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NEWSLETTER OF THE AUSTRALIAN DIVISION OF

THE ROYAL INSTITUTION OF NAVAL ARCHITECTS

Courtesy of Image Marine Group

THE ROYAL INSTITUTION OF NAVAL ARCHITECTS (AUSTRALIAN DIVISION)
Box No. 4762 ,
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NSW 2001

COUNCIL MEMBERS:

Please send all correspondence and advertising for the next issue of 'The Australian Naval Architect' to:
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Australian Naval Architect
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SYDNEY, NSW 2001

The deadline for the next 'Australian Naval Architect' (July 1998), issue 5, is Friday June 26, 1998.

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Cover Photo: Image Marine Group's 24m Seabus "Evercrest". (See 'Just Launched' section.)

A NOTE FROM THE DIVISION PRESIDENT

I have been impressed with the quality of the issues of this journal and with the amount of work that the members of the WA section have put in to get it off the ground. This edition may be the last unless we can get some other members to take over the job as David Lugg and the others involved have indicated that they are not in a position to continue this work. Are there any offers to continue with the publication of the journal?

I read with interest Trevor Blakeley's piece in the Secretary's Column of RINA Affairs in the January Issue of the Naval Architect. The Australian division represents about 9% of the overall RINA membership and we now have a seat on the Council in London. I was in London in early December and paid a call at 10 Upper

Belgrave St to see if the new constitution could be expedited through the London Council so that we could change the format of the Australian Division to make the organisation more relevant to the geographical location of the industry and to involve the various sections more in the running of the organisation in Australia.

The Council in London was receptive to new constitution but have proposed a fundamental change in funding arrangements which, in my opinion, if implemented, would emasculate the Australian Division. What London proposed was that each section would be separately funded from London. The Australian Division would be given about $3,000 to act as the coordinating body for matters that affected the sections on a national basis This amount would be just about spent in organising one Council meeting with the majority of the cost going in fares. In all, London proposed that the sections and the Division should get a total of about $15,000 which is a bit better than we get now.

I had a look at the percentage that I, as a Fellow, would get back to help run the organisation in Australia. My subscription is presently $331.20 and London is proposing to provide an average sum per Australian member of about $44. For me then this represents about 13% of my subscription. As I have to pay for the publications that I receive then I think that the question could be asked what am I getting for the other 87% of my subscription. The reply is "not much".

The basis for London's proposal was that the section funding would be on a par with that given to the various branches in UK. The flaw that I see in this reasoning is that we, in Australia, are unable to take advantage of the services that RINA members have available to them in UK. There seems to be an unalterable mind set with the present London Council that the Australian Division operation can be equated to a UK Branch. This is not the case. On a good day you can drive from one end of England to the other; you can't do this out here. Also our UK counterparts have the opportunity of attending conferences put on by RINA and access to the library. If we want to get the same benefits we have to pay a return air fare and lose a week's pay. The Division Council discussed the matter at its last meeting and decided that the financial proposal was unacceptable and it is in the process of putting an amended proposal to London.

The sum total of the situation is that we can not implement the new constitution at the next Annual General Meeting but the Division Council wants to set up the new arrangements as soon as it can get some agreement with London on a realistic funding arrangement.

I had a letter from Alan Taylor, who is President of the Australian Division of IMarE and is about to be installed as the first colonial President of IMarE, in which he proposed that the Australian Divisions of RINA and IMarE have a cooperation agreement. The proposal is that the two Divisions sign a Memorandum of Understanding whereby they agree to cooperate on all matters of a maritime engineering nature in areas of common interest such as:

- Technical meetings at Branch & Divisional level;
- Symposia at Branch and Divisional level;
- Combine submissions to Government and other bodies at national and state level;
- Investigate the setting up of joint branches throughout the Division;
- Invite the presidents of each institution to the other's Divisional Council meetings;
- Explore common ground to enhance the future merger of the two institutions (if it ever happens!!!, my comment); and
- Any other areas of mutual interest in the maritime arena that may be nominated.

A number of these arrangements, while not formalised, are already in existence. I think that a closer association between the two bodies will help to rid the industry of the "us and them" approach that has been around in my working life. Once upon a time the demarcation lines

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between naval architecture and marine engineering were fairly well defined but in the present climate they have become somewhat blurred. I believe that a joint approach in Australia will be to our collective advantage and it may help to galvanise our parent bodies into acting on the collective majority wishes to merge the two institutions.

This matter is to be discussed at our next Council meeting so that members that wish their views to be put forward should either write to the Executive Officer, Keith Adams, or contact one of the members of Council.

I hope that I will have the opportunity to put a few words together for the next edition but if not then......

All the best

Noel Riley

EDITORIAL

Twelve months ago the committee of the Western Australia section of RINA committed themselves to producing the first four issues of the Australian Naval Architect. The aims of the newsletter were outlined in issue 2. At that time it was decided that the newsletter would be reviewed after the fourth issue to determine whether it should continue, if so in what form and who should have responsibility for it.

There appears to be strong support for the newsletter to continue. However those currently involved in its production are unable to continue. I believe that we need to find someone within our ranks with some spare time to take over as editor. He must be supported by a reliable network of members in each state who can feed information to him.

Printing and mailing costs for the ANA have exceeded advertising revenue by $300 and $200 respectively for issues one and two. Issue three was the first to break even. A major problem in producing the ANA has been the work involved in finding advertisers. Our rates are cheap and our target market is very direct. For those suppliers who want to advertise to naval architects there is no better forum. However it does require time to promote, collate and prepare advertisements as well as the extra accounting burden on the local treasurer. Perhaps the amount of advertising required could be reduced if the ANA was subsidised by RINA funding. Another suggestion offered is to charge a small subscription for the ANA.

Although the ANA has done much to increase our exposure locally it has not improved our standing internationally. Many RINA members in the UK and other overseas branches know little of the Australian Division. It has been suggested that we use the pages of RINA Affairs to achieve the aims of the Australian Naval Architect. While I believe that it is essential to contribute to RINA Affairs we also need our own forum to air our views and present local news. I suggest that the new Editor of the Australian Naval Architect also be responsible for supplying news to RINA Affairs and to the RINA web site.

Finally, thankyou to all those who contributed towards the ANA over the past four issues. Don't forget, if the opportunity arises, please support our advertisers. They need your feedback to confirm that their ANA advertisement is great value.

David Lugg

NEWS FROM THE SECTIONS

VICTORIA

The Victoria section of the RINA met at the Institution of Engineers building on the 17th of February to hear Brian Walsh's talk, "Exercise for Type 12 Destroyer Pertaining for Ship Survivability". Brian described the final three months of the HMAS Derwent. During which time the vessel was used for a series of destructive experiments including 28 smoke propagation experiments, 4 large compartment fires and 9 weapons tests. Following this extensive program she was towed out to sea and sunk. Brian discussed the outcomes of these tests, the data generated and the lessons learnt for the design of future RAN warships to achieve improved survivability. Brian's talk was supported by videos and was enthusiastically received by 40 members and visitors.

Bryan Chapman

Western Australia

Evan Boyle of Kvaerner Brown Pty Ltd addressed a joint meeting with the IEAust. Coastal and Ocean Panel last November. Evans talk, "East Spar Gas Field Development - Novel Approach", gave an overview of the East Spar gas/condensate field development. He focused on the unmanned Navigation, Communication and Control Buoy (NCC Buoy). East Spar is a subsea development located in 95m deep water approximately 180 km west of Dampier on the NW Shelf of Western Australia.

The use of the NCC buoy allows the control of the field from any convenient location, with the command response time and the cost of the facility being almost completely independent of the distance to shore or host facility. Evan presented conclusions about the use of a NCC Buoy to develop this field, operating experience to date has confirmed that the design objectives have been achieved.

Mike Davis professor of Mechanical Engineering , University of Tasmania and leader of the AME propulsion research program discussed the "Problems of Waterjet Propulsion" at our first 1998 meeting held in February. He described the problems associated with the introduction of large waterjets with particular attention to asymmetric flows, effects of boundary layer and the consequences for operations in terms of rotor damage, achieved cruise performance and manoeuvring thrust. The AMECRC propulsion research program is addressing these issues with a mix of computational fluid dynamics solutions, wind tunnel testing and design optimisation.

Mike Messenger, a marine communications systems engineer with Electrotech Australia gave a very informative introduction to The Global Maritime Distress & Safety System (GMDSS). The GMDSS now being implemented by the IMO has changed the Safety of Life at Sea Convention to provide a major upgrade of maritime safety communications procedures and equipment. This upgrade will affect not only the SOLAS Convention ships, but all users of marine radio equipment.

The Western Australian section held the AGM on February 17. David Lugg will continue as Chairman and is to be ably supported by Hugh Hyland as vice chairman. Matthew Addison and Shaun Ritson will share the loads of secretary and treasurer. Frank Jarosek, David Austin and Giles Thomas were all elected to the committee. An exciting program of speakers is being assembled for the year. If there is a topic you would like to hear please contact a committee member. When possible the Western Australia section collects papers and copies of overheads from our speakers. If interstate members are interested in any of these papers please call our secretary.

David Lugg

INDUSTRY NEWS

Northern Territory

Darwin has recently been bustling with activity, stemming from three main projects.

The first is the building of a 35m pearl farm support vessel for Paspaley Pearling. To be named the "Roslynne", after one of the company directors, Roslynne Paspaley. The vessel started construction in November and is scheduled for delivery in early September.

Vessel Particulars

LOA	34.95m
Bmax	9.50m
Depth moulded	4.70m
Speed	10.0 knots
Lightship	186 tonnes
Fuel	80,000 litres
Fresh water	50,000 litres
Crew	40
Decks	4

The vessel has a steel hull and aluminium superstructure, and is expected to sit with around 9 metres above the waterline. The vessel will compliment the Paspaley fleet, that already has nine vessels of a similar size or larger.

