OCTOBER 2005 PAGE

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EDITOR'S COMMENTS

There is a lot of good submarine substance in this October '05 issue of THE SUBMARINE REVIEW and, naturally, it is all recommended reading. There are several articles, however, to which we call your special attention.

Most of us who have been around the submarine world for a while have been part of discussions about some sort of weapon which we could use against ASW aircraft, be they helos or fixed wing planes, and the fast attack craft found in so many parts of the world in hostile littoral waters. It's a real need and now there is expectation that something can be done to fill that need. Two engineers, one at the Naval Undersea Warfare Center in Newport, and the other with Raytheon's Integrated Defense Systems describe an ongoing effort to adapt one of the latest variants to the Sidewinder missile for a demonstration of a Littoral Warfare Weapon for submarines. It looks to be the beginning of a credible program, long desired and finally possible.

There is also a unique, and very interesting, three-part look at the Submarine Force of today, the officers who are directing it, and the ways in which the modern sciences of knowledge management and decision making are being used. An overview of the Force and its direction was given by Vice Admiral Munns, Commander Naval Submarine Forces, at the May NSL/JHU-APL SubTech Symposium, and it is published as our first Featured Presentation. The second feature is by Captain John Richardson, Commander Submarine Development Squadron TWELVE, and is based largely on his presentation also at the SubTech Symposium. His subject is the decision process used by submarine commanding officers and how it can be taught and enhanced. Those who remember the IS-WAS days will be very comfortable with his description of the intuitive process and how best to develop that capability along the road to command. In the last issue of THE SUBMARINE REVIEW Captain Bill Clautice offered his view of some lessons to be relearned in Submarine Navigation Revisited. In this issue, CDR Mike Bernacchi, PCO of ALEXANDRIA, answers some of the points

raised in the July issue, and gives us, as his title suggests, A Closer Look at Today's Submarine Officer.

There is an excellent account of an incident involving one of the early SSBNs and a surface ASW unit that got contact on it, and prosecuted their contact as a possible interloper, during trials in the Virginia Capes operating areas. Captain Frederick Hallett, who was riding the boat at the time as a Guarantee Engineer for EB has reported the incident, and resulting collision, in a well researched, objective manner without late-date judgement of actions by those involved or those who were in higher command. In addition, it is a useful picture of the pressures felt by all in those days of new capabilities and heightened threats of the Cold War.

We have two tales from World War II. One is about one man's experiences in at-sea rescues from a submarine which can remind all of us that the sea is always there with us and is always ready to exact its toll. The other is about the end of the war and a last patrol in the inland Sea of Japan. A third bit of history goes much further back and relates how our first submarines got out to WestPac by riding on the Navy's coal colliers.

There are also two discussion pieces which comment on issues raised in past issues. One is about the Norman Polmar/K.J. Moore book Cold War Submarines, which has had a rather lengthy run as a discussion item. Mr Polmar commented at one point that the discussion was getting longer than the book. The other piece seeks to derive lessons to be learned from the KURSK disaster.

On the lighter side, there are several items in THE SUBMARINE COMMUNITY section which recall sea stories, tell a little about past organizations and even acquaint us with a group interested in submarines–on a smaller scale. That is; the submarines are smaller, not their interest. We offer a warm welcome aboard these pages to The SubCommittee and we hope to hear more of their activities in the future.

Jim Hay

FROM THE PRESIDENT

The deployment of USS VIRGINIA (SSN 774) as soon as she completed her shakedown operations and Post Shakedown Availability attests to the capability of this fine ship and crew. The nation needs these ships in increased numbers. All of us should strive to educate the country's leadership of this fact.

The BRAC process recognized the importance of a vital Submarine Force. The justification for removing the Naval Submarine Base New London and Portsmouth Naval Shipyard from the BRAC list was testament to the Commission's understanding of the Submarine Force contribution to National security. Admiral DeMars and Admiral Trost discussed the importance of this decision in the July *Submarine Review*.

The USS OHIO (SSBN 726) is nearing completion of conversion to the Nation's first SSGN. Early next year USS OHIO (SSGN 726) will reenter the fleet. The unique capabilities of this ship will put a whole new set of arrows in the National Security Authority quiver. Two exercises, *Giant Shadow* and *Silent Hammer*, provided a glimpse of the remarkable flexibility that SSGN will bring to the fleet. The League prepared a DVD of the *Silent Hammer* presentation given by RADM Steve Johnson and CAPT Rick Bremseth at the 2005 Corporate Benefactor Days. The DVD has been distributed to the Chapter Presidents for your viewing.

This year's Corporate Benefactor Recognition Days are 31 January – 1 February 2006. Corporate Benefactors continue to be the foundation of League support. Currently there are 74 corporations actively supporting the initiatives and activities of your League.

The Submarine Force celebrated the 50th anniversary of Special Projects Office and the development of the Polaris Missile this year. This weapon system was instrumental in the ultimate winning of the Cold War. SSP was the driving force in the development and deploying of the Nation's most reliable and survivable strategic weapon system. The NSL will feature ***"SP at 50"*** as the theme of the Fifth Annual Submarine History Seminar on 11 April 2006 at the Navy Memorial. RADM Jerry Holland has taken charge of this program and recruited RADM Bob Wertheim, VADM Ken Malley and RADM Charlie Young as featured speakers for this seminar.

Preparations are well underway for next year's Submarine Technology Symposium (STS). STS will be held at The Johns Hopkins University Applied Physics Laboratory on 16-18 May 2006. The theme is "***Submarine Technology in an Era of Transition***". VADM George Emery is leading this effort. The Call for Papers has been released. You can find more information about STS on the League webpage.

The date for the Annual Symposium has been set as 7-8 June 2006. Look for more information on the symposium early in 2006. I am seeking your input on what you would like to see and hear at this event. RADM Bruce Engelhardt has relieved RADM Larry Marsh as League Vice President. We welcome Bruce to League leadership and thank Larry for his tireless participation in League leadership. Please send your recommendations for the Annual Symposium to the League office, attention of RADM Bruce Engelhardt.

This is an exciting time for the Submarine Force. The VIRGINIA class is at sea and SSGN is about to join her. The VIRGINIA construction program is sound and on track. The League is working with the membership and Corporate Benefactors to support initiatives that assist in making the Submarine Force the best in the world. League members have the talent, experience and expertise to contribute to our Submarine Force. As we enter a new year I solicit your thoughts in the form of an article for *The Submarine Review*. We will continue to put these ideas in front of those who can act on them. I commend you for your effort.

Finally, let me wish you a wonderful fall and holiday season and ask you to continue to pray for the safety of our troops deployed all over the world. I am pleased to represent you in the leadership of our League and look forward to our continued success together. Please recommend membership to your shipmates and friends.

J. Guy Reynolds

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VADM CHARLES MUNNS, USN
COMMANDER SUBMARINE FORCES/COMSUBLANT
REMARKS GIVEN AT
NSL/JHU-APL SUBTECH SYMPOSIUM
18 MAY 2005

It's a great time to be here with the Force. So George, thank you. APL, thanks for hosting this. Submarine League, Admiral DeMars, thank you for organizing this fine event. Admiral Chiles, great to have you here today. Sezin, you're the real one I should say thanks to, I appreciate what you did and what you are doing to run this event.

It is a good time to be here and I think we've got a good morning lined up for you. After all, we are the greatest Submarine Force that's ever existed. That's pretty ominous when you put it that way, but I believe it's true; I believe it in my heart and soul. The challenge is to keep it that way, and so I'm going to talk a little bit about that this morning.

Our Force is not just ships. It's not just crews. It's not just doctrine. It's all of these, but it's also the community and I include all of you in that community. The Force is what it is because of events like this. The rigorous introspection of our processes, our technologies, our equipment and so on, that we like to claim is landmark to us, is what keeps us where we are. So it's great that we are holding this symposium. As Kirk Donald said yesterday, I've been to many of these and I always learn from them; from being here. So thanks for what you will teach us over the next couple of days.

Now, Jeff Cassius, ComSubPac, and I are going to do a little bit of a tag team. We've got about an hour, and if there's time we will take questions, but not to extend the program. If we don't get to the questions, there's the round table tomorrow. So keep track of your questions. We want to get them answered.

I'm going to talk from the strategic perspective today as Naval Submarine Force. And Jeff is going to talk from the operational perspective, focusing on the Pacific, but really across the whole

globe. I'm going to talk about why and what, more than the how. He'll talk a little bit about the how. And so, I'm going to talk principles. Why is it that we are doing this? What is it of value that we bring to our nation? I hope to go through that here in the next twenty minutes or so.

I thought principles were a pretty good place to start. So let me start with some engineering principles, which may make sense to some of you out there. I've got a few that make pretty good sense to me.

- The first principle doesn't have a title, but it says the probability of a dimension or value being omitted from a drawing is proportional to its importance. Does that make sense?

- Another one says that tolerances will accumulate uni-directionally towards maximum difficulty of assembly.

- Interchangeable parts won't.

- Another states that the necessity of making a major decision change increases as the assembly and wiring of the component approaches completion. That one's clearly true, in fact, beyond completion will change the necessity for major design.

- And of course this one. I know you know this one. This is actually for Tom Elliot and his folks. An integrated circuit protected by a fast acting fuse will protect the fast acting fuse by blowing first every time.

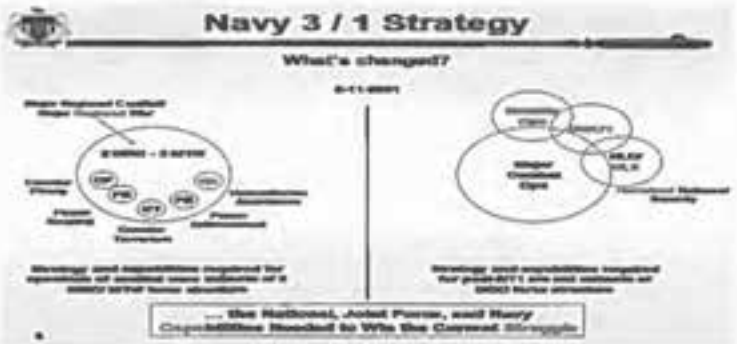
- That's the world we live in as we're trying to keep these systems going. They're much more stable and reliable than the sonars I grew up with, and I think, many of you all grew up with, too. And there are others we could say here.

- Lastly, I guess, a pretty good principle is, it always, always works better when you plug it in.

Anyway, those principles are about details. Those principles are about analysis. Those principles are about hard work. Those principles are about collaboration. And again, that's what we're about here today.

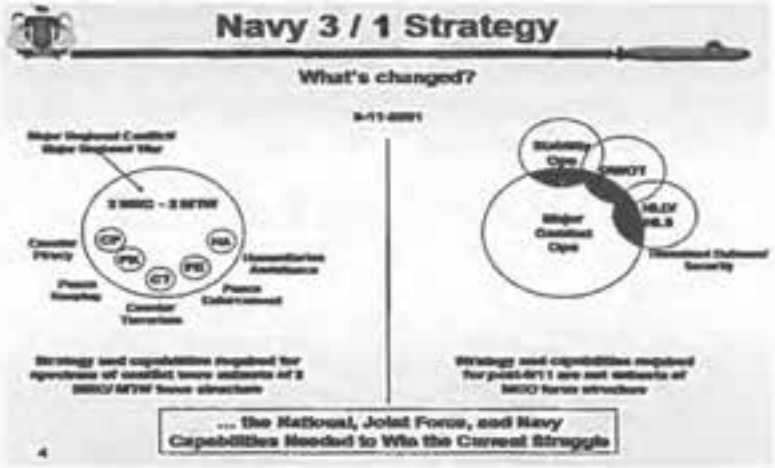
So let me start with an anecdote, because it sort of sets the stage for one of the principles that I'd like to get across. This goes back to the late 50's and 60's. The aviators were working on the next design for jet airplanes as we were getting into the supersonic flight regime, and that technology was moving us forward. The designers, together with the military resource folks, decided that the F-4 Phantom would be produced without a gun. That was because they looked out into the future, into the world you might expect. The need for that airplane, they recognized, was about missiles, not guns, and so they designed it and built it without a gun. As you know, I suspect from history, as the Navy and Air Force got into Vietnam, as they were tested in reality out in the real world, that gun became pretty important. They back fitted the gun into the plane and trained pilots how to do dogfights, how to use the gun, and life was better at that point.

I hope we don't do the same thing. We are off designing new things. We are off looking at the world in a different way than it was a decade ago. And I am one that very much thinks we need to go forward. I'm not at all talking about sticking with legacy. The point is we need to make that transition very carefully, and that means holding onto legacy in some cases – legacy technologies, legacy principles; to make sure we make the transition and that we get the new thing tested in the real world before we give up and take our foot off the lily pad behind us.



So let me talk about some of those things today. Let me start with the strategic framework of where we are and where we're going. And so, I'll use the vernacular of QDR, if you will, and briefly describe this slide. The left hand side is where we were. The left hand side is a world with that big circle that says 2MRC, 2MTW, focused on major combat. Our structure and our processes were focused on major combat and everything else was just assumed to be incorporated inside that structure. That's what the last QDR said. That's where we have been. The current QDR is ongoing today, and so I won't say this is the answer, but the structure we think, from a Navy perspective, is different. Now we can argue about the size of the circles and about their placement, but the principle here is that the circles do stick outside and they're larger than they were on the left.

So there are stability operations. There's global war on terrorism. There's homeland defense and homeland security, as well as major combat operations. And so, what is of interest, I think, in trying to understand the next requirements, what we need of the VIRGINIA, and what we need of the capabilities of the force in the future, is that intersection piece. We've got to design so we can do all four of those missions, and maybe we'll end up designing for things outside the major combat ops circle. I'm not sure, that's part of the current debate...how much do those circles overlap.



But a point I'll come back to as we talk about what we need out of our next platforms, is the time span here, as well. This circle sort of implies that we have a force ready in waiting to take action for whatever the nation needs. These other three circles sort of imply a force that is working day in and day out producing a better world, taking action every day. And I'm going to argue that the Submarine Force is that latter, it is a force that works day in and day out and produces a product every day.

Now, we're also ready to go fight the major conflict, whatever comes. We're ready to do that. We've got great kinetic systems; torpedoes and missiles and so forth. But we're a force that does both, and that's a little bit unique. In the past, we've not talked as much about that day in and day out activity. We've spent more of our time talking about the left circle.

