New Zealand Naval Architect

A quarterly newsletter of the New Zealand Division of the Royal Institution of Naval Architects Issue 20 • December 2003

MAXI OR MINI

by Brett Bakewell-White

INSIDE

Bakewell-White Yacht Design have recently had headlines for the design and launching of their maxi race yacht **Zana** that was featured in this newsletter, but BWYD has also been responsible for the Minis of Chris Sayer and Liz Wardley. This design was being developed at the same time as **Zana** and although opposites in size the design process was in many ways similar.

Zana testing on Wellington Harbour

Originally they designed an Open 50 for Sayer, but this had to be put on the back burner when Sayer was unable to raise sponsorship for the project.

"I spent fair amount of time talking to him about how he likes to sail the boat and we discussed my thoughts on single-handed sailing

(Continued on page 2)

A Word from the President

I would like to take this opportunity to wish all members of RINA (NZ) a Merry Christmas and trust that you all manage to find time to relax and enjoy the festive season.

Although elected as President in April, this is my first opportunity to write the President's column and, on behalf of the membership and RINA council, would like to offer our heartfelt thanks to Michael Eaglen for his work as President. Michael put a considerable amount of time and effort into the role and was instrumental in manage the transition from NZNA to RINA (NZ) as well as orchestrating the inaugural High Performance Yacht Design conference – Thank you Michael.

There are many members who I have not had the opportunity to meet, so I thought that I should begin by giving a brief introduction of my work and activities.

I manage the Engineering Dynamics team at Industrial Research Limited and have been involved in marine related research since the 1988 Michael Fay K boat America's Cup challenge. My team has gained an international reputation for research in the areas of advanced structural composites and dynamic loading on high performance vessels and I am very enthusiastic about the ability of New Zealand companies to innovate and provide cost-effective solutions. The team aims to provide the understanding and technologies that will enable the New Zealand industry to be recognised, not only as a world class producer of marine vessels and products, but also a country that develops unique technological capabilities and products. We are currently undertaking Technology New Zealand projects with High Modulus and Nilsson Winches as well as providing specialist consulting to several international clients.

My personal research interest is on the motion and loads of

(*Continued from page 1*)

recreational marine vessels and I have presented technical papers at both local and international conferences, as well as being on the organising committee for the first High Performance Yacht Design conference. I am also passionate about sailing, having competed in most of the major offshore races, I compete locally on a 50ft racing yacht.

The effectiveness of RINA (NZ) is driven by the members of council who effectively do all the work and I am fortunate to have an excellent team – a good mixture of youth and experience. We will be providing a profile of each council member in subsequent issues so that you can get to know the executive a little better. During my term as President I am keen to increase the membership and activity outside Auckland to ensure that we can justifiably claim to be a national representative organisation. At present 70% of the membership is based in Auckland with Wellington the next highest region with 10%. I have spoken with members in Wellington and Christchurch and hope to arrange local technical meetings in these regions next year.

The organisation is in a very strong position at present due to the hard work of the council members, special thanks go to Susan, who keeps the schedule of members evening meetings working so well, to Angelo for organising the CPD course on project management, to Heikki for managing our web development, to Michael for officiating at the inaugural RINA Babcock Naval Architect prize presentation, and to Helen for producing this Christmas edition of NZNA.

I trust that you all have a great Christmas and look forward to an exciting New Year.

(*Continued from page 1*)

and the sort of boats the French guys had been using and footage I'd seen of people sailing Minis and Open boats. And our philosophies seemed to agree. I think Chris was a bit surprised. I think he thought we might produce a skinny boat, but the reality is that the Open style rule drives you towards these great wide aircraft carrier type boats. You don't have a choice. I set out to do something more elegant. These boats were like trying to smash a walnut with a sledge hammer. But the reality is horsepower is king and the 10deg limit on the static heel drives you towards big wide form stable boats."

