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Ross Gooding QinetiQ

Chairman—Martin Redmayne

Right, to get the session started almost on time I'll call Ross straight away to come to the podium to talk about underwater security and new technology. QinetiQ are a fairly interesting organisation for those who don't know them, but I'm sure Ross will give a brief introduction to who QinetiQ are. A little word of reference—this afternoon in our Refit & Planning session, there are a few potential changes to the panel; our two panellists that you have in your programme have in fact shied away, for personal reasons, not because they don't like coming here. One has had a bereavement, the other has actually been taken ill. So we have some replacements coming which I'll announce in the next couple of hours. When I've found them. No, it's someone from Merrill Stevens, someone from Atlantic Marine who will step in and also we're hoping we'll find one more from Europe, so thank you very much guys for stepping in. Ross, can I hand over to you now please?

Ross Gooding QinetiQ

Some background on QinetiQ. QinetiQ is derived from what was part of the UK Ministry of Defence, who were the Defence Evaluation and Research Agency up until 2001. The new organisation, with the wonderful name of QinetiQ, was born out of that and then shortly followed by privatisation. So working from various diverse projects for the military around the world, we have of course turned to producing some products and also helping other people with product development as well. So I'm going to take a very quick look at my key area which is underwater security, and another area that I've been invited to speak about, which is the Orpheus Helicopter Operation Decision Aid.

So underwater security and new technology—what I'd like to very briefly do is first of all examine the need for underwater security, consider system choices and their effectiveness, look at ways that integration can be brought to bear to further improve the effectiveness of systems, consider deterrents and underwater communication, particularly as a form of deterrent emergency communication and then to move on to the Orpheus Decision Support System. So why worry about underwater security ? Well the threat is fairly diverse. Just last week I was in Sri Lanka for the week, which is the only country in the world that currently suffers from attack from suicide divers and divers actively using homemade limpet mines to try and sink both commercial and military vessels. So it's a very real threat. On the other hand perhaps for this market it's maybe the intrusion of an unwanted photographer or the local thieves who use a snorkel to get alongside and board a vessel. Across ports and harbours and military platforms we are seeing that the above water security is becoming quite advanced and effective. And certainly if we take a look around some of the stands here and at Monaco for instance we can see that above water security on superyachts is also following the same trend. So we're getting very advanced systems which are now becoming integrated, so we have cameras, thermal imaging, automatic target detection and tracking, intruder detection both trip wire and PIR, the use of radar to stop fast incoming vessels and even now the advancement of command and control integration into the bridge systems. However, the underwater side of life is largely ignored. And of course wherever you make it difficult for an intruder to approach he will then go and find an alternative. So a simple analogy—if you look at the modern automobile, this really represents the current state of affairs and certainly the way the above water security is heading. In other words the driver and passenger in the car are surrounded with a whole host of systems which are on the whole sensor driven and also consist of hardware, and each of these comes together to build up a layered defence if you like for the driver. In the underwater area however the situation is more akin to this very early VW Beetle, probably the only safety feature in there is the fact that the steering wheel might stop you from hitting the windscreen in the event of an accident. So after lots of study we can really come up with some ideas of what are the requirements for underwater security capability, and they're not surprisingly different from the above water. Accurate detection, providing enough time to respond is the key one. Of course in the underwater, like the above water, environmental conditions can have an effect on the sensors that you are using, just the same as a pair of binoculars becomes useless in visibility of 300-400 metres or so. And in the underwater environment whatever sensor you use will be affected by underwater conditions. Whatever you use would ideally be automatic and have very robust classification. The one thing we don't want to be doing is responding to false alarms every time a school of fish or porpoise swims by. It should offer 360° cover, be highly accurate, essentially be easily deployable and again this wants to be part of the standard lock down procedure for a vessel rather than adding another hour or so of operation. It should be simple to use, minimal impact on staffing position is a requirement that we see across the whole spectrum of security. So in other words we don't always want to have a trained sonar operator ready to look at a system, it really needs to be verging on the autonomous. It needs to be integrated with existing command and control systems and possibly remote alarm systems. Again, you may want to lock down the vessel and move everybody away with a tender onto a local beach, and of course the only way you're going to be warned of an intruder is if we have some sort of remote way of doing that. And again low through life costs are a key essential. Perhaps the most important one though is providing time to respond. And this again depends very much on your theatre of operation, where you're going to be sailing. But in essence a diver can normally manage a good top average speed of about 1 knot, and the same with a snorkeller. If he's only 200 metres away when you detect him, that gives you 5-6 minutes of time to respond to the threat. Whereas at 1,000 metres upwards of ½hr. So it's a very very key point to the whole of the underwater security aspect. And again, you can draw a parallel with spotting fast incoming attack craft whatever their intentions may be, with long range radar you need to be spotting those out to let's say 10-15 kilometres if you're going to have time to respond. So there's a very close parallel there.