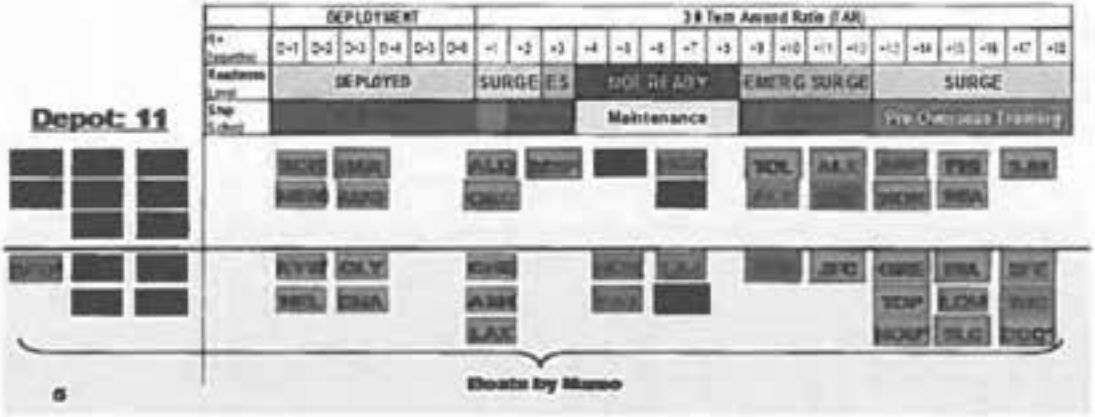
So let me now turn and speak a bit to our products. I'm going to tell you that from my point of view SUBFOR has four products. I'm trying to produce four things. One is operational availability (AO), and I'll come back to talk about this slide in just a second. Operational availability is putting boats forward around the world for them to work day in and day out, and I'll talk about what our product is while we're doing that.

The second product is future capability. Part of my product has to be a capability for the future so we have a force 10, 15, 20 years from now.

The third effort we're working on is the CO decision. It's part of the product. The product any crew provides us is the decision that the CO makes. He makes a decision, the crew then takes action from that decision. And that action produces a product that is important for us today.

CSF SSN Readiness Output

	Deploy (10)	Surge (15)	Emergency Surge (10)		Total (35)
Projected Mon Avg:	11	17	6	=	34
Today's Readiness:	8	19	7	=	34



So I'll talk just briefly about that because it relates to some of what you do. And the fourth thing I do is put the right people in the right place.

I'll concentrate most of what I want to say today on operational availability, the first product, and our future capability, the second.

So in operational availability, this is how we're looking at ourselves today. It's a model of months. Take any one submarine. This is months along the deployment cycle. Here's where they're deployed for six months. Then they're back for a turnaround period. So we're structuring our system to look at readiness and look at what activities take place in these various stages. You might think there is nothing remarkable here and ask why are we looking at this? Come back to the point I made before. The Navy is talking about fleet response plan, FRP, about forces here and being ready to surge, or emergency surge to go fight that next war fighting activity. And we're doing that. That's important for us. But go back to the point I made before. We are also rotationally deploying forces forward six months at a time to work day in and day out. Our plan is to have 10 submarines deployed on any one day of the month; 10 submarines deployed forward doing that day in and day out work, an additional 15 that are available to surge and go fight a war or address a crisis, and another 10 in emergency surge that, with some notice, could get out and go. So we've got about 35 submarines that are available to do the nation's work.

The others are in depot maintenance, and I'll mention just briefly, when we get to it that that's a problem for us, because this does not contribute to Operational Availability, or AO. So one way to improve AO is to get these ships out of the depot maintenance period. Now you might notice the difference from the annual numbers at the top, and that's by design. We're structuring ourselves to look at the world on a monthly basis, to recognize the months that are higher intensity for the surveillance that we do, and months that are less important. We try to structure our annual plans so we put the submarines where they need to be when world events are taking place in order to bring back the product from those events. That's the notion here, the concept is AO, operational availability.

The second product is future capability. Our effort at SUBFOR is to make the annual plan more efficient every year, to have the

future force structure level that allows 35 to go do the work with a total of 45 to 50 boats. Then we need to work readiness down here, to make sure these that are out can perform their jobs and are ready to go work.

And many of you are working on this future capability; that's the substance of much of what we're talking about here today.

The third product is CO's making better decisions, which is crucial from my view. Maybe we are different than other corners of our military structure. A submarine is very commanding-officer-centric. That submarine will succeed or not, it will excel or not, based upon the decisions that the commanding officer makes. Now I don't mean to say it's solely his decision. We want him to have a structure inside the ship where it's collaborative, where he's being informed by the best insight of his key advisors, his department heads, his chiefs and so forth. But in the end it's his decision, and the ship will implement that decision, and succeed or not.

So we've placed a lot of emphasis there, I'm not going to say much more about it today. But if you've got a piece of that, if you're designing a piece of display or a piece of gear, or a layout in control or in sonar, your goal ought to be to design it so that the CO can make the best decision. Best does not always mean fastest. But it needs to be timely with regard to the situation.

Lastly, the right people right place, and then I'll come back and talk AO and future capability more clearly. I think the right people in the right place is a product we provide to the Department of the Navy. And a perfect example of this is here with us today, Mike Tracy, a submariner who is one of our first strike group commanders. It is great to have Mike here today. He was the right person in the right place to get us into that business, to understand it, and to inform them of some of the principles that we hold dear. It's a great effort. We have 16 submariners who are chiefs of staffs outside the Submarine Force; in various places around the world, at the fleets, they're either chiefs of staffs or EAs. That's a product we supply. It's an intellect. It's a rigor. It's an attention to details. It's a discipline that I think we provide, a culture if you will, that we provide to the rest of the Navy.

Let me then come back now and dive in a little bit more to this OA piece. So let's look at it in a value chain sense. And what is the

value of what we bring back? I'm going to tell you. What we have that makes us of value is that we can go places that others can't. That's the bumper sticker. We can go places that others can't go. And in doing so, there are significant products that we bring back. But I don't mean to say that this is always the most important product of our force. The point is that we've been adaptable, flexible and agile over our history.

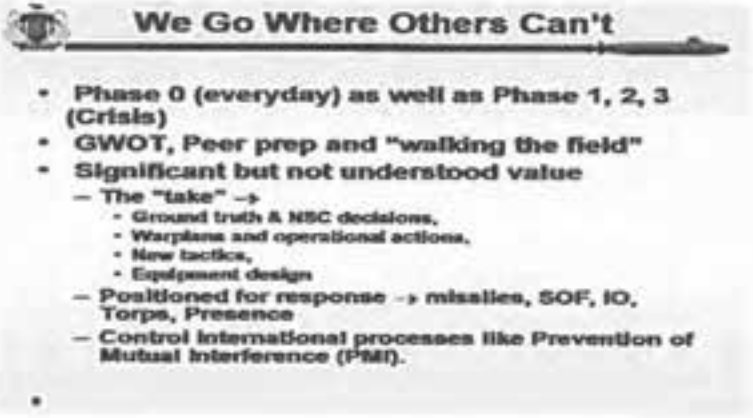
You heard from one of the speakers yesterday that prior to World War II, our submarines were designed as scouts to go out and sense the environment, and, yet, after Pearl Harbor, they were the main event. They kept us going, they were the main attack force, much more than scouts. We evolved. The SSBN force evolved out of the SSN force. The 688, designed to go with the carriers in an escort mission, do much more than that today. I don't want to leave you with the impression that this is a static, always has been, always will be reason for our existence. But I believe today, and into a long future while we're in this global war on terrorism, while we're in this world of competition for resources, that what we have of value for our nation is that we can go where others can't go. And so while we're there, we can go to the littoral regions on the other shores of the oceans and understand those places. And we can make them our home field. And that's very important when we have to return to address military activity there.

Let me come back to this time dimension then and use a chart. I've said this already, but I think it's really important. Because we work in this left hand side of the chart. It's called phase 0, in the vernacular of those that talk strategic thought, phase 1, 2 and 3 take place in this short period of time when the crisis or the war fighting takes place, phase 4 is stability operations after the war fighting event. And as I said before, much of our strategic discussion recently has been about this piece of spiked intensity. It's important. We obviously need to be able to do that, and the Submarine Force can.

But we also work in this long term phase 0 piece. During the Cold War, the 30 years of the Cold War, this is where we worked. And we produced a product that helped ensure a hot war was never fought. So that's what we're about for phase 0. And when you think of it that way, it takes a different set of processes and gear than being able to work in the high intensity time. Now, we have to be able to switch from one to the other on a moment's notice, therefore altering some of the challenge that we face, and this comes back to design of equipment at the same time.

So it's day in and day out, and it's getting ready for that thing, or, said better, doing activities over time so we don't have to do that high intensity activity. Now, on the next slide is a view of the world going forward, including global war on terrorism, I'm not sure we'll have one of those, if you just look at the global war on terrorism

spike, not what might happen to a peer competitor, then maybe the future is just the phase 0 day in and day out activity; the things we were doing to kill terrorists, the things we were doing to find them, the things we were doing to move them from one place to another so we can better get at them. And this is going to be our 30 years of activity, different from the cold war but the same sorts of activity.



Let's now switch to the take. That's the why, that's what we're after, that's the environment we're operating in. I've described the ten-fifteen-ten ship distribution, how we deploy forces to that model and work on that effort. I've talked about day-in day-out being more than just ready to go to a major event. Let me talk about what we bring back. Let me talk about the take here for a little bit.

It's not well understood because we've probably focused on that MCO more than the day-in day-out stuff. But having submarines around the world brings back information that allows us to follow a value chain in these four categories and allows us to find product at the end of these value chains. So the chain starts with the take, the intelligence nugget, the understanding, the knowledge that we bring back from this littoral area, a sensitive area most likely forward on the other side of the oceans. We're there every day and we bring back information that works in these four parameters. One, as it was in the Cold War, is ground truth. It's a set of information that allows our country, our National Security Council or President to under-

stand what's going on in that other country, sometimes at the highest levels, and this obviously gets into the very classified nature of what we do.

But as we did that in the Cold War, we're doing that today, in the global war on terrorism. Working in that environment and bringing back information knowledge that helps us write better war plans for the possible MCO. We were doing that in the Cold War, to affect the plans, should we have had to go to war with the Soviets. We're doing that today with what might become peer competitors, and so, we can follow the take, the nugget we bring back, follow it into the war plans and operational plans, and we know that we're making an impact there, a significant impact.

Likewise, new tactics: going where we go, by going where others can't, by watching ground truth, we're bringing back the nuggets that many use to help us with tactics and equipment development. They sort of go hand in hand. DEVRON 12, in Groton, works with a larger part of the Navy on the tactics, and it's not just submarine tactics. Some of the current tactics for our surface force come from our understanding by having been there and watching the activity that goes on.

And likewise, equipment design. A great, great example here is ARCI, Acoustic Rapid COTS Insertion. The displays that I see on VIRGINIA, the displays that I see on modern ARCIs, are worlds ahead of where they were just a few years ago. And that's because we bring back information of the real-world environment, from the shipping congestion, from the oceanography, from the SVP structure that allows you to make better displays so that we're better when we go back the next time. So there is a lot of take here and we don't often talk about it but I wanted to spend a few moments on that today.

Let me shift gears and move on to future capability, and this is where I'm not going to talk that much, because other speakers are going to cover this either later today, tomorrow, or they did yesterday. But let me put it in some context. First of all the future has to be integrated. This future of platforms, this future of weapons systems, this future of networks, has to all be integrated together in a holistic, end to end fashion, much like Admiral Elliott's group was talking about yesterday. It really is about how they all tie together. Nothing

can be done as a single individual node any more, at least not very effectively. So it is about holistic and end-to-end, and is also about testing it in the real world. It's not about view graphs. It's about getting a design, the rigor of the design, getting it in place, and taking it out into the real world and testing it.

So, turning to platform strategy; John Butler talked a little, Ron O'Rourke talked a little, Admiral Donald talked some. We need to come to grips onto a single vector that we're going to head from where we are today into the future. And that vector has to get us to a place that first maintains capability, and I define capability as what we have in the VIRGINIA today. I cannot imagine that we need less capability than that with the uncertain future that is in front of us, so this vector has to maintain capability. Secondly, numbers are pretty important. Ron O'Rourke said yesterday, more than 40 submarines are required, and I think more than 45 will be needed. And so that's a real challenge for us and I don't have the answer to that today, but it's a challenge for all of us to understand the economics of our nation for the next 10, 20 years, and how are we going to make capability and numbers at the same time.

And third, part of that, maybe second order, but it's so important I'll talk about it as sort of a first order effect, is our ability to keep designing submarines. It's not sufficient to get capability, to get numbers, but not have an ability to design and build out into the future. My view may be colored, but I think submarines will be here for a long time. We've been here 105 years, and I think what we bring will be of value for another 105 years and probably more. They won't look the same as today. We don't look today like we looked 105 years ago, not by a long shot. To be under water, to take advantage of stealth and mobility and persistence, are all parameters, which will be important in the future. So design; our ability as a nation to design these submarines and systems, the whole system, is crucial, so that's got to be part of this direction that we take.

Others will talk more about this, but that's a key strategy that I wanted to leave with you today. Now let me dive down one more layer, a couple pieces for how do we do that, and there's lots that we're working. One is just to make the cost of building the submarine cheaper. There are contracting actions that can take place to enable cheaper production. There's design activity that can take

place to make the building easier. There's design activity that can probably take place to give us the same capability but with a different design, if that design is less expensive. On the operational side, there are things we can do. The real metric is that AO metric that I spent some time talking through, not necessarily the number of submarines. There are things we can do on our side to increase AO with whatever number of submarines the nation can give us, and we're doing that. We've put three submarines in Guam; Jeff Cassias will talk about that in a moment. I think three is about the right number, because of the infrastructure there and because of the vulnerability of that place in the future, that gives us more AO. Those submarines are closer to the fight, that gives us more AO.