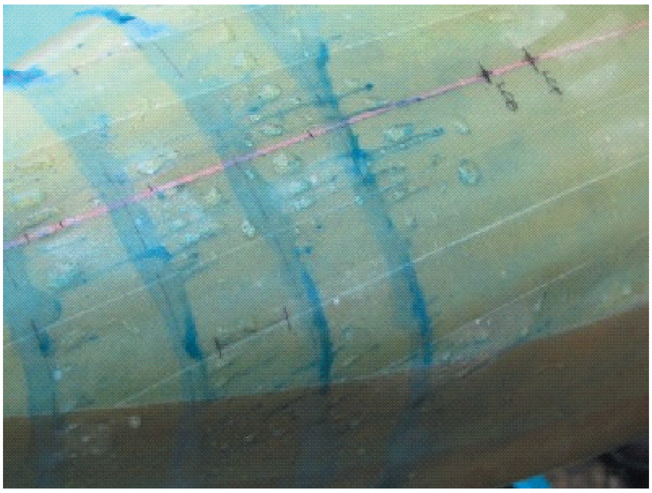
Having sailed *Navman* in the 1999 Mini Transat Sayer had a lot of input into the design. "Chris put together some data on the course and a weather model and we modelled his original boat and then we came up with four new designs of varying styles that we felt were worth pursuing and ran those through a reasonably sophisticated VPP programme, down the course using the weather model."

One boat was clearly better than the others with the forecast weather, but another was better all round. "One of the dangers of working with a weather model is that the average is seldom what you see. So there was a danger of running with the design that was best for that weather model. So we concentrated on those two designs and we looked at the differences between them and why we thought one was better all round than the other and why the other boat was specifically better in the race. We came up with another boat that was a hybrid design between the two and that finished the course within 20 minutes of the best of the first group and was also a good all round boat, so that was the boat which was built in the end."

Some basic tank tests were carried out in a swimming pool to establish flow around the boat in various states of trim to locate and orient the forward daggerboards.

Structural work on the boat was carried out by Team New Zealand's Andrew Kensington, formerly of High Modulus, while rig development was handled by Chris Mitchell who has worked on all Team New Zealand's rig development since NZL20.

One of the radical ideas used was a 600mm long forward facing strut used effectively to pole out the top of the forestay. Bakewell-White says that under the Mini rules you have rectangles to fill forward and aft of the mast. A mainsail with a large roach does the job, but the forward area is bisected by the forestay. "So we looked at poking it out to take up a bit more of that rectangle, but there are all sorts of other aerodynamic benefits from doing that.



By using dye lines and then towing the model the flow streams could be established.

With most rigs the point with the highest drag is where the forestay meets the mast and the sails come together very closely. By projecting that out forward of the mast and allowing the strut to pivot in all directions you can control the distance between the two sails with your forestay/runner tension. You can allow it to fall to leeward and open the slot out or by tensioning it on more you can pull it up to windward. And we are also flying fractional spinnakers off the end of that strut and that allows, if you ease the runners off when you're heading downwind, the gennaker to rotate around to windward on the end of the strut as the forestay goes slack." "It took a lot of messing around to get it right."

They are able to fly both masthead and fractional kites on a single halyard - a tweaker pulls the halyard into the mast when fractional kites are used.

Equally unusual is the boat's forward raked canting keel. The advantage of this is that the top of the keel foil and the 16:1 tackle to cant it doesn't invade the already cramped accommodation. However it also allowed the keel to be canted using the primary winches and without having to leave the helm.

There are significant low speed stall issues with the forward rake, however on a canting keel the keel strut is not there to provide lift. In fact its only function is to attach the keel bulb to the boat. This has lead him to another concept: "I spent quite a lot of time trying to do an Open boat without a keel and came up with a couple of ideas that worked, because the keel is just wetted surface - it's just drag. But the problem is being able to make it come back upright from upside down. Maybe we'll work on that a bit harder."

Bakewell-White dismiss the obvious argument - that the forward facing keel will shovel up all manner of flotsam. "It doesn't make any difference. You've got to have a rake aft of more than 30degrees before you shed anything off a foil anyway, so that is not really an issue."

