New Zealand Naval Architect

The newsletter of the New Zealand Division of the Royal Institution of Naval Architects — Issue 29 •August 2007

INSIDE

MULTIHULL STABILITY

by

John Holtrop

Over the last ten years we have seen the popularity of cruising multihulls grow from a backyard novelty to a well-engineered cruising platform that can carry four couples in total luxury. They have done exceptionally well in the charter industry, where they now outnumber monohull boats in some ports. The safety record for these newer cruising multi-hulls is excellent. Hopefully, it will remain so as more multihulls are selected for offshore cruising.

Even though the newer multihull boats are extremely stable, they can capsize. Last autumn a large cruising cat, heading for the Seattle boat show was lost off the Oregon coast. The boat was a modern design, with a professional skipper and two crewmen. We will never know exactly what went wrong, but the accident underscores the need for tools that will quantify and help manage the risk of capsize. This is a broad field that includes vessel preparation, weather prediction, crew experience, and stability details unique to the particular vessel.

The purpose of this article is to introduce a technique for estimating the wind strength necessary to capsize a multihull, with respect to specific vessel dimensions, weight, and sail plan. The final product of this exercise is a document, unique to your particular vessel and personal risk level, that recommends what action the crew should take as wind velocity increases. It starts with light air conditions (full sails and a cruising spinnaker), and ends under bare poles facing hurricane force winds.

The first step in this process is to throw away the traditional 0 to 180 degree "Static Stability Graphs". We know that multihulls have tremendous initial stability. A skipper needs to know how close the boat is to capsizing and what tactics should be used to avoid capsizing. One way to estimate stability is to look at the wind strength that exists when the windward AMA (outside hull of a multihull) is pulled out of the water. This wind speed is called "Capsize velocity" or CV, and it is assumed that in

(Continued on page 2)

A Word from the President

Hello fellow members, I am honoured to take on the role of president of the New Zealand division of RINA. I have been on the council and vice president and I plan to work with the council to continue the good work that has been done over the years in building a strong and vibrant New Zealand Division.

I see our main focus as one of providing a means for the continued professional development of members and the encouragement and strengthening of our links with both the academic and industrial sectors in New Zealand.

The council's first meeting for this year was an opportunity to reaffirm our role and direction with the organisation of CPD

(Continued on page 2)

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courses, increased numbers of technical meetings and visits for members and the creation of further RINA prizes and scholarships.

The council have established a small working group to establish a strategic plan for enhancing and developing the profile of Naval Architects/ Designers within New Zealand. We plan to strengthen our relationship with the Marine Industry Association to raise that profile and the public awareness / perception of the role of the Naval Architect in our industry.

I would encourage all members to contribute their ideas on the best way to achieve this and I would also ask for your help in improving the exchange of ideas and technical information between the members. I would encourage members to consider the submission of technical articles in their respective areas to allow us to improve and develop the Division's Newsletter to illustrate the depth and breadth of Naval Architecture within New Zealand to a wider audience.

I trust that I will be writing to you next year thanking you for your support and congratulating you on the achievement of all of these aims.

Brendan Fagan

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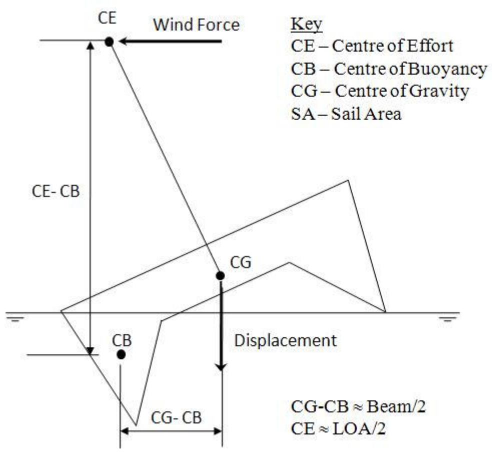
this condition, the slightest additional gust will capsize the boat. An approximate value for CV can be calculated using just four basic boat dimensions: Displacement, Beam, LOA, and Sail Area. The exact calculation requires the Centre of Gravity, Centre of Buoyancy and Centre of Effort, which are difficult to collect. Regardless of the equations used, a high CV of say 60 to 70 knots, minimizes the risk of capsize. Lower CV numbers indicate a higher capsize risk.

