New Zealand Naval Architect

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The Effect of Turbulence on the Performance of the Keel of an AC90

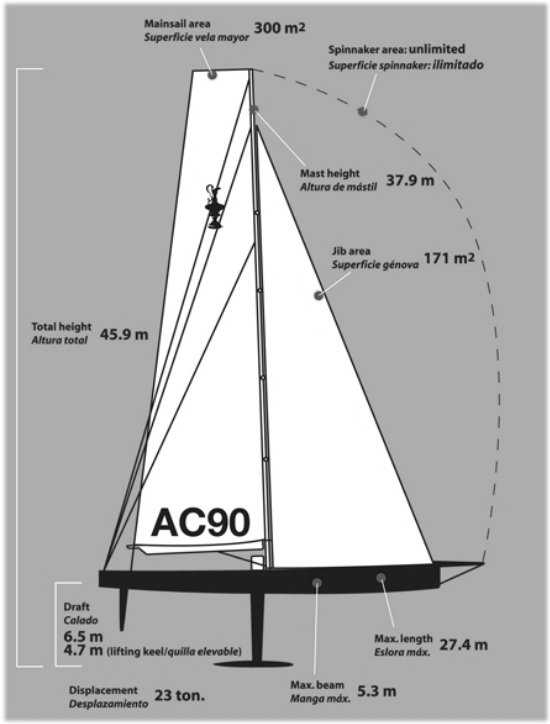
by

Chris Blake

The turbulence present in the ocean is not particularly well understood, especially the effect that turbulence has on the performance of sailing yachts. The research that was conducted was centred around the effects of turbulence on the keel performance of an America's Cup 90 class sailing yacht (AC90). This was one of the class of yachts that were proposed for the 33rd America's Cup, originally scheduled to take place in 2009.

The Computational Fluid Dynamics (CFD) code Ansys CFX was used to model the AC90 under a variety of operating conditions. Good agreement with tank testing data was achieved.

The AC90 was then modelled under conditions that represented an actual sailing case of 12knots of wind, sailing close hauled. The results of this simulation were used to determine a representative operating condition for the keel of the AC90.



The AC90
Photo credit ACM

The input conditions, generated from the Ansys CFX simulations were used in the two-dimensional CFD panel code XFOIL to model the effect of turbulence on the performance of the keel of the AC90. The mid-span section shape of the AC90 was then optimised using XFOIL and Ansys CFX under a variety of optimisation

(Continued on page 2)

President's Message

As we celebrate the start of a new year there seems to be some positive signs in the market and the economists are all talking about recovery and growth. It is time to look forward to a brighter 2011 and make the most of the new opportunities that the year may bring.

Our local division of RINA had a fairly busy year in 2010 with technical meetings and industry visits on a regular

(Continued on page 2)

Inside this Issue

(Continued from page 1)

basis. We have been working alongside the local branch of IMarEST to share meetings and provide a greater variety of technical talks and visits to both our memberships. With a wider range of subject matter and industry colleagues with differing backgrounds and experiences to share the combined meetings have been lively and well received.

Many thanks to all of the RINA New Zealand committee members who have worked hard on organising these events and called upon their contacts within the industry to provide the most interesting meetings possible.

We are aware that the bulk of our activity is centred around the Auckland region while our membership spans the length and breadth of the country. While we don't intend at this stage to start sub committees around the country we do have members in Wellington and Christchurch who are keen to get in contact with other Naval Architects in the region to share the occasional social evening with like minded technical people for networking and peer discussions.

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and in Canterbury contact
Alan Stephenson alan.mvs@xtra.co.nz

Ian McLeod

(Continued from page 1)

criteria, to determine how the level of turbulence present in the water and the accuracy of boundary layer transition prediction affects the optimal keel section shape. The final optimized keel section shape was theoretically found to outperform the original section shape, for turbulence intensities up to 2.8% and full scale boat speeds between 4.5m/s and 10m/s (8.75kn to 19.44kn).

