GLOBAL SUPERYACHT FORUM 2006

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Engineering Forum

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Paul Crawford	Rolls Royce
Hugo von Wieringen	Azure Naval Architects
Hans Ooms	Quantum Electronics

Martin Redmayne

OK. Let's try and finish the programme on a high with a fairly good debate. A subject that seems to be both a necessity and a fashion statement—to be stabilisation, anchor, all the new stability issues, new technologies. I think this will be quite an interesting session. We've got some very good brains on the panel; Tork and I not included, obviously. Not after last night. We'll kick off very quickly just to get the maximum time available for discussion—Hugo von Wieringen now of Azure Naval Architects, his own dynamic business, a dynamic position I think he's put himself into. He's not even listening to me. I'm going to ask Hugo to come and set the scene with sort of naval architect comments on the stability issues. Then we're going to go politically correct in order of alphabetical names, Naiad want to be called Naiad not VT Naiad so they come first, so we'll start with Naiad then go to Quantum and finish up with Rolls Royce with a very nice animation at the end. Then we'll open it to the floor, we have some interesting people in the audience who'll no doubt stimulate a debate and we have three manufacturers who are all within the same remit, and the same game, so I'm hoping this can be a good final session to the whole programme. Hugo, thank you.

Tork

And as ever don't forget you can also send us questions both by text and also by email and don't feel shy about sending them in as we go. That way we've got a nice bunch of questions to go with once the presentations have finished.

Hugo von Wieringen Azure Naval Architects

I hope you can hear me because I cannot see you with lights in my face. Martin thank you for inviting me to tell you something about manoeuvring stability control on motor yachts. I've been in my life almost completely now in yachting, and one of the key things owners like yachts, they like to sit on it, but sometimes they directly tell you I don't like the motion of a yacht. So over the years we've done a lot of it, to minimise that and of course it doesn't only come from the naval architects, it's all the different parties in industry working on this.

So just to touch upon a few main subjects. The subject has been discussed many times before, either at Project or at Global Yacht Forums or other places; I won't go in too much detail. In fact if you talk about those three subjects, stability and effect what you mean is then we like the boat not to roll too much. If you look back, this is nothing new to reduce roll, build skills were there as soon as the powered commercial ships came into history they had build skills, and they had quite developed a valve, it's all small openings to have maximum effect, that is one. And of course it has been adopted for yachting also. I remember from the first days of yachting we had one captain asking for flopper stoppers and these were kind of big drag devices you would hang over the side suspended from the cranes, the davits of the boat, to limit the rolling of the boat. In fact the same system is also used by fishing boats, especially on the American coast they kind of drag boards in the water on both sides to limit the roll of the fishing boat. Of course soon after that we got the active fin stabilisers, only working when the boat was under way. Over the years I think they started the retractable ones, because they started with the larger boats and in the harbour they couldn't have these long fins sticking out of the boat touching the harbour sides so they started the folding ones and later on more for yachting the fixed ones, where I mean they are always there, you cannot fold them in somehow. It was quite something at that time, considered revolutionary. In my days with the force we had one client really stressing I cannot accept any roll to the boat so we had a whole study on hull shape, on all kinds of means to dampen the roll or prevent it. Out of that came at that time the anti roll tank, nothing new again, was already described in articles some 25 years ago but never applied to yachting, so on a couple of yachts these were applied. Not all this with the same success, some were done and the owners were really happy with it and said well, I like it, we use it, some yachts—maybe depending on the area where they were sailing they were not really finding any gains to using the anti roll tank. And of course it's always an amount of volume you're missing in your boat just reserved for the anti roll tank. Of course we knew already at that time that the fins were developed to reduce roll at speed. I think that’s quite an achievement, initially we said that cannot be, but they worked very well, we had tests done on say 50—55 metre yachts to check the performance of fin stabilisers and the zero speed stabiliser against anti roll tanks. Typically the result was that up to a certain wave, I'd say about 1metre really the fin stabilisers are doing very well, with zero speed, and of course if you were in a heavier swell the anti roll tank always reduces roll by a certain percent, it's also the higher roll amplitudes were reduced by the same percentage. But looking at yachting, really if the weather is getting that bad that the boat is rolling too much, the boat's not there any more, at least not with guests on board. So I think that was really the start of the zero speed fins combined with good marketing from Quantum. Then the next thing is of course OK we have zero speed stabiliser fins, they have a little bit different shape, they have a different position for the axis of rotation, good for zero speed, not so good for in a wave, because the effect had the wrong aspect ratio. They're long, but in fact they should be sticking out more sideways. So the newest thing, one of the speakers after me will further explain that. Then the next thing is the test has to be done, the retractable fins with zero speed option, so they're retractable, part of it still sticking out of the hull, but I think that’s really an interesting option also. Because what you see with the four fin system for zero speed you get at a larger yacht say 60metre and higher in length you need four fins, because the fins have to be within the draught and the beam of the vessel, and you cannot reach only two fins so we ended with four fins, still the four fins have to be fore and aft of mid ship section enough still to stay within beam and draught of the vessel, and you ran into some problems with that. I'll come to that on the next page. So the next development we see is retractable fins with zero speed option. And of course also Quantum has addressed this to make the fins say partly extendable, they were going to have an extension piece coming out. In practice we'll see what we'll gain with that. And of course the next one was a question mark—what is the next solution, or the next development. Maybe we'll hear after my speech. So I touched upon already what's the problem about the stabiliser? In the end the effect is there, the boat is stabilised either under way or at anchor, so that’s all nice, we say what's the problem. Still there's always something—it could be done better. The four fin configuration. It takes little bit of waste to have four units, it means that every point on the boat has to have a fin, you need a water tight compartment behind it, mostly the fins aft are already getting close to propellers so we don’t like that, also given most hull shapes of boats the fins are