The simple equation given below, using the nomenclature from Figure 1, can be used to compare the stability of two different boats, evaluate the effect of water ballast, or help sort out what sail combination is best. Anything that makes the CV larger is good, from a stability viewpoint.

The "Overturning Moment" equals the Wind force*(CE-CB), and the "Restoring Moment" = Displacement*(CG-CB).



Wind Force = Q * SA (SA in ft^2)

where Wind Pressure (lbs/ft^2) $Q = V^2/295$ (V in knots)

exact $$CV = \sqrt{\frac{DISP * (CG - CB) * 295}{SA * (CE - CB)}}$$

estimate $$CV = \sqrt{\frac{DISP * Beam * 295}{SA * LOA}}$$

Raising the CV lowers the risk of capsize, but the changes often come with a performance penalty. Increasing displacement and decreasing sail area are two common ways to raise the CV. On an offshore passage, the prudent skipper will update the CV associated with the vessel, apply a safety factor (2 or 3), depending on the vessel) and instruct watch crew on what action to take, if the wind should approach that velocity.

Even though the CV calculation is a simple estimate, if we apply it evenly to a large number of boats it is possible to identify important trends. A few hours surfing on the Internet yielded basic

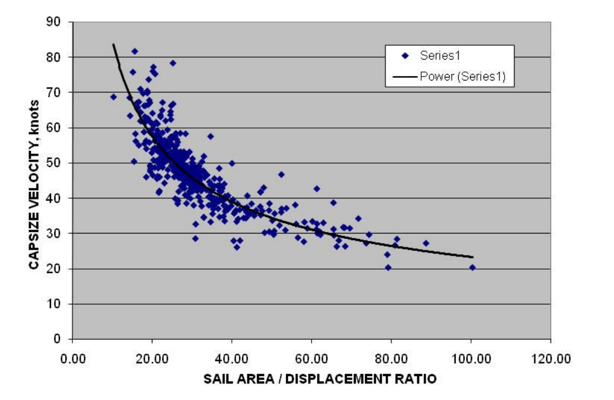


Figure 2

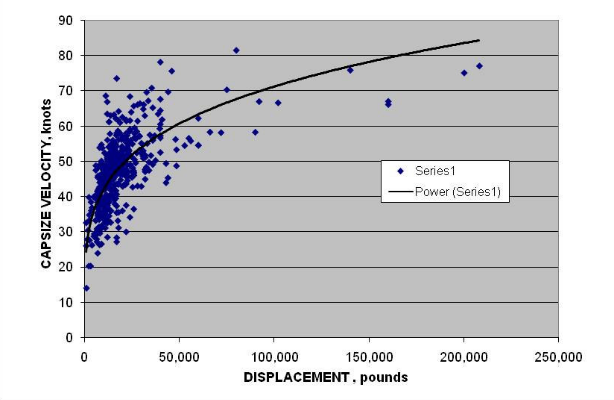


Figure 3

information on 512 multihulls, which were assembled into an Excel database. The first task was to sort the database for CV. There was a spread, from a high of 80 knots to a low of 20 knots. The results are shown in Figure 2.

The sorted data in figure 2 is interesting. A quick glance seems to show the small boats clustered around the lower values of CV, however a few big boats have low CV numbers. Table 1 overleaf lists 25 boats that have the highest value of CV, and another 25 having the lowest. Weight plays heavily in these figures.

The average CV for the "hard to capsize" boats is 72. The average for the more tender boats is 27. If we select a displacement of 25000lbs, we can see boats with CV as low as 28, and as high as 70. Before you buy, or charter, a multi-hull, you should calculate some basic CV numbers and compare them with respect to your expected use. Boats with a small CV are generally higher performance, but easier to capsize. Figure 3 shows the relationship between CV and Displacement. Like Table 1 the heavy boats have high CV values and the smaller boats have low CV values.