We're looking very hard at where we put our SEAWOLF class submarines. They have the speed and agility to get to the fight very quickly, so we're looking at where will we homeport them and make use of that. We're looking at ways to make more operational time available out of any one submarine. This goes back to my point about maintenance. We need to do the maintenance that has to be done so that we can safely submerge, but we need to do it efficiently and keep the submarine out where it's supposed to be around the world. Those are things that we're working on our side to maximize this AO. And then obviously, new capabilities are coming to us, which we're dealing with here.

It's a wonderful year. Since I took over six months ago, we've commissioned the VIRGINIA and JIMMY CARTER. We've had two of four SSGN's through construction, the OHIO, out of the dry dock, and ready to be delivered this year. So there's some great capability coming, and it really is different. The VIRGINIA, if you haven't had a chance to see it, is everything we hoped it would be. It's just eye-watering what the capabilities are in that control room. It's now a control room/ sonar room combined.

Let me digress. This is such a wonderful story for the nukes out there, and I'll stay on time. I took the Vice Chief down to the VIRGINIA and we toured him through the whole ship. It was wonderful. We went to maneuvering, the control space for the propulsion plant. And so here we are, and I know this was staged, but it's staged based upon reality. So we walked into maneuvering and the Shutdown Reactor Operator (SRO) is there, and so is the

Engineering Duty Officer. The Shutdown Reactor Operator turns to the Engineering Duty Officer and said, "Sir, request permission to take logs", since it was 11 o'clock on the hour. And as I expected, the Engineering Duty Officer said, "Shutdown Reactor Operator take the logs". Normally on the 688 the SRO would pull out this clipboard, and on this clipboard there would be 15 log sheets. He'd look at each meter and write down the readings. It takes about 10 minutes. Well, in this case, on the VIRGINIA, the Shutdown Reactor Operator turned and said with a smirk, "Take logs, aye," and went up to the panel, pushed one button, pulled his finger back out, and said "Logs taken."

And that was it, I mean it was put on for us I know, but it's systemic of the capability throughout the whole ship, and that set of log readings now is electronically captured by a database, and their activity now is not 10 minutes out of every hour writing down these numbers. Instead, their activity is analysis, looking at trends, looking at maximums, minimums, and using the computer as the computer is meant to be used. And that philosophy applies in control and maneuvering and everywhere throughout the ship. So we're making great inroads.

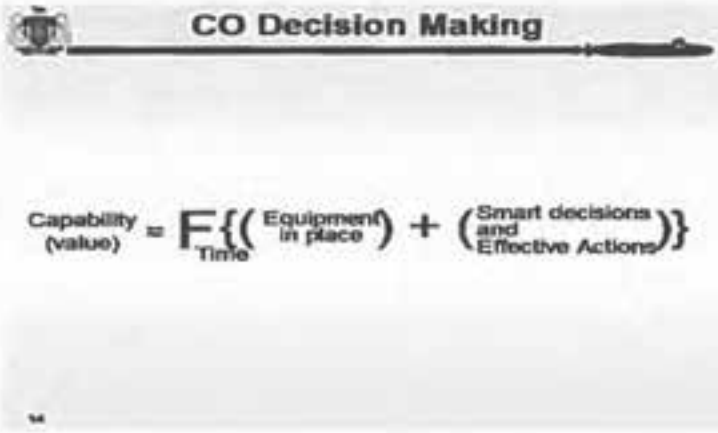
So let me end that section. Others are going to talk about what we need in the future. I'll come back to payload because that's my next point; come back to designing these systems and getting with the whole purpose of AO, getting that submarine forward, underwater, doing those things that I discussed earlier, or others as the future might demand of us. And so, we can look behind us here for maybe a benchmark.

I know things are harder today, but I was at a SEADEVIL reunion down in Norfolk about three months ago. CAPT Mark Stiles, some of you may know, was the commissioning CO of SEADEVIL, the World War II diesel SEADEVIL, in 1943. He's about 94 years old. He gave a better keynote speech than I did. He was wonderful. But what he said, going back and living the time that he lived was inspiring. From the day that the keel was laid for that SEADEVIL, to when the crew sank the first Japanese freighter was 300 days. The ship was built in Kittery, Maine. You obviously know where the Japanese freighter was. So in 300 days the keel was laid, the ship was built, got underway, tested, through the Panama Canal, into the

Pacific, to the war zone with torpedoes on the war patrol and they sank a ship. Now I know things are harder today, John...

And that's a different ship than we're building today. And it's not just the PEO (Program Executive Officer). It's all of us. It's an anecdote, but it's what we really need to be working hard on. As we go forward on this path of future capability, as we maintain that capability, keep the numbers up, part of the answer is getting the submarine out into the world's littorals and spending more time out there.

Let me come back. Payload strategy is next. We've got a platform strategy that in order to be effective, needs to be connected to a payload strategy. You'll hear others talk today. Steve Johnson, Charlie Young and Terry Benedict, will be talking about some of those pieces. The first payload we need is for that day-in and day-out activity that I mentioned before. This is not necessarily kinetic payload, but this is payload in order to do information operations where we actively engage in a network, a computer network, in that littoral overseas. Or payload in order for us to better tie together the intelligence collector to the intelligence analyst. The success of what we're doing in Iraq right now and that piece of the global war on terrorism, the success that our forces are having there is due, in part, to their ability to get the analyst together with the intelligence collector, the troops, working quickly in situ to get a better understanding of what they're learning so they can exploit the situation. That synergy they've developed over the last year is the kind of thing we need to develop more. So those are the early kinds of payloads. Charlie's going to talk about ballistic missiles and how we are trying to make them more precise, and the effect that that might have on us as we go forward.

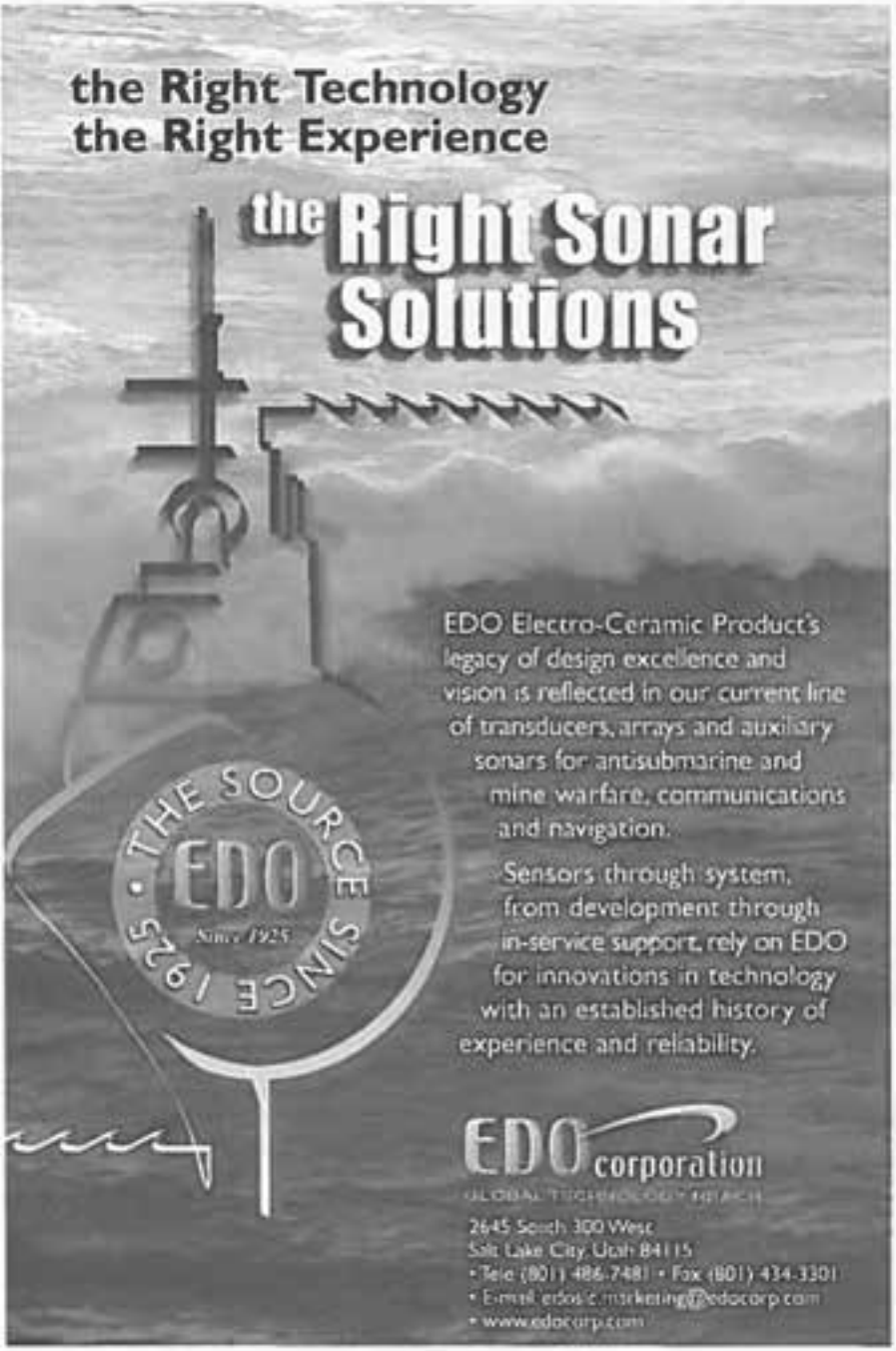


Let me wrap up. I was going to spend a few minutes on CO decision making as the next important thing. I think I've already said that. If you move beyond AO, which is where I've been camped out here, the next important thing for us to do is to improve CO decision making. I've said what I wanted to say of that.

So in the way of wrap-up, as we design and implement these capabilities for the Force that is needed for our future, I think it's about being flexible and agile. It's about putting in place what we need today, but putting it in place in a way that it can do something different tomorrow or ten years from now, as we have done for the last hundred years. It is about addressing these day-in and day-out activities that the ship performs. That's just as important as what it does to be ready to go war fight, and again, don't minimize the war fighting piece, but this day-in and day-out piece is central to what we do. It's about developing solutions for this new world, this global war on terrorism world, this competition for resources as we go forward with maybe a peer competitor, without forgetting the major combat op, should it come to that.

So again I complement this session. Thanks for listening to me today. Thanks for being here. Thanks for thinking hard about these issues. I was really taken by Admiral DeMars' and Admiral Emery's points; that there were a hundred submissions to this symposium from people who have ideas that want to talk about betterment of our Force, and that's really a fantastic world to live in.

Unfortunately, my time is up. Thank you very much. ■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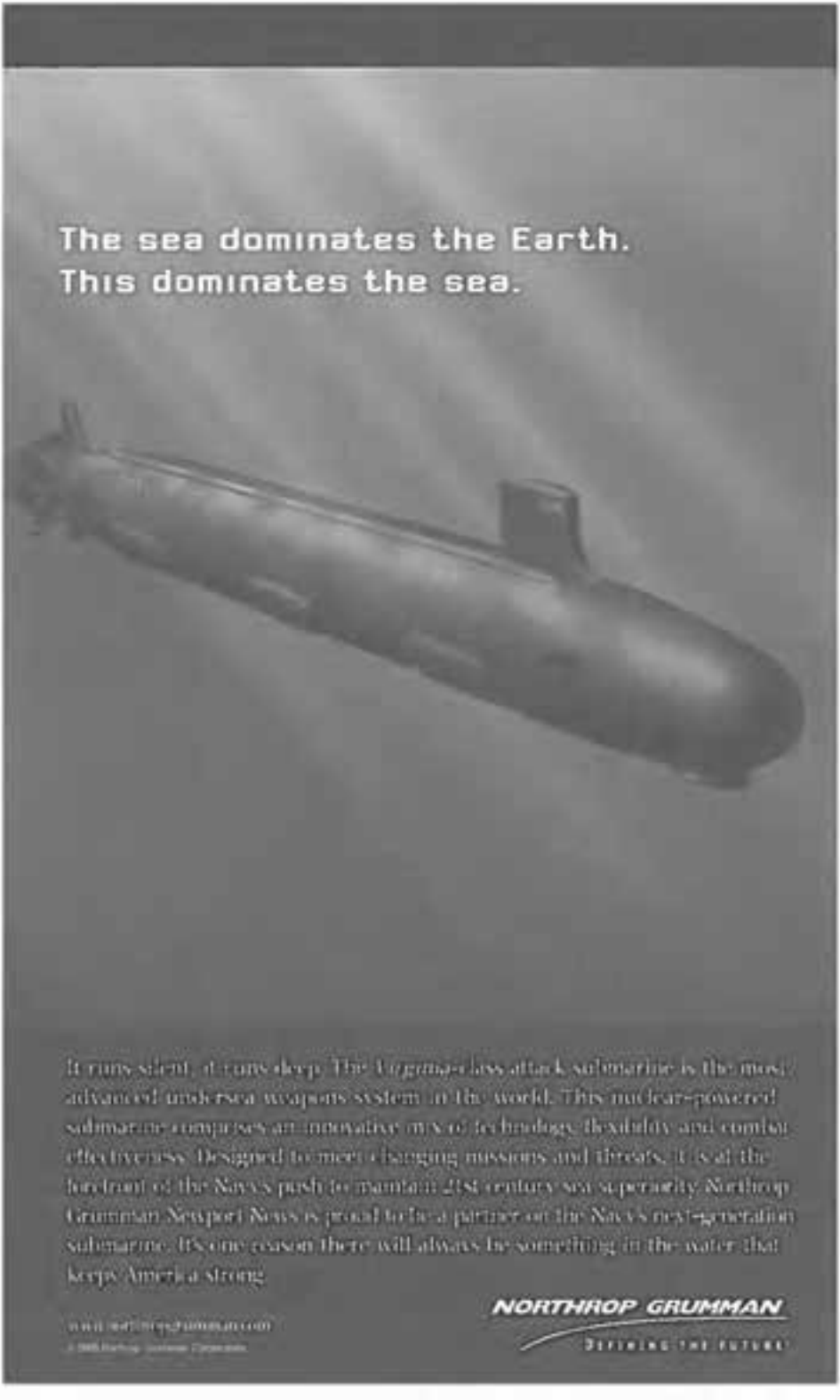
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DEFINING THE FUTURE

ATTRIBUTES OF DECISION-CENTRIC TECHNOLOGY

by CAPT John Richardson, USN
Commander, SUBDEVRON 12

One great aspect of being in the Submarine Force is that we ship-drivers have always been firmly supported by the very latest, most advanced technology that the scientific and engineering communities can provide. One visit to any of the technical symposia, research labs, or submarine industrial partners is immediately convincing. The powerful mixture of talent and passion is palpable - you can feel it everywhere. It's no wonder that the relationship between the Undersea Enterprise and our partners in technology and industry is the envy of the defense department.

