in a strong breeze – an effective safety feature. A conventional rig, when reefed down, creates drag, whereas a wing mast prevents a boat from being a sitting target for waves. St Clair Brown jokes that it's *Maximus*' storm trysail.

*Maximus* has a relatively narrow waterline beam, to achieve low wetted surface, but the hull flares to the gunwale to provide a wide spreader base to support the rig.

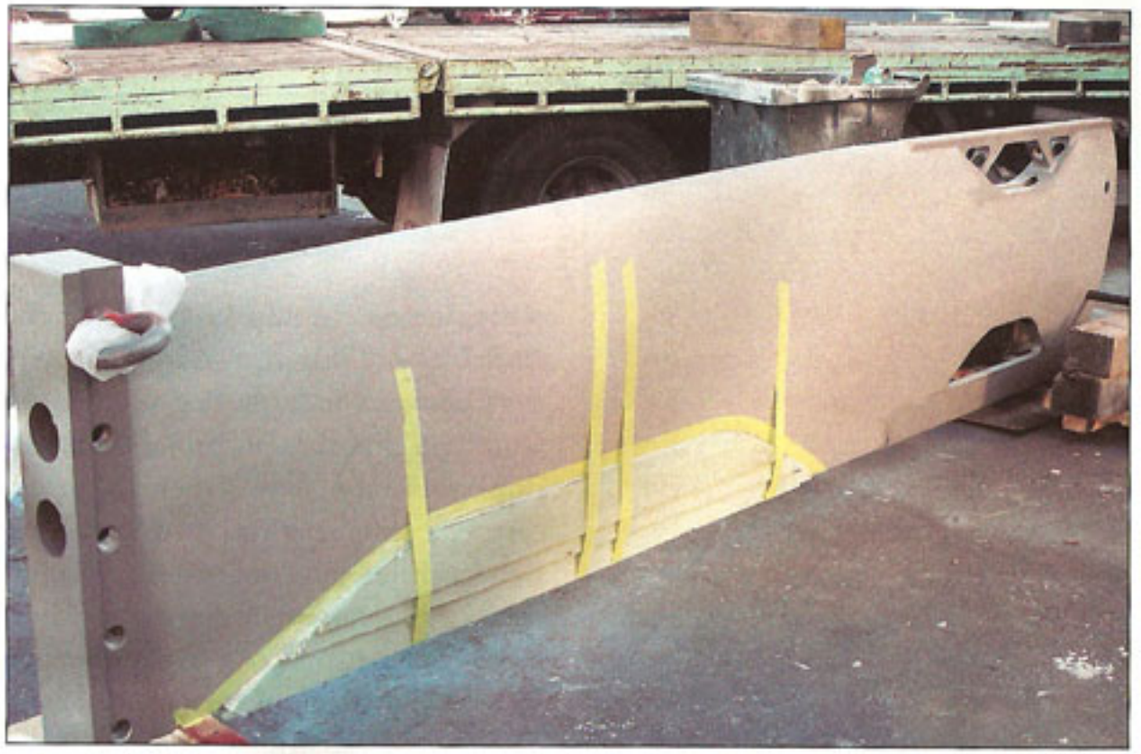
When tacking or gybing, the crew release the rotating mast and allow it to swivel to the opposite tack, where it is trimmed in, similar to a headsail. It even has woolies. Load cells in *Maximus*' forestay enable crew to set the backstay tension according to the headsail, the wind angle and wind strength.

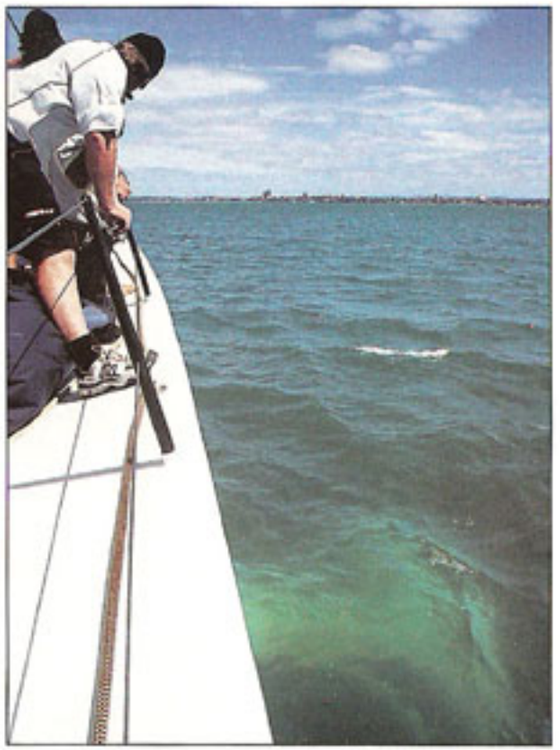
## THE KEEL

When belowdecks in *Maximus*, the only indication that you are standing on one of the world's most innovative keel systems is the slightly higher sole. We weren't allowed to photograph beneath it but here, in a large wetbox, resides the keel system.

**The construction of the hydraulic canting keel mechanisms, by Buckley Systems Ltd, is the subject of several patents. The six-metre fin carries a 12-tonne bulb, which can cant to 50 degrees off vertical, creating a righting moment equivalent to putting 200 people on the rail.**

When the boat's stationary, this wetbox is full of seawater which enters where the canting keel passes through the hull – this is normal for a canting keel boat, albeit disconcerting. The





**FAR LEFT, LEFT:** The keel fin and outer fin in build. **ABOVE:** This is weird – the canted keel, as seen from the deck.

water venturis out when the boat reaches eight knots of speed.

