New Zealand Naval Architect

A quarterly newsletter of the New Zealand Division of the Royal Institution of Naval Architects Issue 18 ? December 2002

WAVEPIERCER POWER TRIMARAN

by André Moltschaniwskyj

Fig I – 6m Wavepiercer Trimaran Proof of Concept Model (photo credit Geoff Green)

A sure-fire means of grabbing the attention of the New Zealand public and boaties in particular is to draw a vessel that looks vaguely military in appearance, then launch it painted primer grey (there wasn't sufficient budget to do a final gloss coat) and have it buzz around Auckland's Waitemata Harbour.

So just what is it? The best description is 'wavepiercing trimaran' and it employs elements of boat design that have been well proven in the past, but perhaps not assembled in quite the package that the company – Craig Loomes Design Group Ltd - has arrived at.

The concept was born following an inquiry five years ago for a high speed passenger ferry capable of carrying 350 passengers and 20 tonnes of cargo on a rough weather

INSIDE

A Word from the President

2002 has been a defining year for the New Zealand Division. We have welcomed a substantial number for new members, we have successfully launched our CPD programme and we have organized New Zealand's first ever yacht research conference.

It has been good to see a healthy influx of new members in the last year, largely on account of the growing profile the RINA is enjoying within the New Zealand industry. As more and more people learn of the organisation and our activities here in New Zealand, growing numbers are joining and making the most of what we offer. Of particular note is the number of members in Wellington and in the South Island – maybe we should be looking to hold a few meetings for our more southerly members sometime.

It is especially gratifying to note that we have the largest Council membership on record, with 11 members currently serving. Thanks to Jerry Bennett (secretary), John Cable, Susan Edinger (members' meetings, website), Graeme Finch (Vice President), John Harrhy, Angelo Lavranos (editor of monthly updates), Chris Marks (Treasurer), Chris Marks, Helen Quekett (Editor of NZ Naval Architect) and Laurence Withy. These people give their personal time free of charge to the running of our events and services; without their dedication there would be no NZ Division.

Our Continuing Professional Development (CPD) programme is gaining wide recognition around the industry for providing relevant, informative courses with the opportunity for strong networking with industry colleagues. Our first course, on Lightning Protection was conducted by Dr Ewen Thomson (University of Florida, USA). This was a great success, with many of the lessons learned now being actively applied to many of the vessels built and building around the country. After a substantial break, our next course was on Noise and Vibration Control on luxury yachts, presented by Sjaak Van Cappellen (Silentline B.V, The Netherlands), and sponsored by Industrial Research Limited. Our final course for the year, 'Principles of Yacht

(Continued from page 1)

Design', by acclaimed author, naval architect and hydrodynamicist Professor Lars Larsson (Chalmers University, Sweden), is in the final stages of organisation as this magazine goes to press. Interest is the strongest of any course yet. We are now in discussions with several people over possible courses for the 2003 programme and are looking forward to developing this key area of our work.

High Performance Yacht Design 2002 promises to be a great success. The product of an enormous effort by RINA, The University of Auckland and Massey University, this conference promises to be the focus of the yacht research world. Response from authors to the event has been incredible, and comments from the international technical review panel descibe the papers submitted as of the highest standard. Registrations are strong from both local and international delegates keen to be part of this exciting event. Much credit is due to our sponsors, in particular the New Zealand Government through its development arm Industry New Zealand, as well as our Gold Sponsors, Industrial Research Limited, High Modulus and VT Shipbuilding / Fitzroy Yachts.

As well as these larger events, we continue to run members' meetings on a monthly basis. These events attract a small but lively crowd and are invariably both interesting and informative. Our library is now fully operational, thanks to our hosts, Industrial Research Limited and the collection's founding benefactor Ted Ewbank FRINA. Members are encouraged to contribute to this resource for current and future generations of naval architects in New Zealand.

We have recently signed a sponsorship agreement, confirming Clendon Feeney as Honorary Solicitors to the New Zealand Division. The first part of their work has been to update the NASNZ Standard Terms of Trade and Standard Design Contract, both to reflect the organisation's new identity as RINA, but also in response to recent law changes. Members are encouraged to make use of these documents as they become available. To make this even easier, they will be available for free download from the NZ Division website.

Finally, a continuing project in recent years has been our work with other industry bodies in the establishment of tertiary marine qualifications. In particular, we have been working closely with the BITO in their efforts to develop marine drafting, marine systems design and marine project management courses. Many of our members have generously contributed to the best practice drawing project in which we aim to produce a set of example drawings for the next generation of designers and draftspeople in our industry. We also continue to work with the University of Auckland in their development of small craft related courses at the School of Engineering.