The second major project that is proving to be a considerable undertaking, is the repair of the patrol boat HMAS Gawler. (I am sure you all saw on the news the display of how not to unslip a vessel!). After the vessel was back in the water, and considered relatively stable, she was towed from the navy yard to Darwin Ship Repair for an emergency slipping. The incident resulted in damage to the superstructure, sheer strake, forward keel and associated structure, propellers and propeller shafts, among other structure and machinery. (Unfortunately at the time of the vessel being unslipped, a hatch on the aft deck was open, which resulted in flooding damage to the steering gear compartment and the auxiliary engine room). All things considered, the damage could have been a lot worse, but there is still a lot of work to be done.

The other major project has been the salvage and repair of the navy synchrolift platform and winches. (The salvage operation took a bit of brain storming to figure out.) The platform was constructed in three separate sections which were all interlinked. (Unfortunately, when the incident occurred, they didn't stay interlinked!) The sea-end section suffered a large amount of distortion to it's main transverse beam, and this was the first section to be moved out of the way. This was achieved by lowering the section onto three especially built pontoons and towing it to DSRE. Meanwhile, the middle section of the platform and the majority of the keel trolleys all had to be located by divers and lifted out by crane whilst the platform itself, had to be floated using salvage bladders and then towed via the pontoons. Both sections were lifted out with the syncrolift at Darwin Ship Repair and Engineering (DSRE), and are currently under repair.

Likewise, the damaged winches and stairways are all under repair by DSRE and all wire ropes have been replaced. Providing the weather is kind to us, the lift should be operational again by the end of February.

With these three major projects and several trawlers, one barge and a 64m rig tender up in the yard at the moment, things are very lively.

Samantha Tait

TRADE NEWS

Way Out Evacuation Systems

Photoluminescent Lighting

Way Out Evacuation Systems of Melbourne have recently supplied the Spirit of Tasmania with the Australian designed and manufactured "LUM INK" low location lighting system. The system consists of an aluminium strip of photoluminescent material, in an aluminium casing which attaches to the deck or bulkhead.

LUM INK uses the most advanced photoluminescent technology available. The standards for the Spirit of Tasmania installation called for 1020 lux of light to be applied to the LUM INK system to measure the amount and duration of light released in an emergency. The Spirit of Tasmania had many dark areas. The system was retested at 6 lux. The tests confirmed that the system could emit three and a half times the minimum light discharge levels at 6 lux of light.

The company also supplies luminous safety tapes, signs, stair nosings, luminous and reflective clothing inserts, helmet decals, ceramic tiles, architectural fixtures, luminous inks and paints and design and consulting services. They have Lloyds register type approval for low location lighting panels.

VEEM

MJP Waterjets

VEEM Engineering Group already well known for their highly successful range of propellers, marine shafting and general castings in bronze, aluminium and stainless steel have announced an exciting new addition to expand their range of marine products. They have been appointed sole Australian and New Zealand agent for MJP Waterjets.

The MJP waterjet is technically innovative in design and material selection. The waterjet design features:

- A mixed flow pump specially adapted for water jet operation with short vanes and a large nozzle.
- Specially developed impeller vanes with low drag, low surface pressure and minimum cavitation.
- Careful design of impeller bearings giving high efficiency and freedom from vibration.
- Water intakes adapted to individual craft for simple installation and small power losses.
- Reverser designed to give effective redirection of the jet flow without the risk of becoming locked in reverse.
- Built-in, well protected hydraulics and electronics to minimise malfunctions.

EDUCATION NEWS

CURTIN UNIVERSITY

Two students who graduated from Curtin University in 1997 carried out research of interest to RINA members. James Gale completed a Postgraduate Diploma in Applied Physics with a research project on the lifting capabilities of an offshore operations vessel in a seaway. The dynamic behaviour of the vessel when using the deck crane was investigated, to determine the limiting sea state for safe operation taking into account swell and wind-wave directional spectra, and the vessel's static stability condition. The resulting motions were then compared to the limiting conditions determined from a combination of the crane certification and Lloyd's rules. A spreadsheet was written to enable these calculations to be made by the vessel operators prior to a specific lift operation. James works for a Perth based offshore engineering company.

At the other end of the naval architecture spectrum, Jonathan Binns completed a Master of Science thesis within the Department of Applied Physics, entitled "Hull-appendage interaction of a heeled and yawed vessel". The research investigated the effect of hull-appendage interaction on the resistance of a sailing yacht, and the effects that changes have on velocity prediction. Two variables were investigated for the AME yacht series parent model-rudder angle and keel-rudder separation. A series of wave-cut experiments were carried out in the Australian Maritime College tank at Launceston and the processed results incorporated into a Velocity Prediction Program (VPP). Jonathan received an AME scholarship to conduct his research. He is now employed half time as an AME researcher and half time with Murray, Burns & Dovell (formerly Iain Murray & Assoc.) in Sydney.

TAFE

South Metropolitan College of TAFE at Fremantle offer training courses for Remotely Operated Vehicles (ROV) pilots. They have also recently acquired a ship handling simulator which can be used for training on high speed ferry operations and other activities. For further details contact the Marine Operations Development Officer, Capt. Robin Gray on 08 9239 8040 (fax 08 9239 8078)

Kim Klaka

University of NSW

SHIPSAFE '97

This seminar was held at the University of NSW on 10 November 1997 and attracted almost 100 delegates from Australia and overseas. Papers were presented by experts on many safety aspects including bridge resource management, maritime safety developments, passage planning, fast serry safety, the ISM Code, bulk carrier safety, social factors, maritime training, and structural problems. Among all the interesting presentations, Mr Andy Westwood's closing address was memorable. His philosophy was interspersed with anecdotes and there was good humour in the telling, especially his thoughts on risk management. If you missed it, then I suggest that you beg, borrow or steal a copy of the February 1998 issue of "Marine News" from the Sydney Branch of IMarE and catch up.

COMING EVENTS

Ekranoplans

A workshop "Wise up to Ekranoplan GEMs" will be held on 15 and 16 June 1998 at UNSW. Mark this date in your diary now, and watch this space for further details.

Structural Analysis

A 2.5 day short course "First Principles Structural Design" will be held on 13-15 July 1998, and a 2.5 day workshop "Computer-based First Principles Ship Structural Design" will be held on 15-17 July 1998 at UNSW. Presenters for the short course include Prof. Owen Hughes, Prof Don Kelly, Mr Mac Chowdhury and a representative of one of the classification societies. The workshop will provide hands-on experience with Prof. Hughes' structural analysis and optimisation program MAESTRO. The workshop and seminar are self-contained, but are expected to provide maximum benefit to those who participate in both. Costs are $600 for the short course, $1000 for the workshop, or $1400 for both. For further details or registration, contact Dr Prabhat Pal at the AMECRC, Sydney, on Phone (02) 9385 4081, Fax 9313 6449, or e-mail P.Pal@unsw.edu.au.

21st Century Marine

A seminar "50 Years on - Meeting the 21st Century" will be held on 18 November 1998 at UNSW. Mark this date in your diary now, and watch this space for further details.

UNDERGRADUATE NEWS

Where Have They gone?

Our 1997 graduates are now employed by the following companies:

David Amott	Consultant
Christian Babet	Baulderstone Hornibrook
Andrew Baker	Accutech and Samson
David Bruce	Geoff Glanville and Co.
Michael Fitzpatrick	Consultant, Netherlands
Steven McCoombe	Travelling, Spain
Bruce McNeice	Aust. Defence Force (Navy)
Paul O'Connor	ADI, Garden Island
Timothy Paton	Baird Publications
Jacqueline Rovere	ADI Garden Island
Robert Rostron	Det Norske Veritas
Timothy Sexton	Sydney Maritime Museum
Alexander Tickle	Forgacs
Lachlan Torrance	JP Kenny, Scotland (Offshore)

Paravane Stabilisers

Mr Antony Krokowski's investigation of the hydrodynamic efficiency of paravane stabilisers (ANA v.1 n.3) has concluded, with results showing a reduction in resistance of several percent for foil-type paravanes, which is much less than expected. The flow around the paravanes is highly three-dimensional, and this is considered a worthwhile area for investigation using computational fluid dynamics. Because of the complexity of the flow and the interaction with the free surface, two research projects (one BE and one PhD) will soon commence to continue this work.

Lines Lifting Using Photogrammetry

Interest is being shown in high-tech methods of lifting ship's lines, including articles by Austin Farrar in The Naval Architect and an undergraduate thesis at UTas using a theodolite. In his 1996 thesis project, Mr Christian Babet lifted the lines of James Craig using photogrammetry, and produced the lines plan from the results with the high-end CAD package, "ProEngineer". The photogrammetric results tied in very well with the lines lifted manually by Mr Mori Flapan and others. However, the digital camera used was also a high-end one, costing about $70 000, and not for hire without the personnel to operate it, placing it out of reach of the average consulting naval architect.

In an extension of this work, Ms Lina Diaz has begun a project on lower-cost photogrammetry. A 35 mm camera gives better accuracy than the similar-priced ($500-$800) digital cameras now available, and accuracy is improved with larger formats. Using a medium-format camera (cost of hire about $100 per day), the lines of a 12 metre workboat were recently lifted in conjunction with a manual lines-lift. The photogrammetry took an hour to place fourteen targets and take the photographs, plus two hours with a theodolite to accurately locate the targets (three hours total), and the manual lift took five hours. It will be interesting to see how long it takes to produce the lines plan from the medium-format photographs.

Simplified Inclining Experiments

The results of a project undertaken several years ago by Mr Matthew O'Brien are deserving of wider circulation. In a study of simplified stability data, he was looking for an alternative to the roll period test, for which the roll period factors give only a first estimate of GM. As part of the study, he conducted two inclining experiments on each of four vessels, firstly with standard masses, and then using people as the inclining masses. The vessels varied from a 9 m GRP catamaran to a 42 m navy patrol vessel. There were stringent conditions on how the people were braced to the vessel, and bathroom scales were used to determine masses. The results of the "people" inclinings were almost identical to those of the standard mass inclinings, and certainly better than those of the roll period tests.