So we can look at the choices of system. And let's face it, there are various ways in which you may wish to tackle the potential problem. Of course leaving the lights on underwater will certainly act as a potential deterrent, and in terms of detection can be very useful if you do have camera systems or indeed observers who can keep a constant eye on the perimeter of the vessel. But of course only effective at very short ranges, in other words if someone is right alongside the boat. Passive acoustic sensors or hydrophones, again can be very very useful and there are some very good systems with classification software behind them. However again to be effective at any range this requires a big deployment operation, are certainly quick to deploy and also complex integration into a system. Dive teams of course are an obvious way of protecting your assets but are expensive and again are not particularly effective at long range. Active acoustic sensors, in other words sonar, are of course effective but only as effective as the system is designed to be, and certainly from the background in which we operate, narrow band systems tend to be less effective because they're less robust to changes in the water environment whereas the military style wide band sonar becomes very effective. Specifically designed systems offer the very best potential to detect a threat at long range and again if we were to look at the pedigree of sonars that are used in this type of environment those derived from mine hunting become particularly useful, not least because they're designed to look for very small objects at very long ranges. The last thing you want to do is steer your frigate over the top of a mine. Tracking also, the best tracking comes from the military background and that used for very fast classification and tracking of torpedoes; to put in torpedo counter measure systems offers the very best alternative. Just to illustrate the point a little more this image is from the website of a supplier of diver detection systems and shows how 6 systems can be used to cover this vessel. I should point out this is a large vessel, it's round 300 metres. But you can imagine the integration nightmare that goes alongside that type of arrangement. Military style single wide band system suddenly opens up a whole new area of coverage and has the tracking early warning to go with it.