It seems clear that a trade off exists between performance and CV. Table 2 looks at the effect of implementing various features that impact CV. A 4/1 aspect ratio catboat rig is used as a base line, and the variants are sorted on "change". The biggest payoff is the Bi-plane rig (two masts, arranged transversely), seen in some racing multihulls. The CE is lowered 8 feet, raising the CV almost 9 knots. Other advantages of the Bi-plane rig include smaller sails, which are easy to raise and lower, and the option of running with just one sail. The second highest payoff, 4.5 knots, is to simply reef the sail 10%. In third position is water ballast. Adding two 1500lb water tanks is a major job, but not impossible. One nice thing about water ballast is you can pump out the tanks when it's safe to do so, and regain some performance (the SA/DISP ratio goes from 18 back up to 21).

The remaining changes, like increasing the beam, are best left to the manufacturer. Implementing all the changes raises the CV to 67 knots, a 12 percent gain.

Table 3 shows how CV data can be compiled into a table that minimizes capsize risk by calculating a maximum wind speed for each sail combination, from spinnakers to bare poles. Next, a safety factor (2-4, based on the skipper's judgment) is added to account for wave action and other dynamic effects. Just filling out a plan as shown in Table 3 will not make a boat immune to capsize, but it's a place to start and may develop into something better as we learn more about safe multihull cruising. Most people learn to sail on monohull boats that present clear symptoms when overpowered, such as excessive heel angle (decks awash) and control problems (rounding up or broaching). Multihull behaviour is much

NAME	LOA	BOA	DISP	SA	CV
Crowther 45, #90	45.00	29.02	65,000	1,182	102
Oceanic 60	59.09	30.00	80,000	1,798	82
Excursion 18m	59.00	56.07	40,000	1,830	78
Crowther 98, #167	98.08	42.07	208000	4,420	77
MM 85 Cruising Cat	85.00	40.00	140000	3,366	76
Oceanic 50	49.10	25.03	46,000	1,206	76
New Look 305	102.00	43.03	200000	4,400	75
Tonga 46	46.03	39.06	17,000	785	74
Edel Cat 43	42.08	23.11	35,420	1,141	71
Crowther 69, #124	69.00	32.00	75,000	2,070	70
Catana 52 Ocean	51.8	28.20	44100	1454	70
Luxury Cruising Cat	53.07	30.02	32,778	1,126	70
Albatros	42.00	19.11	11,250	320	69
Oceanic 41	41.00	20.10	24,000	740	68
Mancenillier	59.00	32.10	40,000	1,399	68
Oceanic 45	45.00	22.10	33,600	1,076	67
Crowther 94, #96	94.00	37.06	160000	4,130	67
Oceanic 70	69.11	28.10	92,000	2,454	67
Daycharter 45	45.00	30.00	12,000	526	67
Crowther 81, #166	81.10	41.04	102000	3,422	67
Voyage 440	43.70	25.1	29249	1120	67
Crowther 100, #126	100.00	42.06	160000	4,528	66
KHSD 56	56.0	30.0	31226	1126	66
Crowther 44, #220	44.00	24.00	28000	1,029	66
Logical 46	46.00	23.10	26,000	890	66
Cheetah	26.0	20.0	1980	485	30
Havkat 42	41.00	26.20	6,800	1,388	30
Legs of Mann V	52.00	24.06	8,000	1,200	30
Cheshire Cat	60.00	25.00	22,000	3,000	30
Cobra 45	45.00	22.00	7,000	1,150	30
Novara 44R	44.03	30.06	8,200	1,884	30
Sebago	45.00	27.08	6,940	1,409	30
Te Henga Mk 2	42.08	29.11	5,205	1,227	29
Tiros	45.00	26.11	4,930	1,020	29
Catamaran 13.5	44.04	10.12	12,125	1,012	28
Nova2net	80.00	43.00	17,000	3,350	28
Crowther 49, #130	49.11	29.00	6,500	1,449	28
Aquilon 26	26.2	14.7	1875	398	28
Tiki 28	28.0	16.2	1500	330	28
Tri Star 31	31.0	21.0	2625	688	28
Challenger	49.03	30.10	6,600	1,615	27
Catamaran 80	80.00	43.00	17,000	3,650	27
V.S.D.	62.07	36.00	9,000	2,180	27
Aikane X-5	62.06	31.00	8,000	1,704	26
Blade Runner	43.02	26.11	3,997	1,040	26
Maine Cat 22	22.0	13.0	1000	257	26
Stars & Stripes	60.00	30.00	7,000	1,800	24
Happycalopse	46.07	27.03	3,307	1,388	20
Wind Warrior	46.00	24.00	2,300	860	20
Westcoaster 43	42.08	34.09	1,080	1,313	14