more angling down and not horizontal so they start acting more as steering. It's always a real stretch to get the best position for the fins, looking at the external part of the boat, the shape, and the flow around it, as well as internally, because you need the water tight compartments and so on and you need some access to them. So there's a need for further development instead of having the four fin system on the larger boats. They had a drag, of course, step by step all those things come in, that if at the sea trial the hull wouldn’t have any appendage, keels, fins, struts, you have a certain resistance, but all the appendages added resistance and even with the four fins it's quite considerable, it's about 15—20% added drag. Compared to the bare hull. Why is that? You can optimise the fin for a certain speed, say top speed 15—17 knots, but of course the boat is going through a number of different sailing speeds, you have a lower cruising speed and the fin for each speed would have its optimum kind of zero angle of attack position to minimise drag so maybe something can be done on stabilisers, we tried a long time ago to measure a kind of torque left on the fin but it's not easy to find. You need some device on the fin like an airplane has a little wool wire on the cockpit to see if you're flying straight ahead. So somehow the fin should have a means of centring them in the flow round the boat at zero angle of attack when you don’t use them. That would of course reduce drag already. The steering I mentioned will be influenced by fins; the point is and also it's not an exact science, you ask Quantum or any factory making those fins OK, it's a lot of experience and adjusting by feeling OK this is good, this is not. It's not an exact science at the moment. The other point we have, if you look at the faster vessels which are either built of aluminium or have a hard chine so really a V section, it's very hard to put the fin there. They're really pointing down, which really limits their effects. So again there is not an optimum solution there. We do studies and refits on a number of yachts replacing the normal fins with the zero speed stabilisers but it is very difficult in an aluminium vessel having the hard chine. In the end you could say well it doesn’t matter, it's a yacht, but in fact it's an expensive solution to have four fins to be installed in the boat. Of course we kind of focussed on the zero speed fins and in a way originally you can see why do we have this problem. Of course there are other concepts for hull shape, I think I've mentioned that earlier; we mentioned this to clients but I could say perhaps 39 out of 40 owners are not really open to have a different shape from normal mono hull type vessel. We talked to one owner who said no I don’t like the roll, why should I have a mono hull, let's consider catamaran, trimaran or other type. So some owners, but very few, are looking at other concepts, because really their problems started with all this roll. And again, saying this, you could solve maybe the zero speed roll, the catamaran is an obvious solution, look at the Caribbean, all the sailing boats with the charters, lots of catamarans, and once you talked to a couple of sailors, mono hulls, catamarans you know why. But of course once you solved the at anchor problem or improved there you have another problem sailing. Then of course the boat is so stable and really sitting flat you get more roll once there really is a swell. So of course there's an optimum solution. If you look at commercial shipping, ferry boats, there's a lot of development going on, fast mono hulls or the catamarans and trimarans, and the latest one I saw in a recent magazine, I think it was built in Italy, what a shape. It's a kind of combination of submarine and swat vessel. But all to reduce the motions of the boat. Of course when you do all this testing you start thinking how it should improve, now we have the four fin system or whatever and they have dual purpose. Maybe you should split it up, just have your retractable fins, the good aspect ratio really taking out, thrown away and maybe have at the optimum position of the boat a large flap kind of recessed in the hull and you only deploy them when you need this zero speed stabilisation. Because you could make a large flap and it's much less in the way, just an idea. Maybe someone will market it next year, I don't know. And if you just look around the whole parameter of the hull shape, what is the optimum position to do some roll stabilisation. The fins are always on the side because you have the largest arm in the central gravity of the boat so you have more effect from it and on the other hand if you go down it's more still water so you get a better reduction of roll from there. Again, a couple of questions marks, we're not at the end of it. Maybe ten years from now we'll laugh about what we're discussing and installing today in the boats. Now from Martin I have the kind of three things, manoeuvring, stability and control, I think control has to do with control of the boat in all kinds of ways, so just a couple of things on manoeuvring. You see a lot of boats they like dynamic positioning, of course I am not on the boat so much, I don't know how much it's really used, but it's a nice gadget to have, it's quite simple to do, it needs some electronics, once you have the bow thrusters, two propellers which all the yachts have almost, and two rudders you can make this dynamic positioning, it's only one thing you have to do, you need better continuous variable propulsion control, thrust control, on the main propellers. I have seen solution where you have one engine in forward and one on reverse and you can change some RPM but that is not really the ideal one. So in effect you need some back up, some small amount of power, more logically to have this electric motor on the gearbox so you have limited amount of power with this continuous variable fore and aft. Or you could even do one propeller. In harbour I think the problem is manoeuvring, you need a good bow thruster what we see, and if you calculate back, maybe with the harbour some more overcrowded or captains like better control or we have more wind but really the bow thruster size is going up, you need that, normally you don't even do up to 20 knots and you really need more. And of course once you have the rudders and the fins and of course stability of the boat, the boat is more stable. This is not always good by itself, that is really critical for manoeuvring at sea, or I mean really course control, broaching, to prevent broaching and if quartering seas to handle well. Also there is nothing new, but you've seen over the years yacht dimensions and main parameters are changing, they're getting fuller, you don't like to go too deep a draught, especially for the larger boats, if you would have the ability to put 4½ metre draught on a say 70metre vessel, no problem. You have a very good course control. But there's a limit there also. And another thing on manoeuvring which you see sometimes that if you want a longer time or running at slow speed for some reason which present normal propulsion system that's also not easy, again comes in electric motors. We have done quite some studies in the last 2 years about all kind of different options for electric motors inside and so on. It's taking on, step by step, at the moment it's a little bit more cost although much less than you would expect, so we have to see if there's a solution there. And that's about manoeuvring. I think I like to keep it with these couple of notes. I'm eager to hear after me what is being talked about with systems.