So obviously this is the one product I know best—I'd just like to run through how this aligns with some of the requirements that we've looked at. This is the Cerberus system or as Andy Gifford would say, the blue egg, and we can look here at how the system deployment would normally look. The egg itself houses sonar, so in common with most other wideband systems, this has an umbilical cable bringing it back to a break out box, or a junction box at some point on the vessel and this essentially is where power comes in to feed the sonar and data is taken out to go through to the processing system on the right. The system is quite heavyweight—it's at the top end of the military spec, if you like. So whilst it can be deployed over the side, and in fact we're working at the moment with 4 naval frigates to design a system to do exactly that, in the superyacht area it's best suited to going through a moon pool or a tubular cofferdam. This of course makes deployment very straight forward, a single push of a button on the bridge. But that means specifying this type of equipment at the planning stage. So for retrofit, it may be that smaller lighter systems are far more applicable. Now I know that sonar has once or twice come up with some bad press, particularly if you talk to navigators, so I just want to put in a couple of notes here on sonar. High frequency wide band sonar is if you like the military standard when it comes to object detection. The reason for that is the wide range of frequencies gives you a far better chance of operating when the water environment is less than ideal. And I'll explain that in the next slide. High frequency also gives greater detail, much the same in non destructive testing, ultra sound and also in medical ultra sound for example, and the use of an extended pulse length increases range by allowing you to put more energy into the water but over a time period. So some wonderful ray trace models here, provided by our technical teams, the two main causes of failure of a system to spot a potential target are temperature layers in the water, various thermoclimes and also the sea state—the more air that is being mixed in at the surface of the sea the more difficult it is for a sonar to detect that target. Unfortunately the laws of physics apply very rigorously here and are difficult to defeat. However there are always some frequencies that will get through into these areas, and that’s why the use of the wide band systems over narrow band will always give you a better performance. I touched on ease of use and we see this as a key factor, not just in the yacht market but also of course if we're talking about a port or a harbour where security is run usually by civil operators. These tend to be guys who are used to using closed circuit TV so it's essential to try and get down to a certain level of operator skill that means that skilled operators aren’t always necessary to get the best out of a system. However it is quite important that we have the ability to look at the raw data within a system, this helps us to set the system up and also where there are sonar operators available helps them to make the best of the information available should they be called to make some decisions on classification of the target. So in this picture here we can see the very colourful sonar image plus thousands of contacts coming back on each ping and at the right hand side the red line with the number 11 at the end of it is the track left by a diver. In this setting we can still see all of the contacts coming back, and the point I should make about those contacts is there are several thousand there, and each one of those has the potential to be a threat. Everyone of those meets one criteria of the classifier that is built into the system, so maybe it's the structure that fits the classification, the movement or the signal strength. However, unless a certain combination of them come together then the system should not report this as a threat. The ideal operator display is one where you don't see any of the clutter, any of the returns other than those that are deemed to satisfy the criteria of being a threat or a target. So in this instance the display would sit there blank of all returns and only really come to life when a track is formed. Now that track in this case is formed by a diver but we have to be aware that the laws of physics apply. And therefore no matter what system you have, you'll always get some false tracks, the same as radar can often find it very difficult to distinguish between a flock of birds and an aircraft. However as long as the system has a good database behind it and an advanced classification algorithm there should be ways for the system to try and determine very accurately what it is seeing. On the right hand side here, I'll just use this light saver, the system gives us the position, classification, speed, heading, bearing of the target. Obviously these are all key things that help the classifier but they're also essential if you're to make a decision about an underwater threat and how you're going to respond to it. Sorry, just going back one—also we maintain in the bottom right hand corner here the close up sonar image, and again this can be very useful if we do have a sonar operator to help determine exactly what the target is. In this case there are some returns here which having used the system quite a bit, would probably reflect the use of an open circuit set of tanks and indeed here these are bubbles, so this would indicate an open circuit diver. As I highlighted before, automatic target classification would be seen as an essential, you don't want to respond to every potential target that comes into the field of view. These are some of the basic things that we look for; target speed, direction, its behaviour, all these types of things are absolutely essential if you're trying to determine the difference between a porpoise and a diver. Target structure, obviously also very important; some very strong returns are obtained from large sharks but because a shark doesn't have a swim bladder, although we get a very strong signal strength we don't see the air to water interfaces that you get with other mammals and other types of fish with a swim bladder or indeed humans. Another essential—many ports and harbours have lots of flotsam and jetsam; these are often carried on the wind and sometimes in tidal flow and where a river runs into the harbour for instance you will get some motion of objects. There's something to point out here—a little point—an empty beer can which is about 30% full of air will have the same signal strength as an open circuit diver. So you can imagine, it's quite difficult in some of the areas of operation to actually determine exactly what it is you're looking at. So even the best system will sometimes be defeated by objects that are moving in the right direct with the right speed. But what we can do is start to look at whether those objects are recurring, that type of target repeats itself and that the direction, although it is in a constant direction, is not a threat direction. So systems should be equipped in such a way that the operator can select this type of target and tell the system not to alert every time it sees it, but to keep it there on the screen so the user is aware, but only to start an alert once one of the other parameters changes. So if the speed alters, the direction alters or the behaviour changes in some way.