This type of inclining can be useful for small vessels using a GM criterion. The main requirement is that the vessel's displacement can be determined independently of the lines plan, e.g. by trailing to a weighbridge or using a dynamometer in a crane line (not the dial indicator on the side of the crane!). You pay a price in having to "weigh" the vessel in some way, but you get a much more reliable result than from a roll-period test. Anyone interested in the detailed conditions for this type of inclining, please contact me.

POST-GRADUATE AND OTHER RESEARCH

Scholarship Supplement

A scholarship supplementation offered by NSK-RHP Bearing Co. for research in Japan has been awarded to Mr Dugald Peacock. This scholarship will be used for background research on the Techno Super Liner project and to gather further information on motion predictions and viscous roll damping mechanisms for high-speed ships. The information gathered from this research will be used for ongoing projects within the Australian Maritime Engineering CRC at the University of NSW. The research period is from early March until mid-June 1998, at Osaka (National) University. These dates have been selected to coincide with the presentation of a paper by Dugald at the 3rd Osaka Colloquium on Advanced CFD Applications in Ship Flow and Hull Form Design conference in May.

Design of High-speed Cargo Vessels

A study conducted jointly by the Australian Shipbuilders' Association and the Australian Shipowners' Association and published in December 1995 showed that there is a need for an Australian high-speed cargo service, especially in the east. Dr Prabhat Pal is undertaking a study to develop a model for the preliminary design of a high-speed cargo vessel with the best combination of speed, deadweight, and hullform to carry cargo at the minimum freight rate.

Economic Analysis of River Catamaran Ferries

A model has been developed for the preliminary design of river catamarans, considering primarily the resistance aspects to minimise shore damage due to waves created by the vessel. Dr Prabhat Pal is undertaking an economic analysis for incorporation in the model to determine the principal design parameters for a ferry to operate at the minimum cost per passenger-mile.

Phil Helmore

THE INTERNET

If you come across a web site of relevance to naval architects tell us about it. Kim Klaka discovered the following;

The UK Marine Accident Investigation Branch
http://www.open.gov.uk/maib/maibhome.htm

The Australian Marine Incident Investigation Unit
http://www.miiu.gov.au/

Both sites contain accident reports of value to naval architects. For those of us still involved with timber construction;

Windsor's World of Woods
http://www.windsorplywood.com/worldofwoods/

This site has extensive details of all timbers, including mechanical properties, which can be searched by timber name, durability, region or use. Quite a gem!

Kim Klaka

LETTERS TO THE EDITOR

Dear Editor,
Well it's been nearly four months since we met at Fast 97 and discussed Canberra contributions to the Australian Naval Architect, and slightly less time since I packed my bags and disappeared to South America (looking for new RINA members of course). Being in Argentina hasn't helped our local section much, but I'd be more than happy to organise the inaugural RINA tour, including of course an excursion to Montevideo on an Australian built catamaran.

Back to earth, the Canberra section has been quiet for sometime, however we're looking to the new year and a revitalised organisation. While an exciting technical agenda is not yet apparent, negotiations are under way with a local pub (I use the term loosely in this part of the country) for a new year get together.

This section also suffers from the woes described by Mark Smallwood, despite having one of, if not the, highest concentrations of naval architects in Australia. New graduates arriving in Canberra have very little contact with the naval architecture profession in general, and in fact can no longer be guaranteed a naval architect as a supervisor when joining Defence. The situation is unlikely to improve with the dissolution of the specialist naval architecture group within the Defence engineering organisation.

With this in mind the primary role of RINA in Canberra for 1998 will be reunifying the naval architects and improving the interaction through all levels. By developing a social relationship we will foster our professional relationships and maybe even sign up some new members.

On the horizon, Defence is organising an in-house naval architecture symposium for early next year. Attendance to this will not be limited to Defence staff, and while RINA will not be directly responsible, we will have a major role in the organisation and content.

Please, anyone who wishes to find the Canberra section get in touch: either by phone on (026) 266 2815, fax on (026) 266 4879 or e-mail with dudley_simpson@navmat.navy.gov.au. Include your current contact details!

Finally, thanks to everyone behind the 'Australian Naval Architect', it is a very professional publication and fills a very large hole!

Regards
Dudley Simpson
Secretary
Canberra Section, RINA

ACADEMICS, WHO NEEDS THEM ?

Dear Editor,
Hands up all the practicing Naval Architects around Australia who have complained about those academics in universities who are in dream land, don't have a grasp of the practicalities of engineering and are quite content to spend their time and tax payers dollars while on sabbatical leave studying esoteric subjects of no useful application to the industry?

Certainly, I have heard these sentiments on more than one occasion from people of varied backgrounds. But I don't want to take the same line in this short discussion.

Having been trained and employed by the Department of Defence as a Naval Architect since 1987, in recent years in the field of ship hydrodynamics, I have had the pleasure of being taught by, meeting and dealing with a number of engineering and applied mathematics academics with enviable talents.

While I could dwell on the knowledge that has been passed on by the academics that had taught us 'all we know' (well maybe not all), and how that knowledge is put to use in the industry on a daily basis, the thrust of my message is in what the academic staff of this country could offer the Maritime Industry as a whole, if only their skills were fully recognised and utilised effectively.

As the fast ferry industry is surely one of Australia's maritime success stories, I particularly have this sector in mind while writing these words. The success in this area of shipbuilding has undoubtedly been due to the foresight, imagination, engineering skills and practical expertise of those who entered the field in the early stages. I have always felt, however, that the Australian market share in the construction of such craft will slip once other strong shipbuilding nations gain experience in the design and construction of fast ferries. There are surely already signs of this trend.

While work force productivity, product marketing, availability of raw materials, sound management, government support and subsidisation and economic factors amongst other considerations obviously play a role in the success of the industry, design and production innovation must surely be one of the key factors in its success. This can only be sustained in a competitive world market if designs are further refined, or as the next generation of craft are developed through a strong base of technical expertise.

From my own limited experience and from those of some of my colleagues, the impression I have gained is that the design and analysis methods available to the engineering personnel in the Australian shipbuilding industry are by no means comprehensive. I would be pleased to hear feedback in this journal to the contrary. For example, how many of the shipbuilding firms in Australia have invested in robust finite element analysis codes to optimise the structural design of their craft to avoid fatigue and buckling failure while minimising structural weight? Are reliable resistance prediction codes available to the Naval Architects in these firms for first estimates of powering requirements of fast ferries? Are ship motion codes available and being used regularly to assess the acceptability of the seakeeping behaviour of these craft, or is it a relief if the client doesn't specify any passenger comfort criteria in the contract? How much use is made of any such codes in systematically optimising the craft design to minimise powering requirements or increase speed for a given installed power, to maximum payload, to improve passenger comfort or to enhance economy in production and operation rather than being used merely as analysis tools?

There are a number of academic staff in Australian universities and colleges who are more than capable of providing the industry with expertise, software, sources of information or just advice in any of the above areas. It is a simple case of reading through some of the papers presented in the recent Fast '97 conference proceeding to make this abundantly clear. This does of course not mean their services are going to be provided free of charge or that they will be able to solve problems at the drop of a hat as the industry may expect. Quite significant consultancy services with long term benefits can be obtained at relatively modest costs when compared to the cost of production of just a single large high speed car/passenger ferry.

So what is stopping us making more effective use of the services of academics? The Department of Defence has over the years had ship motion and resistance software (including for various multi-hulls and air cushion vehicles) developed by a number of Australian academics. These codes have undoubtedly broken new ground in the application of theoretical methods, while at the same time we have found them to be extremely useful tools for routine engineering analysis. The predictions from these codes have typically been good when compared to experimental data. Ship manoeuvring codes, dynamic stability analysis, hullform optimisation studies and ride control systems are other notable achievements of academics Australia wide.

While the general opinion in the private sector may be that the Department can afford to squander money on software development, this is hardly the case, particularly with the funding constraints faced in recent years. We public servants are also tax payers and don't like seeing our taxes wasted. The Department would surely always be interested in considering co-operative funding or development of analysis tools for the common good as this makes simple economic sense, and the end products are undoubtedly better as a result of such co-operative efforts.

I am well aware that some firms in the marine industry have recognised the resource on their doorstep and have consulted with academics to address engineering problems. The development of ride control systems for catamarans being a better known example of such consultancy services. It would be nice to read about other examples of applied research conducted on behalf of the industry in future issues of this Journal.

While I don't mind being controversial, I wouldn't want readers to go away thinking that I had any intention of being negative about the way the industry operates. In fact, I can only wish this letter in its own small way will help stimulate a continued positive long term outlook for the local industry.

Note: This letter contains personal views and is not necessarily intended to represent the views of my employer. In addition, I have not been bribed or coaxed by any party to write the above letter, nor am I fishing for a job in academia!

Martin Grimm
Naval Architect
(and hydrofoil enthusiast!)

Dear Editor,
In the last newsletter, I floated the idea of technical/social gatherings for Naval Architects, Techos and other interested groups in Victoria. I felt we needed a new forum particularly given Victoria's fragmented marine industry. For those few who responded, thanks! Your details have been recorded and when (if) things get off the ground, I'll be in contact.

However, to be truthful, the level of response was very poor for reasons unknown. Perhaps industry members believe IMarE already fills this role with its monthly meetings. Perhaps its simply apathy or a lack of interest. Whatever the reasons, my enthusiasm has waned.

Being a glutton for punishment, I still hope to at least organise an inaugural "gathering" so interested people can discuss if such a group has a future (and to have a few beers!). If you'd like to be there or have any thoughts on the subject, drop me a line at 9602 5100 (fax)

Cheers
Mark Smallwood

Sorry to hear of the disappointing response. Perhaps we need to look at our organisation and what we offer to find the reasons for the lethargy that appears to afflict us nation wide. What can RINA provide that will enthuse members?

OUR PROFESSION

DO YOU MEAN DRAFT WHEN YOU SAY DRAUGHT?

P.J. Helmore - UNSW

Abstract
A recent publication says that the primary spelling of the word for the depth of water required to float a ship is draught, with draft as the secondary spelling. A survey of thirty practising naval architects was made to check the claim, and found that a large majority of Australian-educated naval architects spell it draft. The overall results are interesting and are given here.