Table 1 - Catamarans with the highest and lowest CV

CONFIGURATION	LOA	BEAM	DISP"	SA	SA/DISP	CE	CV	Change
4/1 Aspect ratio cat boat rig	44.0	22.0	18000	900	21.04	28.0	48.1	BASE LINE
Bi plane rig	44.0	22.0	18000	900	21.04	20.0	57.0	8.8
10% less sail area	44.0	22.0	18000	810	18.94	26.0	52.7	4.5
3000lb water ballast	44.0	22.0	21000	900	18.99	28.0	52.0	3.9
10% more beam	44.0	24.2	18500	900	20.66	28.0	51.2	3.0
10% more disp.	44.0	22.0	19800	900	19.75	28.0	50.5	2.3
10% less CE	44.0	22.0	18000	900	21.04	26.0	50.0	1.8

Table 2 - Effect on CV of changing Various Criteria

more subtle. The boat may be right at the edge of a capsize condition and show no distress. This makes the skipper's judgment especially critical, and having a Heavy Weather Strategy plan in place can only help.

This article should spark some discussion on how to best improve multihull safety starting with the design, then on to the manufacturer, and finally the end users. Having a Heavy Weather plan is a good start, but it's only one factor in a successful and safe voyage. Leadership skills, weather issues, crew experience, personality conflicts, hardware failure, and each individual's physical condition are only a few of the issues a competent skipper must consider. Understanding capsize risk and preparing for it should be a basic part of multihull operations, right up there with collision, fire, man overboard, and personal injury.

John is a retired mechanical engineer, with over 30 years experience in weapons design and testing for the US Navy. He keeps busy, and broke, taking care of SPICE, a 39-foot cutter, berthed at Channel Islands Harbour, California, MOLLY, a 17-foot trailerable gaff rigged catboat, and a HOBIE 14 with a very small CV. You can download the Multihull database from his web site, www.johnsboatstuff.com or contact him at john@johnsboatstuff.com

BEAUFORT SCALE	WIND KNOTS	DESCRIPTION	WATER SURFACE	SAILS /ACTION
0	0	Calm, drifting	mirror	Drifting
1	1 to 3	light air	small ripples	All sails set, just moving, steerage
2	4 to 6	light breeze	small waves, no crests	Full main, full jib
3	7 to 10	breeze	large wavelets with crests	Stow loose gear, check dinghy
4	11 to 16	moderate breeze	larger waves, some with white caps	Reef jib, close ports and vents, pull dinghy in and secure it
5	17 to 21	fresh breeze	moderate waves with many white caps	First reef in main. Break out foul weather gear, harnesses, and life jackets
6	22 to 27	strong breeze	large waves, many white caps, some spray	Flood ballast tanks, furl jib and lash down second reef in main. Rig storm staysail and jack lines furl jib and lash down
7	28 to 33	near gale	heaps of waves, some breakers, foam streaks	Set storm stay sail, check emergency gear. Secure main
8	34 to 40	gale	moderate-high waves, many breakers, spray, well defined streaks	Bare hull Set sea anchor stream lines and run off
9	41 to 47	strong gale	high waves, dense foam crests rolling over, reduced visibility	
10	48 to 55	storm	very high waves with long overhanging crests sea looks white, zero visibility	