Martin

Hugo, thank you very much. John do you want to come up and start the ball rolling.

John Venables Naiad Marine

I'll start the yacht rolling. Well, good afternoon. Expanding a bit on Hugo's discussion I'll just kick this off. The topics that I'm going to discuss will be summarised in these four bullet points. What I've termed the comfort imperative, I'll discuss a bit about hull forms, and obviously motion control solutions then more importantly we'll get right to case studies, the first 3 I'll try and go through very quickly.

Enjoyment of the sea, obviously, from the mackerel perspective is all about comfort, we feel and I think we all recognise that comfort leads to enjoyment and enjoyment leads to endorsing the lifestyle so we see discretionary spending at that point and hopefully all our jobs secure. But we see comfort as a real route to this sequence of events. We're all undoubtedly familiar with the 6 degrees of freedom and we're going to talk about devices that will enhance at least 4 of these motions. Over the years many different hull forms have been tried, certainly owner objectives and preferences, as Hugo pointed out, will drive the design. We see in the yachting industry many more mono hulls than any other hull form but these other hull forms are used frequently in commercial and military applications and increasingly so in yachts as well. Here is a better shot of some of those—most people would recognise the swath, the slice is a new Lockheed Martin design, very similar to a swath in some respects. So getting back to the motion control we see enjoyment of the sea as being tied regardless of hull form, motion control systems are designed to improve sea keeping and dramatically improve comfort, which enhances pleasure and provides a much better yachting experience. And this hopefully leads to enhanced usage and we're seeing that undoubtedly with stabilisation at anchor. Here's just a few examples of our current designs; all of these have been selected because they're going to be in the case studies to follow. I think that most people know that our group is comprised of many of the pioneering companies in this field, Vosper, Naiad, Coopnautic, and Maritime Dynamics all combined under one umbrella over the years and we've developed many different devices for generating forces which should improve the ride. Several devices aren’t shown here, for example there's a retractable fin shown—this is a lightweight retractable but we have since the 80s through the Coopnautic side of the business done rotary stabilisers and in the Naiad side had done retractable stabilisers that are high aspect ratio flap to fin, similar to I think what Brown Brothers does today. Both of those certainly have been fielded since the 80s. Getting to the heart of the presentation we've assembled a diverse sample of motion control applications applying those devices. Given the time constraints I'm going to go through these in fairly rapid succession. But a quick word before I start putting graphs up there. About performance data. Trials are always conducted on a day prescribed by the builder and the builder's schedule, and sea conditions are rarely suited to our purposes, which would ideally be heavy seas with a wave period near the vessel's natural period, which of course would then show the worst case condition and for us the resultant highest percent reduction. When we have those days maybe some people are unhappy; we're happy when the seas are heavy and the wave period coincides with the boat's natural period. But these graphs that will show, again I'll flick through them in fairly rapid succession but a pre word about them, essentially time series data analysis using comparisons of the system on and off, and doing that by using standard deviations of motion is much more realistic and meaningful, despite our industry's tendency to talk in terms of percent roll reduction. Because those percent roll reductions tend to be from best case conditions, in other words what I was describing earlier, the so called resonant roll condition. So when you see 70—80—90% reductions we're talking about something that isn’t statistically as meaningful as which is just a peak number as a standard deviation which takes account of all the data. So we're going to show system performance and to hold your interest we'll show it in a variety of ways most often as a standard deviation measure which provides I think a comparison the most honest assessment of system performance. But we'll also show it in video and in photos as well. So moving along, this is a displacement hull, this is what we'd call a classic application of both underway and at rest stabilisation using the same pair of fins, in this case it's a two fin system. We use the terms—there's a bit of confusion about the terminology in the industry —stabilisation at anchor, at anchor, at rest, at zero speed, interchangeably, generally. And some of these are obviously trademarked by our company, some by other companies, but they're all referring to stabilisation while the boat is either anchored or at rest. So the graphs that we're going to present are all in this case at zero speed. The underway performance is actually much better than this because generally the fins are sized, the area required for zero speed and at anchor stabilisation is larger than the area required for underway, so therefore the underway performance is always very good. So I'll focus on the worst case scenario, which is the at rest performance graphs. So this is a good case as a classic example. The other thing is that we're showing the roll energy spectrum which is a measure of the energy, it's also called power spectral density which some people are familiar with and you always see very high performances there, so you can see, as I was saying earlier, 70% but that's even more meaningful than an isolated statistical point of just maximum. This is actually taking account of all the data but it's an energy measure. Whenever we show that, because we don't want to mislead anyone, we also show the standard deviation, so these bar graphs are actually the standard deviation roll angle and roll rate. This is a similar system, it's a Benetti 35metre, again you see the similar performance, 70% reduction in roll rate actually using the standard deviation 69—70%. And higher, you can't read that, or maybe you can on this enormous screen, but 83% of reduction of roll energy. This touches on what Hugo said which is the faster planing hulls and whether they're practical for stabilisation and anchor. Naiad and others combined to do some research I guess it was about two years ago now, and it lead to the application of stabilisation at anchor on planing hulls. This one remarkably has a 4.65 second roll period. Some would say it's not possible below 6 seconds to do a good job of stabilisation at anchor but to quote Heesen here "the system is highly effective and significantly reduces rolling and general movement when the yacht is at anchor". The Marin data is shown there as well and that shows the active fins are more effective than other solutions when the waves are at ¾ metres in that particular test. There's three of these yachts under construction at Heesen and they now will all be fitted with this technology. So you could see a good solution for a planing hull. This is a confidential project so we won't talk about names but it's actually not 40metres it's 55metres, that's a typo; it's a very high speed mono hull obviously, it's got a light weight retractable fin unit and it stabilises both pitch and roll because it has a trim tab system integrated with the fin system. The data shown is at 25 knots. [Gremlins have crept in]. Well we'll move along I guess. This is a very unusual application; this is a 93 metre sailing yacht and the objective here was threefold, it's underway stabilisation, it's something that we've termed tack enhance which is where they wanted to set the leeward fins to add lift while the windward fins were set to minimise drag. And then the third objective was kind of secondary to everything but it was —we're providing fins on this boat, it's a sailing yacht, we don't want to maximise the area for stabilisation at anchor and we also don't want to maximise the shape so there are normal aspect ratio for underway, they're not reduced aspect ratio fins. So the system is not at all sized or optimised for stabilisation at anchor and the target was basically can you get anything more than zero by putting the control system on, and these graphs show that we're actually able to reduce the roll energy by 55% and 28% roll rate, which certainly better than zero, so that was just considered a bonus. And there were other special considerations about this yacht, not least of which was the high inertia due to the masts and the high GM due to ballast. So that was a challenging application and worked out well. We've actually provided the control with an ability for the captain to set those angles as he wishes so there is a screen in the control room where he can set his windward fins and his leeward fins as well. Moving along, this is a completely sort of other extreme, small 24metre boat, what makes this interesting is that it's a sailing hull motor yacht and anyone who knows Steve Dash knows that he's very experienced and into this. He's been heavily involved in the design of this and it's a small keel that relies heavily on the fins and actually this was where there was another video clip—I have to think that's probably not going to work either. Ah, here we go. Magic. So watch the waves pass under the boat from right to left on your screen and you can see for a small

24metre vessel it's astonishingly stable. The boat is still fairly new and this fellow has reported all sorts of data and he's been all over the globe really. If you have a chance go to his website, it's really interesting. These are fairly good sized seas that he's in; he's going along at a fairly slow speed, usually that's a recipe for the stabilisers struggling to maintain the boat's stability because when the boats slow down the lift is varying at the square of the speed, so usually the boats if you slow down too much—he's certainly losing fin stability but it may be necessary because of the sea, so in this case he was able to go along at 11 knots and in real comfort from the roll point of view. This is an even faster Heesen than we saw earlier, this is a 37metre 32 knot and it's got active trim tabs and the data here is in 1½ metre seas. The top graph shows the tab in the neutral position and it's set for optimum running attitude at that point, and then we stabilise both roll and pitch around that point and the graphs depict the performance from different headings. This is a larger non hull, it's a four fin application, 73metres, good size, and again we're showing the roll energy spectrum as well as the roll motion standard deviation. This is an interesting vessel because it's a fast water jet mono hull and it's applying the technology that we call active interceptors. They've been tried and certainly used as static plates and that's been done for a longer period of time. Our group has been providing active interceptors for a number of years now and they're primarily applications in the commercial sector but there are certainly opportunities to supply this technology to the yacht sector so this is a good example of transfer of technology. You can see from this graph that's it stabilising both pitch and roll and also lateral and vertical acceleration reductions are shown and for fairly small device and therefore low power consumption it's generating quite a difference in the performance of the boat. Again, at the other extreme, this is an 11 metre rib and it's an extremely interesting application; it's another ride control application, it's for the special forces, the target was the reduction in vertical accelerations and pitch. Previously some men on board had actually debilitating spinal compression problems because the forces were so great, the accelerations were so great, and in fact the peak short duration Gs and short duration being obviously less than a second, we're talking milliseconds, but they were measured at more than 12Gs so you can imagine the crew is going out somewhere, and by the time they get there they're almost completely useless because they've been pounded by the movement of the boat. We were able to cut that peak down to 5 or 6 Gs from that 12 and reminding you that a G is 9.8 metres per second squared, 32.2feet per second squared. The graphs depict the standard deviations in motion, they're not the peak reduction values. Again they're standard deviations and you're talking about occurrences, so the number of occurrences based on Gs above 1G because we're all subject to 1Gg, so these are Gs above 1G. But you know it's an interesting application; it's another example —we're showing very large applications, mono hulls and we're going to get into a few of these dense hull forms but this is a very small boat and you wouldn't think that we'd be able to do much with it and very hard to do something with it when in that photo it's actually under the water. So hard for us to have an underwater appendage that's generating forces. But managed to make a substantial improvement in the ride of this small craft. And maybe it can apply to yacht tenders, who knows. Going to the other extreme this is a boat about ten times the prior boat's length; this is a 100metre fast ferry so again we're trying to show diversity in extreme—this has got Tfoils, fins and trim tab ride control system that's working completely together. This is the Corsair 11000 series. So all of these technologies are absolutely transferable into yachts if we had owners who were interested in seriously improving motions. This is a 28metre fast catamaran yacht. The vessel was fitted with both water jets and propellers at different period in time, the same boat in two different photos. And the equipment photo is just a manufacturing photo from our Connecticut facility where we built this unit. But it's interesting only insofar as it's equally the same ride control system satisfied the requirements whether the boat's water jet or whether it was propeller driven. This is a