A few words on integration and expansion. There's lots of current work going on at the moment to try and aid the classification of a target. So just because the system has told you there's a target and it appears to be a diver, depending on your type of operation, certainly in the military arena, people are less keen to go and drop scare charges on top of a diver if they don't actually know it's a diver, for instance. So NATO and some of the civil ports and harbours are now looking very closely at the use of unmanned surface vehicles. Great toys, yes. But also can be very useful. They certainly allow you to interrogate a target with various payloads at high speed and with minimal risk, in that there are no personnel on board the platform. The use of underwater loudhailers as an aid to classification warning such as this enforcer system from Westminster Technologies, can again be extremely useful. There are very simple signals that can be put into the water from the loudhailer which would cause many other types of mammal to swim away at high speed so let's say for instance you do have a porpoise who is cruising along at a knot to a knot and a half, by putting in a particular sound level and frequency nothing particularly distressing, but is alien to that environment —what we've seen in studies is that the porpoise will turn and change direction and swim away quicker than a diver ever would. Divers on the other hand tend to either stop or swim away at the same speed. I mentioned command and control earlier. Again there's a lot of evidence that points to the use of command and control to integrate all your sensors and again I'll demonstrate this in a moment. Very very useful again, if you're on the shore and know exactly what you're seeing or you're looking for continuity to classify a threat—so, for instance, we may have picked up a fast moving surface vessel on the radar which then changes to an underwater track. And this is a classic delivery method for divers. And as an illustration, we worked last year very closely with NATO in looking at integration studies and although this is obviously the image you've already seen, but this is from some work we did in the la Spezia, and basically working with a command and control system, as soon as the Cerberus system picked up the diver track the thermal images automatically followed the diver track. Divers will often use the surface as a way of avoiding detection by sonar and hydrophones; and as soon as they come near the surface or break the surface as indeed a snorkeller would do, the thermal imager has the ability to pick him up. So having decided there is something in the water, but you still don't know what it is, I guess the next big decision is how we're going to decide and what is our response. I've been playing with this all morning so hopefully these two will run in unison. But I'll talk you through it just in case, although it worked 5 minutes ago. On the left, what we should have running is a video of an unmanned surface vehicle that you saw the images from a little while ago. These can be fitted with various payloads. One of the things we're trying here is the use of a high resolution sonar, only of use really at close range and here we can see, at around 5-6 metres looking directly down on 2 divers, but there's absolutely no doubt in your mind that they are divers. A little more on the loudhailer, both as a way of communication and deterrent. As I say, there are several available, they can be very useful as a way of communicating not only with unfriendly but also with friendly divers at some pretty impressive ranges. So again, you can imagine the situation—if you have your own dive teams in the water perhaps using re-breathers and you've lost communication, this is a very acceptable way of trying to get a message through to them. This particular system, again this is the enforcer from Westminster Technologies, it has multi language support with pre recorded warning messages, it can also be used with a microphone so you can put your own message into the water but it also has low frequency capability so it is possible to deter underwater attackers using physiological effects to make them feel uncomfortable. Now as I've said there, this does raise issues of responsibility and I think it's very interesting just listening to the last session on legal matters as to exactly how owners and captains would operate in this method.