As you can see, it has been a busy time for the New Zealand Division. However, if the growth in activity is indicative of the future of the Division, the next few years are looking most exciting.

Wishing you all a safe and happy Christmas,

Michael Eaglen

President.

route of approximately 134 nautical miles between the Indian Ocean islands of Mauritius and Reunion. The potential operator was keen to compete with airline turn-around times, requesting an average route speed of 50 knots. The 40 knot catamarans operating the route at the time were experiencing structural problems, difficulties adhering to timetables, sea sickness and even physical injury of passengers due to the rough seas commonly experienced on the route – in the order of 3-4m significant wave height on any given day.

A number of hull types were examined for their suitability to meet the brief.

Two limiting issues kept arising – the power required to achieve the high average speed requirement, making SWATHs impractical, and limitations on geometry required to ensure that large volume passenger cabins remain clear of wave slamming that would have required the overall size of the vessel to be of commercially impractical proportions.

The solution, developed by CLDG, was to stop worrying about going over waves and simply go through them – with the entire vessel if necessary.

Designer Adrian Thompson and Paragon Mann of the UK had developed a monohull wave piercer for military deployment of assault troops at high speeds through rough weather. The choice of the monohull form was driven by aircraft loading requirements rather than sea-keeping qualities. Although at optimum speeds these craft display very good passenger comfort in rough seas, the roll stiffness at lower speeds is diminished (where the dynamic lift offered by large chines is lessened) and at rest the large roll angles and long roll period can be uncomfortable for passengers.

An obvious way to gain increased levels of stability without resorting to ballasting was to use additional hulls or sponsons placed outboard of the main hull and this is the solution used by Nigel Irens on his Ilan Voyager and Cable and Wireless designs.

In the Wavepiercer Power Trimaran design the sponsons were kept well aft. This was to keep the longitudinal centre of gravity much further aft than would normally be aimed for in the interests of preventing bow bury in following seas. The distance between the main hull and the sponsons and the fore and aft location of the sponsons has a significant effect on hull resistance, powering requirements and fuel burn at different speeds.

The ferry project remains active and initial funding is now being put in place to construct a 24m scale model of the 55m ferry in Mauritius. Hopes are high of establishing a fledgling – perhaps boutique ferry construction industry catering to short haul, rough weather routes suited to the proposed hull form.

In New Zealand, local interest in the design was growing. Darren Schofield, managing director of Auckland boat building company Custom Yachts, wanted to use the design as a fast pleasure boat for him and his family to do their traditional Auckland to Great Mercury Island Christmas run. The trip can mean encountering waves of 2 – 4m.

Darren Schofield agreed to build a 'proof of concept' model, the result being the stealthy looking primer grey 'tri'. The model was built for two reasons. Firstly, although it is not a terribly expensive exercise to tow test at the Australian Maritime College in Tasmania, the 50-knot sprint speed the client was looking for would have resulted in a scale model of very small dimensions to fit the maximum carriage speed of the Launceston facility. This would have meant a diminished degree of confidence in the results. Secondly to understand sea keeping performance both subjectively and numerically it is difficult to get a 'human feel' for how it would handle at sea from acceleration data obtained in wave tank tests.

With a mixture of funding sources, the 6m scale model of the 18m ship was constructed in foam sandwich composites over a male mould. Powered by a 90hp Mercury outboard, it displaces around 650kg, although once ballasted to correct for the exaggerated aft placement of the power plant and two up, it is approaching the 1000kg mark normal for a runabout of around 5 – 5.5m.

Performance is as expected for this power to displacement ratio – with a top speed in the order of 38 knots. The actual top speed of the model is less important than achieving the scale speed for the 18m ship and the model needs to do 28 knots to mimic the

behaviour at 45 knots of the 60 footer.

At the time of writing, a program of towing the model behind another boat is planned. Using load cells to determine resistance, powering predictions for an 18m ship can be made more accurate. This is a technique has been used on scale models in the past, with very good results.

But of significant interest is how the model performs in rough weather.

This is a two-step process; ultimately CLDG intends to work with Industrial Research Ltd to place accelerometers on the boat and run it through standardized wake patterns generated by the Police boat Deodar. This data can then be matched against data gathered from other boats of similar displacement and/or overall length and will provide a valuable comparison of performance. Industrial Research is interested in the ability to instrument the 18m vessel at a later date and use the twin sets of data to assist in their future ability to predict vessel motions from hull form geometry and model data.

A large number of people have driven the boat in varying sea states. Generally their responses have been positive.