49metre ex Condor 9, some of you may know it. It was built around 1990 or so. It's one of the first ever ride control system applications. Our group was supplied this back at that time, it was one of the first ever done and it's got a new lease on life now, it's actually running a different route entirely in another part of the world, but what they've done now is they've refitted Tfoil and an interceptor, they've removed the fins and this is showing the reductions and the improvement in performance. It's actually 45% reduction in roll angle, using a standard deviation of motion. This is a 58metre catamaran so now we're getting into again different hull forms, the standard deviation data shown here is without the Tfoil but it's still showing with just the interceptor, reductions in pitch, roll and vertical acceleration. That's significant. Incidentally we try whenever possible our standard operating procedure is to use off on off to establish stationarity to make sure that sea conditions haven't changed dramatically. This is a Director 72metre, it's the Alaska Marine highway vessel, it's got an active interceptor only. So this is a relatively small investment from a motion control standpoint. Active interceptor stabilises pitch, roll and heave and we certainly could further reduce pitch motion if we added a Tfoil but I've shown this—it's a nice shot of the transom because you can actually see the interceptor at the bottom. Getting back to yachts, this is an advanced hull form in a yacht, application. I think most of the industry should be aware of it, it's a very interesting 62metre, it's got actually 4 active spanning foils, we say spanning because they're actually spanning the hulls and they reduce pitch and roll and the graph, although it's not defined there the graph is in degrees and degrees per second obviously and this is standard deviations in motion. But that's a really neat application I think of ride control system being applied to a yacht that makes a dramatic difference in performance. In this case it's on off on but again, we're establishing so called stationarity in that respect. Normally it's off on off. This is an application of a swath, it's a 25metre, there's no graph here because we feel that no graph is required, the pictures work for themselves. It shows the power of a four fin ride control system using our controls and it's a good example, I think it's an excellent example really of a technology transfer from commercial applications, in this case German and Dutch pilot boats into yachts, I mean they're applying swath technology into yachts, I think certainly in The Yacht Report we've seen a recent write up on the picture at the little right hand corner which is Rasmussens application of this technology into yachts. One thing that wasn't mentioned in the article which probably should be is that swath is a hull design just like all the others that we've described but they are always enhanced with a motion control device. So although roll may be more stable because in this platform you certainly can reduce motions dramatically, this is forced roll and forced pitch so you can see the power of the forces; you can invert this in your mind and say if the seas were that severe would the fins have enough power to keep the boat stable if they can do this in relatively calm water and the answer of course is yes. Remember that the wave energy increases as the square of the wave height, so you can get up to very large forces quickly due to the seas. This is a really unusual and neat application, I think it's called a slice, we showed an earlier slide on it, when we were talking about different hull forms. We've actually done two of these, the picture in the upper right hand corner and the lower right hand corner are the same boat. The one in the top left is actually a different boat but we've shown that because I have an arrow pointing to the fin—you can actually see it more clearly in that photo. That's actually a different boat but it's still a slice application. There's 6 active fins on this boat, 4 inboard facing fins and 2 outboard. It's a Lockheed Martin design and it's a very challenging control system, motion control performance system. Lockheed Martin selected us and our commercial military side of our business which is Maritime Dynamics to solve this problem and the graphs depict the required limit in Gs at all headings and the result in performance. So it met the threshold in all sea conditions and the vertical acceleration is shown, selected that just to try to show some variety here but we have the same graphs for pitch and roll and in fact I think they're even more impressive. Vertical acceleration is one of the motions that we're actually stabilising. More interestingly I think our fins also control heading, so they're acting as the steering system for the boat. And therefore we can’t show off on off because the boat is relying not only on the steering but on these fins to completely keep the boat stabilised. So that’s the last of the applications and then I just have a summary slide. I've gone through those in rapid succession, I have with me the general manager of Maritime Dynamics, he works in our group, and he knows specifics about some of these and I know specifics about others so feel free to ask us questions related to any of these applications. So in summary we've noted what I call the comfort imperative of the pleasure yachting industry. It's an imperative, I think owners don’t have enjoyment, don’t continue the lifestyle if they're not comfortable first. So we've shown a wide variety of hull forms all made more comfortable by the application of our motion control systems and we've shown applications where technology both vessel design and motion control systems themselves used in the commercial naval sectors are being applied into yachts. We certainly support this and to the extent that it makes owners more comfortable, hope all of us in the yacht industry benefit from it. Thank you.

Martin

John thank you. Hans, can you follow that, in slightly less time, so that we have some time for discussion.

Hans Ooms Quantum Electronics

Good afternoon, ladies and gentlemen. On behalf of Quantum Solutions I am going to present you briefly, because my 10 minutes are not as long as somebody else's. The products that we have for roll stabilisation for large yachts and we are focussing on this engineering form on 80plus metre vessels and although our range stretches from 25 to 100 plus, we'll focus on the high end. So before we go into the specific products that we have on offer we first have to ask ourselves what we have to expect from a stabilisation system. I listed a couple of desirable features of such a system. I should have said put the second one first because excellent performance is what we're all after. All the other ones are technical issues which are important in their own right but performance becomes no. 1. Then it was already mentioned by Hugo there are systems that are specifically for underway stabilisation only, others that are for zero speed stabilisation only. But of course the best of two worlds is to have both zero speed and underway in one system combined. If you are using fins to stabilise then of course another issue that comes repeatedly is having a low drag, the lowest possible drag. We'll see more of that a bit later. Then a small installation footprint is important as well, because no matter how large a ship becomes, space is always at a premium and there's always some wrangling going on about where can we put the stabiliser and even though most of it is outside the ship they're still trying to provide as little space as possible inside. Power consumption can be an issue as well, it has to be acceptable, in general with new builds it's not much of a problem but when you have an older vessel and you're doing a retro fit and you have an existing generator arrangement then it can become an issue. We were surprised over the years, well when we started with zero speed 6 years ago, with the numbers of hours the systems were racking up. Before zero speed came along ships had a stabiliser active for say 500 hours, 1000 hours a year. But now we see regularly systems that are operating for 5000 hours a year. So if you have a certain number of operating hours between maintenance, and 5000 hours goes a long way to bring those maintenance sessions quite close together. Low maintenance, like using proper materials, and so on help to reduce the cost of ownership. The cost of ownership is not the initial outlay only, for a system but also what do you pay over the years to keep it up and running. So what products has Quantum Controls to offer. Well basically apart from some other more special products we have three products, first of all a zero speed stabiliser fin which has been on the market for about 6 years, is a huge success but the most recent development is, you've heard about it from Hugo already a bit, are XT fins. More about that later, the extendable fins. And we have another product the Maglift magnus rotor. All these three products target specific applications and each product has to be seen on its own and the best solution has to be determined. First of all the zero speed stabiliser fins, most of you have probably seen those fins and are familiar with it. For the few who aren't, a brief explanation. What you see here is basically a standard stabilisation fin but one with a low aspect ratio and as you also see, the stalk is quite far forward in the fin so the fin is unbalanced. When under way it works like a normal stabiliser fin although it's somewhat hampered by the low aspect ratio but in general that's never a problem and when in zero speed it's used in different loads because no water is flowing past the fins, and then it's more used like a pedal, so you can see the position of the shaft at the hull and rear end of the fin is acting like a pedal. So you like to have as much area as possible there and you like to have the balance of the fin as low as possible so the stock shaft is as far forward as possible. Those fins have a couple of important advantages. It's a dual purpose system, they work well under way and at zero speed, it's a simple principle, simple construction, relatively low maintenance, it gives excellent roll reduction—more about that later but 80% in 1 metre waves is routinely achieved. It's a proven system, very important; we have 120 plus of them operational and another 150 in the works at several stages of completion. And of the three products we have, it probably has the lowest cost of ownership. Then it has some disadvantages as well. I don't like to mention the disadvantages but it's only fair to do so. Those fins can become quite large for 80metre plus ships, in fact for smaller ones as well. That often translates into placement limitations because the ship hulls these days are so full that you can't place the fins in the middle any more and you have to use four fin solutions which have also been mentioned. And then given the big size and the requirement to keep them within the envelope of the ship means that you're limited in where you can put them. Also compared with the standard old fashioned under way only fins they use so much more power whilst under way as there is plenty of power available in that condition that is in general not considered a real problem, but it's only fair to mention it. But to overcome these disadvantages we recently launched our latest product which is the XT fin. This is an extendable fin so the upper part is basically the same as the standard series fin but it has an extendable part which is used in zero speed operation. So when under way you use only the retracted configuration and the size of that fin can be smaller than from a standard zero speed fin because the size of the fin, was mentioned already, is mainly dictated by zero speed requirements. So if you then can extend the area by 30% as is the case, in zero speed operation you have the much larger area that you would like to see for zero speed operation while keeping the size for under way operation reasonable. The added complexity is limited, basically it's a pivot point, over here, and there's a hydraulic cylinder that extends and retracts the extension of the fin. This configuration has some very important advantages. Again, it's a dual purpose system so for both under way and zero speed, for under way you have a reduced fin area which translates into less drag as well, the geometry of the fin with extension is better because we like to have most of the area in zero speed at the rear end of the fin and the extension is doing just that. Another important thing is that given the fact that the fins are smaller you have more freedom for fin placement, so you can put them in a better place, the aft fins more forward, the forward a bit more aft, whatever you like. It's even so that in those cases where you are having to choose between a two fin system which is a bit on the small side or a four fin system which is then quite generous, there are some cases where you can make do with only two XT fins rather than four zero speed fins, which translates in substantial savings, of course. And another advantage is that the