Table 3 - Example of Heavy Weather Strategy Plan

Yacht Research Unit Update

By

Heikki Hansen

The Yacht Research Unit (YRU) offices at Hannigan Drive in Mt Wellington are busy again after the conclusion of the 32nd America's Cup. David Le Pelley is back in Auckland after spending 24 months over the last 3 years working with the BMW Oracle Racing team. He ran their wind tunnel program and was involved in full-scale data acquisition. Professor Richard Flay spend the majority of his sabbatical year in 2006 with Alinghi team in Valencia modelling the wind patterns. Heikki Hansen, after completing his PhD at the YRU, for which he developed enhanced wind tunnel techniques and sail force models for VPPs, has joined the YRU team full-time as a research engineer. He also conducted the wind tunnel test programs for Emirates Team New Zealand and Team Shosholoza. Associate Professor Peter Richards is continuing his research into the computational fluid dynamics (CFD) simulation of downwind sails and validation against wind tunnel measurements. Stuart Norris, a postdoctoral fellow, strengthens this research by further developing the CFD software of The University of Auckland.

It is evident that the next Volvo Ocean Race is approaching fast as the YRU is already running wind tunnel programs for three teams. Wind tunnel testing is also becoming more and more popular for Open 60 campaigns which further fosters the close working relationship with North Sails New Zealand. While most commercial work is related to high performance yachting, last year saw the YRU investigating the fly-bridge design of a 37m high speed motor yacht. In other parts of the world wind tunnel studies to determine wind comfort levels on the decks of super yachts are common and it is hoped that this type of work will also be performed in New Zealand.

This year is also the 20th anniversary of the YRU. It was founded as a result of the interest in yachting after the 26th America's Cup in Fremantle in 1987 with the financial support of Fay, Richwhite Ltd. When living in Valencia last year Richard Flay was surprised by how many familiar faces from the YRU he recognised. He determined that at least 20 graduates from the University of Auckland were involved in the 32nd America's Cup. To celebrate these achievements a function bringing together graduates, supporters, friends and members of the marine industry is planned for the end of the year. It is hoped that this function will provide the forum to discuss ways of fostering and funding future yacht related research to ensure that New Zealand's leading role in the industry is further strengthened.

A New Degree in Marine Technology

by

Cristiana Chiappini (ME, BEng)

Many people are not aware of the new (only 3 years old) degree in Marine Technology that Unitec offers.

The course combines most aspects of a Naval Architecture degree but without the full engineering approach that is sometimes a bit daunting for many. The degree includes hand drawing and lofting, CAD, naval architecture principles, study of materials and their applications, mechanical systems, propulsion, resistance, and some aspects of applied mechanics. Pure physics and engineering mathematics are substituted by more practical generic courses like project management, communication and sustainable technologies. During the course students undertake a technology project in year 2. In year 3 they conclude with a major industry project that can be in the form of a design dissertation.

The course is structured in three years and papers are divided as follow:

Year 1:

Marine construction, OR Materials, welding & fabrication

Marine drafting

Marine Mechanical and Systems

Communication, problem solving & health & safety

Self-employment and Managing projects

Year 2:

Composites, OR Fuels & Fuel systems

Propulsion & Resistance, Repair & Transportation

Lofting and Small Craft Design

Metal construction

Marine Interiors OR Engines (in place of Metal construction and Marine Interiors)

Technology Project

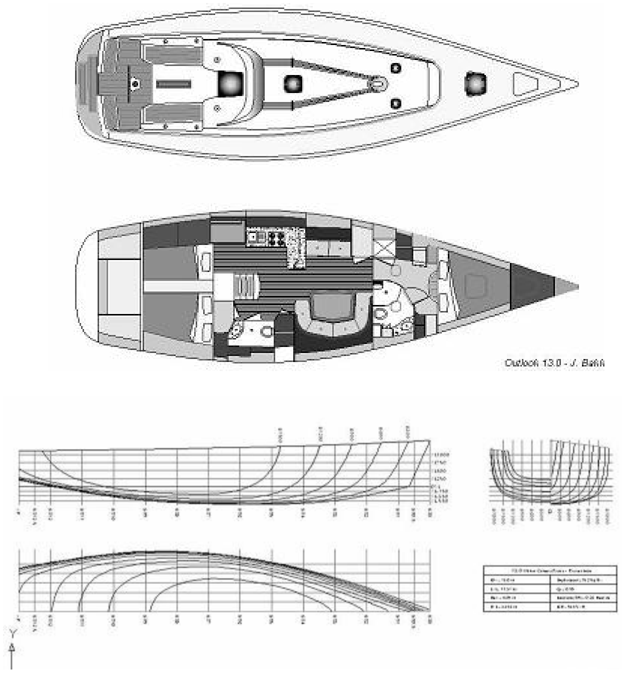
Year 3:

Sustainable technologies

Societal context

Innovative uses of Technology

Industry Project



Examples of Marine Technology student's work

The aim of this programme is to prepare students for unique career opportunities in New Zealand or overseas, with roles ranging from project manager, marine designer/draftsman, consultant and more.