Focus on the Commanding Officer's Decisions

Advances in technology have enabled clear improvements in capability and performance across all aspects of submarining. In particular, the rate of technology insertion into the submarine's tactical systems is currently faster than ever before – optimally tuned to Moore's Law and production life cycles. My experience as Commodore, Prospective Commanding Officer Instructor (PCOI), Deputy Squadron Commander, and Commanding Officer have convinced me that if we're to translate improvements in *technological capability* into improvements in *tactical performance*, we must focus on technology as a tool to *improve command decision-making*. At the end of the day, it's the Captain who will make the key decisions as to how to employ the ship. Thus, when introducing a new tool or system, the question must be asked:

> *What command decisions are involved in the scenario, and how is this system going to enhance that decision-making and improve performance?*

Anyone who has been at sea can attest that capability and performance are related, but are quite different things.

The Decision

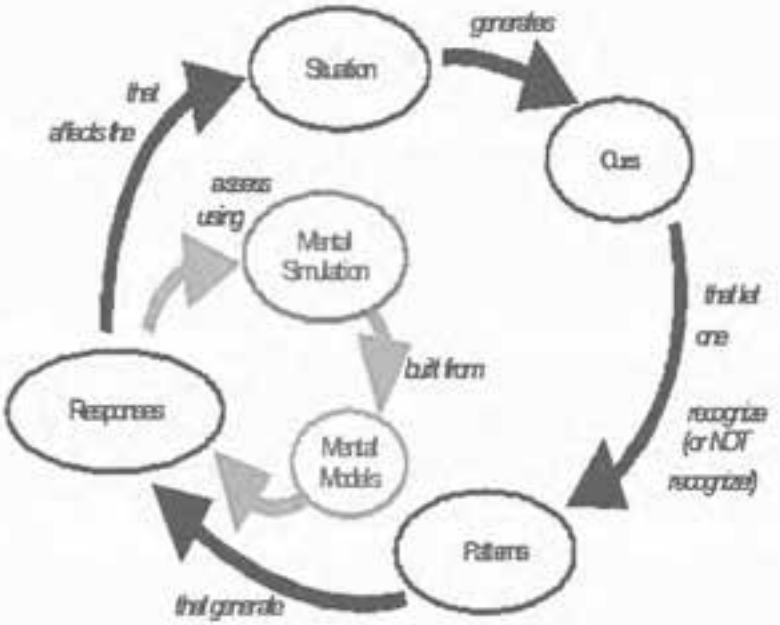
A quick discussion of decision-making will help formulate a systematic approach to answer the above question. For the purposes of this discussion, we will roughly define two general types of decisions: analytical decisions and intuitive decisions.

To make analytical decisions, one weighs several options, and decides on the option with the best balance of risk and gain. This type of decision-making is well understood, and is used often by submarine COs. While this is a necessary strength for Command, it is not sufficient, and is not a good predictor of tactical performance. In fact it is not uncommon that very good analytic decision-makers struggle in the attack center, where more complex intuitive decision-making becomes important.

Intuitive decisions are made after one detects the cues and patterns that emerge from complex situations, and then chooses a single course of action that will likely be successful. The action chosen is based on experience – the person has seen similar situations, and has a "library" of pre-planned responses (mental models) from which to draw. Based on recognizing the situation that faces him, the decider quickly converges on a single course of action, and runs a mental simulation of the action. If the simulation ends with success – he executes that option. If the simulation is not successful, he quickly makes adjustments to correct the difficulty or tries another model altogether, running through the process again, until he finds a successful course of action to take. It's important to realize that intuitive decisions are made quickly compared to analytical decisions, and that the decider is not comparing options. If the first projected course of action works – he executes.

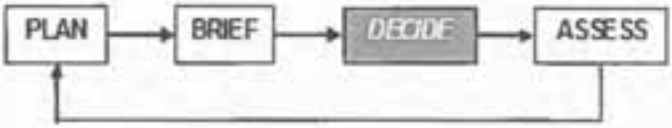
Knowledge of this type of decision-making is not so well understood, but has applications in most tactical and maritime scenarios. As a simple example, a CO may recognize the patterns emerging from a crossing situation ("That contact has a zero bearing rate and port angle on the bow, and will collide with me if nothing is done"). He then projects a mental simulation of his action based on the "mental models" he has developed through his experience ("I should turn to starboard now"). If the projection results in a satisfactory result ("I will get off his track by 2000 yds, and he will pass safely down my port side"), he executes his decision. If the

projection does not have a happy ending ("I will run aground on that beach to starboard"), he chooses another option to consider ("I should slow by backing down and let the contact pass ahead."). Even in this simple example, one can see that there are several correct courses of action. The CO, by virtue of his experience, can quickly converge on a course of action that will work. I have borrowed this model for intuitive decisions from Dr. Gary Klein[1], which serves to provide a useful structure in enhancing intuitive decision-making. This model will serve as a reference for the rest of the discussion.



1 Klein, Gary. The Power of Intuition: How to Use Your Gut Feelings to Make Better Decisions at Work. New York: Currency, Doubleday, 2003.

There are a number of procedural structures already in place to make command decision-making as robust as possible. As taught in the Submarine Command Course and on the waterfront, the tactical decision (or execution) phase is supported and enhanced by a cycle that begins with detailed analytical planning. The plan is then communicated to the operational team by a comprehensive briefing scheme. Then, once the operation is complete, the decisions are examined in detail by a rigorous assessment. The conclusions from that assessment are then fed back into the process, to enable the decision-maker to do better the next time he faces that situation.



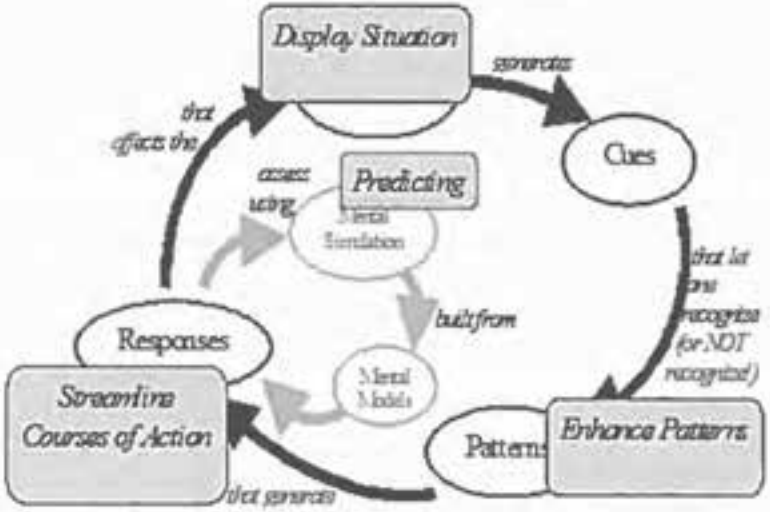
Throughout, the decision model is used to focus each phase. The planning and briefing phases are focused on anticipating the expected cues and patterns that a situation may offer. A set of pre-planned responses (courses of action) may be sketched out. Experience is key, and all members of the command team are expected to leverage their experience in the preparatory phases so as to support optimal decision-making when the operation begins. After the evolution is complete, the model again serves as the focal point of the assessment – what patterns and cues were missed? Where did our library of pre-planned responses fall short? And so on.

Acting like the force of gravity on all of the command's efforts is a risk-management priority structure that mandates that one must first ensure safety, then tactical security, then once these are firmly established, strive to achieve the aim of the mission. This "submarine risk management pyramid" also serves to maintain focus in the decision-making phase. Should a CO, during the execution of his mission, find that he is at risk of being counterdetected, he must first guarantee stealth – even if this means suspending the mission until he is once again secure. If things degrade further and he finds himself in jeopardy, then he must establish safe submarine operations as a top priority – even at the risk of compromising stealth. Thus as operations unfold, a submarine CO can find himself dynamically moving up and down the pyramid in response to various circumstances.

The figure below sums up the decision-making discussion as it is applied to submarine operations. Submarine operations are complex enough to require a combination of analytic and intuitive methods. Any team that does not do their analytic "homework" will be ill-

prepared for the complex decisions that they will face during execution. In general, we prepare our watch officers initially to be *safe* – supported by a thorough knowledge of submarining knowledge and procedures, an analytic process. For their first watches, junior watch officer's decision-making is largely based on the analytic work officers did to qualify. No wonder they are monitored closely during their early watches! As they become more experienced, they are able to recognize and manage more complicated scenarios – recognizing more subtle patterns, and building a bigger library of mental models. For instance, they will become adept at maintaining not only safety, but also stealth. As the situation becomes even more complex, experience plays a correspondingly larger role. Eventually, at the most complicated levels, the Commanding Officer may be the only one on board with sufficient experience. He will be guiding the operation – either personally or through his more experienced watch officers – deftly leading his team up and down the submarine pyramid as required to guarantee safety, security, and mission accomplishment.

Starting with the decision model; considering the planning, briefing, and assessment structures that support the Commanding Officer's decisions; all of which are influenced by the hierarchical priorities of safety, stealth and mission; one can begin to see several roles for technology.



For instance, technology must be used to present the situation to the decision-maker. Taking this presentation a step further, it is possible to enhance the important patterns that characterize a situation (and to suppress the *noise* that can hide the important cues and patterns). Similarly, there is a valuable role in predictive simulation – allowing a team to *try out* or *practice* different courses of action in a simulated environment before entering the actual tactical situation. Finally, in the heat of the moment, once a CO commits to a course of action, technology can expedite that course of action in a streamlined manner—minimizing the required effort to translate the idea into action.

In reality, it is much more dynamic than that. The description above generally relates a scenario where technology comes to bear in discrete points along the decision cycle. The truth of the matter is that processing and display power have progressed to the point where there is a constant 'dialogue' between the decision-maker and the supporting technology at all points of the process—and in all phases of planning, briefing, deciding, and assessing. Instead of a "human-machine interface," it is now more accurately a conversation between partners—the decider and the system. An image that might help is an early scene from the movie "Minority Report," where Tom Cruise, playing the role of a law-enforcement officer, interfaces with a futuristic computer to sift through and mine a complex and diverse data set to determine the details of a crime that has been predicted. His goal is to intervene to prevent that crime. The situation facing the submarine Commanding Officer is much the same: he also must sift through lots of data to make sense of what is going on around his ship, and then to act to shape the future of that situation in the manner he desires. Like all good science fiction, the dialogue between Tom Cruise and his future-computer is both entertaining and educational. We are not far from realizing that level of interaction today.

Some Qualities of a Good Partner:
Confidence and Communication

A trusted mentor often tells me "submarines are like old English villages – predisposed to be suspicious of outsiders." This is true! The combination of a hostile operating environment and the intolerable price of failure has produced a community with extremely high standards. We need to be *convinced* of our "partner's" utility before we begin to trust them. To continue this thread, it may be useful to discuss the attributes of technology in terms of those qualities that a Commanding Officer might desire to have in a partner that is focused on solving a common problem. Many of the qualities that set apart good partners from bad fall broadly into two categories: *Confidence* and *Communication*. If the decision-maker can be *confident* that the technology will perform as desired when required; and if he can quickly and easily *communicate* ideas to the machines, and just as quickly and easily understand the results of the

machine's contribution; then there is the foundation of a healthy dialogue. If there are problems in either of these areas, the relationship is in trouble.

Confidence Begins with Transparency

Systems placed on submarines must be fully checked out—examined from all perspectives. It is a great strength within the Undersea Enterprise that we are not afraid of a thorough inspection—in fact we welcome it, and the lessons we learn from it. This must be true where technology is concerned, and it must include transparency in all aspects of the process—development, engineering, and implementation. Submariners detest *black boxes*. It is insufficient that the system comes with an externally stamped *seal of approval* when it arrives. The algorithms, sensors, displays, materials, construction and testing that characterize our systems must be thoroughly evaluated and understood not only by experts but also by the operators. After all, it is the on-board decision-maker—the Captain—who is the person who must understand the system well enough to trust it underway in a tactical situation. It may be certified for use by external engineers, but it will only be *actually used* when it gains the trust of the Captain and his team.

Related to transparency is need to know the principles and intermediate steps behind the final answer. Submariners embody the adage that "the devil is in the details." We do not accept the 'Q.E.D.' unless we know the steps involved in the proof. Systems that only serve up the final answer can eventually make us stupid—and even unsafe. Relying on the final answer will lead to atrophy of our healthy tendency to question initial conditions and assumptions, and we may lose our ability to know when the answer makes sense or not. I have seen examples of this in tracking exercises. Evaluators managing digital plots, where the computer does the line-of-sight mathematics behind the scenes and displays the final result, will fail to recognize or question when the plot clearly does not make sense—when it does not match the system solution. To address this phenomenon, for no system is infallible, we at DEVON 12 are working on producing a set of *primers*, designed for the junior officer, that would focus on the principles and fundamentals behind

processes like TMA, Search, and the Sonar Equation. Our hope is that these primers will complement the great work of the Submarine Learning Center and on-board training programs to maintain this critical knowledge of fundamental principles.

This requirement to know the steps leading to the final answer also has important implications for Tactical Decision Aids (TDAs). Using vast computing power, these spectacular tools can evaluate complex situations (sound propagation in shallow water), and make valuable recommendations about the best sonar lineup to use to achieve the desired aim. To image that target on sonar, what frequency range is best - HF or MF? Should it be active or passive? And, once these big questions are answered, what are the specific settings required to optimize performance? Computers can greatly assist in answering these difficult questions—as long as we keep in mind that in the end, the CO must make the decision—because only he can properly assess risk to his mission and crew. So, TDAs should enable an operator or supervisor to *walk* the CO through the process that led to the recommended mode. This *walk* would allow the CO to check assumptions, ask the right questions, and in the end have confidence that the recommendation is sound. Only then will he use it.