XT fins and zero speed operation use somewhat less power. Disadvantages? Here too; there are some submerged mechanical and hydraulic components, but as I already told you we kept those to the bare minimum with only a hydraulic cylinder and a pivot point. So the construction is such that even if the fin gets a knock or a dent then it will not impede the proper deployment and retraction of the fins. It's at the early stage of development, well that's not probably a true statement because we are actually engineering them at the moment. So they will be fitted in the foreseeable future and we did already a couple of mould tests with them which showed the potential of these fins. Another new development is the magnus rotor system which works on a completely different principle. I suppose that most of you are more or less familiar with the magnus principle which is based on the fact that water flowing past a rotating cylinder generates a lift force, and if you then change the rotation speed and the direction you can change the direction of the force and the magnitude of the force. Well obviously, like with all fins it depends on flow past a rotor so when we are using this system for zero speed stabilisation we have to do so by making the flow ourselves, and that we do by rotating the rotor in a forward and back fashion so it's rotating about a pivot point, about 60° from the centre position, which is perpendicular to the hull and then it can move 60° to one side and then 60° to the other. Meanwhile the rotor is rotating at a constant spinning speed and by doing so we generate significant lift forces. When the system is not in use we just fold it back and it's stored in a pocket in the hull so we have minimal space requirements inside the hull and minimum drag at the same time, when they're not in use. The advantage of the system is that they're retractable, very little drag, for smaller yachts it's a dual purpose system because a yacht with a speed of 8—12 knots can use that when sailing as well, in fact we have a ship where it has been operating for more than a year now and the reports are very good indeed. Another thing that's gained is the freedom of longitudinal position, because you don't have to be concerned, like with fins, that they will be sticking out of the envelope of the ship when they are not in use so you can put them at the optimum position. Hugo already referred to that as well. Magnus rotor systems have the advantage that they also give good performance at low speed so for those applications it's an ideal system. Moreover they can be fitted in yachts with hard chines where fitting a fin would be very difficult as well. Again, Hugo referred to that as well. And you can also consider the use of them in sailing yachts. Disadvantages ? just as well. For 80plus metre yachts it's probably not a dual purpose system because the loads on the rotors at 16—18 knots becomes excessive so for those applications they are for zero speed only and they have to be augmented by under way zero speed stabilisation system like retractable stabilisers or fixed stabilisers. This system is under development, that's again not quite a good statement because we're actually building them, we have one already in the field for a year, another two are coming on stream, smaller ones, but we are building some huge ones as we speak. They have somewhat higher power consumption than a normal zero speed stabilisation fin but we have taken steps to address that problem so the total penalty is not very large indeed. Performance wise, if you compare it, I show this graph and I do so hesitantly because it's a bit of a dangerous graph. We have done many model tests in significant wave heights of ½ metre, 1 metre, 1 ½ metres with several ships, ships of 55metres, ships of 110 metres and everything in between as well. The data for the XT fins and the Maglift rotors well, they are still not too much of that compared with the zero speed fins where we have reams of data. Furthermore the danger in this graph is that we have some figures that don't look too promising but sometimes we have applications where a ship has to have the bare minimum of fin size and then the performance at higher wave heights suffers. But OK on average we could say that for a zero speed fin system or XT fin system or a maglift system, if it's properly dimensioned the reduction is at least 80%. The condition of these tests was all resonant frequencies but it's routine that when we do model tests we not only test the performance at resonance, so we have a wave period equal to the ship's roll period but also at shorter and longer waves to make sure that they perform there just as well. The performance penalty you pay then is often 5% or something like that, depending on the conditions. How to select a stabiliser system ? Well I have a list here with things you should do, get familiar with the subject, ask captains, ask suppliers, they will be all too willing to outline the shortcomings of their competitors' products and boast about their own products so you have to talk to them all to get a balanced view of it. In addition to those reasons listed here I could add, read The Yacht Report no. 77 which gives an excellent overview of what's on the market, what's available and I think the Captain's Corner did an excellent job to get feedback from the field to this magazine and to our suppliers as well. Time, my 10mins has run out. We are still working on further developments, more powerful controllers, we are refining control algorithms, minimising power consumption, reduction of maintenance, it's an ongoing process. You'll hear from us again. Thank you very much.

Martin

Hans, thank you very much. Paul I'm sorry we've run out of time! Come on. I will be fair and give Paul his due time and also with your blessing extend the session by the minutes necessary for debate.

Paul Crawford Rolls Royce

Good afternoon, ladies and gentlemen. I'm going to keep to 10 mins, because that’s all I've got really, I'm going to run out of words. Really what I'm going to talk about is stabilisation at rest and tell you in the last 12 months what we've done and also the challenges and changes we've made.