The students gain a sound understanding of the marine industry and learn about every aspect of yacht design. They learn about composites, lofting and small craft design, marine interiors and marine machinery, gain confidence in the use of Computer Aided Design (CAD), and improve their understanding of the management side of business, while learning communication and problem solving skills.

The students make the most of the Marine Technology building facilities during their 3 years of study. Facilities include a large scale lofting floor, theory rooms, drawing rooms, Computer lab with a variety of specialised software (i.e. AutoCAD, Autoship & AutoHydro, Solidworks, MS Project, and more) and an Instron testing machine.

(Continued from page 6)

The workshop allows the building of more than one project at a time, including a separate fibreglass bay, and autoclave.

Many graduates from the programme are already working in the industry for highly respected companies like High Modulus, Marten Spars (now Southern Spars), Craig Loomes Design Group and more.

This degree is a first in NZ, and is the answer to the industry request/ need for skilled people to work in the ever growing NZ marine industry. The degree is open to school leavers with a passion for yachts and boating but also to "returning students", people that have already been working in the industry and want to improve their knowledge or learn about different aspects of yachts and their systems.

For more information contact Cristiana Chiappini on 09-8154321 ext.7018 or e-mail cchiappini@unitec.ac.nz or Rob Shaw rshaw@unitec.ac.nz

Cristiana completed a BEng (Hons) in Yacht & Powercraft Design at the Southampton Institute in 2001 and graduated from a ME (Hons) at the University of Auckland in 2003. She worked in the Marine industry for 2 years before lecturing in Marine Technology at Unitec.

Council Changes

Since the AGM there have been a few changes to the council. Brendan Fagan has been elected to the position of President. Our thanks go to John Harrhy for the time he has given to the position over the past years. We also welcome Brett Bakewell-White to the council.

We have a vacancy for vice-president. If you are interested in joining the council and/or filling this position please contact any of the council members.

HELP

We need articles for the NZ Division Newsletter?

If would like to see your name in print contact the editor.

hquekett@xtra.co.nz

NZ Division Library

The library is now housed 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.

A full list of books will be available on the RINA NZ website.

Designers Group

Following a discussion at the RINA AGM it was decided to form a sub-group that would look specifically at issues confronting practicing professional Designers and Naval Architects. New Zealand has a proud history in marine design and much of New Zealand's marine export business can be attributed to the work of the Logan, Bailey, Farr, Davidson and Holland names. It was the work of these designers that largely alerted the rest of the world to the NZ industry and yet now our industry seems to have left our designers behind, instead courting the overseas professionals rather than using home grown talent. We would like to promote New Zealand based talent through raising awareness of the New Zealand design profession and to help individual designers move forward by assisting as a collective and united front.

Any members interested in getting involved with this group and who are willing to contribute should contact the coordinator for the group, Brett Bakewell-White. brett@bakewell-white.com

Forthcoming events

Site visits: **YDL (Yachting Developments Ltd)**

McDell Marine

Dates to be confirmed closer to the time.

CPD courses: October dates to be confirmed

Ship Construction

A two day course covering the requirements and options in ship construction using steel, aluminium and fibre reinforced plastics. Principle speaker John Harrhy RCNC FRINA, FIPENZ supported by invited guests

Stability of Vessels

A one day course suited to those interested and involved in the issues of stability. Principle speaker John Harrhy RCNC FRINA, FIPENZ.

For further information and to express your interest in these CPD courses please email Susan at susan.lake@highmodulus.co.nz.

The New Zealand Naval Architect is published quarterly.

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