As I said, the other area that I was asked to present a few slides on is Orpheus. So what is Orpheus? It's basically a decision aid which is currently under trial with the Royal Navy and is designed to help the ship navigator be in precisely the right place to assist helicopter operations. What it takes into account are things such as weather, pitch and roll and then gives some advice on where the system believes the ship ought to be headed and also its position. It's currently a demonstrator, but it can of course be tailored into various aspects. So not only naval vessels but also at the moment we're working with oil and gas support vessels who of course have a very similar problem. It takes in environmental conditions, both measured and manually entered into the system, the ship motion predictions come from the current condition in environment through a series of sensors and the real motion data is both measured and displayed. This is what the system currently looks like, fairly simple and straight forward, a laptop with the operating system on board, a series of sensors which help us to input motion environment and an anonometer and GPS unit. So the basic interface—I'll do a quick run through on this and then it also comes up with some pointers on the screen. It's perhaps easier to talk through it. On the left hand side here, these are the user inputs, so very simple things such as are we operating in day or night, bearing in mind that this is all against a background of a database for the various helicopter operations. So is it a day or night time operation? What is the current state of the vessel? And what type of aircraft operations are we performing. Are they emergency, are they routine, is it take off and landing, winching procedures, all of this type of thing. The main display which looks like a compass shows you the current ship heading, its speed is displayed as this inner ring, so here about 21-22 knots. The white area represents areas where the wind speed exceeds the safe operating wind speed for the current helicopter operation. The yellow represents an area where the wind speed is OK, it's below the maximum wind speed and it is within 50% to 100% of the ship's roll and pitch limits. The red, both are exceeded, so obviously an unsafe area to perform the operation, and green is the ideal if you can get there. On the right, upper and lower limits of roll and pitch for the vessel for the particular type of operation and a wave display which as you can see in both circumstances here exceed the operating parameters. At the bottom right here, the current values, what would be required for an emergency landing for instance of the helicopter and the current emergency recommendations. So again, just to reiterate the most important part of this, which is the actual user display—here we are within motion limits, here the white area outside of wind speed limits, current heading, areas where it's unsafe to operate and the ideal area. So here we have some recordings from an actual operation, obviously this is the night time setting (which for some reason again is refusing to run. Sorry about this). What we would normally see on this is the recommended headings coming through, the system would recommend a heading of 285, we would see the recommended speed come down to approximately 17 knots and this would take us into this yellow area here. And in real time we would then see the parameters here for pitch and roll falling well within the limits of safe operation. I'll be happy after the presentation, by the way, to go through these on the laptop, where they will work. So far, very positive feedback from the platforms where this is fitted, integration is on its way to bridge systems and obviously what I'm looking for is feedback from this industry as to applications and where this might sit. OK, thank you very much. I think it's questions and answers straight on?

Martin

Sure. Ross, thank you very much. OK, any questions from the floor please?

Tork

Every measure has a counter measure. Presumably since it's such an open system in terms of the diver protection, if you were one of the bad guys what can you do as counter measures against detection?

Ross

Well, without giving too much away because of course that's exactly what people want to know, it's usually a case of trying to mimic part of the environment, is the easiest way of trying to counter detection. If Junio were here of course he's done exactly this type of operation so—there are various things you can do to try and avoid detection. But at some point you normally have to change your behaviour in some way, and that can be detected.

Martin

Sean, please?

Sean Dooley Nautilus Underwater Systems

Good morning. A sort of part of my question was just answered there but one is that I wasn't quite sure if you were actually discounting having divers in the water, since that was expensive in short range but you mentioned several times a layered defence. I was wondering wouldn't divers be part of a layered defence if in fact you wanted to use a system like that?

Ross

Certainly, yes, divers can be used. I think the main problem with divers is their effective range which of course becomes a factor of visibility underwater. So if you've got enough divers encircling a vessel, then OK, you have a fairly strong perimeter. But you are never going to have enough divers in the water in real terms to give you 300-500 metres of perimeter.

Sean

OK, agreed, but we're talking about a layered defence so obviously they would use tools, if not your product specifically, others similar. So it's a multi layered approach, obviously they're not—I think what you're referencing is almost like a visual detection by divers, am I wrong, is that what you were saying?

Ross

I think in the simplest form, yes. But of course again divers utilising hand held R resolution sonar for instance again with good communications systems between themselves and the surface do all factor into the multi layered approach.

Sean

OK. And the last question was the thermal imaging on the surface at La Spezia, where I imagine the water's a little bit cooler out there with the diver on the surface. Have you guys had any experience with it in the warmer Caribbean waters where a lot of these yachts actually go, as far as being effective?

Ross

Yes, not in the Caribbean but in Bahrain for instance, and also it's part of our trials in Sri Lanka over the last year.

Martin

OK. There's another question out there? Oh, pass the mike across to Nick, please.