Introduction
Language is a living and ever-changing chameleon, and dictionaries and style manuals document the changes at intervals for practitioners of the writing craft. The Oxford English Dictionary (first published 1884), and Fowler (first published 1926) have had a long influence as the final arbiters of English spelling and usage. However, Australian English and the parent language are diverging at an ever-increasing rate as both absorb influences from many different sources.

The changing face of Australian regional spelling is documented by The Macquarie Dictionary which is now accepted as the Australian spelling bible by the Commonwealth Government's Style Manual for Authors, Editors and Printers (AGPS, 1994). This Style Manual, together with The Australian Writers' and Editors' Guide (Purchase, 1991) and Modern Australian Usage (Hudson, 1993) document Australian usage. These contain much technical information and are formal in style, and are not books you dip into to read.

The Cambridge Australian English Style Guide (Peters 1995) provides a breath of fresh air. It is an excellent reference for style, useful for spelling in general, very readable and is highly recommended. She uses descriptive accounts of many aspects of language, gives the facts about variants, and often leaves the final choice to the reader. It is written with a sense of humour, and it is the sort of book that one can dip into anywhere and find something interesting. The sort of book that one can leave beside the bed for night-time reading.

It was on one such nocturnal excursion that I came across the entry for "draft or draught".

Draft or Draught
Under this entry, Peters says that the spelling "draught persists in references to ... the draught of a ship". A quick check of The Macquarie Dictionary gave the definition of draught (Item 12b) as "the depth of water a vessel needs to float it", with this as the primary spelling. Several other dictionaries also confirmed this finding.

I was taught draught when studying for my degree thirty years ago, but have been spelling it draft for the last twenty years. I was therefore interested to see how others spell it, and so conducted a survey of practising naval architects by phone and e-mail during the week of 8-12 December 1997.

Survey
In all, thirty practising naval architects were contacted, from recent graduates to seniors, from the naval and commercial spheres, classification societies, marine authorities (federal and state), shipbuilders, research and educational institutions, and those who received their education in the United Kingdom and in Australia. It is considered to be representative but, like all surveys, it has the potential for bias:

(a) The sample is of limited size, mainly due to the time a wider sample would take. There are about 400 members of the Royal Institution of Naval Architects in Australia. Not all naval architects are members, and not all members are still practising. There may be 500 practising naval architects in Australia, so the sample would be about six percent.

(b) The University of New South Wales has been producing graduate naval architects since about 1960, and the Australian Maritime College since about 1990. I am not familiar with many of the AMC graduates, but the two I know are included. This makes seven percent of my sample, which is probably representative of AMC in the overall scene.

(c) The profession is heavily male-dominated. I have contacted three female naval architects, making ten percent of my sample, and probably over-representing them in the overall scene.

Results
Of the thirty respondents, four spell it both ways, i.e. draft and draught, for a variety of reasons. Excluding those, eighty-five percent of the remainder spell it draft.

Of those spelling it one way or the other, three were educated in the United Kingdom and spell it draught. If they are also excluded, then ninety-five percent of Australian-educated naval architects in the sample spell it draft.

There were some interesting comments:

(a) Several of the Australian-educated naval architects felt that the spelling draught was archaic, and one thought it pretentious!

(b)One of the reasons given for using both spellings was that vessels were being designed for both the United Kingdom and the United States of America, and spellings were tailored for the particular country.

Conclusion
The survey results indicate that a clear majority of practising naval architects in Australia spell it draft. Professor Peters (who is also on the editorial committee of The Macquarie Dictionary) has been advised.

Acknowledgements
I would like to thank all those who participated in the survey for their time and the frankness of their discussion. Names have not been used in order to protect the innocent.

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COMPOSITE TECHNOLOGY

This article is a summarised version of a technical paper delivered at Project 97 by ***Graham Harvey****, General Manager, SP Technologies Ltd &*
Alex Shimell*, Projects Manager Powered Craft, SP Technologies Ltd*

Abstract
Today there are many materials classed as Advanced Composites, which are specified to achieve the designers/owners requirements such as light weight, low maintenance and thermal/acoustic insulation. However the phrase advanced composites should not just be associated with resin and fibres but more holistically with the complete design, material selection and production processes. A vessel may be termed as having an "advanced composite structure" not through the use of Formula One style materials, but because of the engineering design and/or the production process used.

A full understanding of composite materials technology and manufacturing techniques, as well as skills in designing with highly an-isotropic materials, are necessary if the full potential of advanced composite materials are to be exploited. This requires an integrated approach, covering structural engineering, resin development, reinforcement design, mechanical testing, process engineering and liaison with the builder to ensure that the design on the drawing board can become a practical reality.

It must be realised that weight savings illustrated in figure 1 represent an average overall structural weight for the vessel and those individual areas such as the hull bottom, sides and deck will have different percentage weight savings if evaluated individually. For example we would anticipate for a sandwich glass structure saving only 5-10% of the weight on the hull bottom but in excess of 35% on the superstructure. This occurs due to the toughness requirements overriding the strength requirements on the hull bottom.

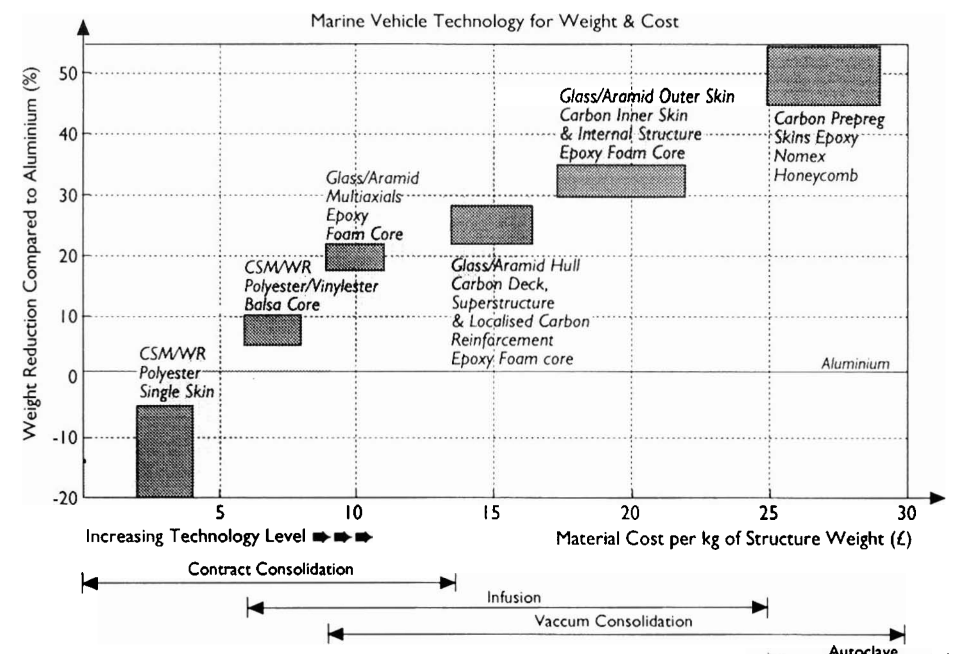

Fig. 2 - Technology Section

To give some idea of a typical design loop followed with a powered marine craft, we have gone through a brief outline of some of the design processes illustrated with examples from the latest 50m, 40knot motor yacht under construction at Oceanfast (MY Thunder).

Design Level

The first step is to study and agree with the customer the level of strength to be achieved and to define the performance envelope required.

Design loadings set out by Classification Societies are the basis for any design, as usually some form of classification is required for insurance purposes. However care should be taken as the rules are usually formulated around more general craft and high performance, made achievable through composite construction, can mean that the design is outside the classification society load predictions. SP Technologies have found it more helpful to agree on certain acceleration limits which can be used to derive loadings and can be then monitored on the vessel.

•The boat yard requested the design in a vinlyester laminating resin as the standard practices on the shop floor were set up for this system. An epoxy resin system would have allowed better mechanical properties and a slightly lighter laminate due to vacuum consolidation.

•Due to the size and speed of the vessel and therefore the anticipated loadings and impacts, it was decided to design the vessel with a single skin hull bottom. The single skin construction meant the hull could be laminated in a simple female mould, with recesses for the spray rails. The female moulding also reduced the fairing weight, time and costs but increased the labour costs to construct the vessel.

•The hull sides were constructed in a thick sandwich using glass and aramid heavy multiaxials to provide the necessary toughness with the minimum working times. The deck and superstructure were of carbon sandwich construction, providing minimum weight for these protected areas of the structure. Thick PVC foam core sandwich panels were used in these areas to minimise the number of internal supporting beams and thus make weight control and fit-out easier and faster.

•The proposed construction was discussed in detail with the builder to allow as many pre-made components as possible to be built and fitted in to the vessel.

•Once the basic shell laminates have been derived, the longitudinal strength of the vessel has to be checked. This includes simple stress concentration factors and panel bucking checks. Usually, due to weight saving requirements, the contribution of the superstructure to the hull girder strength has to be reviewed.

Finite Element Analysis

Finite Element Analysis is an enormously powerful tool and was used extensively for the Oceanfast project. FE analysis was used to study the interaction between the longitudinals, bulkhead and transverse frames. This allowed most of the internal structure to be pre-fabricated to speed up the construction.

With the Oceanfast project, the size and speed of the craft meant that there was a realistic chance that the hull would be subjected to considerable global bending loads. Due to the relatively shallow hull girder depth and long overall hull length, this was an important area of engineering.

As the superstructure was relatively long, it was partially effective in terms of the global bending strength of the boat and the large glazing areas in the superstructure sides further complicated this. Working with the designer, Jon Bannenburg, a number of forward mullions were heavily reinforced and shear panels added as structural interior to transmit the shear loads in to the superstructure. These reinforcements reduced the shear deflections in the forward part of the superstructure and decreased the bending stresses in the main deck

As well as the normally highly stressed areas such as bollards, cranes and swimming pools, the following components were also designed and built in composites with the aid of FE analysis:

•Water jet ducts, which due to the increased fatigue resistance of composite structures compared to aluminium alloy, produced considerable weight saving. Most of the laminate utilised E-glass reinforcement for improved impact resistance, although it was found to be more cost effective to use carbon fibre in the following local areas to increase their natural frequencies.
• 10m long passerelle box.
•Mast and Radar Wings
•Trim Tabs

Processing Techniques
There are some advantages to be gained with the modem stitched reinforcements, where the number of reinforcement layers can be reduced due to the better properties. This can, for example, allow the beam spans to be increased, allowing the interior designer more scope.