The first reasonable waves encountered at 25 knots can invoke a little apprehension as the crest of a 1m wave is almost at the height of the driver. However, instead of the expected crash that would be experienced by a 6m planing runabout, the boat smoothly punches straight through the waves.

There is no noticeable vessel deceleration when wing deck slam occurs. There is no tendency for the bow to 'go down the mine' in following seas. This is a result of keeping the longitudinal centre of gravity well aft.

Fig II – One man on the gunwhale and negligible roll angle (photo credit Geoff Green)

Steering at high speeds has also proved to be very good – the sponsons providing a significant measure of dynamic stability. The boat simply turns flat as if on rails – the impression from inside the cockpit is similar to that of a video game – with little impression of any roll or sideways forces – just the horizon sliding past the narrow slot of a windscreen until you straighten the wheel.

In head seas in excess of approximately 1m in height, forward progress can be impeded by visibility problems – the windscreen is flooded by each oncoming wave and clears just in time to catch the next one. In the 18m ship the seas will need to be in excess of 3m to achieve the same result, but a good set of wipers recessed from the wash of green water running over the deck would be helpful.

Even before a formal trials and measurements program on the model has begun, it has been judged a success. Schofield is keen to make a start on the 18m full-scale boat and plans are afoot for a circumnavigation record breaker of 30m overall length.

Given the length of time taken for the power catamaran hull form to gain acceptance in the market place it is unlikely there will be a flood of power trimarans, particularly as there are aspects of the boat's design that will be less than practical for some

Fig III – Wave piercing! (photo credit Geoff Green)

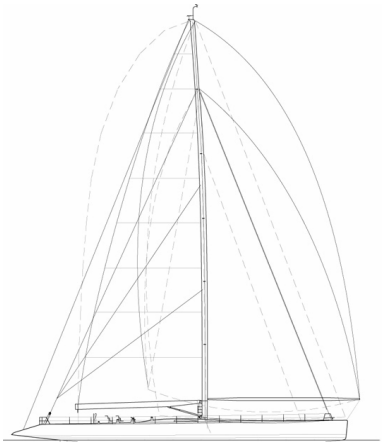
applications. But with this design, the terms of the brief have been met and maybe a small step has been taken in the ongoing quest for a boat that has smooth ride characteristics in rough seas at high speed.

André Moltschaniwskjy is a shareholder and director of Craig Loomes Design Group Ltd (CLD). He is a degree qualified mechanical engineer, specializing in marine composite structures having worked with well known composite materials supplier and consultancy, High Modulus for a number of years. He worked with Craig on a number of projects prior to joining CLD, including the award winning wavepiercer catamaran 'Ultimate Lady' and has been involved in the wavepiercer trimaran project from its inception.

IRC 1.6 MAXI RACE YACHT

By Brett Bakewell-White

It is rare to be invited to develop a design for a new maxi race yacht with a relatively open brief, particularly for a New Zealand owner. One of the first issues to deal with is "where do you start?" This is made all the more difficult by the current situation with rating rules and no consensus on where these are headed in the near future.



IMS is on the decline in most parts of the world and IRC has limited use outside the UK, Australia, and South East Asia. In this case the client is not particularly interested in corrected time results and has a belief that the general community can only relate to who finishes first over the line, so this means that speed is the number one objective in this exercise.

Other stated objectives from the client were the desire to win the Sydney to Hobart race, a crack at the 24hour speed record for monohulls, and a chance to break some of the coastal and offshore race records in the Pacific. Initially the client also expressed an interest in the possibility of utilising spars and sails from Americas Cup campaigns. The only one of these events that places any rating limits on the boat is the Sydney to Hobart and an IRC 1.6 limit maxi is always going to be faster than an IMS maxi, so the decision was made. This was further helped by a number of other potential owners making a similar decision and so a new breed has been born.

Traditionally maxi race yachts have been approximately 80ft or 24m long and this was still the case with the current IRC boats, which are around 75 to 82ft in length and in some cases carry water ballast and quite extreme mainsail profiles. The Bakewell White office had some experience with the yacht "Nicorette", designing her new foils prior to her winning the Sydney to Hobart race and so this gave us some benchmark data with which to start our analysis.

Limited experience with the IRC rule meant that the next stop was the RORC Rating office in the UK to try and get some direction as to what could and couldn't be done within the rating process in order to establish the design target. They were helpful in supplying certificates for a number of yachts that were either at or approaching the 1.6 time correction limit. This data was then put into a matrix to get some sort of handle on what is happening with the rule. IRC is a 'secret' rule and manipulation is strictly forbidden, there is a limit of 6 trial certificates for any one boat within a 2m length range.