Interestingly he says that the Mini that Sayer lost last year was carbon and Kevlar construction. "Chris decided to run with Kevlar/carbon because it was tougher in case he ran into something. There was a small weight penalty, but it was considerably more expensive to go to Kevlar. So when he lost the boat, and the keel got torn out of the bottom the Kevlar didn't help him at all. So this time he's building in carbon and will take the weight saving – and it's a whole bunch cheaper!"

The second boat is also marginally different in order not to be so on the edge in terms of its measurement. "We had it pretty fine in terms of freeboard measurements and internal volume. We've just decided we can live with slightly more safety margin. So we increased the freeboard by a few mills. The cabin got 100mm longer because Chris couldn't quite reach the jammers from the helm before, but essentially it is the same boat."

The mini is a boat that is strictly controlled in terms of basic dimension – it is a box rule. But there is also much freedom and remarkably there is far less consideration of human occupation than in a larger design such as **Zana**. The boats are so small and the space so cramped that the sailors simply accept that they will be uncomfortable and seldom go below anyway, usually sleeping in the cockpit.

Chris Sayer testing in the Hauraki Gulf

Generally Bakewell-White holds that most Open-style monohulls are far too complicated. "The important thing is that you've got to make it relatively easy to sail and a tolerant boat. It's all very well to have a boat that is 1 or 2% faster, but if you can't extract it out easily then generally you are probably worse off because most boats when you are getting to the front end of things with a high performance race yacht, tend to be fairly tweakly and if you don't sail them at 100% they don't perform particularly well. They tend to have a fairly narrow groove whereas if you just back off slightly then you end up with a more tolerant boat that will achieve 90 or 95% of its performance most of the time whereas a boat that is fully whipped as a race boat that is not being sailed at 100% its performance tends to drop away pretty rapidly."

This he says refers to the whole boat, giving sail handling systems as an example. "I sat and watched videos of guys racing Minis and there was the start to one race and the breeze started to back, and one guy got a lead of a couple of hundred metres and so he decided it was time to put up his gennaker. So for 20 minutes the thing was thrashing and slapping and carrying on and by the time he got the gennaker set he was just about last. So if you can set the boat up so it is easy to operate then you make it much easier on the crew, so you don't get tired so quickly and you'd be prepared to make sail changes. If you could save 10 minutes on gennaker sets - that's far more useful to you than getting a fraction of a percent out of the boat by tweaking the design or having a foil that is supposedly better."

The end result proved to be a well mannered boat that very nearly won the race – unofficially!

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

Update on the Yacht Research Unit at the University of Auckland

By
Associate Professor
Peter J. Richards

The major topics researched during the year include:

Real-time Velocity Prediction Programme

Sail testing in the twisted flow wind tunnel is usually conducted at fixed heel angles. It is only after the data is collected that a velocity prediction programme (VPP) can be used to find out how fast the yacht would be moving under those conditions and what heel angle it would actually sail at. The real-time VPP allows this analysis to be carried out while the tunnel is running, and then through an automated heeling mechanism alters the heeling angle on the spot. This process allows more realistic trimming to occur and means that the trimming can be adjusted to give maximum speed rather than the current practice of trimming for maximum thrust. Two papers on this research were presented at the Modern Yacht Conference in Southampton, UK in September 2003.

Computational Modelling of Downwind Sails

It will be some time, if ever, before computers can take over from wind tunnels, however we continue to seek effective and accurate ways of using computational fluid dynamic techniques for sail modelling. Work in the past year includes: the development of finite element models for rigging in order to allow for the deflections and distortions of sails under loads; a visiting American academic has been studying various turbulence models for use in modelling downwind sails and a student has been looking at adapting a locally written

(Continued on page 5)

(Continued from page 4)

unstructured finite volume code for modelling downwind sails.

Other projects during the year include: a study of the kites used for kite surfing; blockage corrections for the wind tunnel; Pacific sailing canoes and the optimal trimming of spinnakers.