This concept has been used on the some of the Sunseeker range of boats. Here the modern materials have not been used necessarily to reduce weight, but to speed up production by simplifying the structure. The number of frames has been dramatically reduced. By reducing the number frames, the size of deck panels have increased, and it has then been cost effective to use carbon fibre reinforcements where the stiffness has been critical and the normal working strains are very low.

Summary
The number of composite marine structures increases every year. However sometimes these "plastic" solutions are seen and used as a marketing tool, with the desire to show that a structure uses carbon or aramid fibre and therefore must be good. The structural integrity of the material is then a secondary consideration

Advanced composite structures are not simply about using the most expensive available but using them wisely within a design to achieve the owners requirements.

JUST LAUNCHED

IMAGE MARINE LAUNCH 24M HIGH SPEED CATAMARAN PASSENGER FERRY *"Evercrest"*

The Seabus 24m "Evercrest", is the most recent launching in a series of aluminium catamaran and monohull ferries from the Image Marine Group of Western Australia. This vessel makes a sharp contrast with another recent Image launching, the 30m live-aboard dive charter catamaran, "Paradise Sport".

In performance and working role, the new vessel is closer to the high speed Seabus 30m catamaran ferry "Marineview" delivered to Japan last year.

Image Marine Group principal naval architect Gordon Blaauw has drawn an easily driven catamaran design with fine entry and hulls that give an uninterrupted run aft. The vessel was built in marine grade aluminium alloys to Lloyds Register using construction techniques developed over more than a decade by the Image Marine Group in producing a range of commercial fishing vessels, pilot and patrol boats, charter vessels and ferries.

The 24 metre ferry has a beam of 8 metres and an uncluttered layout that places all accommodation in the air-conditioned main deck with a sun deck and wheelhouse above.

An interior designer has joined the staff of the Image Marine Group and colour co-ordination and flair along with first class-legroom are features of the spacious seating for 100 passengers who will be guests of the Evercrest

Yacht Club when the vessel commences service at this Philippines tourist resort.

The bridge wheelhouse has wing steering stations for docking and is equipped with a comprehensive range of electronics, television monitoring systems and entertainment console. Two Perkins 62 kVa generators supply the ferry's electrical requirements and the main engines, twin MTU 12V 2000 M70 diesels producing 1050 hp at 2100 rpm continuous drive five bladed Teignebridge propellers via ZF 250 gearboxes to give the vessel a light ship speed of 31.9 knots and 30.9 knots fully laden.

Principal particulars

Length overall		24 m
Length waterline		22 m
Beam overall		8 m
Draft		1.5 m
Fuel capacity		4,500 l
Deadweight		11 t
Passengers		100
Crew		4
Speed max	(lightship condition)	31.9 kts
	(fully loaded)	30.9 kts

THE AUSTRALIAN DIVISION OF RINA

RINA MEMBERS HONOURED

Congratulations go to two Australian Division RINA members who have received recognition for their efforts in the Australia Day Honours list. Mr. Donald George Fry (AO) of Queensland was honoured for "Engineering, Marine Engineering in the areas of design and construction and to the community". Mr Alan Mitchell (AO), our secretary/treasurer, was similarly honoured for "Service to the profession of Naval Architecture through the Australian Division of the Royal Institution of Naval Architects".

It seems that Don had a tradition to maintain. His mother also received honours and in his lifetime Don's father was awarded an O.B.E. and a C.B.E..

EXPORT CONTRACTS

Denis Pratt of Promarine in Victoria relates his experience with two Asian contracts during the currency crisis.

What happened to the Asia/Pacific economy might one ask, one day it was there and the next it was gone. How does this affect boat builders and designers in Australia is more to the point to the reader.

Having two projects for Asia running through recent times gives the experience one gets when one does not get what is paid for.

The projects were set up quite differently, the first with a well established and cautious client who arranged for a letter of credit (l.c.), with draw down facilities at two stages, let in Australian dollars and hedged against currency fluctuations by fixing the rate of exchange at l.c. set-up date. The second project, set up with a new player, on a deposit and progress payments basis, the goods not shipped before final payment received, penalty payment/liquidated damages for late delivery, again let in Australian dollars. All sounds simple and water tight, not too many problems one would think.

The first project's only problem was time and dotting the "i"s and crossing the "t"s. The l.c. took a month to place which delayed the project start, the draw down at the first milestone took time to verify and process documents. At shipping the plethora of documents required in duplicate mailings, with wording exactly as the l.c. requires from shipping agent, insurance companies and document couriers all making the process into an orchestral headache. However, because the l.c. was irrevocable, payment even though the route was arduous, was assured.

The second project's set up was simple, contracts were exchanged and a deposit paid within one week. Work commenced, the client visited and saw progress being made and both the builder and client were walking down the road of life hand in hand each never funding more of the project than was initially agreed. Until the crisis. Almost overnight the project cost increased by 20%, progress payments were not forthcoming. The builders quandary was whether to press on reducing his own liquidity or have a production bottleneck by stopping the project. Funds may never be forthcoming, the project may end in dispute, fire sale and loss greater than the 20% price rise. What are those losses, not only the realisation price reduction on the contract price but the costs for factory overhead, insurance, interest charges, possible legal costs and a plethora of other items each reducing the price by time over-run .

So, what to do with export contracts in light of recent events and experiences. Well one is in business to do business. For exports, experience says that a simple contract will never take the place of an irrevocable letter of credit. Having such a device in place goes a long way to ensuring both builder and client have a fixed price to work from. The builder has the security of knowing that a bank has provided the client cover for the funds no matter what. Set up projects in a secure manner but remember both sides have got to be happy for an agreement to take place so give a little if needed. Potential problems exist for the client and builder with any contract, these do not need enumerating here. Once currency rates have to be considered the problems only increase, this will be the problem with global trade until a single currency exists, which will not happen whilst money can be made on the daily rate changes.

Should we continue to trade with Asia? Asia to me is a vibrant area with rich culture and new experiences at every turn. It has a diverse requirement for water craft and the people really like trading with Australia and Australians. The decision to fund and complete the second project was taken without hesitation. Delays were inevitable with the negotiations for a revised payment strategy where both sides had to be accommodated. The acid test is still to come with hand over and final payment due any time now. Are the final funds available, will the project end in harmony or bitterness? No matter what, the experience was worth it.

Dennis Pratt
Promarine

TECHNICAL PAPER - A

Uses and Abuses of Marine Hydrometers

P. J. Helmore

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Abstract

The two types of marine hydrometer commonly used by naval architects and surveyors measure two distinct, but related, properties. The properties have different units and are used for different purposes. Some users may not be aware of the two types of hydrometer, the properties measured, or the errors which can significantly affect the end result.

The relationships between the measured properties are discussed, together with the specific applications of the two types of hydrometer. The conversion of measurements made on one type of hydrometer to the other type is given, with examples of the conversions. Application of the principles presented here will prevent confusion and ensure the use, rather than abuse, of the two types of marine hydrometer.

1. Introduction

Two types of marine hydrometer are used by naval architects and surveyors for two main purposes:

(1) A loadline hydrometer is used to determine the displacement (mass) of a vessel floating at a given waterline, as in an inclining experiment or loadline survey.

(2) A draft survey hydrometer is used to determine the apparent weight (i.e. weight in air) of a vessel floating at a given waterline and, subsequently, at a different waterline, as in a draft survey. This is usually done for bulk-carrying cargo vessels to calculate the amount of cargo loaded onto or discharged from a vessel, where apparent weight is the commercially-accepted measure of cargo.

Loadline and draft survey hydrometers have different scales because they measure different properties. A good introduction to the use of the two types of hydrometer is given in *Marine Notice 6/1988* (DoTC 1988). This is still current, available from the Australian Maritime Safety Authority, and is recommended reading. However, it uses the term weight for both mass and weight, does not distinguish between mass and force units, and uses the term specific gravity (see Section 2).

The mass and apparent weight of a ship are related (see Section 3.1), as are the relative density and apparent density of the water in which the vessel floats (see Section 3.3). A precise definition of the terminology will help us to clearly present the relationships between them.

2. Terminology

Mass is the fundamental measure of the quantity of matter in a body. It is invariant with respect to gravity or buoyancy and, for ship work, is usually measured in tonnes.

Density is mass per unit volume and is measured in tonnes per cubic metre (or kilograms per litre, which has the same numerical value).

Relative density is the ratio of the density of a fluid at a given temperature to some standard density. For most work with liquids and solids (but not all hydrometers) this standard is the density of fresh water at 4°C, which is 0.999 972 t/m^3 (NSC 1988). The term *relative density* has replaced *specific gravity*, which should not be used. This is because *specific* always means *per unit mass*, and specific gravity becomes meaningless (AS 1997, Massey 1989 and Morrison 1998).

Apparent weight or weight in air is the gravitational force on a mass less the upthrust force of air buoyancy acting on it when the mass is surrounded by air. This upthrust is often called the air buoyancy correction, and those interested are referred to OIML (1979). In the SI system a force is measured in newtons (or multiples thereof) but, for practical ship work it is measured in tonnes (Aiton 1998). Care is required as this is a force (not a mass), and so I distinguish force units by using tonnes-force (tf) or kilograms-force (kgf).

Gravitational force is the force of attraction of the (rotating) earth for a mass. Since the earth is not

spherical, this varies with latitude. However, in draft survey work, no account is taken of variation with latitude (Aiton 1998). This will be discussed in Section 8.
Apparent density is the apparent weight per unit volume, in tonnes-force per cubic metre (or kilograms-force per litre, which has the same numerical value).