Experimental testing was conducted to determine the laminar to turbulent boundary layer transition locations under real sailing conditions. This was done, as the boundary layer transition location is heavily influenced by the presence of turbulence in the free-stream fluid flow and has a large effect on the drag of the foil section.

The results were compared with modelling conducted in XFOIL and Ansys CFX. The XFOIL predictions matched up well to the experimental values.

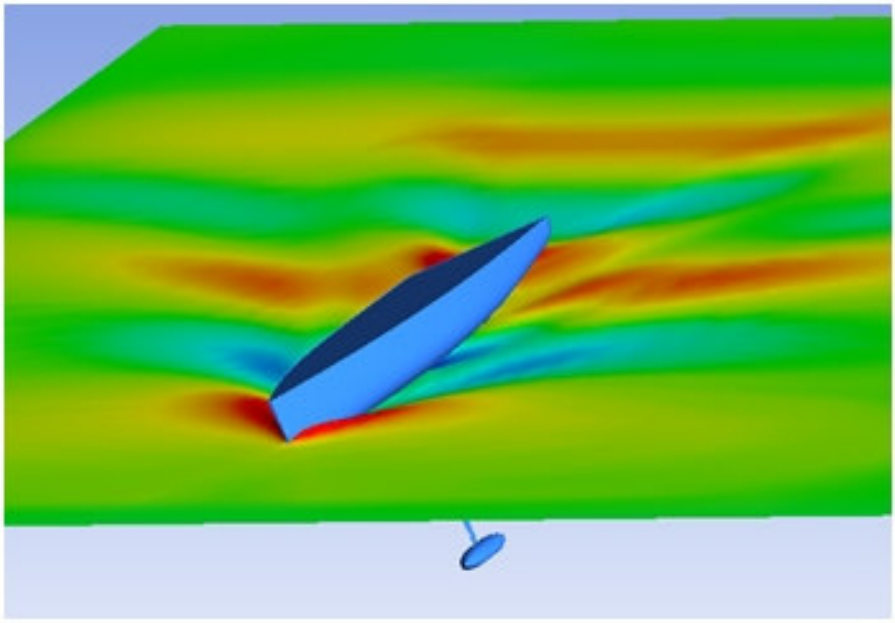


Figure 2: Screenshot showing the wave pattern produced in the CFD simulation of the AC90 sailing upwind in 12kn of wind

Have you got news for us?

Have you got an interesting project you are working on?

We are always on the look out for articles, short or long, that relate to the marine industry in New Zealand.