Relocation of the Twisted Flow Wind Tunnel

For some time it has been recognised that the wind flow in our Twisted Flow Wind Tunnel was not as steady as we would like it. Two visiting overseas students have been working on a 1/8th scale model of the tunnel and building and have been investigating various ways to solve this problem. The conclusion of these studies has resulted in a plan to move the tunnel 5m into the middle of the building and to shorten it by 2.4m. This solution sounds simple enough, but moving a 25m long, 7m wide, 4m high tunnel that weighs several tons is not something that can be completed in an afternoon. However, it is hoped that with the help of some house movers, carpenters and electricians this move can be completed during February 2004.

An Investigation into Deck Diving of High Speed Catamarans in Following Seas

By Martin Hannon

Deck diving is a dangerous phenomenon encountered by high-speed passenger catamarans travelling in following seas. It occurs when the vessel is travelling faster than the waves, at speeds slightly faster than the wave celerity. After over taking the wave crest the vessel can bury its nose into the back of the wave in front, resulting in possible structural damage. In the worst case scenario, where the vessel has fine bows with little reserve buoyancy in the deck structure, the forces associated with water on deck and with a downward hydrodynamic lift may not be balanced by a corresponding increase in buoyancy, resulting in the vessel deeply burying its bows and forward deck structure.

Typical scenarios include situations where the bow of the vessel is buried up to 5m above the static waterline, in waves of only 1m. What happens is that the vessel, which is travelling in following seas at a higher speed than the waves, ploughs into the back of the wave in front, takes on water and submerges at a very rapid rate. The only remedial action the skipper can take is to go full astern, however by this time it can be too late and serious damage can be done to the bow section above the static waterline. In some cases passengers can be swept over board, including one case where a passenger was swept into the propellers and killed. In at least one other case the sudden deceleration caused by impact with the wave ripped seats from their mountings and caused broken bones amongst the passengers.

A continuing investigation into deck diving has been conducted. The surging behaviour of vessels in following seas has been well studied in relation to broaching work. It is known that the motions of the vessel can depend on initial conditions. A time domain mathematical model was developed to predict the motions of a vessel in deck diving. The inputs to this time domain simulation are the vessel's table of offsets, pre-determined calm water resistance, heave and trim values, the vessel particulars including cross deck structure particulars, propulsion characteristics, predetermined values of wave induced surge, heave and trim for the hulls as a function of the wave parameters and the wave environment for the vessel to be tested in. The longitudinal wave induced surge force, based on the linear superposition of Froude-

A typical semi captive model test. In this instance the model is being tested with a Vee shaped cross deck bow structure

Krylov forces, was predicted using an existing and extensively studied theory that relies upon the quasi-steady assumption. This assumption meant that the wave induced surge force, sinkage and trim were not expected to vary with the speed. Wave induced heave and trim were based on balancing the vessel hydrostatically in the wave position. Semi-captive model experiments were conducted in regular following seas to measure the wave-induced surge, heave and trim. This was done for various wave steepnesses and the results from these experiments were used to validate the quasi-steady assumption for a range of speeds faster than wave celerity and therefore the theoretical predictions. The model was constrained in sway, yaw, roll and surge (so that U is held constant). The model's vertical displacement was recorded from two linear displacement transducers (LVDTs) and a strain gauge was attached to the forward post, approximately in line with the underwater centre of pressure, to measure the longitudinal force.

Cross deck structure geometry and its effects were investigated by means of captive and semi captive tests. Equations to determine the coefficients of lift and drag were formulated as functions of angle of attack, geometry and Froude immersion. It was found that a Vee

(Continued on page 7)