3. Relationships Between Properties

3.1 Mass and Apparent Weight of Ship

The apparent weight defined above is the gravitational force on a mass less the air buoyancy acting on it. This would be the weight experienced by the blocks under a ship in dry-dock, and is given by:

$$W_A = mg - m_A g = \Delta g - \rho_A V g = (\Delta - \rho_A V)g$$

where W_A is the apparent weight of the ship, kN;
Δ or m is the mass of the ship, t;
m_A is the mass of air displaced by the ship, t;
V is the volume of air displaced by the ship, m^3;
ρ_A is the density of air displaced, t/m^3; and
g is the acceleration due to gravity, m/s^2.

Note that the unit for apparent weight is the SI unit of force. However, for practical ship work the unit used is the tonne-force (see Section 2). We therefore divide the right-hand side of the above equation by the acceleration due to gravity to obtain:

$$W_A = \Delta - \rho_A V \qquad (1)$$

where W_A is the apparent weight of the ship, tf.
The displacement of the ship is usually found from the volume immersed in water by:

$$\Delta = \rho \nabla \qquad (2)$$

where ρ is the density of water, t/m^3; and

∇ is the volume of ship immersed in water, m^3

Substitute Eqn (2) into Eqn (1) to give:

$$W_A = \rho \nabla - \rho_A V$$

It is not practical to calculate the volume, V, which includes the lightship, consumables, cargo and personnel. The approximation usually made is that this volume is equal to the volume of the ship immersed in water. This gives:

$$W_A = \rho \nabla - \rho_A \nabla = (\rho - \rho_A)\nabla \qquad (3)$$

It must be borne in mind that there are *two* approximations in this equation; one in the volume of air displaced by the ship, and one in the constancy of gravity in the unit used.
The density of the water in which the ship is floating is found from the relative density by:

$$\rho = RD\ \rho_{FW} \qquad (4)$$

where RD is the density of water relative to fresh water at 15°C (see Section 4); and
ρ_{FW} is the density of fresh water at a reference temperature, T_2, (see Section 4).

The loadline hydrometer measures the relative density of the water in which a ship is floating

3.2 Mass and Apparent Weight of Water

Now consider the apparent weight of a sample of the water in which a ship is floating:

$$W_A = mg - m_A g = \rho vg - \rho_A vg = (\rho - \rho_A)vg$$

where W_A is the apparent weight of water, kN;
m is the mass of water, t;
m_A is the mass of air displaced by the water, t;
v is the volume of air displaced by the water, m^3;
ρ is the density of water, t/m^3; and
ρ_A is the density of air displaced, t/m^3.

Dividing throughout by the volume gives the apparent density of the water:

$$AD = W_A/v = (\rho - \rho_A)g$$

where AD is the apparent density of the water, kN/m^3.

Note that the unit for apparent density is the SI unit of force per unit volume. However, for practical ship work the unit used is the tonne-force per unit volume (see Section 2). Dividing the right-hand side of the above equation by the acceleration due to gravity gives:

$$AD = \rho - \rho_A \qquad (5)$$

where AD is the apparent density of the water, tf/m^3

The draft survey hydrometer measures the apparent density of the water in which a ship is floating

3.3 Relative Density and Apparent Density

Substitute Eqn (4) into Eqn (5):

$$AD = RD\ \rho_{FW} - \rho_A$$

The standard value for air density is 0.001 2 t/m^3 at 20°C (OIML 1979). The relationship also depends on the reference temperature, T_2, at which ρ_{FW} is measured. At 15°C, the density of fresh water is 0.999 100 t/m^3 (NSC 1988). Using these values, the above equation becomes:

$$AD = RD - 0.002\ 1$$

for all values of RD between 1.000 and 1.040, the usual range for marine work. The value of 0.002 1 is subject to air temperature and pressure, and most references (e.g. Zeal 1997, ISO 1994) round this to:

$$AD = RD - 0.002\ 0 \qquad (6)$$

This equation shows the relationship between relative density and apparent density for a reference temperature, T_2 of 15°C.

4. Loadline Hydrometers

Relative density, according to the definition established in Section 2, is the ratio of the density of a fluid at a given temperature to the density of fresh water at 4°C. Loadline hydrometers, however, measure the ratio of the density of water at a given temperature, T_1, to the density of fresh water at a standard temperature, T_2. Both T_1 and T_2 are usually 15°C; T_2 may be 4°C but, if so, then Eqn (6) must be changed to suit, using the density of fresh water given in Section 2 in lieu of that at 15°C.

If the temperature of the water being measured varies from T_1 then a correction must be applied to the hydrometer reading, since the hydrometer will have expanded or contracted according to the temperature difference from T_1. This correction is found from the calibration data, and so:

$$\text{RD} = \text{RD reading} + \text{RD correction} \qquad (7)$$

The density of fresh water at 15°C is 0.999 100 t/m^3 (NSC 1988). This is not the same as the value of 0.999 0 t/m^3 given by the 10th International Towing Tank Congress in 1960 (quoted in Paffett 1971) or Rogers and Mayhew (1988). However, the advice given by Morris (1998) is to treat the values given by NSC (1988) as gospel. This density of fresh water at 15°C must be taken into account when determining actual density using Eqn (4); see final stage of calculations in the example given in Appendix B.

5. Draft Survey Hydrometers

Draft survey hydrometers measure the apparent density of water at a standard temperature, T, usually 15°C. However, if the temperature of the water being measured varies from T, *no correction is applied* (cf. loadline hydrometers). This is because the hydrometer will have expanded or contracted according

to the temperature difference from *T*, but so will the ship (whose apparent weight we are trying to determine). The coefficients of cubical expansion of glass (draft survey hydrometers) and steel (bulk carriers) are similar, and the corrections required to compensate for these two changes in volume are of opposite sign and tend to compensate for each other. As it is not practical to calculate any temperature correction for the ship, for draft survey work no correction is applied.
After measuring the apparent density of the water in which a ship is floating, a draft survey proceeds by referring to the hydrostatic tables to determine the ship's displacement (mass) at the draft at the LCF and the density for which the hydrostatic tables were prepared (usually 1.025 t/m^3). This is converted to an immersed volume using this density, and the immersed volume is then multiplied by the apparent density to give the apparent weight of the vessel as surveyed using Eqn (3). All deductions (lightship, ballast, bunkers, etc.) are then figured in terms of apparent weight to arrive at the apparent weight of cargo.
Those interested in further details of the calculations involved in a draft survey are referred to Stokoe et al. (1984), IMSA (1989) and ISO (1994) for starters, and to their references.

6. Conversion of Readings

When a loadline hydrometer is used for an inclining experiment or loadline survey, or when a draft survey hydrometer is used for a draft survey, there is no problem and the results are straightforward. However, a measurement taken on one type of hydrometer can be converted to a value for the other type of use. Some care is required in the conversion, as a temperature correction is required even for a draft survey hydrometer (cf. Section 5).
For the draft survey hydrometer:

$$\text{AD} = \text{AD reading} + \text{AD correction} \qquad (8)$$

where AD is the apparent density, tf/m^3

This equation is of the same form as Eqn (7) for the loadline hydrometer, and the correction is found from the calibration data for the draft survey hydrometer. However, note that this equation does *not* apply for draft survey work, but *only* for conversion.
For the conversion of either type of measurement to the other, use Eqn (6) after applying the temperature correction to the particular hydrometer reading. Examples of both types of conversion are given in Appendices A and B.
The measurement on one type of hydrometer may be used to verify the measurement on the other type of hydrometer. For this, use Eqn (6) after applying the temperature corrections to each hydrometer separately using Eqns (7) and (8).

7. Calibration

Hydrometers, like any other testing equipment, should be calibrated regularly. For inclining experiments and lightship measurement checks, the *USL Code* (Section 8) requires calibration annually, and *Marine Orders* (Part 13) requires calibration every two years for a brass hydrometer or every five years for a glass hydrometer. There are no known requirements for calibration of hydrometers for loadline or draft survey work (Aiton .1998).
A glass hydrometer for marine work costs between $20 and $200, depending on the quality. The only known hydrometer calibration service remaining in Sydney is that provided by the CSIRO Division of Telecommunications and Industrial Physics at West Lindfield, and costs $363 in January 1998. Recalibration is therefore no longer economical. This may be good news for manufacturer G.H. Zeal and bad news for CSIRO, but it also means that naval architects need bigger bottom drawers to hold a growing collection of out-of-calibration hydrometers!
It is, of course, possible to have either type of hydrometer calibrated for the other type of reading (e.g. to have a loadline hydrometer calibrated to give apparent density). However the cost of so doing now puts this exercise out of court.

8. Discussion

Fortunately, most marine hydrometers have markings which indicate their type. Loadline hydrometers are usually marked with the notation RD or Sp.Gr. (for specific gravity) and two temperatures, T_1 and T_2. Draft survey hydrometers, on the other hand, are usually marked with the units kg/L (remember that this means kgf/L!) and one temperature, *T*.

It is worth noting that, for marine work, hydrometers must be adjusted for the effect of the surface tension of water (a liquid of medium surface tension). A hydrometer calibrated for use in petroleum (a liquid of low surface tension) would read too low if used in water. Loadline and draft survey hydrometers correctly allow for surface tension.

A good quality hydrometer has a narrow stem and correspondingly long scale intervals of either 0.001 or 0.000 5, and it should be possible to read four decimal places, giving five significant figures.

For small vessels of less than 100 tonnes displacement, three significant figures give the closest 0.1 tonnes, and calibration corrections are unimportant. However, for ships at the other end of the scale, where the displacement and/or the cargo mass can exceed 100 000 tonnes, five significant figures give the closest 10 tonnes, and five should be used. ISO 1994 says that four decimal places (i.e. five significant figures) *must* be used for draft survey work. There are shades of grey in between these two extremes.

Mention has been made of the variation of gravity with latitude. The earth is a prolate spheroid, and the acceleration due to gravity for the rotating earth varies from about 9.780 m/s^2 at the equator to 9.832 m/s^2 at the poles, with a standard value of 9.806 65 m/s^2 at 45° latitide. Values can be calculated to five significant figure accuracy with the international gravity formula, which is based on an oblate spheroidal model (see Meriam and Kraige 1993). Consideration shows that this affects the third significant figure. However, no account is taken of the variation of the acceleration due to gravity with latitude, or of its effect on the apparent weight, in draft survey work.