If you think that you could provide us with an article please email the editor

hquekett@xtra.co.nz

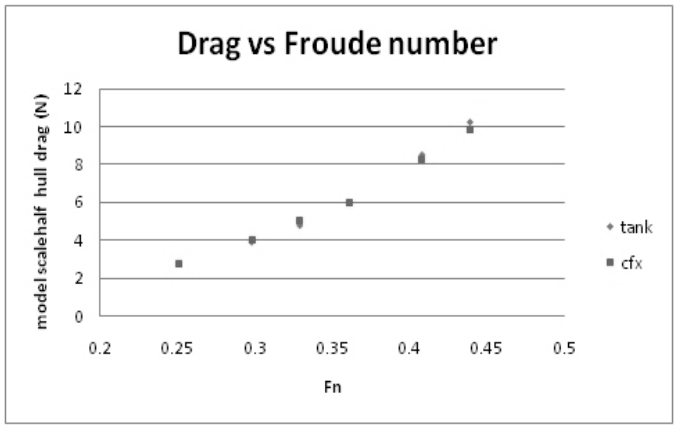


Figure 1: Graph comparing tank testing results with CFD simulations

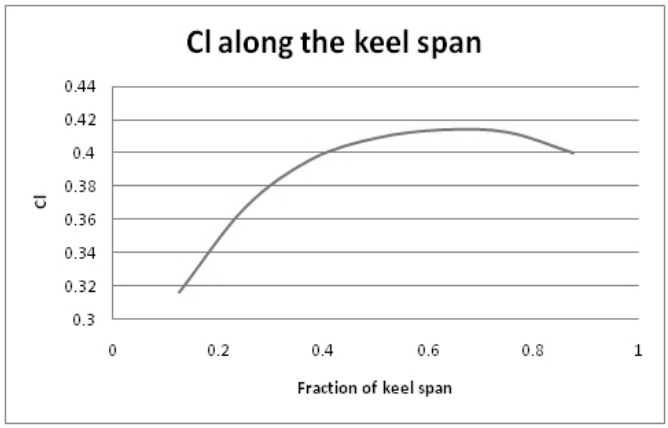


Figure 3: Graph showing the variation of the local lift coefficient along the span of the keel of the AC90 while sailing upwind in 12kn of wind

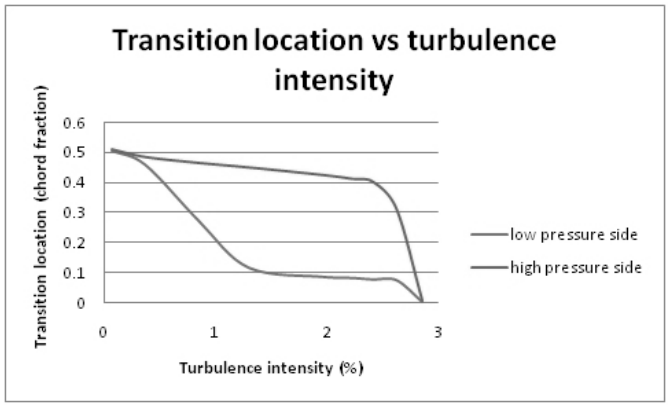


Figure 4: Graph comparing the Drag of the original and optimized keel shapes over a range of turbulence intensities

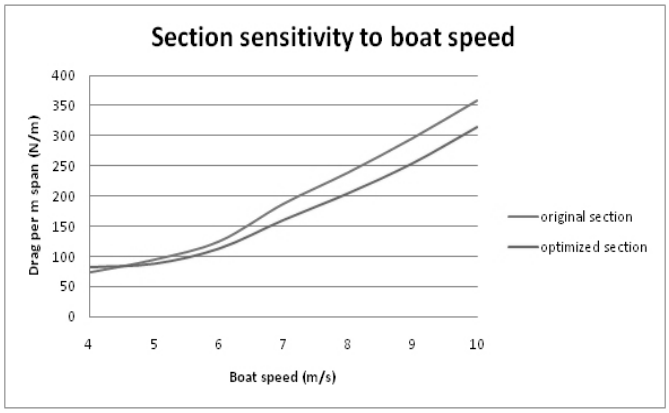


Figure 5: Graph comparing the Drag of the original and optimized keel shapes over a range of boat speeds

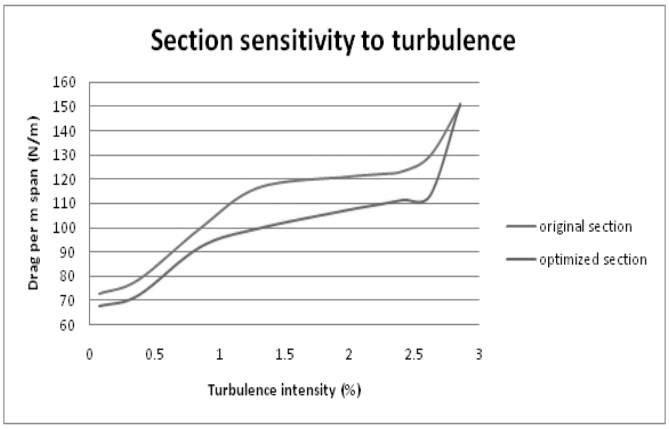


Figure 6: Graph showing the change in boundary layer transition location on both sides of the keel section over a range of free-stream turbulence intensities, while operating in its representative upwind sailing condition