Our company has been building stabilisers since 1934 and we have over 1,000 installations, some very big and some quite small. And the first stabilisers we built were athwart ship stabilisers, they actually retracted into the hull almost telescopically. We use a one piece fin technology which we've been doing since 1990. Also part of our company is Intering in Hamburg, they make stabilisers, also we've worked on rudder roll projects which haven't really been mentioned so far I don’t think for the Danish Navy and also a swath vessel. We've been supplying yacht stabilisers since about 1960. Most recently we've had good successes with vessels like Ecstasy and Giant and some of the OceAnco projects. In 2005 we were putting a plan together on how to develop a product for this market and trying to understand what was important; at the same time OceAnco came to us and asked if the systems that we supplied to hulls 701 and 702 could be upgraded for stabilisation at rest using a folding fin and we believed we could do this. So both Rolls Royce and OceAnco jointly have been working on this project with a sea trial coming up very soon for a hull 701. On the left hand side is what a normal system that we would make, retractable fin, looks like and on the right hand side is the modification we've made to the fin for hull 701. The standard system that we supplied originally was 3½ sq metres, it was about 11 Kw and this is what we basically upgraded to the new system. In December last year we did some initial testing at Marin on Hull 701 which proved very promising. We basically tested three sizes of fin by changing the cord of the fin. This is really the amount of cord behind the shaft and we used a model scale for OceAnco which was 1 to 11.75 and also we used a transducer between the fin and their servo motor on the model so we could understand the forces. And this graph here really sort of demonstrates the improvement that we obtained. On the left hand side of the graph is the original system that we built, so we tested that in its first condition and then we upgraded the fin size on the model to get about 80% at the end of the day. Also we do different control settings; we used different fin angles, also different acceleration amounts for the fins. And really the Marin conclusions were three fold, simply we could achieve about 75—80% roll reduction. With the controls we used during the test they could be optimised and maybe we could do more in performance, or at different speeds etc. And also one of the last things that we concluded for this particular project and size we had similar performance to two pairs of low aspect ratio fins. Really that’s a graph that we've made from that previous slide, just really to get the concept over of how much performance you could expect to achieve on this specific project. The folding fins, when they're actually extended, you do get some performance while they're not moving, maybe 20—30%, 80% is what we were saying for the rest mode. And 90% is not something that we tested but that was my calculation. But that’s pretty straightforward, so that’s the under way condition. During our design work we've looked at various parts of the system and we've used various tools to actually develop the product; one of the things I skipped out really—before we're using a Rolls Royce gated review process, so we go through each stage and it's signed off, and we go ahead with it. Really the four parts that the project broke down into was developing a retrokit fit for the adaptation of the fin shape and to ensure that the existing equipment had the low capability. The hydraulics was one of the big issues that we had to solve and also they were writing this new control algorithm which we used. The challenges? Well, there have been a few. In 12 months we've come quite a long way and also with 701 when you have a retrofit there's a lot of working on site and a lot of obstacles to manage. But that’s all gone pretty well. We basically increased our fin area or the cord from 1.1 to 1.8 and we've decided, and you'll see it in the animation, which I'll play shortly, to leave the trailing edge of the fin outside the fin box, acting really as a sort of passive bilge keel. The tadpole design of fin we've come up with—we're not using our traditional fishtail design but using this tadpole design. Also the fin velocities and accelerations that we've made have been a big step forward. And also we had the opportunity and one of the key things to get the performance was actually to increase the fin angle so we could actually get this moment. The power unit was a big thing; we went from 11 Kw to 28Kw; and on a retrofit or an upgrade there are obviously space requirements. Control system—we didn’t have to change any of the hardware but basically the algorithm. Also things like installation of the classification for the seating and the stresses that we went through. But basically working on site with a good cooperation between our two companies OceAnco and Rolls Royce we've managed on time and it's looking pretty good. Just really where we are at the moment—we've got all this information coming from 701, 702, and 704 and also we have a new order from Italy for a retrofit for a stabilisation at rest. Sea trials are coming up pretty shortly in a couple of weeks so that’s a sea trial of Y701. after that we plan to develop our Aquarius model so that we can offer it through a greater range of the sizes of the yachts. The next obstacle we're going to have to tackle is different arm materials, looking at aluminium and composites. Also later in December and partly next year we're going to do some more model testing on various other projects and also improve our software, I think. One of the areas we want to look at is investigate if can integrate with a motion control system maybe using part of the steering as well. This is the animation—I'm just going to let it play. I hope you enjoy it. Thank you.

Martin

Paul thank you.

Tork

Can we have the lights on the audience please? Any questions, comments, queries? There's one in the middle, thank you.

[**from the floor]**

It's more what Hugo said about the four fin configuration about the resistance; what we have noticed in testing a four fin configuration on 50 and 55 metre hard chine was that the flow at the end of the fin was not at the same line as at the root. So basically what you would need was a warped fin, and that is a big part of the resistance was caused by this effect. So basically what you would need if you would have a better fin for resistance is a custom fin specifically designed for that boat.

Hugo

In fact variable warping because at different speeds you will have a different slope.

[**from the floor]**

A rubber fin might be the solution!

Martin

Yes Nigel?

Nigel Newnham Solent International

I'd like to compliment the speakers first of all on giving us a list of advantages and disadvantages which is always nice to hear. One disadvantage that I didn't hear any of you talk about which I think probably within this hall we've all heard of is that, at rest, at anchor, zero speed, whatever you want to call it, you can hear these things moving. You maybe hear hydraulic noise, mechanical noise, because obviously your ship is at rest, you don't have main engines running. I guess you can fix that with good engineering. But I've also heard that when you're on the aft deck in some nice quiet anchorage you can hear these things flapping away. Would you care to comment?

Martin

Nothing's perfect, Nigel. Apart from Mike Perkins. Yes, Hans, please.

Hans

Noise is of course an issue, because you rightly said that at anchor with the main engines switched off other things become dominant, of which the fins are one potential one. We pay extremely much attention to combating any noise emanating from the power packs, hydraulic system hoses, valves and so on. We try to reduce the amount of noise that the mechanics make as much as possible but of course there are fins moving through the water and there is some swirl of water coming from the fins and that's observable. Once I heard an owner comment on that because the fin was next to his state room and he said oh well, it brings me to sleep more easily because it's such a natural sound. But of course it's something that always needs attention.

Martin

Any other comment? The same applies to all three of you? No-one has found a solution?

Tork

Paul. A couple of questions for you. One, when I was at the factory we looked at electric fins, which were in the very early stage of military horribly expensive development. Have they moved any further towards our market place?

Paul

That's one thing we're sort of looking at. It's traditionally hydraulic but can we sort of remove the power unit and have an electric system. It's still early days. But I mean that was one of the innovative things. In the past we've done some work for the UK Government where they wanted an electric ship concept. And this was part of it. So it's something we'd like to develop further, but there are some cost issues which we need to work out if it's feasible and some design issues, but that's one thing we'd like to do in the future.

Martin

Joe, what's up your sleeve?

Joe

We've had electric actuators in the field and commercial applications for about 18 months now. Two ferries in the Massachusetts area are using them with good effect; they're low cost, lightweight, low power. And we've also had them on Navy seal boats so the new electric actuators are quite tough and can stand up to Marine service.

Tork

I would have said in both cases that they would to some extent address the issue of noise ?

Joe

Absolutely. It gets the power pack off the boat, no hydraulic noise and the electric motors are very quiet.

Tork

My second question Paul is actually to do with you mentioned one of the things you're going to have to look at is installation on aluminium hulls. Since you actually fabricate the whole pocket that goes in there, has one of the approaches you've looked at been using like a tripon so you have actually have a steel pocket welded into an aluminium hull?