There's Gold in the Raw Data

Another role of TDAs is to reduce complex data to enhance operator understanding—to *boil things down* to the essential elements of the problem. There is a vulnerability here: critical information is often in the raw data—information that will be lost by over-smoothing. Just think of the difference between the sonar broadband display (AVSDU) and the Contact Evaluation Plot (CEP) derived from that display. While the CEP displays a lot of important information for decision-making, there is a lot MORE information on the AVSDU. In addition to the bearing-time history of contacts, there are all the *trace-dynamics* of each contact—which ones are the brightest (loudest), which ones are just whispery traces, which ones are transients, etc. To rely on just the CEP would be to lose all this additional data – which could be critical to making a proper decision. So while the CEP and similar TDAs have an important place in decision-cycle – to enhance certain patterns – the raw data may often

contain the *essential* pattern key to deciding what course of action to take. It's important to reduce complicated data to a set of essentials. But it's equally important to retain the raw data, for we often don't know what bits of information will prove to be the deciding factor in a given scenario. Boiling down data generally helps the junior decision-maker to become more effective sooner. Retaining the raw data allows the experienced, *expert*, decision-maker to see the subtle patterns that only he can see (it is no accident that Submarine COs make most of the trace dynamic classifications of submarines while looking at the AVSDU), and to explore his *hunches*. The emerging trend in tactical systems is to do both—provide data reduction and smoothing, then superimpose that smoothed data on top of the raw data. In this way, we enable both beginners and experts.

It's imperative that these systems be designed to support command-level decisions. We must fight the tendency to design displays and interfaces that are solely optimized for the operator. While it's important that the operator can use his display, at some level the system must serve the CO, otherwise it may prevent the most important decisions from being made. A quick example will illustrate what I mean. For discussion purposes, a TDA that assesses the ship's non-acoustic vulnerability, in real time, for a given mast configuration, would be a valuable tool. As discussed before, stealth is a fundamental step in the submarine pyramid. If we place this TDA in radio, it will no doubt provide the operator with a much richer understanding of the electromagnetic environment and the ship's vulnerability. But the operator is not the one who will make the key decision—to raise or lower all masts! That decision is made in Control, often at the command level. So the TDA properly belongs in Control, in a format that can alert the CO (who is *not* sitting in front of the panel as a dedicated operator), that he's got a problem.

Technology that serves the decision-maker is fully transparent at all levels, and is designed with the recognition that the decision-maker should have access to the fundamental principles and raw data behind the final answer. It serves decision-makers because it performs in a way that garners their *trust*, consistently arriving at the answer in a way that inspires confidence.

Communication

The value of any partnership is the power that arises from the communication between the two partners. If, as in our case, the *partnership* of the CO and his technology is focused on solving a problem, then at the most basic level, the conversation must keep pace with the problem at hand. It does no good to solve for the contact's solution after he has faded and opened up outside of weapons range. The channels of communication between the two must enable the rapid cognition required to keep pace with the problem as it unfolds.

Captain to the CONN

It's 0230, and the tactical situation has become too complicated for the Officer of the Deck—he is overwhelmed. He knows he needs help, and buzzes the Captain out of the rack. The CO gets up out of a dead sleep, and walks into Control – he knows it's probably not going to be a good scene. Yet even in this complicated scenario, the CO will enter Control and first look for a few key parameters to grasp an initial sense of the situation – and these parameters are fairly common for all CO's. I'm going to refer to this set of key parameters as the "vital signs" of the problem. The analogy fits. The human body is also an incredibly complex system, with thousands of processes underway at any one time. Yet, when a doctor approaches a patient for the first time – even in a trauma scenario (like our "Captain to the Conn" scenario) – the doctor will want to know the vitals: pulse, blood pressure, respiration, etc. Anybody in medicine knows the drill.

What are these tactical vital signs? For this discussion, it's not important that they're conclusively defined – every reader will have their own set of them, and they'll be slightly different depending on his situation. For this discussion, I'll assume that most sets of vital signs would include own-ship's course, speed, and depth. These parameters, because they are the CO's vital signs, should be consistently displayed in a way that visually prioritizes them – makes them easily and instantly available to the CO. We should strive to display them in a common field, in a common place, in consistent format, on <u>all</u> displays. So that, in the heat of the moment, when the CO is trying to quickly make sense of a complex situation, he will

not have to *think* about where the vital signs are displayed—they will leap out at him! This seems fairly obvious until one considers even our simple vital signs: own-ship course, speed, and depth. On our current systems, depending on where you look – sonar, fire control, ship control, etc., this data is displayed in different fields, in different places, and in different formats. As PCOI, I often found myself hunting around for the data I needed, until I had "calibrated" myself to the system and display that I was using. I often wished that the vital signs display had been standardized. We are just starting a discussion about what data would constitute the vital signs in a given situation, and how this data should be presented to the decision-maker—the Commanding Officer—to optimize performance.

Don't Stress Me Out

In the PCOI scenario above I always found the vital signs, but it was frustrating, and more important, it was stress-inducing. This leads to the next attribute. The dialogue between technology and the Commanding Officer is never more important than at times of high-stress. In a real tactical scenario, when the submarine may be in-extremis, or at the firing point between two submarines at near-parity, there is a good chance that the scene in Control will be rapidly changing and high-stress. In this scenario, decisions will be made rapidly, and will need to be executed just as rapidly. This is the realm of intuitive decision-making. Experience counts, as it enables one to see critical patterns quickly, have a ready-made course of action, and execute. This is the litmus test. In this case, technology should strive to minimize the stress involved. At the very least, it should add no stress! The vital signs of the scenario should be easily and intuitively displayed, and the resultant course of action should require minimal effort to execute.

In the Submarine Command Course, we aim to put the students under stress to see how they respond. And while the primary aim of that exercise is to teach the student how to better handle these situations, I have seen both Commanding Officers and operators wrestle with their systems as they struggled to gain control of the situation. Critical patterns were often difficult to see in the confusion, and many button presses, keystrokes, screen-touches, mouse-clicks, and other manipulations were often required to execute the

desired course of action. We're on a good track to make this situation better, and we need to continue to make progress.

Machines Can't Make Us Experts

No matter how intuitively a particular pattern may be displayed, and no matter how streamlined the desired course of action may become, in the end it's operator experience that matters. Without experience, the CO will not know what he is seeing, and will never gain a sense for the complexity of the situation. Technology will never be able to replace experience. But it can help build experience, and the current systems are better than ever in that regard. New processing and display technology enables embedded training modes and simulation that were unapproachable until just recently. With a very high degree of fidelity, it's possible to simulate just about any scenario that one may want to see. The screens and displays will provide nearly the exact response that a team will see at sea. By cleverly designing the training scenario, it's even possible to create the stress that one might feel during the real thing! The best training uses these trainers in scenarios that are chock-full of opportunities to detect cues, recognize tactical patterns, then formulate and try out different solutions. Once done, the new trainers can allow the team to replay the scenario to assess their performance. They can see the patterns that they missed the first time through, and explore alternate course of action to build up their library of mental models. So while machines will never replace an experienced decision-maker, technology is an essential tool to training in decision-rich scenarios that build experience and intuition as efficiently and effectively as possible.

USS VIRGINIA – A Decision-Centric Ship

There can be no better way to conclude this paper than to discuss the latest class of warship to join the fleet. To see a vision of the power of decision-centric technology, one only needs visit the USS VIRGINIA (SSN 774). I am privileged to have that submarine in SUBDEVRON 12, and have therefore had many chances to see the ship and crew operate together. In fact, it was while watching the command team on USS VIRGINIA that the image of a continuous dialogue first came to mind, for that is exactly what happens on that

ship. The entire ship is designed to provide the command with easily understood information, and then to enable the resultant course of action with almost no unnecessary effort. Much has been written about VIRGINIA, and much more will be written as we learn more about her. Suffice it to say here that she already embodies many of the principles discussed above. It is extraordinary how fast information moves around that ship and gets to the person who needs to use it. Enabled by the superb design and engineering inherent in the ship, the Commanding Officer and his crew have reduced processes that are fairly complex on a Los Angeles-class submarine to much simpler and more streamlined procedures, often handled by much fewer people, with noticeably less entropy. The training modes embedded in her Attack Center enabled the crew to do most of her tactical training not at the schoolhouse, but on board – using the exact equipment she will use underway. Ship control, using fly-by-wire techniques, provide just the right balance of assistance while permitting operator control; the displays are intuitive and very quickly understood. This decision-centricity has enabled her crew to train up and deploy years ahead of the initial schedule. She is on deployment as I write this, making decisions that are *translating technological capability into tactical performance* fighting the war against terrorism. That's a mental model worthy enough for all our libraries.■

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SEA SERPENT
LITTORAL WARFARE WEAPON
"A New Capability For A New Age"

by Timothy Levandowski
Naval Undersea Warfare Center
and Richard H. Messier, Ph.D., P.E.
Raytheon Integrated Defense Systems

1.0 INTRODUCTION

An essential National Capability called for under the Sea Power 21 constructs of Sea Strike and Sea Shield is the ability of the United States to project and sustain naval forces in anti-access or area-denial environments common to littoral regions around the world. This required capability consistently ranks as a high priority under various requirement assessments such as the Quadrennial Defense Review (QDR), the Defense Planning Guidance (DPG), and the newly established Naval Capabilities Pillar (NCP) of the Naval Capabilities Development Process (NCDP) which identifies capability gaps.

The joint vision is evolving that increases the need for the submarine to perform additional or expanded missions in littoral regions. Of high interest are the capabilities to strike with surprise from close-in, participate in interdiction operations against enemy mobilization efforts, provide Special Operations Forces (SOF) support at short and long ranges, and support battle space preparation operations by providing persistent Intelligence, Surveillance, and Reconnaissance (ISR) for Joint operations under anti-access or area-denial environments. In addition to the traditional threats, the deployed naval forces are now faced with the non-traditional and asymmetric threats of coastal surveillance aircraft and high speed small boats.

The Littoral Warfare Weapon (LWW) system is envisioned as providing the submarine force and Battle Force Commander with the appropriate and sufficient firepower necessary to address the asymmetric littoral target set and, in parallel, improve its ability to accomplish its required missions. By incorporating more decisive

Joint capabilities, the Submarine Force can better accomplish the Power Projection and Force Protection elements of Sea Power 21's constructs of Sea Strike and Sea Shield.

2.0 THE "NEED"

As noted above, the required capabilities documented for future submarine forces include uninterrupted strike operations from close-in, friendly SOF support, persistent ISR, and interdiction operations against enemy mobilization units. The Submarine Force can currently operate effectively in a littoral, anti-access environment, however, current submarine weapons were not designed for the emerging asymmetric target set. If stealth is compromised against threats, the current tactic is to go deep and reposition to regain a stealthy posture. This tactic has the potential to temporarily interrupt ongoing offensive operations, such as Strike and ISR. The submarine force needs the capability to neutralize the threat while continuing offensive operations. Specifically, the Submarine Force requires a fast reaction weapon of appropriate accuracy, lethality, and range capability to deter or defeat hostile aircraft and small-to-medium sized high speed, shallow draft surface craft. A major consideration is that the weapon system can be employed under the rules of engagement for littoral regions. Any solution should leverage current submarine systems for targeting, weapon preparation, and launching while having compatibility with Los Angeles, Virginia, and Ohio Class SSGN submarines and the potential compatibility with US Surface Naval and Coalition platforms.

3.0 HOW WILL LITTORAL WARFARE WEAPON SUPPORT JOINT OPERATIONS?

The LWW system will provide a revolutionary increase in Force Protection for Joint operation in the littoral regions of the world. Asymmetric threats such as High Speed Patrol Craft (HSPC) and aircraft represent a stressing challenge to the Joint Battleforce security. In order to be effective in both a deterrent and wartime environment, the Joint Force must be able to operate with impunity in the face of these asymmetric threats. Recent Joint Capabilities War Games have highlighted the need for enhanced capability in this area. The submarine, which often deploys long before other Joint

and Combined assets to operate clandestinely for long periods of time in far forward locations, is ideally suited to detect and engage the Air and HSPC threat early in their operation and prior to Anti-Surface Cruise Missile (ASCM) launch. Typically, the submarine is in theater early in part to deploy and recover SOF. The LWW will provide the submarine with the capability to provide Force Protection for SOF during the most vulnerable periods of their operation. Focusing the submarine's assets on anti-access and area-denial systems provides maximum benefit to follow-on forces, and contributes greatly to the overall potential for success of the Joint and Combined Force. In addition, clandestine early presence permits neutralization of these systems prior to follow-on Joint force arrival, thereby enabling access.

4.0 SEA SERPENT DEFINITION ACTIVITIES

Naval Undersea Warfare Center (NUWC) employed an analytical model of weapon candidates to measure the attractiveness of Non-Development Item (NDI) solutions to the LWW need. Candidate weapons were evaluated in terms of operational effectiveness, cost of implementation, and system maturity. Overall, approximately sixty-five weapon system candidates were assessed. Types of systems considered included cruise and ballistic land-attack missiles, anti-aircraft missiles, anti-ship missiles, anti-tank missiles, and a variety of man-portable and hull-mounted gun-launched munitions. Results suggested that AIM-9X was among the more attractive options for the demonstration of a LWW concept and potentially as a candidate for use as an effective near term LWW solution that can be readily fielded.

Using this and other related studies as a basis, the submarine community with support from NUWC and Raytheon, formulated a related LWW system concept commonly referred to as Sea Serpent LWW and have initiated risk reduction activities to mature critical subsystem components. Ongoing Navy and Air Force programs will be leveraged to develop an LWW system that can successfully prosecute the entire spectrum of the challenging littoral target set, including Maritime Patrol Aircraft (MPA), Helicopters, HSPC and other small boat threats. Specifically, the risk reduction activities include live fire test range launches of an LWW based on missile

technology from the AIM-9X program, encapsulation technology from the Submarine Payloads & Sensors program, and capsule launcher technology from the Tomahawk program.

At the time of publishing of this paper, a land based test launch of an AIM-9X, including engagement of a QH-50 rotary wing drone, was in the final planning and execution stage. Future efforts are currently being planed to focus on encapsulation technology risk reduction leading to in-water testing in FY07.

