New Zealand Naval Architect

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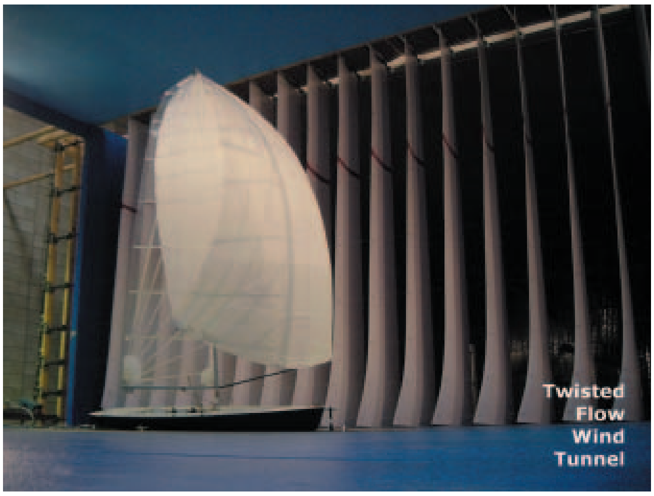
TWISTING THE FLOW

by Heikki Hansen

Wind tunnel testing is an effective tool in the design process of rigs and sails. But why is this the case and what happens during a wind tunnel test session?



Volvo Ocean 60 model in the Twisted Flow Wind Tunnel of The University of Auckland with flow twisting vanes upstream of the model

INSIDE

Wind tunnel testing of yacht sails is used by researchers, yacht designers and sail designers. There are primarily three wind tunnel facilities in the world that conduct most of the work related to sails: the Wolfson Unit in England, the Glenn L Martin Wind Tunnel in the USA and the Twisted Flow Wind Tunnel (TFWT) at The University of

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A Word from the President

It is hard to believe that we are now a quarter of the way into 2004, that daylight saving has finished and that winter looms ahead. I trust that you were able to enjoy the good periods of weather over the summer and that the start of 2004 has been kind to you.

There are many benefits of belonging to the New Zealand division of RINA and I thought it might be appropriate to remind members of several that accrue from our link with the Marine Industry Association (formerly the Boating Industry Association). Perhaps the most important benefit for RINA is having a representative on the executive management board of the MIA and hence the opportunity to have our members perspective represented. This of course doesn't necessarily mean that we are always in agreement with the actions or direction of the MIA but at least we have the opportunity for our views to be taken into consideration. One area where we have had a strong interest and have made a valuable contribution is the development of the new advanced training courses run by the BITO. Several of our members have been co-opted to provide lectures for this training and I think this is a very positive arrangement. It recognises our member's marine industry expertise and provides a mechanism for students to be exposed and instructed in current commercial best practice. I believe the individuals involved have also enjoyed the opportunity to provide training back into their industry.

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Another recent more tangible benefit from our link to the MIA was the invitation our members received to attend an "industry only" preview of the Imtec Auckland on the Water Boat Show. I know that many of you took the opportunity to look around the show without the normal crowds. I appreciated the positive feedback about RINA NZ I received from those of you I met at the show.

The stream of regular RINA activities has continued thanks to the efforts of your Council. A select group of 20 or so enjoyed a delightful Christmas dinner at the Royal NZ Yacht Squadron. We were fortunate to secure the Commodore's Room overlooking the harbour which proved an ideal setting for the delicious buffet meal. In February Trevor Blakely, RINA's CEO visited New Zealand as part of a whirlwind Australasian visit. During his time in NZ he met with RINA members as well as providing official RINA recognition for the new Marine Transport Design degree at Massey University.

As well as the upcoming Annual General Meeting to be held at the National Maritime Museum in April, we are trying a new concept with a breakfast briefing by our Honorary Solicitors Clendon Feeney. This promises to be a very informative event touching on a number of important issues for the industry including contracts, employment law and professional indemnity insurance.

I trust that you have an enjoyable Easter and look forward to meeting you all at the AGM.