Paul

That's something we've not actually looked at so far and if that's one way of doing it that would be interesting. We're looking really for aluminium that we would build the sort of fin box and maybe when we go to a composite hull it may be the shipyard builds part of the fin box, but that's still something—that's one of the activities for us to look at early next year.

Hans

At Maglift we have the same problem where the box has to be built for the 40 hull. Some yards bark at it and others see no problem so basically what we try to do is to cooperate with a yard who could do much of that work for us. We are not shipbuilders; if they can do it for us then that’s fine with us.

Tork

It does mean that you have to trust their FEM though because if they get it wrong you're going to get the blame.

Hans

We are doing a bit of that ourselves as well.

Martin

Any more questions out there. I think you're all blinded by the presentations. I'm sure. My solution to the whole problem is buy an island. With a small sailboat. Any questions from the panel to each other? Hugo, I thought you might.

Hugo

I had a question for Quantum. Many times I get a question how much can you do about pitch control with the four fin system because you look at the pitch control, the fins should be more at the outer ends of the boat which is conflicting with other reasons so I don’t know how much you can gain there. Do you have any idea?

Hans

That’s a tough issue. Physics are against us in this field. First of all it's the length of the ship means that it's very stiff the pitch period is very short, and because of the large amount of ship body moving there's a lot of wave damping, so the damping of water pitch is already very large. Then if you want to do roll and pitch stabilisation with the same system then you need to have your fins far forward and far aft if you want to work with the four fin solution, and then you can run into problems when you're in the sea of more than say 2½ metres with your fins starting to surface and then they're not terrible effective any more. So if you would like to do that, it's very difficult in the first place but then you should have to think about a Tfoil somewhere forward in the ship rather than having the normal fins trying to do that. We did a couple of model tests for this issue and we got 10—20%; we tried some configurations that aren’t really practical and they would let it go up to 25% under certain conditions. But it's certainly not getting near 80%.

John

Just to comment on that we've certainly used a lot of other devices. When we're looking at pitch control we tend to look at more elegant means of generating those forces. If we're already supplying four fins I see the point of wouldn’t it be nice to get some additional benefit in the respect of pitch but trans emonid devices have much more leverage for pitch. So we tend to look at other means of doing that but I think Joe might have a comment regarding fins.

Joe

Our experience on the commercial side is similar, that it's very difficult with the four fins system to control pitch. There are some reductions but it's not very efficient and we tend to go with a forward mounted Tfoils which can accommodate the loads that the effectors will see when they're mounted far forward. The specific problem is when the fins broach the surface there are huge slam forces which drives the size of the equipment, the weight gets very high, structural reinforcements etc.

Hugo

I've one other question. At Marin we have done a lot of tests and I speak about displacement boats going at relative high speed and we always had trim vetches. We did the test, it was for 701, we did naval architecture at Hamburg and used a model interceptor. Which is very nice work but it just referred to complaint at the transom and we had similar results, although I was a little bit afraid of putting just exactly the same kind of brake plate at the end of the boat as a transom to use 15% on drag. But maybe a question for my neighbour. You've been using interceptors there but practice is in real life.

John

Our experience with interceptors has really been outstanding. They're not as efficient as trim tabs, they only produce about 60% of the lift force compared to trim tabs but the drag characteristics are actually quite good. Interceptors in effect set up a hydrodynamic wedge at the transom of the vessel so rather than a structural wedge you have a hydrodynamic wedge and by modulating the interceptor by raising it and lowering it you change the geometry of that hydrodynamic wedge and you modulate the lift force. The forces, the power required to operate an interceptor is very very low. Whereas trim tabs require huge amounts of hydraulic power, the power required for an interceptor is low. For example an interceptor with a span of about 4metres on both sides of the vessel only requires about 3Kw. So you get big bang for your power load.

Hugo

So it looks a little bit underused device to me.

John

Absolutely. Now there are some restrictions with the use of interceptors. They generally require a vessel speed of greater than 20 knots. OK. Trim tabs operate from two standpoints. The first is there's a flow change, when the trim tab is deployed the flow direction changes and that generates a lift force but also with the trim tab there's a momentum reaction where slamming the trim tab down into the sea and we get a reaction from that. There's no equivalent with interceptors. All we have is the hydrodynamic force. So generally yachts are running at slower speeds so interceptors are not always good candidate for them but clearly high speed mono hull yachts are excellent candidates. Particularly in the electric variant. No hydraulics, no noise.

Martin

Thank you. Any more hands coming up?

Eric

A question for the gentlemen on the panel. As you're a good gathering of leading edge in the technology of motion control can any of you enlighten us about I don't know the right term. Inertial dampening, maybe? Which would be the use of a very very large or massive gyroscope.

John

Just a quick comment on that, yes. Certainly that's a technology that's been applied. I'm aware of, I think it's 1908 or 1903 an application of exactly what you're saying. I think back then the industry quickly moved away because it was fairly impractical in the sense that it's a massive weight—you're getting the gyroscopic effect, it certainly can stabilise roll, but it's a relatively inefficient way to do that with a spinning mass so we saw it disappear. What actually happened the next step was using the gyroscope as a control sensor and then using that control to signal fins to move, which were very efficient at generating the lift force. So that sort of trend to go to a spinning mass moved away for decades in fact. It's come back now because the technology has moved along where you can actually have fairly high RPM, this spinning mass, the higher the RPM the smaller the mass could be to generate the processional forces so if you can spin the mass higher you can reduce the size. But it's still relatively inefficient when you compare it to a fin system.

Hans

Another thing that needs to be considered. Modern fin stabilisers used to work for the control of the fins with a combination of roll angle, roll velocity, and roll acceleration. The very first systems only used roll velocity. The gyroscope is a roll velocity based system only so it's behind stabilisers in that respect. When you're in a beamseas and this beamseas had a period that is close to the roll period of the ship then there is no problem, they'll probably work properly if they're sized properly. But when you have for instance stern quartering waves with low frequency of encounter, where the roll of the ship is very slow then such a gyroscope does very little. So it could be nice, it can be used for zero speed stabilisation but then the other things like weight, space, power consumption, kick in as well. So you have to consider that very carefully if you look for particular application and compare it with what other systems have to offer.

Tork

Hugo you mentioned flaps. I know that Benetti have actually fitted to one of their 55metre builds that's very close to being completed I think. I believe two 20sq metre flaps. Which simply fold out from the hull and the other one is moving weights, which systems have been around and have been used. Is there any comment on either of those?

Hugo

Hans can tell you about the moving weights. I remember that one. And the flaps you are right, Tork. I remember that I had to use big flaps because the bigger the flap the smaller the movement you need from it, it will act as a kind of big build skill by itself so —

Tork

This is a passive system, it simply unfolds?

Hugo

Oh just passive. I'd add a little bit of motion to it and then you're there again. Maybe others can comment also.

John

Yes I'd just add a comment on that. We've actually been dealing with Benetti to some extent with respect to those projects —a company called Stabtech is actually doing that and we've been speaking closely with Stabtech and have talked about building the equipment and so on. They're not only doing it on those Benetti hulls but also on a 68 Azimut as well. And that’s already —the first one has already been fielded and works. It's a purely passive system, it works at rest, for underway you still need another system and so on the Benetti boats they actually have a Naiad fin stabiliser in combination with the retractable flaps or doors or surfaces, but they're strictly passive at this point.