Having completed a look at where everybody was currently at within the rule, some basic parameters were established for the new design. The starting point was a yacht that was slender and 90ft long. At the same time, a design was developed that was seen to be an improvement on 'Nicorette' using the same basic rule parameters – this became a "control".

It was suspected that water ballasting was treated fairly harshly under the IRC rule and so a VPP comparison was run with our 90ft boat up against the water ballasted control. In some conditions the new boat was faster – so what would happen if it were made longer still? Inevitably the longer the boat the better the answer, but how would it rate?

With only six trials careful use had to be made of them. The target design had grown to 29m or 95ft so it was decided to trial it with an Americas Cup rig and see how the rating turned out. Surprisingly it was still well under the maximum rating, and so this confirmed the suspicions about water ballast. It was Bakewell-Whites contention that it was better to take to take the additional length and its associated increase in performance in all conditions.

Having confirmed the direction in which to develop the design of this yacht, 30 variants were created and raced in the VPP, always including water ballasted control. It has been an interesting exercise working through the development of a yacht of this size and displacement – a hull form that is quite different from that which was expected has emerged, and quite different from those developed for smaller yachts even though an almost identical design process has been used. This was to be a precursor to the development of all other aspects of this yacht, and one that other designers of these new 'super maxis' will be going through as well.

So the hull was now at 30m in length, but the testing was showing a potential vulnerability in light air downwind when competing with the control – not enough sail area! A discussion with various people early on had ruled out the use of a modern Americas Cup rig offshore and any modifications rapidly diminished the economic sense of the exercise, and on top of this they are heavy compared with a custom built rig. Americas Cup sails still made some sense for inshore regattas, but the loads that this yacht will see were taking on epic proportions. At the same time the dimensions of the opposition designs were becoming known and it was rapidly becoming clear that a bigger rig was needed! 'Best guess' models of the other boats being built were developed and run in the VPP - except in light air downwind the new boat was looking good. That sealed it, and the rig became taller and longer. During this process, trial applications were sent to the rating office and then the results back were factored into the design process.

So at the end of the trials, the design was for a long slim boat that looked great, and it is fast – now came the hard bit, holding it all together and finding the equipment to get the boat around the race track with the crew in one piece.

Applied Engineering Services had made a number of analyses of rig and sailing loads, and these, along with general drawings of the yacht were then taken along to a meeting with composite engineers High Modulus. From here a discussion of structural arrangements and material options took place in conjunction with the owner. High Modulus then carried out an extensive study of laminates vs. stiffness, vs. weight, vs. cost prior to any decisions on being made on construction and structural layout.

During this period a building team was being assembled and once this had been established then the principal building contractor, Hakes Marine, was brought in as members of the design team. Paul Hakes and his team had just completed building an Americas Cup yacht for the ill-fated Illbruck campaign and so they brought state of the art composite boat building experience to the project. Their input was pivotal to decisions on materials and construction techniques.

Potential equipment suppliers now became involved in the process of developing sailing systems. The problem faced here is that there are not too many full-blown race yachts of this size prowling the world's racetracks and so experience in this size gear is limited primarily to the Americas Cup, only this design was taking it offshore. Reliability and safety take on a higher priority during sailing and maintenance costs are also a more important consideration.

A further complication for the layout and structure within the yacht is that although using water

THE YACHT RESEARCH UNIT AT THE UNIVERSITY OF AUCKLAND

Professor Richard G.J. Flay, Mechanical Engineering Department

The primary function of the YRU is to coordinate and promote research and engineering activities related to yachts within the University of Auckland. It has done this well and its graduates have been very successful in contributing to the marine industry and are prominent in the areas of mast, sail, and hull design including the Team New Zealand designs which won the America's Cup in 1995 and defended it in 2000.

Since its beginnings in 1987, research topics have covered a wide range of areas including the analysis of mast and rigs, predicting the aerodynamics of sails, wind-tunnel measurements of sail forces, hull/keel interactions, performance prediction of yachts, and race simulation. Its early work on composite hull structures also led to a rapid expansion of activity in research of composites in many other fields of engineering, and eventually led to the University's Centre for Composites.

Some YRU milestones have been:

- obtaining the first successful computational solutions for the coupled structural / aerodynamic behaviour of sails
- application of computational fluid dynamics to the flow around spinnakers
- construction of the world's first wind tunnel with twisted flow for testing sails
- the inclusion of advanced optimisation methods into a velocity prediction program.