9. Conclusion

The two types of hydrometer commonly used by naval architects and surveyors, the loadline hydrometer and draft survey hydrometer, are used to measure different properties with differing units. The quantities are related, and measurements made with one type of hydrometer can be converted to a value for the other type of use if necessary.

Naval architects and surveyors should be aware of the differences, and conversant with the use of the particular type owned so that no errors arise in the subsequent calculations.

10. Acknowledgements

I would like to thank the following people for their helpful discussions and the provision of technical information in the preparation of this paper: Capt. Neil Aiton (Gibson, Minto and Aiton), Mr Laurie Mayer (Australian Maritime Safety Authority), Mr Ed Morris (National Measurement Laboratory) and Prof. Graham Morrison (University of New South Wales). In particular, I would like to thank Capt. Neil Aiton and Mr Laurie Mayer for their comments on drafts of the paper. And last, but never least, I would like to thank my wife, Helen Wortham for her usual peerless editing. The responsibility for errors and omissions is mine alone.

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Appendix A. Conversion of a Loadline Hydrometer Reading to an Apparent Density

As an example, assume that a loadline hydrometer was used at a draft survey and gave a relative density reading of 1.024 at 19°C. From the loadline hydrometer calibration data, the RD correction at 19°C is +0.000 3. Using Eqn (7):

$$\text{RD} = \text{RD reading} + \text{RD correction}$$

$$= 1.024 + 0.000\,3 = 1.024\,3$$

To convert this relative density to an apparent density use Eqn (6):

$$\text{AD} = \text{RD} - 0.002\,0$$

$$= 1.024\,3 - 0.002\,0 = 1.022\,3 \text{ tf/m}^3$$

This is the required apparent density of the sample

Appendix B. Conversion of a Draft Survey Hydrometer Reading to a Density

As an example, assume that a draft survey hydrometer was used at an inclining experiment and gave an apparent density reading of 1.018 5 tf/m^3 (= kgf/L) at 21°C. From the draft survey hydrometer calibration data, the AD correction at 21°C is +0.000 6. Using Eqn (8):

$$\text{AD} = \text{AD reading} + \text{AD correction}$$

$$= 1.018\,5 + 0.000\,6 = 1.019\,1 \text{ tf/m}^3$$

To convert this apparent density to a relative density use Eqn (6):

$$\text{RD} = \text{AD} + 0.002\,0$$

$$= 1.019\,1 + 0.002\,0 = 1.021\,1$$

This is the density relative to fresh water at 15°C. However, to find the actual density, the effect of the density of fresh water at 15°C (0.999 1 t/m^3) must be included using Eqn (4):

$$= 1.021\ 1 \times 0.999\ 1 = 1.020\ 2\ \text{t/m}^3$$

This is the required density of the sample.

TECHNICAL PAPER - B

COMPUTATIONAL METHODS FOR INVESTIGATING SAIL FORCES - A CASE STUDY[1]

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Introduction

The International Mirror Class World Titles, held in Kingston Canada last year, saw a marked improvement in boat speed and pointing ability of the British and Irish fleets. Performance the Australians, who had dominated the International Mirror Class racing scene for many years, could not match in the prevailing light airs.

This improvement was thought to be due, in part, to the raked rig favoured by the British and Irish sailors. These boats had the mast raked aft by 4°, whereas the Australians used a conventional rig with a vertical mast. The dagger board and rudder were also changed from the more conventional configuration favoured by the Australians to improve the yaw moment balance.

This paper describes a computational study which was undertaken to obtain a better understanding of the changes which led to these improvements and to identify sail design aspects worthy of further investigation. This study was undertaken as part of AME's Yacht Technology Research Program. Computations were carried out using a vortex lattice code capable of predicting the potential fluid flow over the jib and main. This code is based on the work of Greeley and Kerwin (1982) and Greeley et al. (1989).

Computational Model

Six models were used for the analysis. Two rig set-ups were tested: mast upright and mast raked. For each of the set-ups three sail sets were used: both sails set, main sail only and jib only. Each sail was represented by 20 spanwise panels and 16 chordwise panels. Previous experience has shown this panel density to be sufficient from a convergence point of view. A typical panel arrangement is shown in Figure 1, and may be compared with the actual rig in the upright condition, Figure 2. In all cases the sail forces were calculated for zero heel angle, in air of density 1.206kg/m^3, and the wind speed and direction were kept constant with height. The sailing conditions for the calculations are summarised in Table 1. The sail plans of the upright and raked rigs are shown in Figure 3; dimensions are in metres.

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Apparent wind speed	12 knts
Apparent wind angle	
Main sail sheeting angle	6° to centre line
Jib sheeting angle	14° to centre line

Table 1: Sailing conditions

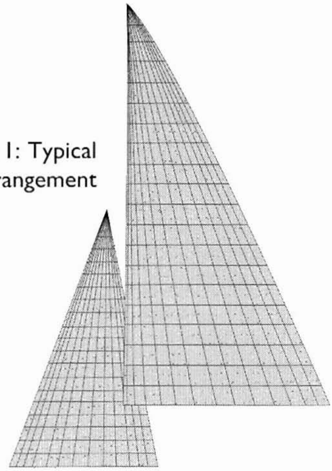

Figure 1: Typical panel arrangement

Figure 2: The real thing

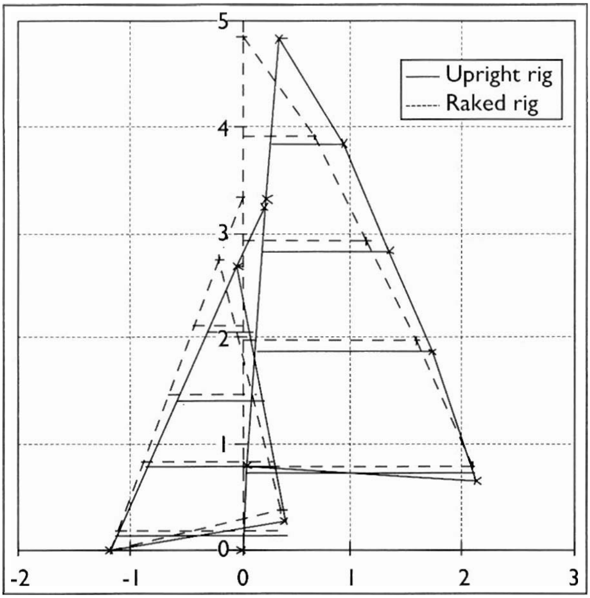

Figure 3: Idealised rig geometry.

Results and Discussion

The directions of the computed forces and moments are given in Figure 4. In Table 2, for both rig configurations (upright and raked), the results are presented for the combined sails rigged together (normal sailing configuration), this result is then separated into the components contributed by the main sail and jib, finally the results for the main sail and jib rigged in isolation are given.

Table 2 gives the results for the three components of the force and three components of the moment generated by the sails. The directions of the positive force or moment are also specified. The force data are also presented graphically in Figures 5 to 7. It may be seen that in all cases the sails rigged in isolation produce significantly different forces compared with the forces generated by each sail when they are rigged together: the main sail generates greater forces in isolation and the jib produces lower forces. This is not necessarily true for the moments, indicating that the centre of pressure of the sails change. These results are to be expected since, when rigged together, the jib operates in the upwash of the main resulting in greater forces, and the main operates in the downwash of the jib resulting in lower forces. The effect on the main is less pronounced since the rig is fractional and the jib only influences the flow over the lower part of the main sail.

	Drive F +ve fwd N	Heel F +ve leeward N	Sink F +ve d down N	Heel M +ve leeward Nm	Pitch M +ve bow up Nm	Yaw M +ve weather helm Nm
Upright Rig	82.4	197.5	-15.1	398.6	-175.1	45.3
Main	42.4	115.3	3.2	290.9	-124.2	74.1
Jib	40.0	82.2	-18.2	107.7	-50.8	-28.8
Main Alone	54.4	128.2	3.6	304.2	-136.9	71.0
Jib Alone	28.2	65.0	-13.1	84.5	-34.2	-23.2
Raked Rig	83.7	198.9	-20.8	391.6	-177.1	72.0
Main	44.0	117.3	0.1	289.5	-128.5	94.6
Jib	39.7	81.6	-20.9	102.1	-48.6	-22.6
Main Alone	55.9	130.7	-0.2	303.5	-140.2	93.0
Jib Alone	28.4	65.1	-15.1	80.8	-33.2	-18.5

Table 2: Forces and moments. Complete rig; main and jib contributions; and main and jib in isolation. For upright and raked rigs.

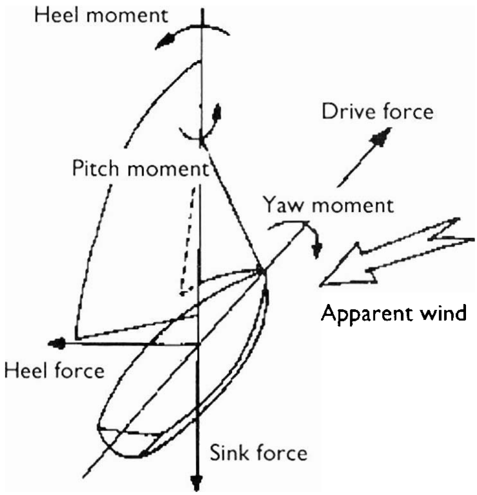

Figure 4: Force and moment direction and orientation

When comparing the forces generated by the main sail in isolation and when operating behind the jib, it is important to consider the influence of the boundary layer. The vortex lattice method assumes potential flow and boundary layer separation is not modelled, however these effects should be born in mind when interpreting the results. If the main is operating in isolation at high lift coefficient (e.g. travelling upwind with the main sheeted hard) then it is possible for the flow to separate from the leeward side of the main causing the drag to increase significantly and a reduction in lift, i.e. the sail stalls. When the main is operating behind the jib it is less likely that this separation will occur; the presence of the jib may delay the onset of stall of the main sail if it is able to influence the main sail boundary layer. Hence it is probable that the main in isolation would not develop forces as large as those predicted by the vortex lattice method since it could not be sheeted so hard without causing the sail to stall.