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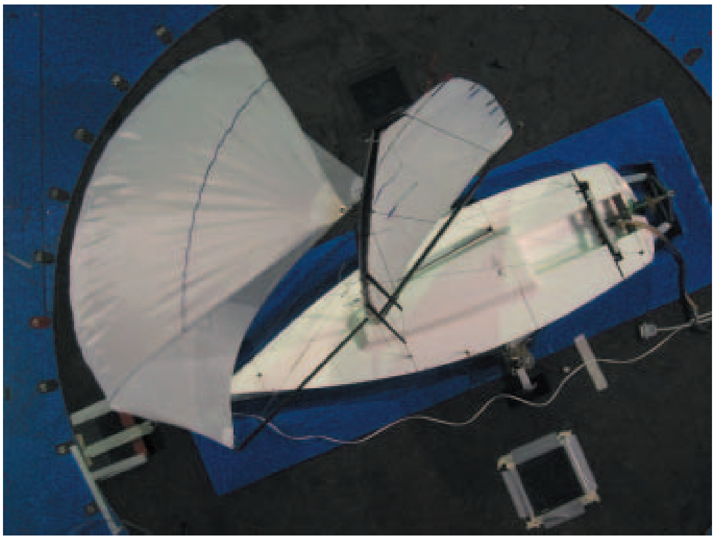
Auckland. The TFWT is unique in that is has been developed specifically for the testing of yacht sails. It is the only wind tunnel that can simulate the wind twist in the apparent wind with height necessary for testing yacht sails. Wind blowing over water (or land) is slowed down by the skin friction between the two elements. As a result the wind speed increases with height above the surface. This region is called the planetary boundary layer and is usually between 1500 and 2500 metres high depending on the weather pattern and the terrain the wind blows over. When the yacht moves through this boundary layer the apparent wind it sees is a combination of the true wind and the yacht's velocity. Since the yacht's velocity is constant with height, the apparent wind changes in speed and direction with height above the water. Generally it can be said that the effect of twist increases with increasing true wind angle, i.e. the deeper a yacht sails the more twist is experienced by the sails. Secondly the amount of twist also depends on the performance potential of the yacht, i.e. the faster the yacht sails relative to the true wind speed the more twist is experienced by the sails. Wind tunnel testing is mainly carried out for high performance yachts, where extensive research and development is conducted to gain a competitive advantage. Of particular interest in the wind tunnel is the design of reaching and downwind sails, where numerical methods such as computational fluid dynamics (CFD) are still not sufficiently advanced to predict the large regions of separated flow. Hence, for many situations that require wind tunnel testing of sails, twist is likely to be of interest. This led to the development of the TFWT by the Yacht Research Unit at The University of Auckland in association with North Sails NZ and Team New Zealand for the America's Cup Challenge in 1995. After extensive research a system of vertical vanes, which twist the flow upstream of the test section, was chosen. Since 1995 the concept has remained the same but improvements are constantly being made, and the wind tunnel is now owned by The University of Auckland and used for general consultancy work. In addition to being used by Team New Zealand in the preparation for the defences of the America's Cup in 2000 and 2003, the TFWT was used by all but two syndicates for the Volvo



Symmetrical fractional spinnaker tested in the TFWT

Ocean Race 2001-2002, Open 60 projects like Kingfisher, Maxi yacht designers and record breakers like Marie Cha III and IV.

So, why is the wind tunnel regarded as an effective design tool? When designing a sail, rig or indeed any part of a competitive sailing yacht it is of interest to the designer to know how well each component will perform. Clearly the earlier in the design process this can be established the better, since time and money can be saved. There are principally three ways to determine the performance of a yacht component: by full-scale or large-scale tests, by model-scale tests or by CFD or theoretical calculations. Since it is not crucial to determine the sail shape early in the design process full-scale or large scale testing of different sail shapes on the water is a feasible and practiced option. Building a full-scale or large-scale sail is however much more expensive than building a model sail for the wind tunnel. A spinnaker for an AC yacht costs in the order of US$ 20,000 whereas a model sail might be US$ 100. In addition testing a sail on the water is very time consuming since the natural test environment is not controllable and many test runs are required to gain confidence in the results and it is often difficult to pick up small differences in sail performance. Although the performance of different sails can be compared on the basis of the archived boat speed is it extremely difficult to separate the individual force components acting on a real yacht, i.e. how much force was produced by the sails, how much side force by the keel and how much resistance by the hull? The individual force components are however required by Velocity Prediction Programs (VPPs) and a few purpose built sailing dynamometers have been used to achieve this. Apart from these few exceptions testing of sails on the water may reveal the fastest sail but the information has only limited use for future VPP analysis.