The Twisted Flow Wind Tunnel (TFWT) at the University of Auckland is the largest facility of the YRU (test section 7 m wide and 3.5 m high), and has been designed as a research tool specifically to simulate the flow of wind over yacht sails. Typically, the yacht models have a mast height of about 2 m, which results in a scale of around 1:15 for an America's Cup model, and 1:12 for a Volvo Open 60. The TFWT is used to carry out sail testing for Team New Zealand, and has also been used to test sails for several of the Volvo Round the World Race syndicates, including the 2002 winner.

The YRU is currently very active with research collaborations with Team New Zealand and other organisations. It has several Masters and PhD students, as well as a steady stream of students from European universities on Exchange Programmes, who are carrying out their "International" project within

ballast had been discounted when rating the yacht, it had not been abandoned from the perspective of ultimate performance. How can 5 or 6 tonnes of water be loaded, transferred, and dumped as quickly as possible? At the sort of speeds that these new yachts sail, even upwind, minimising the time involved in water management is critical from a tactical perspective – the yacht will have travelled more than 120m every 20 seconds while waiting to tack. The plumbing and pumps involved take up a significant amount of internal space whilst having a serious impact on the design of structural members.

Critical structural components have been carefully reviewed by High Modulus and then put through finite element analysis to establish the most suitable solution. This process has been crucial to establishing the most cost and weight effective solutions to various areas of the structure particularly keel grounding loads, and the impact of penetrations through structural components.

The sailing systems and deck layout have been carefully scrutinised and discussed by a number of sailors experienced in both Americas Cup and offshore Maxi boats. Various scenarios have been played out so that there have been established methods of handling sails, manoeuvres, and breakdowns. The loads involved are such that it will not be possible for the sailing crew to simply 'suck it and see' once out on the water.

Due for completion mid 2003, the yacht is now well down the build timetable with the hull completed and 80% of the internal structure built. The use of 3D computer modelling has meant that all of these structural components were built outside the boat from full scale patterns and will later be fitted to the hull itself. All bulkheads, frames, and floors have been built this way. The deck mould is 50% complete and the shear size of the yacht is becoming apparent.

The foils will be CNC milled and are complex structures on their own. The carbon fibre spars are under construction at Southern Spars and the custom deck gear and winches are being manufactured in the US and Italy by Harken.

There is a huge team of people involved in the creation of this exciting race yacht, and it is a privilege to be involved in such a major event in the New Zealand yachting story.

Brett Bakewell-White is Design Principal at Auckland based yacht designers Bakewell-White Yacht Design Ltd.

Recent Technical Meetings

Over the winter we have had a series of technical meetings including three from members of Auckland University.

Meetings are generally held at 7pm on the second Tuesday of the month at the BIA offices 1/38 Ireland Street. These meetings are open to all members as well as interested people from the wider community.

AUGUST: ***EU Recreational Craft Directive 94/25/EC and Related ISO Standards. An Outline of the CE Certification Process.*** Nicholas Kyprianidis, EU surveyor of the International Certification Institute, Australia and New Zealand.

SEPTEMBER: ***Wind Tunnel Testing of Yacht Sails and the Comparison to Full Scale Aerodynamic Sail Force Measurements.*** Heikki Hansen, University of Auckland, Yacht Research Unit.

OCTOBER: ***Introduction to the University of Auckland Centre for Composite Research,*** Professor Debes Bhattacharyya, Head of Mechanical Engineering Auckland University.

NOVEMBER: ***: Soft Body Impact of Honeycomb Sandwich Structures.*** Dan Wadsworth, PhD candidate, University of Auckland, School of Engineering.

Forthcoming events

HP Yacht Design Conference: 3rd—6th December:.

Louis Vuitton Cup:

Semi-Finals:	9th-16th December
Repecharge:	20th-28th December
Final:	11th-21st January 2003

Americas Cup: 15th—22nd February

There are no technical talks scheduled for December and January as it is the holiday season and most of us will be enjoying a well earned break.

ClendonFeeney
BARRISTERS & SOLICITORS

The Royal Institution of Naval Architects (New Zealand Division) would like to announce that Clendon Feeney Barristers and Solicitors have committed to a five-year sponsorship of the Division.

The sponsorship, confirming Clendon Feeney as Honorary Solicitors to the New Zealand Division, provides for legal services and offers the opportunity to organise programmes for continuing development covering current legal issues.

Clendon Feeney has been closely involved with RINA NZ (formerly NASNZ) for many years. The first part of their work has been to update the NASNZ Standard Terms of Trade and Standard Design Contract, both to reflect the organisation's new identity as RINA, but also in response to recent law changes. Members are encouraged to make use of these documents as they become available. To make this even easier, they will be available for free download from the NZ Division website as well as www.clendons.co.nz.

The New Zealand Naval Architect is published quarterly.

All correspondence and advertising should be sent to:

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