It is interesting to note that the total drive and heel forces, and heel and pitch moments remain approximately constant for both upright and raked rigs. This is true also when the sum of the forces / moments of the individual sails in isolation are compared with the total forces/moments of the sails rigged together. This indicates that the loss in forces on the main is almost exactly matched by the increase in forces on the jib. (See also Figures 5 and 6.)

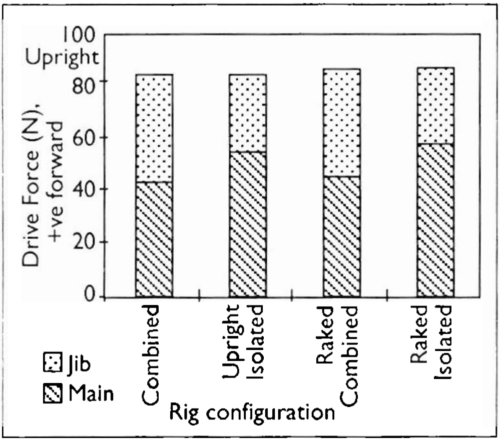

Figure 5: Individual sail contributions to drive force, for different rig configurations.

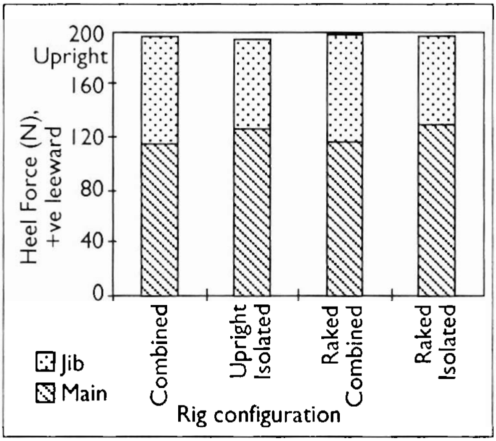

Figure 6: Individual sail contributions to heel force, for different rig configurations.

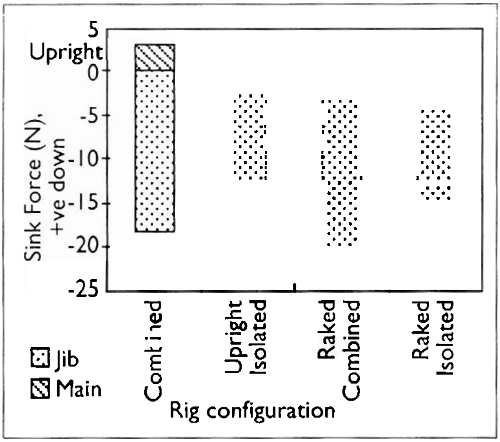

Figure 7: Individual sail contributions to sink force, for different rig configurations.

Raked Rig	Main Alone	Jib Alone
+3%	+2%	+1%
(Main +4%)		
(Jib +0%)		

Table 3: Percentage increase in C_L/C_D due to raking the rig aft.

Differences in the upright and raked rigs is most apparent in the sink force (Figure 7) and yaw moment. The differences in yaw moment are primarily due to the centres of effort of the main and jib moving aft as the mast is raked back. The yaw moments generated by the sails in isolation are slightly reduced when compared with the sails rigged together. The effect of rake is seen in the sink force generated: the force vector is rotated so that a larger portion acts in the vertical direction. The jib, which even in the upright rig has a raked forestay produces a relatively large upward force, whereas the main produces a small downward force, mainly due to twist producing a downward component of the normal vector of the sail's surface. When the rig is raked aft, the jib produces a slightly greater upward force, but the vertical force generated by the main sail is reduced to virtually zero.

Table 3 shows the percentage improvement of lift:drag ratio achieved by raking the rig. An improvement of 3% over that of the upright rig is achieved and this seems to be mainly due to an improved lift:drag ratio of the main sail in the raked condition. The change in lift:drag ratio of the jib shows no significant change. The improvement of

the main sailis performance appears to be due to both improved main/jib interaction and improved performance of the main sail in isolation. When compared with the upright case, the raked main sail shows a 2% increase in lift:drag ratio in isolation and a 4% increase with both sails rigged. This indicates that, for the raked condition, the force vector has been rotated to a more beneficial direction.

It has been found that the raked rig produces a 1.6% increase in drive force, marginal increase in heel force and a 37.8% increase in sink force which acts in the upward direction when compared with the upright rig. Previous experience (Couser 1997) has shown that the increase in boat speed is approximately 20% of the increase in driving force, thus it might be expected that a boat with a raked mast would sail 0.3% faster that one with an upright rig. The effect of sink force may be estimated by assuming that the hull wave making resistance is proportional to displacement. Thus if the all-up weight of the hull and crew is 1730N and the increase in upward sink force is 5.7N, the wave making resistance might be reduced by 0.3%, given that the wave making resistance is approximately 50% of the total resistance, this might correspond to a total reduction of hull resistance of 0.15%, corresponding in turn to a 0.03% increase in speed. Although these differences in speed are small they are the margins by which yacht races are won and lost, 0.33% of a 100min race is 20sec.

Summary of effects of mast rake and sail interaction

There are several effects which may occur due to raking the mast aft. These are discussed below together with the degree to which they were observed in the numerical modelling:

Enhanced endplate effects and reduced leakage under the foot of the sails. If the mast is raked aft the boom and foot of the jib will be closer to the deck, potentially this will increase the lift and reduce the induced drag of the sails. Past experience has shown that the benefits associated with a sealed off sail foot rapidly diminish as the gap between the sail foot and deck increase. It is unlikely that 4° of mast rake would lower the foot of the main sail to produce any discernible improvement. The case for the jib is not so clear since it is already quite close to the deck and further lowering the clew could be beneficial. The vortex lattice method did not show any large differences in the sail loading in the foot region of the sails due to mast rake. However, the calculations indicated that the lift:drag ratio of the main was increased by 4% when the mast was raked back, whilst the lift:drag ratio of the jib was virtually unchanged. The increase in lift:drag ratio of the main was attributed to improved lift:drag ratio of the isolated main and improved interaction between the main sail and jib.

Reduction in span, hence reduced aspect ratio leading to greater induced drag and reduced lift. The reduction in span due to 4° of mast rake is likely to be insignificant (0.2%). No such effects were observed from the computations. In fact, as has been noted above, the lift:drag ratio of the main was improved and that of the jib remained virtually constant.

Reduction of jib / main sail overlap. As may be seen in Figure 3, the difference of the overlapped area with and without mast rake is small. However, it does appear that the vertical extent over which the jib influences the main sail loading is reduced in the case where the mast is raked. The fact that the forestay length is increased and the head of the jib is further from the luff of the main, as in the case where the mast is raked, may be beneficial. There will be a more gradual transition from where the jib influences the main sail to where it does not. The reduction in overlap may reduce the maximum achievable lift coefficient of the main since stall may occur earlier.

Increase in vertical component of sail force. This is achieved since the normal vectors of the sails' surfaces are rotated to produce a greater vertical force component. This is clearly predicted by the vortex lattice model. It is not immediately clear why a vertical force would improve the dinghy's performance, unless the Mirror is super critical to weight. In the raked condition the sails produce an extra 5.7N of vertical force (Table 2), this corresponds to only 0.3% of the dinghy's all-up weight (hull 602N, crew 1128N). It has been estimated that this reduction in displacement may increase the boat speed by 0.03%, which is virtually insignificant. The increase in boat speed due to increased drive was found to be an order of magnitude greater.

Centre of effort moved aft. As might be expected, the centre of effort of the sails is moved aft when the mast is raked. This may improve the balance of the dinghy, hence improving its performance.

Conclusions

This case study has shown the value of the vortex lattice method for investigating the interaction between the sails and determining the relative effects of raking the mast aft. These types of computational tools allow detailed comparative investigations without the high cost of wind tunnel tests. As with wind tunnel tests the benefits of detailed flow visualisation are available.

A number of effects have been observed, particularly the increased vertical component of the sail force when the rig is raked and also the increase in yaw moment, some slight increase in thrust was also achieved by raking the mast. It appears that this was due, in equal parts, to improved lift:drag ratio of the main in isolation and improved interaction between the main and jib. From estimates of the gains in boat speed attributed to these phenomena it was found that the vertical force had a relatively insignificant effect. However, margins of around 20sec would be achieved over a 100min race due to the increase in thrust produced by raking the mast. There is scope for further investigation, in particular information relating to the hydrodynamic performance of the Mirror and its sensitivity to weight would allow a more complete analysis using a VPP (velocity prediction program) to be performed.

It is worth emphasising the difficulty in assessing the effect of rig changes without including the hydrodynamic properties of the yacht. AME's VPP bridges this gap but requires that the hydrodynamic characteristics of the hull and appendages are known. Unfortunately this information was not available for the Mirror dinghy.

It is likely that additional improvements in performance were gained by improving the yaw moment balance and improving the distribution of side force generated by the dagger board and rudder. This hypothesis is supported by the results of the Kingston World Titles: In stronger wind, where the upright rigs were again competitive, the centre of effort of the sails would have moved aft due to deformation of the sail shape. On the other hand, the centre of effort of the raked rigs, whilst in the optimum position for light wind, would have moved too far aft in stronger wind.

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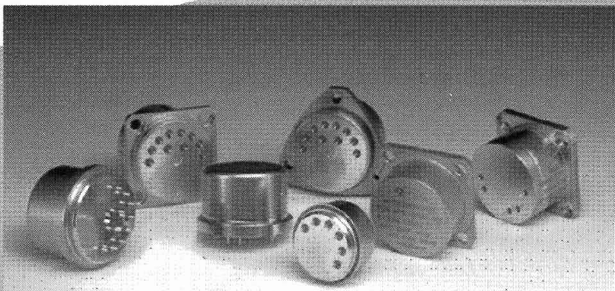

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