The other alternative to wind tunnel testing is to conduct CFD or theoretical calculations. Theoretical calculations are a good basic tool but due to the complex three-dimensional flow structure around sails, their application to real problems of interest is very limited. In CFD calculations, the governing equations of fluid flow are used and rather than solving them theoretically, they are solved numerically with the aid of computers. For upwind sails, where the flow is largely attached to the sails, accurate solutions can be achieved by using potential flow CFD simulations. For down wind sails the flow is however separated over large parts of the sails and since flow separation is a viscous effect, viscous flow equations need to be solved to model this. The lift and drag forces on a sail depend strongly on the separation and reattachment points of the flow. Predicting these points correctly is still a complicated challenge in viscous flow CFD simulations. The simulations are hence still computationally very expensive and require extensive validation work.

In addition to being more cost effective than full-scale or large-scale testing wind tunnel testing provides a steady and controllable test environment where the individual forces

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acting on the sails can be measured. Wind tunnel testing is much less time consuming than testing on the water and can be conducted much earlier in the design process to evaluate not only sail shapes but also rig options. Since soft sails with similar properties to full-scale sails are used in the wind tunnel the trimming process is similar in the wind tunnel and on the water. The wind tunnel models are equipped with remote control winches so that the primary sail controls can be adjusted while the forces are measured. Modelling a soft sail in viscous flow CFD simulations increases the computational time immensely as there must be an iterative process between the calculated sail forces and the corresponding new shape adopted by the sail until force equilibrium is satisfied. Trimming the sail by looking at the shape and the resulting performance, as one does on the water and in the wind tunnel, is not possible with viscous flow CFD simulations at present.

For all these reasons wind tunnel testing is an effective tool for designing rigs and sails. Researchers use it to develop and improve semi-empirical aerodynamic force models and to obtain the empirical input required for these models so that the sail forces can be calculated by VPPs. It is also useful to analyse and better understand the flow behaviour around sails. Yacht designers use the wind tunnel to compare different rig configurations and obtain empirical input for VPPs that is specific to their designs. Sail designers come to the wind tunnel to compare different sails to determine which is the fastest for each sailing condition. From this the best sails can be chosen and a sail selection chart developed, which helps the crew to decide which sail to use for a given true wind speed and direction.

Finally, what happens during a wind tunnel testing session? Since many yacht and sail designers work closely together on racing yacht projects, the wind tunnel testing is often conducted in conjunction to benefit both parties. A typical test session of one week might look at two or three different rig configurations and around 15 sails. Different rig configurations for an Open 60 might for example be a fixed mast versus a rotating wing mast. The emphasis on testing the sails is usually on reaching and downwind sails and a number of Code 0 type sails, reachers and spinnakers are tested. Each sail and rig combination is tested for a series of apparent wind angles in the range where the sail might be used. For each apparent wind angle the sails are trimmed to the optimal shape. This is a task similarly complex to trimming sails on the water and many designers bring experienced sailors to the tunnel to trim the sails. Traditionally the sails were trimmed by eye and by looking at the measured forces. The forces and moments are recorded once the trimmer is happy with the sail shape. After the wind tunnel test

The typical mast height of a model in the TFWT is about 2.3 metres

session the lift and drag coefficients and the centre of effort height for each apparent wind angle are calculated from the measurements and used as the input in a VPP to determine which rig configuration results in the fastest design and which sail performs best for a given sailing condition.