5.0 DISCUSSION OF SEA SERPENT SUBSYSTEM TECHNOLOGIES

The AIM-9X is the latest member of the AIM-9 Sidewinder missile family currently in use by more than 40 nations throughout the world. This next generation Sidewinder Missile is currently in Full Rate Production. AIM-9X is a launch and leave, air combat missile that uses an imaging infrared (IR) seeker for acquisition and tracking. It can be employed in the near beyond visual range and within visual range. AIM-9X provides US and Joint Coalition fighter aircraft full day/night employment, resistance to countermeasures, extremely high off-boresight acquisition and launch envelops, greatly enhanced maneuverability, and improved target acquisition ranges. Additionally, the AIM-9X program is completing a development of a Lock On After Launch (LOAL) capability that is critical to successful employment as an LWW.

A second critical component is an encapsulation device to provide for submerged launch of the AIM-9X missile from vertical submarine launch tubes. This component will consist of a Stealthy Affordable Capsule System (SACS). SACS technology development was initiated under the DARPA/Navy sponsored Submarine Payloads & Sensors Program. This technology is expected to provide a low unit cost, universal packaging approach for integration of future payloads on existing and future submarines.

Lastly, to enable launch of LWW from Submarine vertical launch tubes, a Tomahawk Capsule Launch System (CLS) will be used to accept the encapsulated LWW. This method of vertical launch system integration provides a common interface for launch of the encapsulated LWW from vertical launch tubes on Los Angeles, Virginia, and Ohio Class SSGN Submarines. Modifications to the

CLS will be minimized as much as possible, consistent with use of the SACS capsule.

These technologies will be coupled with existing Submarine organic sensors and Combat Systems to complete an end-to-end LWW system capable of detecting, classifying, targeting, and prosecuting the desired target set.

6.0 PARTICIPANTS AND ROLES

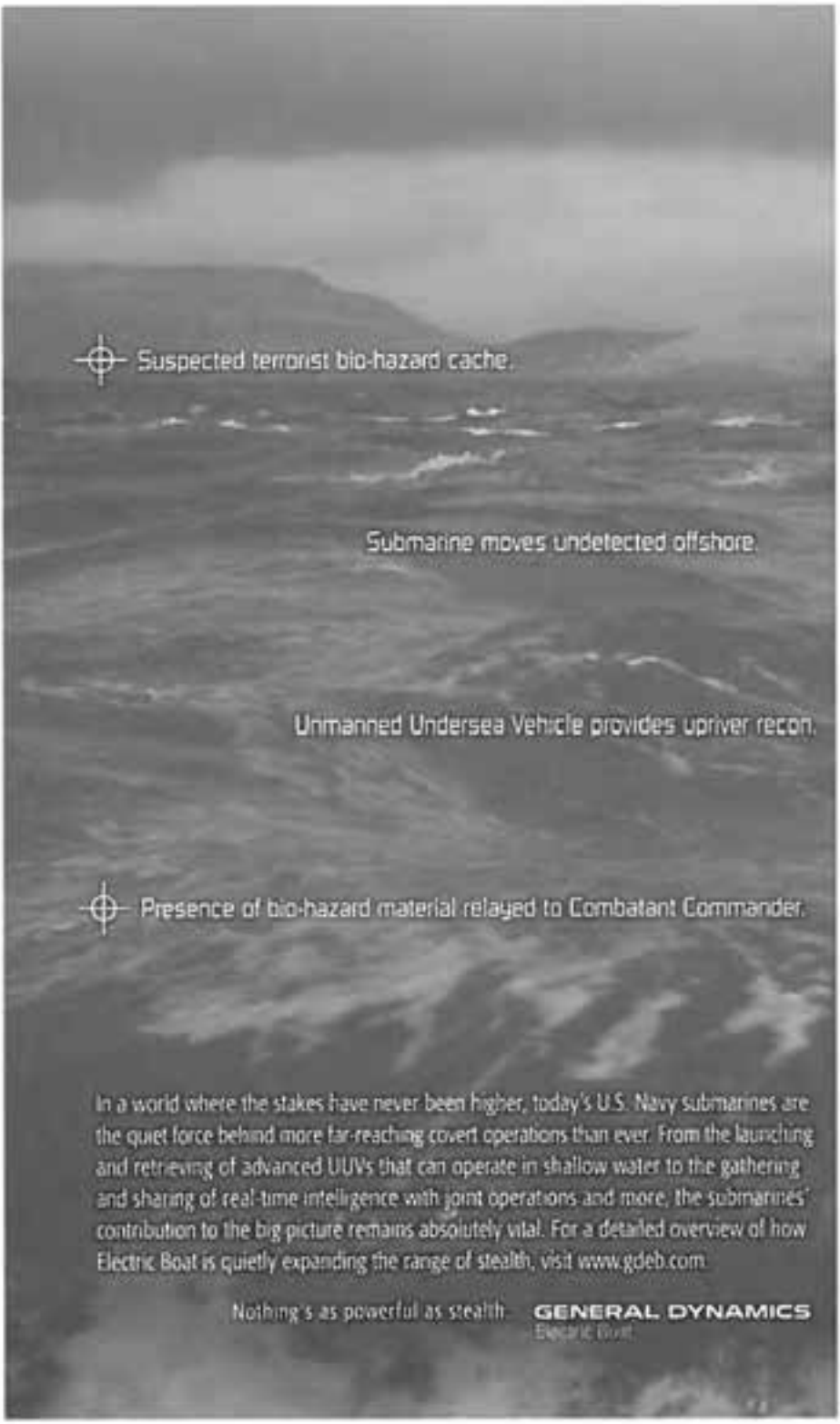
Program Executive Office Submarines (PEO SUB), PMS-415, is the Program Manager for the LWW activities. An industry team led by Raytheon Company, and consisting of Northrop Grumman Marine Systems and General Dynamics Electric Boat are performing the Sea Serpent LWW risk reduction efforts. NUWC is acting as the Technical Direction Agent (TDA) for these activities in support of PMS 415. Independent from its TDA role, NUWC also provides support to the industry team.

7.0 TRANSITION STRATEGY

The Sea Serpent risk reduction efforts will help define the integration path to a low cost, highly capable LWW. In parallel with these activities, an assessment will be made as to the degree that the Sea Serpent AIM-9X based candidate approach is effective in meeting the requirements identified as part of the LWW Concept of Operations and Military Utility Assessments. Alternative candidates will be considered for transition if necessary.

8.0 TRANSFORMATION POTENTIAL

The LWW capability is considered transformational because it provides for a critical component which will afford the United States the ability to project and sustain forces in anti-access or area-denial environments common to littoral regions around the world. This ability is defined as one of six QDR critical transformational goals. It also satisfies Warfighter capability gaps identified in the NCDP. The proposed LWW system will provide a critical ***Maritime Interdiction/Force Protection*** capability to engage ***asymmetric***, anti-access threats.■



In a world where the stakes have never been higher, today's U.S. Navy submarines are the quiet force behind more far-reaching covert operations than ever. From the launching and retrieving of advanced UUVs that can operate in shallow water to the gathering and sharing of real-time intelligence with joint operations and more, the submarines' contribution to the big picture remains absolutely vital. For a detailed overview of how Electric Boat is quietly expanding the range of stealth, visit www.gdeb.com.

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CHALLENGES FOR THE SHIPBUILDING INDUSTRIAL BASE

Naval Submarine League Annual Symposium
June 8, 2005

Mr. John K. Welch
Formerly Executive V P, General Dynamics Corporation
Member, Board of Directors, Naval Submarine League

It is a pleasure to address an audience of fellow submariners, industry and government personnel, many whom I consider close friends and colleagues. Today I would like to take some time to talk about the industrial base that supports naval shipbuilding, the challenges the collective industry is facing, and a little on the submarine industrial base.

Shipyards get most of the attention, but there is a huge array of players within the collective term 'industrial base.'

- Hull, mechanical and electrical (HM&E) suppliers tend to be associated with the basic hull and framework of the core ship – for the most part designed for the life of the ship.
- The combat system and electronics area has shorter technology half-lives and draws heavily on the advances of the commercial market.
- The government clearly has a management and buying role, but it goes much beyond that as the complexity and warfighting capability increases.
- The labs play a critical role in advancing technology and warfighting capability.

Clearly, there is a strong linkage between the many diverse elements of the industrial base and this needs to be considered in its broadest terms.

As much reduction as occurred in the 1990s, there is still significant excess capacity at the big 6 yards associated with naval shipbuilding. With LCS (Littoral Combat Ship) and Coast Guard deepwater programs, yards traditionally considered at the next tier are actively involved. Some of this is a result of looking at commercial hull forms and designs.

The consolidation within the industrial base has resulted in many single or sole source suppliers, especially for unique marine products. Competition is also limited, especially among the yards. At the rate of production of submarines, how do you have meaningful competition? Even when we had 688 competition, the awards looked very close to allocation in order to have 'meaningful' competition over the next flight. Similar parallels exist with the DDGs.

At the rates being procured today, it is becoming extremely difficult to have ongoing competitions. It would likely be a one-time competition for a series of ships.

There is limited commercial work; exclusively that associated with the Jones Act trade; mostly cargo carriers and double hull tankers.

The yards have invested large amounts in facilities, design systems and processes over the last 10-15 years, while significantly downsizing. It is important to note there is not an even distribution of capabilities across the industry and government: one yard to another; surface vs submarine; nuclear vs non-nuclear; naval vs more commercial yards.

Today's situation is further complicated by a wide variation in projected force levels. There was a goal of 375 ships in the Navy and we are hearing now of numbers from 260 to 325; and even those are said to be unaffordable. In addition, requirements are changing and across the shipbuilding programs production rates are very low.

It seems also the procurement holiday of the 90s have forced a major recapitalization of the Navy all at once with many new programs; some with very high technical development risk. We have before us intentions to build the T-AKE as well as LPD 17, LCS, DD(X), CVN 21, LHA(R), CG(X), MPF(F) and VIRGINIA class submarine.

Recently a Global Shipbuilding Industrial Base Benchmarking Study was conducted by the Deputy Under Secretary of Defense. The First Marine International Corporation did the benchmarking with support from the Navy and both domestic and international shipyards. The objectives were: (1) To survey global shipyards for manufacturing and business practices; (2) To assess US shipyards; (3) To compare and identify opportunities; and (4) To identify Department of Defense, Navy and Industry actions, policies and the

contract incentives to implement them.

The findings of that study indicated that the use of Best Practices improved yard performance significantly, as did both improved facilities and higher levels of technology. On the average it was found that US yards were better at pre-outfitting and storage. Several of the more important categories of performance which were rated were in Pre-Erection Activities, Ship Construction and Outfitting, Design and Production Engineering and Organizational & Operating Systems

In assessing productivity, the study concluded US yards significantly trail high-output commercial yards, while some operate at equivalent, or above, core production levels of international naval shipyards. It went on to state that core level was not always achievable because of overly complex design, unstable production rates, and increased overhead in the naval environment.

This Global Shipbuilding Industrial Base Benchmarking Study is highly recommended for review by all concerned with shipbuilding and the productivity of the industry.

The cost growth in US naval shipbuilding is often cited as a negative factor in discussions of defense budgeting. It is important, therefore that we know what that factor entails and look at the various causes for the numbers which we see.

Cost Growth in US Naval Ships

Ship	[illegible] Cost ($M)	%Constant Growth (FY06)	% Total Program Cost Growth
DDG51	917	8.7	12
DDG93	935	5.4	7
CVN76	4,226	7.8	7.9
CVN77	4,376	1	12.3
LPD17	664	24.2	100.6
LPD18	762	22.6	45.3
SSN774	2,260	12.9	11.6
SSN776	2,382	14.2	21.8
Total	$16,241	12.6%	13.1%

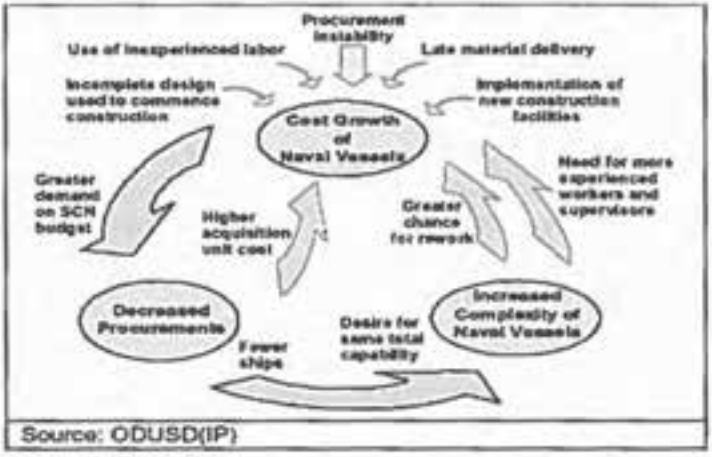
This chart shows, for two ships in each of four major naval programs, the initial cost, the percentage growth in FY 05, and the total projected growth, also as a percentage of the initial cost.

This is not a good picture, especially when one considers that the SCN budget has represented, on average, 33% of the Navy's and 12% of the Department of Defense procurement budget. That total cost growth of $3.3 Billion for these eight ships is equivalent to one VIRGINIA, or three DDGs, or six LCSs.

There are many reasons for cost growth in naval shipbuilding:

- Procurement instability
- Immature design–particularly in the lead ship
- Material ordering, delivery and schedule delays
- Capability enhancements introduced
- Poor estimating up front
- Change orders for whatever reason
- Material & equipment cost increases; especially STEEL
- Poor project management
- Inability to recruit appropriate labor
- Poorly defined construction specifications

The Benchmarking study also identified a vicious cycle which can occur due to the various causes of cost growth which could amount to a program death spiral. This chart seeks to show the interrelation of those various cost growths which tend to make a bad situation much worse. Controlling these identified factors is paramount to control ling cost, once you have settled on a design/class of ships.



Source: ODUSD(IP)

The **Keys to Affordability** can be deduced from an understanding of the causes of cost growth and their interrelation.

- Workforce experience and knowledge is a huge factor in design and construction; and this is an issue within the Navy and industry.
- Managing risk, especially with the lead unit. This also applies to new processes which need prototyping such as design and production systems. It is critical to this effort to know the realm of the possible.
- A stable design with minimal concurrency between design maturity and construction.
- The right balance between government and industry. Both must understand this is a team game and each side of that balance must know when to turn loose and when to be heavily involved.
- A good contract with the right incentives is necessary. Risk management is central to this on both sides.
- Common development where possible.
- Re-use of design where possible and the use of common modules-to the extent that tools allow it.
- Stable production rates and funding.
- Aggressive overhead management.