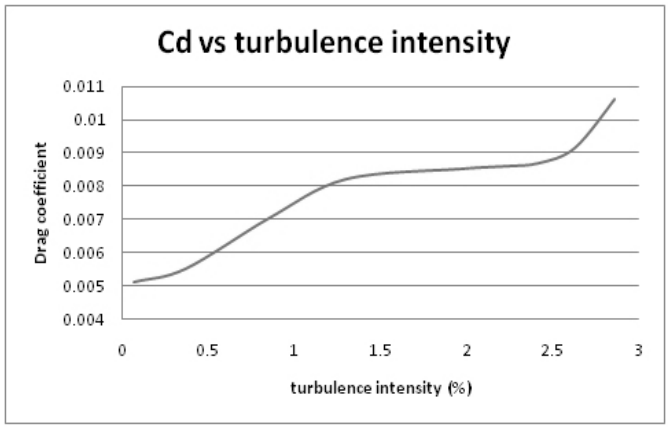


Figure 7: Graph showing the change in the drag coefficient of the keel section over a range of free-stream turbulence intensities, while operating in its representative upwind sailing condition

An Investigation of the Effect of Heel Angle on Upwind Sail Performance

by

Dan Jowett

This project was a Masters degree research topic investigated at the Yacht Research Unit at the University of Auckland's Twisted Flow Wind Tunnel. It was supported by Emirates Team New Zealand.

The effect of heel angle on upwind sail performance has been investigated. This was done with a scale model of an AC33 class yacht with semi-rigid fibreglass sails, shown in the figure below.

AC33 Model

This model was tested in the wind tunnel at a range of heel angles. The forces generated were measured and recorded before being compared to those values predicted by theory.

It was found that the drive force produced by the yacht decreases with heel, and that the Effective Angle Theory (EAT) is not able to completely model what happens to the forces when the yacht heels.

The Effective angle theory (EAT) is a theory used in many Velocity prediction programs (VPPs) to predict what happens to the forces produced by the sails when the yacht heels, when only the forces at one heel angle are known (this is usually upright)

Some possible reasons for the theory not working as well as it might have been investigated. These include the effect of windage from the hull and rigging, non-uniform airflow in the wind tunnel, a buoyant force due to water beneath the model, and the effect of the twist of the sails changing with heel.

The semi-rigid sails are shown here on independent supports during testing to measure the windage forces on the hull and rigging.

Semi-rigid sails

This research has found that the EAT is a very good starting point, but that it is sensitive to sail shape and in particular the amount of twist in the sails. If the amount of twist in the sails due to heel is known, then the EAT prediction of the lift and drag coefficients can be improved.

Sails showing markings

The twist of the sails during testing was measured using the markings on the sails shown above, this was then used to improve the EAT prediction, with reasonable results.

Further research in this area should include the effect of the individual sails on the theory and how to account for this, as well as how to account for the changes in sail shape as trim is optimised with heel.

Dan Jowett is a former recipient of the RINA(NZ) Babcock Fitzroy Prize.

The AC45

At the end of the first trials of the AC45 one design catamarans

The AC45 was designed by the Oracle Racing design and engineering team. It has been designed so that it can fit inside a 40-foot container.

The AC45 is a successful collaboration of New Zealand marine industry specialists. Core Builders, Warkworth, created production tooling for the hull platform and wingsail, and are producing the initial batch of boats in collaboration with other industry specialists including Cookson Boats and Hall Spars NZL. Steering and daggerboard assemblies have been sub-contracted to C-Tech Carbon Technology and Craig Stirling Composites Engineering.