Nick Ruiz Frontier Marine

Just a question—you make reference always to open circuit divers in your explanation. What is its effectiveness against a closed circuit re-breather?

Ross

If we get closed circuit we typically see around a 20% to 30% reduction in range. That's isn't always true, it really depends on the environment. One of the key factors is the lung cavity and if we are getting a strong enough return even at long distances we can start to detect divers at long ranges and again, if I come back to last week, up against stealth divers in Sri Lanka we were exceeding 650 metres.

Nick

Thank you.

Martin

Yes, Eric at the back there please.

Eric Goldring Goldring and Goldring

You mentioned briefly about marine mammals. You're doing a lot of this with the military which sort of exempts them from things like the marine mammal protection act. But if you have a private yacht using high frequency sonar which would be considered by many jurisdictions to be harassment of marine mammals and then you're using discouragement, I think was the word you used, which would also be considered harassment of marine mammals, what is there, what have you looked at, as far as making sure that any yacht owners that use this don't have their yachts seized?

Ross

Yes, that's a very good question. With the sonar itself operating in the region of 120kH but with modulated pulse, so it's quite a low energy pulse over a longer period, as opposed to putting a lot of energy at once. So all our environmental impact assessments and indeed real life scenarios have shown very minimal impact if any on mammals. Of course if we start talking about deterrents operating in the lower frequencies this is the time when indeed—hence the reason I put the question in there about moral responsibility. I think that is where perhaps you start to get into more of a grey area. But in terms of high frequency sonar as opposed to the low frequency sonars which often get a bad Press in terms of distracting whales and causing whales to go off course, high frequency seems to have very little effect. And indeed to cite an example, operating in Bahrain we quite often encountered dolphins who would swim right up to the sonar and take a look at it and then carry on as normal. So in fact they exhibited curiosity rather than any discomfort.

Tork

I've got a quick email question on the subject of fishes again but actually is quite logical in that perhaps sharks are a greater threat than terrorist divers. And the question is: Can the system be used intentionally to detect large toothy fish?

Ross

Yes, this is not the first time the question has been asked. In theory yes it can, despite the fact that a shark doesn't have a swim bladder and therefore doesn't have an air cavity so that we can look at the water air interface. Nevertheless the shark does have very very dense muscle so there is still quite a good return from a shark. However we haven't specifically looked at providing that solution yet, because that costs money after all. Perhaps one other thing to note though is that of course sharks can swim a heck of a lot faster than a diver can, and despite the fact that sharks tend to swim in very quickly, slow down and then circle before attacking their prey, nevertheless the thought that a shark can cover 600metres in not very much time at all I think is perhaps more of a worry than spotting they're there in the first place.

Martin

Alright, one last question there. Then we'll move on to our next session.

Roger Marshall The Yacht Report

It's my understanding that many sonars have problems with bottom bounce in shallow water and as yachts anchor in relatively shallow water how does Cerberus solve the problem of detecting people in let's say 20 metres of water

Ross

In most of our operating scenarios we would love 20 metres of water. We have no problem with shallow water really due to the frequency spread. And that is the essential thing about using wide band systems is that you will always find a frequency that will give you some results. If I can cite an example, the Han River in Korea varies between 1½ to 3 metres throughout most of the tidal range. Fast flowing muddy water. And at times during trials there in fact we could see the top of the Cerberus above the water level but still could effectively take out the navy divers who were trying to defeat the system.

Martin

One final little comment. What about divers using underwater vehicles that will swim faster than one knot?

Ross

Yes, indeed. Although of course unless they're very specialised they don't go particularly fast, they're there really to save your legs rather than get you somewhere quickly. But the signal strength from an underwater vehicle is significantly larger than that of a diver and again in trials they can be spotted quite easily. And I defy anybody to hold on to a standard underwater vehicle at more than about 4½ knots without some kind of fairing and specialist kit to keep them there.

Martin

Alright. Ross, thank you very much. Will it detect Customs Officials?

Ross

We could work on it, for a fee!