This established testing process has recently been altered through the development of the Real-Time VPP. The Real-Time VPP calculates the speed of the yacht instantly from the forces measured in the wind tunnel during the sail trimming process. Hence it is now possible to trim the sails based on boat speed even in the wind tunnel. This makes the trimming process much more similar to the real life situation. The trimming experience is further enhanced by the fact that the new system also allows the model in the wind tunnel to dynamically heel to the heel angle predicted by the Real-Time VPP. The wind tunnel sail trimmer now experiences changes to the centre of effort due to trimming in the same way as on the water, by a

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change in heel angle. The performance of a sail is now apparent right away and not only through the analysis after the wind tunnel test session. These recent developments show that significant advances have been made towards achieving the goal of having a “virtual yacht”.

Heikki Hansen completed his BEng (Hons) in Yacht & Powercraft Design at the Southampton Institute in 2000 and is currently a PhD candidate at the Yacht Research Unit of The University of Auckland. He has published on comparing aerodynamic full-scale and wind tunnel measurements and on the Real-Time VPP for wind tunnel testing

Update on the Relocation of the Twisted Flow Wind Tunnel

As announced in the last issue plans had been made to move the TFWT to the middle of the building it is located in and shorten it in order to improve the flow quality. During February the TFWT was moved and shortened, a number of other improvements were made at the same time. It is now running again and the Yacht Research Unit is in the process of confirming the improvements in the flow quality, calibrating and finalising the set-up so that it will be fully operational again shortly.

Design Defects – Personal Liability for Naval Architect Employees

By James Carnie and Michael Weir

A RINA member recently related a story to us about a Scottish naval architect who had retired then subsequently had been sued for negligence by a customer of his former employer. Due to the fact that he was no longer employed, he was not covered by the employer’s professional indemnity insurance policy. The architect was held to be personally liable for the amount claimed by the client. It so happened that the former employer agreed to indemnify the retired architect but, despite this apparent ‘happy ending’ for the retired architect, the story raises some important issues in relation to negligence and liability of employees.

An employee’s ability to claim indemnity from their employer depends on the contractual arrangements and laws governing the employment relationship. In New Zealand, the Employment Court has drawn an analogy between the employee’s right to an ‘employment indemnity’ and the principles of the laws of agency, which provide that:

“*The relation of principal and agent raises by implication a contract on the part of the principal to reimburse the agent in respect of all expenses, and to indemnify him against all liabilities, incurred in the reasonable performance of the agency*”.[1]

The most obvious limit to ‘employment indemnity’ is therefore that any rights to indemnity are limited to those expenses and liabilities that are reasonably incurred in the performance of the employment contract.

It is also necessary to consider the common law principle of vicarious liability. Vicarious liability arises where one person is held to be liable for torts committed by another, even though the liable person is not at fault himself or herself. The principle applies also to the employee / employer relationship.

The principle of various liability is often misunderstood, with a common misconception being that an employer will be liable in the place of an employee in all employment situations. It is clear however that this is not always the case.

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At law an employee who, for example, completed a negligent design remains jointly liable with their employer for any loss or damage resulting. Although an employee is usually not sued in their personal capacity, liability in law still also rests jointly with the employee.

The next issue that arises is whether an employer who has been found vicariously liable for acts of an employee is entitled to claim an indemnity from the employee. The answer is, depending upon the circumstances, yes.

This point is clearly illustrated by the decision of *Lister v Romfield.* [2] In that decision the House of Lords held that an employer who was being sued by an injured person on the basis of vicarious liability for the acts of the employee, could seek indemnity from the employee for the negligent acts committed.

In the course of the decision Viscount Simmonds stated:

"*I think it is right to say……that the servant owes a contractual duty of care to his master, and that the breach of that duty founds an action for damages for breach of contract.*"

It is therefore clearly the case that an employer will, in situations of a breach of duty of care by an employee, be able to claim damages against the employee for the breach that resulted in the original claim. This is qualified by the possibility that the employer could be considered by the Court to have contributed to the negligence, therefore reducing the amount the employer could claim against the employee.

It has been stated that, as a result of the decision in *Lister v Romfield,* major insurers in both Britain and New Zealand agreed, as a general rule, not to enforce subrogation rights against employees without their employer's consent. It should be stated however that this 'general rule' in no way altered the law in relation to law of employee liability, and would not of course prevent a claim by a third party against an employee directly, or the employer itself bringing a claim against the employee.