Because *Maximus* has a six-metre draft, the keel fin slides up inside another fin to 4m draft, to allow access to marinas – the biggest retracting, canting keel in the world. It was built by Bill Buckley's precision engineering and nuclear physics company, Buckley Systems.

The entire retracting mechanism, involving two hydraulic rams, is within the lower fin; two more, massive hydraulic rams cant the keel's centrecase once the keel is fully lowered. There are many patent applications on *Maximus* – several involve the installation of these mechanisms below the level of the sole, within the narrow waterline beam and below the boat's centre of gravity. Other canting keel maxis tend to have cabins cluttered by hydraulic gear.

"The engineering by Bill Buckley and his boys is just absolutely outstanding," Elliott says. "As much as I gave them parameters for the shapes and the sizes for where it has to go, they did all the engineering and how strong it needs to be, plus all the machining. And it's big, really big gear."

*Maximus* will always sail with her keel fully extended. In light winds she may have the keel dead centre, but never to leeward. As the wind increases to 10 knots, she will cant it fully to windward. Sensors in the keel indicate the degree of cant which displays on the cockpit sailing instruments.

As for downwind sailing – there is no such thing. *Maximus* generates so much apparent wind, like a multihull, that the apparent wind angle is always forward of the beam. At 140 degree true wind angle, she's sailing at 60 apparent.

*Maximus*' main propulsion is also the subject of a patent. Her turbo-charged 256hp Sayer diesel engine drives a hydraulic propulsion system. This saves the weight of a gearbox and provides sufficient take-offs to run all the hydraulic pumps.

## THE CANARD

A canted keel does not provide the directional stability of a conventional keel so *Maximus* has a 4m retractable canard, or daggerboard, for'ard of the mast.

PHOTO: IVOR WILKINS

Without it, she would make unacceptable leeway; with it, and its trimtab, she can hunt extremely high sailing angles.

"She'll go upwind like a homesick angel," predicts St Clair Brown, adding that they expect to achieve 10kts VMG (velocity made good).

## SAFETY

Last year the sight of *Skandia*, upside down and keel-less in the Tasman Sea, spurred criticism of canting keels. Fixed-keel boats also suffered mishaps in that race but there is no doubt that 12 tonnes of ballast swinging out of control beneath a yacht is the stuff of nightmares.

*Maximus*' keel system has three fail-safe measures. Firstly, in case of collision or even a hydraulic hose coming loose, valves will lock the keel in place and require a manual over-ride – we inadvertently tested that system during our sail. Secondly, *Maximus*' wetbox is built to absorb collision loads, fore and aft.

Thirdly, if the main engine fails, a back up generator will power the hydraulics that control the keel. She also has water tight bulkheads fore and aft.

"I don't believe canting keel boats have to break," Elliott says. "Mari Cha IV is the largest canting keel boat in the world. She holds the 24-hour record, not bad for a monohull. She's had no faults, no dramas – it's quite do-able. I think the technology is there, it's just a case of being studious and using the right technology. I've got a lot of confidence in the system we have.

"The boat that wins the Sydney Hobart this year" – he rams his knuckles on the table for emphasis – "is going to have a canting keel."

But, it's also about good seamanship. The static load on *Maximus*' mainsheet is 5.5 tonnes but the boat's motion through big seas can take that to much higher than can be designed for without producing a low-performance battleship.

"So you have to sail within the bounds of what you have," Elliott says: "slow the boat down to the conditions.

"It's quite the opposite to what people think. Forget about canting keels being dangerous; they are actually safer. If the keel is centred then the angle of vanishing stability, AVS, is 160 degrees.

From upright it can be knocked down to 160 degrees off vertical before it doesn't come back." Most offshore race rules demand 120 degrees AVS.

## CONSTRUCTION

*Maximus* is carbon fibre throughout, with foam and Nomex cores. Everything – pipe berths, racks for the wine glasses, fridge and freezer, and surrounds for separate shower and heads – is carbon.

Elliott Boat Design Limited provided CAD files to Cookson Boatbuilders who used CNC technology to create the deck on a female mould and the hull on a male mould. They were built in separate sheds but came together with less than 2mm tolerance around the 200ft-plus of gunwale – Elliott's extremely happy with the result.

"I think it's a very good project for New Zealand," he says. "It's not very often that a boat gets made here for a New Zealand owner and then goes out and has a go at regattas around the world."

But what he really likes about the boat? "I just think the whole thing looks cool. I think it looks way cool."

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**Suppliers to *Maximus* include** – Greg Elliott, Elliott Boat Design Ltd: principal design; Clay Oliver: VPP analysis; High Modulus Ltd: composite engineers; Buckley Systems Ltd: mechanical engineers: Chris Mitchell/ Southern Spars Ltd: spar designers: North Sails NZ: racing sails; Doyle NZ: delivery sails; Cookson Boatbuilders: construction; A Foster & Co Ltd: Harken gear; Adhesive Technologies: resins; Aquapro, Generic Images, Gulf Harbour Refits, Line 7 Events Clothing, Navtec, Nicholls & Maher Ltd, Onboard Systems, RFD, Sailors Corner, Southern Ocean Ropes (Maxwell Marine), Sparloft Industries, A&G Price Ltd, Altex Coatings, BEP Marine: switchboard; Demon Design, Electronic Navigation Ltd, Expedition (Software), Kiwi Yachting, Marine Industrial Group, NeoNeon, Power & Marine, Ronstan, Sealectrics, Southern Spars, Viaduct Harbour Marine Village, Touch Of Gloss: paintwork; Auckland University: wind tunnel testing.