It seems to me the Industrial Base has done a lot, but more still needs to be done. For instance, Modularity can be a key to shipbuilding affordability. It seems important to get more modularity into our shipbuilding manufacturing environment. For instance, in the aerospace industry, some airframe manufacturers became module manufacturers. We have to look at whether this is an option in the naval shipbuilding business. Going commercial wherever possible is another attractive option and can be done on the ship, module and component levels.

We all recognize that numbers count, and force level management only goes so far, but we have to recognize that while industrial capacity also counts it cannot be available at any cost. If the production rates stay low, the industrial capacity and it's inherent costs have to be addressed.

Innovation is most definitely a Force Multiplier, and the competition of ideas is our discriminator, however, funding is again a critical factor. Dollars for Research and Development are key to achieving that innovation on the continuing basis critical to maintaining the technological advantage which drives Force Multiplication.

While competition is highly desirable, as stated earlier, its real value may be limited. The Benchmarking study noted that the use of "best practices" resulted in significant improvement. We need to share best practices and that can be done through NSRP and SIBIF. They have been identified as areas for investment to allow that sharing at a 50/50 cost sharing basis.

Stable procurement provides real value in the shipbuilding business. Industry needs to be able to have some idea of the future. Right now the shipbuilding plans seem unrealistic, because they are unaffordable, and they are always changing. Instability is caused also by jumping to a new program prematurely. Breaks in production or big swings in activity, whether in the yard or at the supplier, equate to big inefficiencies, and consequently cost big money. Each time we march off in a new direction I am concerned that sound technical analysis has been applied to the decision –the laws of physics can not be ignored. Admittedly, the rigor necessary for nuclear and ship safety issues doesn't have to be applied across the board, but ignoring sound *Lessons Learned* is a sure formula for repeating the mistakes which taught them.

In addition to all of these programmatic and management issues facing Navy shipbuilding today, tomorrow's worldly challenge is already on our doorstep in the form of compound, sophisticated threats. On the one hand we have the Iraqi action and the Global War on Terror, which shows promise of being of major concern for some time. On the other hand we have the emergence of China which looks to complicate our force level needs within the time-constants of ship design and construction. While we are focused on the engagement in Iraq, China is becoming the largest user of raw materials, much of which comes from the Third World. It would seem the development of their Navy is vital to insuring these resources. How we as a nation engage, support our forces and deter bad actions as this economic power develops is a major strategic issue. A weakened US naval position does not seem to be an affordable option.

Finally, I am worried that the industry and the Navy are not working together to address many of these issues. It is safe to say that Industry and the Navy are at a crossroad.

For the specific case of submarine shipbuilding there are steps which can be taken to ease the problem. As a first order consideration, we all know that multi-year procurement is the real base for stability. In addition, we should use the opportunity we have with the VIRGINIA class submarine to drive down the learning curve and aggressively go after cost. I look at the TANGO BRAVO effort as another opportunity. It is focused on external payload delivery and distributed propulsion, both of which could significantly lower the complexity of construction, thus the cost, in future submarine designs. On a more current note, the SSGN is truly transformational. It is a very modern example of taking a historical platform and adapting it for new capability for use in new missions. It also has the truck-like capacity to offer tremendous flexibility in addressing new forms of payload. For new security environments it's not hard to visualize the SSGN as an arsenal ship for all kinds of payload. Innovation always has been at the center of submarine warfare, and innovation will be important in the solution of these problems, but funding is needed and some areas are being starved. It has to be noted that the Demonstration program is providing significant benefit. We should also fully embrace the use of surrogate vehicles

to extend the submarine's reach.

Finally, it is clear that an integrated plan is needed which insures an affordable and capable industrial base for the future. I am not sure either OSD or the Congress believe there is a plan, or an acquisition strategy, which supports the Navy's shipbuilding programs. Without an architecture, we may not like what results and will likely have to pay big time to get what we need. The Navy needs to steer this effort because it is their base industry they need to be the architect.

No one is proposing preservation of the past; but we jointly need to determine the future end-state.■

S&T IN THE NAVAL REACTORS PROGRAM, 1949-1959

by CAPT Robert L. Bovey, USN(Ret)[1]

Bob Bovey was a Burke Scholar on graduation from USNA and received his doctorate from The Johns Hopkins University. He commanded SAND LANCE.

In the Navy and Atomic Energy Commission (AEC) joint Naval Reactors (NR) office, the mission and management was a seamless web encompassing research and development (R&D), acquisition and construction, and plant operation and maintenance. NR's vision of its reach was as broad. It saw itself as responsible for creating or providing materials, processes, and qualified people. The first two responsibilities required a great deal of fundamental research.

Submarine nuclear-power development lay on the intersection of the development of nuclear power over time and the world of submarine technology generally. The focus of this review is 1949-1959, this is not entirely arbitrary. In 1949 the Naval Reactors Branch of the AEC was established, headed by the same man who had earlier been appointed head of the Navy Bureau of Ships office, Code 390, for the same purpose. The name changed several times over the years, but the combined office was usually referred to as *Naval Reactors*, or *NR*. In 1959 the SKIPJACK (SSN585), a hull form optimized for submerged performance and powered by a *standard* S5W nuclear power plant, went to sea. Nuclear submarines had reached maturity. For this and other reasons, 1949-1959 was the decade on the time continuum when nuclear power moved from a fuzzy idea to a mature industry.

Although developing nuclear power was crucial to creating a true submarine, it was only one part of the submarine technology continuum. Without nuclear power, earlier submarine hulls had to be designed in recognition that the ships spent most of their time on the surface. At the same time nuclear propulsion was being developed, however, the Navy was conducting parallel developments in several

submarine-related areas, including designing a hull form optimized for high-speed submerged operation and testing it extensively at sea in ALBACORE, starting in 1953[2]. Therefore, the program described here is only a partial picture of a much more complex reality.

In January 1939, in a conference in Washington, D.C., Niels Bohr and Enrico Fermi announced that Otto Hahn and Fritz Strassman had split the nucleus of a uranium (U) atom[3]. Ross Gunn of the Naval Research Laboratory (NRL) heard this presentation and "became immediately convinced of the importance of quickly initiating navy research. . .toward the goal of nuclear power plants for submarines. . ."[4] A few days later, Gunn asked Rear Admiral Harold G. Bowen to initiate work at NRL. Bowen allocated $1,500 to Gunn, "the first government money spent on the study of atomic fission."[5]

NRL began research into the technology of gaseous diffusion to enrich uranium in the fissionable isotope, U-235, for fueling such a submarine. The Manhattan Project adopted this gaseous diffusion technology in 1944 to produce the highly enriched uranium (HEU) for the Hiroshima atomic bomb.

On 2 December 1942, Fermi's University of Chicago experimental group achieved the first controlled and sustained nuclear chain reaction, 10 years and 4 months before NR's Mark I initial criticality. During World War II, three reactors were built for producing nuclear weapons materials. These and five small research reactors were operating in 1946. The technology that existed for developing a reactor that would produce usable power was scattered and buried in classified files, not at all readily available.

In June 1946, a group of Navy officers and civilians were assigned to Oak Ridge to learn about the state of nuclear technology. In August, General Leslie Groves of the Manhattan Project approved a contract with the General Electric Company for a paper study of a liquid-metal-cooled reactor for a destroyer. Earlier, General Electric had agreed to "operate the plutonium production plant at Hanford, Wash., in exchange for a promise that the government would provide a nuclear development laboratory for the company at Schenectady. . ."[6] This laboratory became the Knolls Atomic Power Laboratory and eventually, over the period 1950-1955, was subsumed under the NR program. In sum, a good deal of research began shortly after World War II.

The five officers and three civilians studying at Oak Ridge facility developed an initial pool of information and concepts. They then toured the country, visiting laboratories and experts to refine their ideas. The team leader, Hyman G. Rickover, developed the initial research agenda to fill gaps in scientific knowledge required to support what he saw to be essentially an engineering program.

R&D within NR broadly followed three parallel tracks—pressurized water reactor (PWR), liquid metal (sodium) reactor, and gas-cooled reactor. Gas-cooled reactors were abandoned early (1949) by NR for naval use,[7] although the issue was revisited from time to time. For example, in a 12 April 1957 hearing of the Subcommittee on Research and Development of the Joint Committee on Atomic Energy, Rickover was being pressed by several members who clearly were enthusiastic about gas-cooled reactors. In the context of civil reactors, he responded to Representative Chet Holifield's question, "If you had the privilege of naming the reactor you would like to go into, which one would you select?" with "Gas cooled."[8] Indeed, gas-cooled reactors have been pursued subsequently for land-based applications.

Liquid-sodium-cooled reactor development preceded the formation of NR. In 1946, under AEC contract, General Electric had begun designing a sodium-cooled breeder—a reactor that created more fissionable material than it burned during operation. The sodium-cooled reactor was pursued through a full-scale operating, land-based prototype and into operation in USS SEAWOLF(SSN 575), which went to sea in 1957.

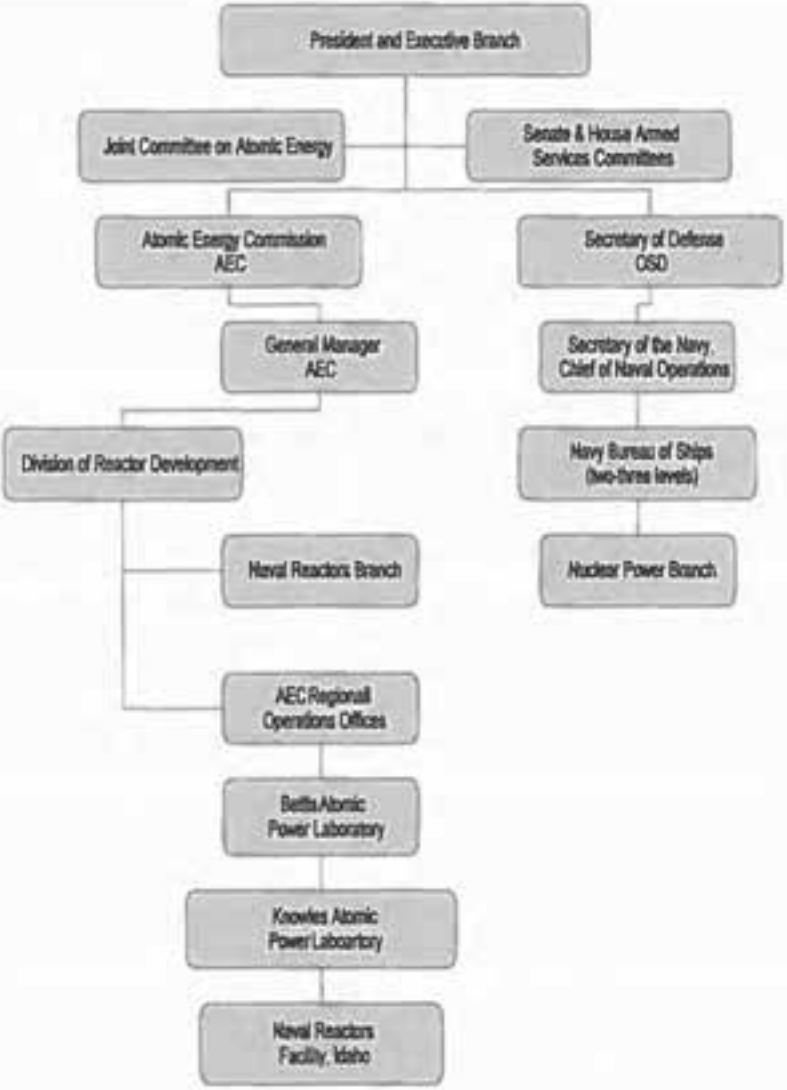
In 1959, SEAWOLF was converted to a PWR after a series of debilitating maintenance problems directly related to the sodium coolant.[9] However, a liquid-metal coolant R&D was continued under AEC, the Energy Research and Development Administration (ERDA), and Department of Energy (DOE) sponsorship in the liquid-metal fast-breeder reactor (LMFBR) program until President Carter terminated it in 1977 on the grounds that production of fissionable material was inconsistent with efforts to stop the proliferation of nuclear weapons. The LMFBR program is of some interest in the current context because the NR R&D management approach was applied with more formality, and hence more visibility, than it had been in the early NR program itself.[10]

The PWR turned out to be the dominant technology to emerge from the NR program. The specific examples below are therefore from PWR-related research. NR's success in naval propulsion led the AEC to task in NR_led team to design and construct the PWR at Shippingport, Pa. This PWR became the world's first purely commercial nuclear power plant in December 1957, when its generators transmitted electricity to the Duquesne Light company grid. The Shippingport reactor was not only larger than NAUTILUS one, it also employed a seed-and-blanket design in which a central cylinder of HEU was surrounded by an annulus of natural uranium.[11] The PWR remains the dominant nuclear power technology in the world. R&D has continued worldwide on gas, liquid-metal, and water-cooled nuclear power plants to the present.[12]

Overall Organization

The NR organization evolved from a loose network of interested individuals in 1947, which largely ignored an existing Navy office, to a formal organization in January 1949. This formal organization was unusual because the director was dual-hatted (in the Navy and the AEC). While there were many changes over the years, for this discussion, a simplified organization chart (see figure) will do.