It should be noted that the question of whether certain conduct will constitute negligence is never an easy one, and will vary greatly depending on the circumstances of each case. It is unlikely to be the case however, that a negligent act committed in the course of employment will be an act *reasonably performed* in the course of the employment relationship. Employees therefore may be personally liable (both to third parties or their employer) for negligent acts committed in the course of their employment

In a 1993 High Court decision [3] a judge noted the exposure of professionals such as architects, engineers and lawyers to the risk of being personally sued if their employment contract does not provide for professional indemnity cover.

Given the 'general rule' adopted by insurers, and assuming that an employment relationship had not entirely broken down, it seems unlikely that an employee would be pursued for negligent acts where their employer has been found liable and PI insurance cover has been called upon.

However, unless an employee is covered by the employer's insurance policy, there is a possibility that an employee can be the subject of a personal claim and found personally liable if they could not establish that the liability was reasonably incurred in the performance of the employment contract.

This is more likely to arise in the case of retiring architects. It is advised that retiring architects enter into deeds of continuing professional indemnity as part of any retirement arrangements with employers.

In summary therefore naval architects may, depending on their employment agreements, be open to liability from both employers and clients if they are not entitled to personally rely upon their employer's professional indemnity insurance cover.

At the least, this may warrant a review of employment contract terms and seeking an assurance if unsure that the employee is entitled to rely upon the employer's PI cover.

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James Carnie is a Partner and Michael Weir a Solicitor at Clendon Feeney, commercial lawyers and honorary solicitors for the New Zealand division of RINA. For more information or expert assistance on legal issues call 09 377 9418 or visit www.clendons.co.nz

<u>*Footnotes*</u>

[1] (2) Halsbury's Laws of England (4th ed) para 123
[2] Lister v Romfield Ice and Cold Storage Co Ltd [1957] AC 555.
[3] Yeowell v Hitchcock Realty Brokers Ltd.

Visit by Trevor Blakely, Chief Executive of RINA

In February the RINA Chief Executive made a flying visit to New Zealand. During his stay he presented a certificate of accreditation to the Director of Design, Azhar Mohamed, at Massey University, Auckland. The Marine Transport Design course at the University has been accredited as meeting the Institutions academic requirements for corporate membership.

Trevor also attended an informal gathering of the committee and some of the RINA members at the offices of IRL.

IMTEC On the Water Boat Show

The IMTEC On The Water Boat Show 2004 was held 10th to 14th March at the Viaduct Harbour, Auckland. It proved to be a huge success. With attendance figures around 15,000 the feedback from both patrons and exhibitors was very positive.

Many of the RINA members who received an invitation from the MIA to attend the "industry only" preview of the Boat Show took the opportunity to look around the show without the normal crowds.

A beautiful day at the Boat Show

Inside one of the exhibitor's pavilions

Don't forget the 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 www.irl.cri.nz/infoservice and search the library catalogues

Technical Meetings

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.

If you have any suitable ideas or wish to make a presentation to the members please contact Susan Edinger.

Forthcoming events

More information on the following events will be provided in Update.

AGM - April 20th

The New Zealand Division AGM will be held at 7:00pm on Tuesday 20th April at the NZ National Maritime Museum. The meeting will be held in one of the galleries with refreshments available afterwards, along with a chance to wander around the exhibits.

APRIL 28th: Breakfast Briefing *7:40am*

James Carnie (Partner, Clendon Feeney) will discuss topical issues relating to contracting in the professional services field, particularly naval architecture, including the impact of Personal Properties Securities legislation and other recent developments.

Reservations essential. For further details please contact Michael Eaglen (michael.eaglen@highmodulus.co.nz)

MAY 11th: Yard visit

Yachting Developments Ltd, 16 Kahika Road, Beachaven, Auckland

Members are invited to view two major composite vessels under construction, a 96-foot Frers design nearing completion and a 80-foot Dubois design.

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

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