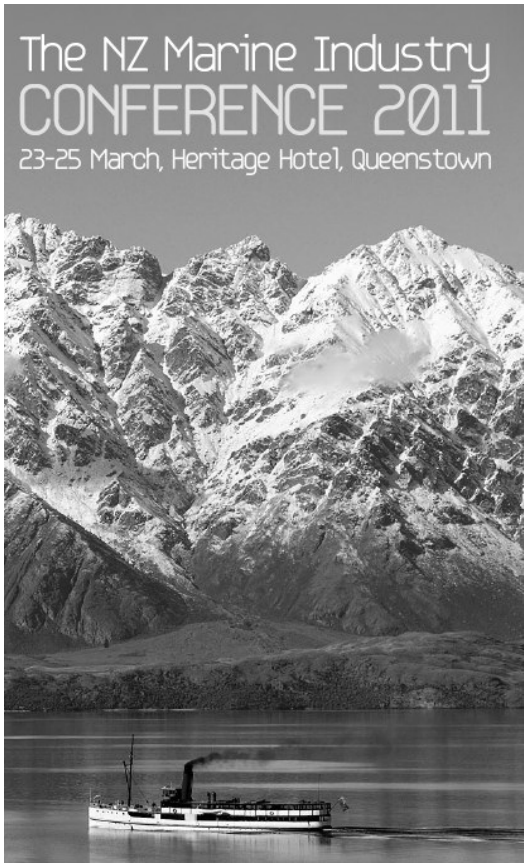
LOA: 44.13' (13.45m)
BEAM: 22.6' (6.9m)
DSPL: 1,400 kg
Mast Height: 70.5' (21.5m)

Student Prizes

Once again in association with the Royal Institution of Naval Architects, Babcock Fitzroy Ltd has sponsored the award for the best marine related final year project at Auckland University Faculty of Engineering.

This year's award was presented to James Brown and David Isaacs for their project titled, "Monitoring and Control of Voids in Resin Infused Composite Sandwich Laminates".

In the next issue of the NZ Naval Architect the students will provide a summary of the project that won them the prize.



New Zealand Marine Industry Conference 2011

The 2011 New Zealand Marine Industry Conference is to be held at the Heritage Hotel in Queenstown on March 23-25.

The NZ Marine Industry Association invites members to spend time working on their business instead of in it. Learn new skills and ideas from a line-up of top speakers, and network with industry peers.

For more information visit http://www.nzmarine.com/conference.html

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Sir William Hamilton OBE

(1899 - 1978) "Innovator, not imitator"

As well as giving his name to the company he founded in 1939, C.W.F.(Bill) Hamilton left a legacy of combining sound engineering practices with innovation and excellence. As a small boy he had dreamed of a boat that would carry him up the swift flowing rivers of his homeland. Such foresight was typical of this distinguished New Zealand inventor and innovator.

In 1954 his dream became a reality, and in the 50 years since then the Hamilton Waterjet has revolutionised the world of conventional boating.

A humble man, Sir William often claimed that it was not he who invented the waterjet - that honour he attributed to the great mind of Archimedes. His greatest achievement was to improve the idea and make it work in the specialised field of boat propulsion.

Charles William Feilden Hamilton was born at Ashwick Station near Fairlie (South Island, New Zealand) on July 26, 1899. He was educated at Waihi School, Winchester, and later at Christ's College, Christchurch. But it was to Ashwick that he owed the education that encouraged his naturally inventive mind. The land provided him with the opportunity to best exploit his unique style of mechanical genius.

In 1921 Bill Hamilton bought the 10,000 hectare Irishman Creek Station, one of the most notable sheep and cattle runs in the Mackenzie Country (Central Otago). Here he quickly established his first workshop - forerunner to the Hamilton Group of Companies.

His first project was the construction of a two hectare dam for a hydro-electric plant to provide power for the station's homestead and workshop. Conventional earth moving scoops proved inadequate so, in typical Hamilton fashion, he invented his own more efficient model. This scoop, the "I.C. Excavator", was used extensively for local contract work, with several more being manufactured and sold in New Zealand and Britain.