Tork

When you said it's on a 68 Azimut I mean there's a significant difference in scale between a 68 and 55 metres. Is it equally, I mean in your conversations with them have they found it to be equally effective.

John

Yes. In fact there was some marine research that we participated in where we compared the different devices. What we found was that the active fins were more effective in seas that were smaller, very similar to an anti roll tank I think Hugo mentioned this, and for the same reason. Active fins were more effective in reducing roll for seas I think it was under a metre, or metre and a half. For seas larger than that, significant wave heights, the passive action when your in very large waves was greater with these passive doors, that are just extended and locked into place. So in the 68 Azimut case it's a fast hard chine planing hole and they're just using it for zero speed of course, and it's got the additional benefit of lengthening the roll period, making the ride a little more comfortable. So for a hard chine planing hole it's not a bad way to go. I think it's actually potentially a very good way to go if we add interceptors on the back. On a fast planing hole we can have retractable doors for the passive condition and then retract them when you're under way and use interceptors. It would be an elegant solution.

Hans

There is a danger in the barn doors that’s often overlooked. One of the effects of having a barn door is that a lot of water is trapped between those doors as well so the added mass of the ship is increased, and that changes the roll period quite a bit, so suppose you're in a ship with a 7 second roll period in a 6 second sea and you extend those barn doors and the roll period becomes longer and comes closer to the 7 seconds then you might even roll even more. If you look at the presentation that was given a few years ago on this subject you could see in the graph that at the peak of the original spectrum the roll was less but at a lower frequency it was actually more, so you could end up with having somewhat more roll, not terribly much, but some.

John

The only comment I'd make on that is oh sorry—

Paul

just to add a bit—one of the things we've actually thought was quite a good idea and we've looked at it but one of the things you'd have to really consider is like the locking mechanism, because potentially if you've got 20 sq metres of swinging out when you're going along you're going to have real big issues, so the locking mechanism would have to be really good.

John

That's a really good point Paul. The only comment I'd make —Hans is correct, on the case of the fast planing hole usually lengthening the roll period is actually beneficial in terms of comfort and they're basically bilge keels but they're effective in the sense that if you get into that situation where they're making things worse you have the ability to retract them unlike bilge keels.

Tork

And Hans, just perhaps we can close on the flying weights.

Hans

We've got some experience with that and I'm still scared of them. Imagine you have a ship of 1000 tons and you need to move around 2—2½ % of the ship displacement from one side to another very rapidly, break it in time, send it off to the other side as well, the loads on your system become very large. We've done a couple of systems for smaller ships so we were moving say 2 tons of lead from one side to another; it needs very sound engineering to get a system that can give a good lifetime without too much maintenance. And if something goes wrong in your system and you lose control of your weight while it's in full swing from one side to another WOW.

Tork

Yes. I'm tempted to ask how you do it and if you could avoid the answer "carefully"...

Hans

How you do it? Well we did it with a hydraulic system , hydraulic motor, and a belt system or a chain. You could use another system as well, so there are different possibilities for that. We tried a few of them. When you have a large chain then you have to take into account that it can start resonating and you have to keep up the tension and if you have then one move going out of control you see those chains flapping and stretching more or less again, it's quite scary.

Martin

Anything else from the floor. I have one question while we're waiting for a microphone. Any issues with supply and demand of these fin systems at the moment? With the amount of orders on the shipyard books?

John

I think well we're seeing entrants into the market —we've been in the industry a long time and we constantly see new entrants and I think that's the nature of competition, that happens. So production capacity follows demand. We used to manufacture in different locations, we've consolidated that in our case, so we're producing in a volume situation on a couple of shifts and certainly keeping ahead of the demand, which is where we want to be. And these guys have certainly jumped into the market so they're helping to fill that capacity.

Hans

Absolutely. Capacity is the key word at the moment because as we know the megayacht market is booming so is the demand for our systems and if you want to maintain your quality level and be able to support your systems properly then you have to control your growth to a manageable level and that's what we're doing. Basically we could sell more if we had the manpower to do so. So we're growing rapidly but as you know it takes some time for new people to become effective.

Martin

It sounds good for you, Paul?

Paul

We haven't got any problem. If you've got any orders to send, please send them to me. But like any other part of the business, which is like cruise ships and ferries, it is a big issue. You're looking at shafts and castings so it is a big issue.

[from the floor]

Yes. I thought it was an interesting point that Mr Ooms raised about the" what if" you lose control of your system. We tested motor yacht Sirocco which was in one of John's slides, 47metre fitted with stability at anchor fins, two times 3 ½ metres. We tested the forced roll at 20 knots with 15% of the total deflection and we rolled it about 20° each side. And because of that I sent Naiad a mail; what happens if for some reason the electronics decide to give full deflection at maximum speed of about 26 knots. And they couldn't tell me but said it's better if the captain then takes back engine power. So that is still a bit worrisome for me. Any thoughts about safety?

John

I could mention, because we are familiar with that. I think as we see the growing dependence on motion control systems, fortunately we're also seeing the growing reliability. I think some of the slides I put up with these advanced hull forms and particularly the last few where they completely rely on the system for steering as well as roll, pitch, heave, vertical acceleration components, these systems have to be very reliable. We certainly build our controls to military standard, we build our equipment to a military standard in an aerospace manufacturing facility, so the same operators, same operators, same machines making aerospace parts for the Dept of Defence as well as stabiliser parts, so we take it very seriously. But it's a fair comment. These fins can generate, fins and other devices can generate tremendous forces and we need to maintain control. We also have some fail safe features built into our software, we have other means of making sure that what you're describing doesn't happen. But never say never.

Hans

Coming back about what happens if the fins go for hard over to one side. It depends a bit whether it's only one of the four, or all four at the same time. If you split it up over separate systems the four and aft ones then it's only half. But if that happens you can make a big lurch to one side. If they stay there then it dies out after a few rolls, but you can have an initial roll of 20°. So for instance the forced roll that you use for testing we're doing that under controlled conditions—but it's implemented in such a way that you can’t accidentally switch it on, because we don’t like that. There are other means to reduce the likelihood of that, for instance we can connect our controller to a speed lock and that speed lock can limit the fin deflection at higher speeds. Of course if a hydraulic valve goes faulty at that moment then a fin can still go to one side but then it's only one rather than four. Should your speed signal drop away then the controller assumes that you're sailing at the higher speed and limits the fin angle to the highest allowable fin angle at that high speed. If you want to go beyond that then you have to think about redundancy, and redundancy then you're going more in the direction of the aircraft industry where they often have triple redundancy. Then you're entering into a whole new field.

Joe

On the commercial and military side that’s exactly what we're having to do now, the regulatory bodies are treating ride controls systems on certain vessels as primary systems so we have a minimum of two layers of redundancy. And in addition during trials it's a failure modes test for us to exercise the effectors to the worst case position during the high speed run and determining what happens. Now usually as naval architects we try to calculate what the resultant angle attitude of the vessel will be and that has to be within certain parameters, but it's a pretty scary test while you're running it.

Martin

Ladies and gentlemen I think we'll wrap up there; we've overrun about 15 minutes just to give everyone their fair share of time. I've thoroughly enjoyed the last three and a half days; I've enjoyed the panel this afternoon as a final session, it could have been a bit more unstable but it was nice and stable so well done guys. Thank you again to everyone who attended, my team, the girls with the microphones; I won't say anything sexist again I promise, and I will see you all hopefully next year. Thank you very much indeed.