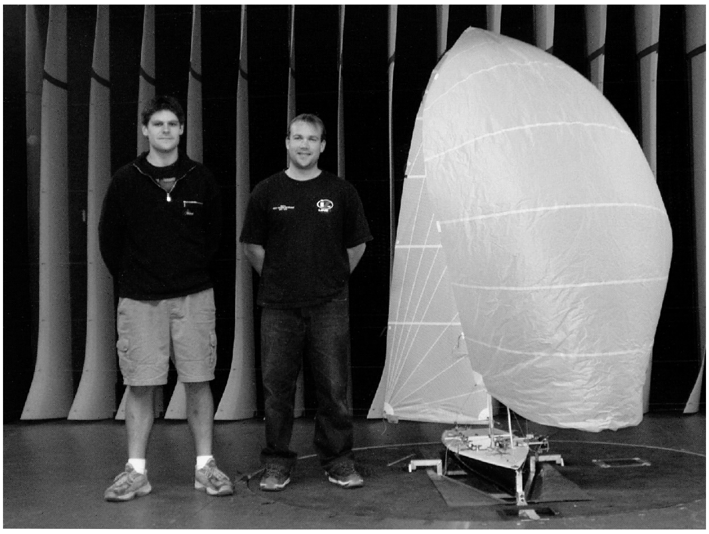
RINA-BABCOCK (NZ) Student Naval Architect Award 2003

At the Department of Mechanical Engineering Awards Dinner for Final Year Students at the University of Auckland School of Engineering, the inaugural RINA Babcock (NZ) Student Naval Architect Award was presented.

All final year students complete a research project, performed in pairs. The projects are then presented to members of public and industry at an open day. Project displays are displayed, together with demonstration objects such as materials used, products produced or equipment used in testing.

Project partners then have a few minutes to present their work to groups of judges from industry, the mark for which contributes to their final grade.

The RINA Babcock (NZ) Student Naval Architect Award is given to the team with the best presentation of their project during judging. This year the award went to Damon Jolliffe and Kain Glensor for their project "The Improvement of Guidelines for Optimum Spinnaker Trim". Damon and Cain will each receive an award certificate and a NZ$200 prize.



Damon and Kain with their model at the University of Auckland's twisted flow wind tunnel

The project investigated the effect that spinnaker pole height, angle and spinnaker sheet have on the thrust produced by a spinnaker over a range of apparent wind angles. Optimum settings found by the study were compared to the commonly perceived version of spinnaker trimming guidelines (rules of thumb) . The revised guidelines developed by this study improved the performance of a spinnaker over the entire apparent wind angle range.

In 2004 Damon and Kain will be giving a presentation of their paper at a Tuesday Members meeting.

Update on the IRL Servo-hydraulic Slam testing System (SSTS)

By Mark Battley

The figure below shows a unique Servo-hydraulic Slam testing System (SSTS) that has been developed by the Engineering Dynamics team at Industrial Research Limited in Auckland. This system, which is believed to be the only one of its type in the world, enables hull panels to be subjected to impact with a water surface to simulate slam loading associated with vessel motion through rough seas. A computer controlled servo hydraulic system provides full control over motion of panel during the water impact. This enables measured motions from real vessels to be reproduced in a laboratory where comprehensive instrumentation can be used in a repeatable situation. Results from this testing are used to develop better understanding of the dynamic behaviour of marine composite materials and structures, and to validate design and analysis methodologies.

The water is contained in a 3.5 m diameter tank with a depth of approximately 1.5m. Specimens tested to date have been 0.5m wide by 1.0m long, and are guided by a linear track system. Instrumentation includes pressure transducers, displacement and velocity, accelerations of the panel and the test fixtures, ram force, and strain gauges on the skin of sandwich panels and within the foam core. The servo-hydraulic ram has a stroke of 1.4m, and can achieve velocities of more than 8m/s and loads in excess of 100kN. A custom designed ram/accumulators/manifold/servo-valve hydraulic installation with a sophisticated closed loop multiple feedback controller is used to achieve the required velocity, force and control.

The system has recently undergone an upgrade of the hydraulics and control system, and is presently being used for government funded research and as part of an industrial R&D project with High Modulus (NZ) Limited.

For further information please contact Dr Mark Battley, (09) 920 3622, m.battley@irl.cri.nz

(Continued from page 6)

shaped cross deck structure was more favourable than a flat plate. Compared to the flat plate, the Vee structure produced a smaller and more gradual surge forces and heave when the cross deck structure was submerged.

Free running experiments were then conducted to check the validity of the time domain simulation. The model was free to surge, pitch and heave but constrained in sway, yaw and roll. The model has a single electric motor driving a single propeller on the centreline giving a thrust. The RPM of this motor was kept constant and recorded. A setup of a laser and moving wave probe was utilised to monitor and accurately position the model in respect to the wave crest. Experiments were conducted with hulls only and also utilising two different cross deck structure geometries at varying speeds in a range of wave heights.