Essentially a self-taught engineer, Sir William spent countless evenings at his drawing board doodling and designing. While he approached problems in an unorthodox way, he always produced machines consistent with the best engineering practices.

The Irishman Creek workshop also became an important machining and engineering training facility during the Second World War. Here Sir William taught many unskilled men to do high-precision work, with the workshop producing munitions as well as earthmoving equipment.

Towards the end of the war, Sir William was required to make one of the most crucial decisions of his life. The increasing demand for agricultural and earthmoving equipment and machinery presented him with the choice of working within the limitations imposed at Irishman Creek, or expanding. Never one to ignore a challenge, he decided to rent a small works building in Bath Street, Christchurch and match the keen demand for his machines.

Steady expansion continued, and in 1948 Sir William purchased a 10 hectare site at Middleton, Christchurch. A 465 square meter factory was constructed for the production of bulldozers, scrapers, excavators and hydraulic machinery.

The shift to Christchurch allowed the Irishman Creek workshop to become solely a research and development centre. This provided the opportunity to devote resources to the development of the Hamilton Waterjet. Sir William's first jetboat was a 3.6 meter (12 foot) plywood hull with a 100 E Ford engine, and the jet a centrifugal type pump. This craft was tested on the

Irishman Creek dam and water race before successfully, if somewhat slowly, travelling up the Waitaki River in early 1954. From then on Sir William and his team gradually improved the design of the waterjet, adding greater efficiency, power and speed.

Continual improvements in the waterjet design, particularly the shift to a multi-stage axial flow pumping system, allowed boats to travel to places that had never been accessible before. In 1960, Sir William's son Jon was a key member of the Colorado River expedition team - the first to travel up through the Grand Canyon. Over the next 20 years other ground-breaking trips were made up the Sun Kosi (Nepal), Sepik (Papua New Guinea), Zaire, Ganges and Amazon Rivers, and jetboats became widely used for flood relief, surveying and recreation.

An early jetboat

Before his death in 1978, Bill Hamilton was recognised for his services to manufacturing with a knighthood. In 1990 he was inducted into the New Zealand Sports Hall of Fame, and in 2004 he was inducted into the New Zealand Business Hall of Fame.

2010 marked the 50th year of HamiltonJet NZ (formally Hamilton Marine Division) building jet boats in Canterbury. This article has been reproduced with permission from HamiltonJet NZ.

The fourth HPYD conference will be held during the Auckland stopover of the Volvo Ocean Race in March 2012. Meet the sailors, see the yachts and attend this highly acclaimed, world-class technical conference.

The focus will be on the design, analysis, testing and performance of cutting-edge racing and super yachts, and the conference includes a full social program.

A Call for Papers will be announced in early 2011. To be kept up to date with developments for HPYD4 please subscribe to the enews mailing list at www.hpyd.org.nz.

RINA NZ Division News

The annual general meeting for the New Zealand Division of RINA will be held in April. Division Business will include the election of new council members, president's report, and treasurer's report.

If you are interested in becoming a council member, please contact an existing council member. Nominations need to be signed by a proposer and seconded, each of whom shall be a current member of the NZ Division, and countersigned by the person nominated stating that they consent to be nominated.

Forthcoming events

Please watch your **Inbox** for the latest events listings. If you do not receive email please pass on your details to to the division and we will ensure you hear about our talks.

NZ Division Library

The library is located at the National Maritime Museum. To access the library members do not need to pay the museum entrance fee. At the entrance show any form of ID and you will be directed to the library.

Emails

Are you getting emails from us notifying you of events etc?

If you are not, please ensure you update your email address.
Email us at jason.smith@rya-online.net .

Also check your spam box!

Please let us know if you move. Changes of address need to be sent to the head office in London.
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