The outcome of this project will be a greatly increased understanding of the directional control of high-speed passenger carrying catamarans in following seas, including a method to determine safe operating envelopes. This will lead to increased safety in the design and operation of these vessels.

Martin Hannon completed his B.Eng. (Naval Architecture & Ocean Engineering) at the University of Glasgow in 1998. He was awarded an Overseas Postgraduate Research Scholarship with the Australian Maritime College to undertake a Ph.D. by research titled, "An Investigation into Deck Diving of High Speed Catamarans in Following Seas", to which he is presently working towards. He is currently working as a naval architect for John Harrhy Consulting Limited in Auckland.

RINA Library

To access the library collection contact

Gillian Ralph: g.ralph@irl.cri.nz

(09) 920 3466

To see a list of the collection via the internet access the site http://www.irl.cri.nz/infoservice and search the library catalogues

Recent Technical Meetings

Over the winter we have had a series of technical meetings given by members as well as some overseas visitors, plus a CPD seminar on Project Management. Meetings are now held at 6pm, usually on the second Tuesday of the month. These meetings are open to all members as well as interested people from the wider community.

Thank-you to all our speakers for giving their time to enlighten and amuse us.

MAY: *Loads and Responses for High Speed Craft in Waves—The Swedish Approach*, Anders Rosen, KTH, Stockholm, Sweden

JUNE: *Measurements of Wake Crossing Motions and Loads,* Graeme Finch, IRL

JULY: *Computer modelling of Downwind Sail Flows,* Steve Collie

AUGUST: *The Big Splash, Slam Loading of Marine Composite Panels,* Mark Battley

SEPTEMBER: *Project Management in the Marine Industry ,* A one day seminar by Tomeck Glowacki

OCTOBER: *Composite Construction Technology - Resin Film & Wet-Infusion,* Richard Downs-Honey, High Modulus

Forthcoming events

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.

In the New Year we have the following technical meetings planned. More information will be provided in Update.

- Tour of the University of Auckland's Centre for Advanced Composite Materials
- RINA Student Presentation from the winners of the RIAN/ Babock (NZ) Student Naval Architect Award
- Pacific Yachting Support Ltd.
- More Stainless Steel Presentations focussing on rigging, chain etc

The Royal Institution of Naval Architects (New Zealand Division) would like to acknowledge the continuing support of Clendon Feeney as our Honary Solicitors.

Don't forget that the NASNZ Standard Terms of Trade and Standard Design Contract are available for free download from the NZ Division website (www.rina.org.uk) as well as www.clendons.co.nz.

The New Zealand Naval Architect is published quarterly.

All correspondence and advertising should be sent to:

The Editor
The New Zealand Naval Architect
C/o RINA New Zealand Division
PO Box 91395
Auckland Mail Service Centre
Auckland

Email:hquekett@xtra.co.nz

Opinions expressed in this newsletter are not necessarily those of the Institution.

Administration and Membership enquiries

Email: membership@rina.org.uk
Web Page: www.rina.org.uk
UPDATE: lavranos@ihug.co.nz

NZ Council:

100354.2164@compuserve.com

President: Graeme Finch
G.finch@irl.cri.

Vice-President: John Harrhy
jhcl@smartships.co.nz

Treasurer: Chris Mitchell
Chris_AES@compuserve.com

Honorary Secretary: Jerry Bennett
jerry@jamesnilsson.co.nz

John Cable
johnc@xtra.co.nz

Michael Eaglen
michael.eaglen@highmodulus.co.nz

Susan Edinger
Susane@highmodulus.com

Heiki Hansen
hhei005@ec.auckland.ac.nz

Angelo Lavranos
lavranos@ihug.co.nz

Chris Marks
marksassocs@xtra.co.nz

Helen Quekett
hquekett@xtra.co.nz

M. Laurence Withy
ml_withy@xtra.co.nz