For S&T management, the left leg was more important because almost 90 percent of NR R&D funding, in the neighborhood of $100 million in FY1958, flowed through it.[13]


President and Executive Branch
Joint Committee on Atomic Energy
Senate & House Armed Services Committees
Atomic Energy Commission AEC
Secretary of Defense OSD
General Manager AEC
Secretary of the Navy, Chief of Naval Operations
Division of Reactor Development
Navy Bureau of Ships (two-three levels)
Naval Reactors Branch
Nuclear Power Branch
AEC Regional Operations Offices
Bettis Atomic Power Laboratory
Knowles Atomic Power Laboratory
Naval Reactors Facility, Idaho

The NR HQ in Washington grew to about 90 scientists and engineers, both officers and civilians, by 1957. These people worked interchangeably for the AEC and Navy. In addition, 150-180 people in the Navy Bureau of Ships worked with NR almost exclusively.[14] By 1959, the NR HQ had grown to about 120 scientists and engineers.[15]

At the beginning of the decade, the main sources of science support to NR were first Oak Ridge and later Argonne Laboratory in the AEC system. The importance of this support declined by the early 1950s because NR built its own laboratory system. Two main AEC laboratories were established during this decade: Bettis Atomic Power Laboratory near Pittsburgh, Pa. (established in 1949 and operated by Westinghouse Corporation), and Knolls Atomic Power Laboratory near Schenectady, N.Y. (assigned to work for NR on 12 April 1950 and operated by General Electric Company).[16] Most of the R&D work done on naval reactors was performed in these two facilities, and no other work was done for other government or private programs. At the end of the decade, a third, smaller laboratory was established at Windsor, Conn. (owned and operated by Combustion Engineering). Together, these facilities employed about 2,000 scientists and engineers, plus supporting people.[17] Bettis alone employed about 5,300 people, of whom 1,300 were scientists and engineers.[18] Reactor prototypes operated at the Schenectady and Windsor sites, but most were at the AEC facility in Idaho. These prototypes were used for conducting engineering tests, training submarine crews, and conducting physics and materials research.[19] At the same time, many other scientists and engineers who worked for the subcontractors were designing equipment for the naval nuclear program.

The laboratories reported administratively through an AEC field office, in which NR representatives were posted, and a program field office was located at each site to carry out functions such as budgeting, contracting, administrative control, etc. The relation between NR headquarters and the laboratories was usually direct on technical matters of most interest to an examination of S&T. Communications with the Navy and the AEC were conducted through NR headquarters.

Early Research

Early in the Navy team's stay at Oak Ridge (June 1946-June 1947), it concluded that the necessary technology base for designing propulsion reactors did not exist. Each team member took a subject area and set out to read, listen to, and question Manhattan Project personnel about it. Each member also wrote a series of papers, which were reviewed by his colleagues. These initial papers were the first step in creating the necessary database. Adding to this database systematically became a primary function of NR.[20]

The striking feature of the research initiated by NR in the late 1940s and early 1950s was its elementary nature, its attention to the sorts of basic measurements and analyses that physics and engineering students perform in class. It was exactly the kind of work that many scientists and graduate engineers disdain; yet, it was precisely the kind of information needed before the reactors could be designed. For example, in reviewing existing data on water, NR was surprised to discover how little was known about the properties of water itself or its effects on materials.[21] Over the years, NR coordinated a variety of laboratory studies on corrosion and wear in water systems. Throughout the 1950s, NR sponsored a series of reactor engineering handbooks that were the foundation of the nuclear industry as a whole. The series included the Liquid-Metals Handbook (1950). The Metallurgy of Zirconium (1955), A Bibliography of Reactor Computer Codes (1955), The Metal Beryllium (1955), Reactor Shielding Design Manual (1956), Corrosion and Wear Handbook for Water-Cooled Reactors (1957), The Metallurgy of Hafnium (not dated, post-1957), and the three-volume Physics Handbook (1959-1964).[22]

Support of Engineering Development—Zirconium as a Structural Material

One development within the PWR materials track serves to illustrate two points about the interplay between scientific research and engineering development that was commonplace within the program. First, research was often done to understand the properties of materials that seemed attractive based on preliminary knowledge. Second, research sometimes unexpectedly uncovered possibilities that demanded further R&D to exploit.

By December 1947, Oak Ridge had completed a very preliminary design of a PWR.[23] One of the problems in building a PWR was to find a material that would be strong enough and workable to support and clad the uranium fuel elements, had little tendency to absorb neutrons, and resisted corrosion by hot water under high radiation. Many materials, including stainless steel, aluminum, and beryllium, were studied. An Oak Ridge engineer, Samuel Untermeyer, had suggested zirconium (Zr) because of its mechanical, metallurgical, and corrosion characteristics; however, it had two big disadvantages Zr had never been produced in quantity, and it seemed to have a large neutron capture cross section. However, in late 1947, Herbert Pomerance, an Oak Ridge physicist, had discovered that the large cross section recorded in earlier tests was mostly the result of a hafnium (Hf) impurity in the Zr test material. Therefore, removal of the Hf would make the Zr neutron capture cross section quite low. However, the removal of this previously undetected alloying material might also degrade Zr's mechanical, metallurgical, and corrosion properties.[24]

Based on the evidence accumulated by the end of 1947, [Rickover] committed to Zr as the metal for fuel-element structural material and fuel-plate cladding. This decision set in motion four parallel tracks of materials scientific research and engineering work. One path was to verify the properties of pure Zr and perhaps discover alloying materials to improve them. The second was to mass-produce Zr. These two tracks converged onto the third, which was to design, test, and manufacture hundreds of fuel elements. The fourth track concerned Hf and is addressed in the following section. Each of these tracks involved iterative but overlapping scientific research and engineering problem solving.

Although Zr was selected in 1947 as a reactor structural material for PWRs because of its favorable nuclear properties and corrosion resistance, it was not until March 1950 that Argonne and Bettis laboratories decided it would be feasible to assemble a fuel plate consisting of a U-Zr alloy fuel element clad with Zr.[25] Research continued to improve the performance of Zr, and out of this, an alloy named *zircaloy* was developed. Zircaloy was less expensive than pure Zr and had improved corrosion and mechanical properties. However, after deciding to use zircaloy as cladding for UO2 fuel

elements in the Shippingport reactor, in-pile and out-of-pile tests revealed unexpected Zr properties. Zr tended to absorb hydrogen (H) from high-temperature water systems. Irradiation affected this, and the behavior of H dissolved in Zr was not initially understood. Both in-pile and out-of-pile tests were used to study the redistribution of H in Zr under thermal and stress gradients. Together, they provided a basis for explaining and predicting the migrations. Further research revealed the role of nickel (Ni) contained in zircaloy in accelerating or increasing H absorption and pointed the way toward a class of Zr alloys free of this injurious feature.[26]

In the meantime, R&D was carried out to produce Zr and zircaloy. For example, in 1948, U.S. Zr production was about 86 pounds at $135-235per pound, all by the Foote Mineral Company.[27] In 1955, the AEC signed 5-year contracts with three producers to produce a total of 2.2 million pounds Zr per year at $4.80-8.00 per pound. In sum, research into some very fundamental physical phenomena continued in parallel with engineering design and even manufacturing. Research was the bootstrap that pulled the engineering development forward.

When one asks an NR alumnus for the important factors influencing the conduct of S&T by NR, the first answer is *people*. This was rooted in the NR emphasis on individuals rather than processes. Rickover required each staff member to have definite responsibilities and to be held personally accountable for every aspect of those responsibilities. To achieve a staff that could succeed in such an environment, NR devoted extraordinary attention and energy to selecting and training people.

The first NR people engaged in independent study and research for the June 1946-June1947 year as a team at Oak Ridge. A second group trained at Argonne National Laboratory. Other additions followed a course of supervised independent study in the NR office. By June 1949, NR had negotiated with MIT to extend a longstanding naval architecture and marine engineering course to include a year of nuclear physics and engineering for Navy engineering duty officers sponsored by NR. In March 1950, NR and Oak Ridge began the Oak Ridge School of Reactor Technology, which had trained over 100 NR, Navy and contractor employees by 1956. The school eventually provided hundreds of trained engineers for the nuclear

power industry.[28]

In the meantime, universities were graduating physicists and materials scientists. The major *people* thrust after the 1949—1959 decade was the selection and training of officers and enlisted men to operate nuclear-powered ships, although the renewal of the NR staff continued to receive great attention. From the early 1950s, the NR approach for the laboratories was different. It was up to the contractor to select and educate its people, but NR evaluated these people and demanded replacement of those found deficient in capability or dedication.

In his later years, Rickover became a well-known critic of the American education system generally and scientific/engineering education in particular. However, in this decade and later, NR training programs focused on meeting its own needs for managers and operators.

In the beginning, Rickover insisted on focusing on specific projects that would lead to a practical nuclear power system. He was ruthless in eliminating research that did not contribute directly to these projects.[29] Later, the focus was broadened somewhat, as discussed below. Still, NR wanted to be in control of R&D—to tell the researchers what was to be done. The NR director wanted advice, but in the end he wanted relevance and sensible work.[30]

The general view was that when an HQ pushes a laboratory, the lab will say that the HQ is not competent to judge. However, that was not the point of NR's philosophy.

> It believed the laboratory is like a violinist in a symphony orchestra. HQ should not tell the R&D contractor what to do (how to play his violin), but the government office must be the *conductor*, telling all the instruments what to play, what aspects of research on which to focus, etc.[31]

NR believed that is must not get into the dangerous situation that it regarded as usual for government, where the researcher does whatever he thinks is fun without knowledge of overall system issues. An example drawn from the LMFBR Program was also illustrative of NR experience. The program was having serious civil heat exchanger problems. The program director ended up in a fight

with a talented academic who wanted to work on some esoteric aspect that probably would never have an application (but was frittering money away), to get him to work on the real problem. In general, the view from NR was that most government people overseeing science are not managerially oriented. They tend to be sympathetic to the *laissez faire* approach of the labs and contractors. The NR view was that when they look at R&D, they need to ask "What is mission value?"[32] In other words, R&D had to be mission oriented, and it had to be the government who judged. To do that, talent was needed. Hence, the focus on people for the HQ organization.

Mission focus moved from a management precept to a crusade for Rickover. From 1974 through 1982, he embarked on a campaign against the system for contractor IR&D then in effect and for those who administered it. Rickover debated with senior political appointees in the Navy and Office of the Secretary of Defense (OSD) and took his case to the General Accounting Office (GAO) and Congress. His fundamental issue was that much of the work being funded by the government in contractor organizations had no relation to military needs. He opened his argument at high levels on 21 June 1978 with a memorandum for the Secretary of Defense (SECDEF) via the Secretary of the Navy (SECNAV). He recommended that IR&D reviewers be guided by the technical evaluations of proposals, that only experts in the proposed work evaluate proposals, that proposals in which the benefits to the government did not warrant the cost be rejected, and finally that the entire system be changed so as to finance worthy R&D by direct contract so the government could supervise the work and retain appropriate rights to the resulting intellectual property. On 24 November 1978, the Under Secretary of Defense for Research and Engineering, William J. Perry, rejected these arguments.[33]

Having said this, the focus was not entirely consistent. First, Rickover interpreted his nuclear-power charter broadly where research was involved. Speaking of the many technical publications of NR, he said.

> By having these books available you get the people in the universities and in other places starting to think about the

> problem and making improvements. . . You will find that today these are the standard books in the United States on this subject. . . There are not any others with detailed scientific and engineering information in this field.[34]

NR was also more relaxed with university research than with industrial research. The money involved was much less, and it was good Congressional politics to have research going on in many places. As a practical matter, NR found that it could get good results from universities because it was possible to press the faculty principal investigators to do good work without incurring Congressional ire, so long as the money kept flowing. University research, however, was undertaken with some reticence because of the folklore that just when the research reached the point that NR needed it, the professor would go on sabbatical.[35]

One of NR's main features was that it internalized the matter of responsibility. For research and other work performed through contracts, NR distilled from this the concept of the *demanding customer*. The following description of this concept is extracted.[36]

> Direction and guidance provided by the customer for contractor activities can take different forms. In many instances, the customer will arrange with contractor organizations to perform specific functions like research and development, design, procurement, construction, testing, and quality assurance, but will retain management of the total effort. In other instances, the customer will enter into arrangements where managing the total effort will be assigned to a selected lead contractor. The latter may still perform functions like those cited or have them provided by other organizations. Depending on the organizational arrangements involved, there will be one feature common to all-the need for the customer to exercise management across a customer-contractor interface.
>
> The key principle is that management and other capabilities of the customer's organization should be used basically for one function: namely to require and otherwise bring about effective management by the contractor organization or

organizations to assure performance in accordance with the contract. The decisive test for any action contemplated by the customer is whether it is conducive to this objective. The principal pitfall is that the customer will use its capabilities to compensate for continuing weaknesses of the contractor. Like other management principles, this one is logically compelling but difficult to apply.

A second principle is that the customer should set forth technical requirements in sufficient breadth and depth to assure that the product will meet customer objectives, but not in such degree as will stifle contractor management, initiative, and innovative capabilities. A corollary is that the customer needs to be able to adjust requirements, as practicable, to accommodate difficulties being encountered.

The prerequisite need in applying these principles is that the customer have *in-house* capability as measured by technical competence among its own employees to shape, guide, direct, and assess the activities and operations of its contractors. . . If the customer organization lacks technical strength, the contractor will not feel the same pressure to achieve excellence.

Having cited the need for strong customer technical capability, it is important to caution against its misuse. The general caution is that is should not be used to do work or perform functions for which the contractor is being paid. . . Many customer personnel would not perceive this as happening: some would not find it objectionable if they did. Such individuals find professional satisfaction principally from making a contribution to the solution of problems. . . It takes a firm hand to keep them from subverting the larger interests of their own organization.

A demanding customer will insist on developing clear, mutually agreed upon understandings about relationships with the contractor. True responsiveness by the latter always obliges the contractor to use his own good judgment in questioning suggestions made [by] the customer staff if the contractor believes them to be ill-advised. Responsiveness is to be measured, not by the extent to which the customer responds automatically to guidance from customer representa-

tives, but rather by the degree of responsibility exhibited in analyzing such guidance and then in acting on it or recommending reconsideration as appropriate. It is also to be emphasized that differences in important matters are not to be held unduly long at lower levels, where they foster animosity and weaken cooperation.

Instead, they should be raised promptly to higher levels of management for resolution. The objective to be sought is open, constructive dialogue between the parties, giving the primacy to objective technical and other considerations and suppressing personal predilection and bias. . . .

The need for the demanding customer to have *in-house* capability emphatically should not be taken to imply that the numbers of personnel be large. A customer operating in a sound managerial relationship vis-à-vis a contractor should be able to provide the needed managerial oversight with far fewer numbers than the contractor is obliged to use. . . the objective should be to keep competence up and the numbers down.

In NR's view, organizational funding was important to good S&T. An organization needed to have, as NR had, mission funding, which provided a steady diet. Organizations that did funding task-by-task ended up just *feeding the tourists*, those who came around evaluating projects for continued funding. Also, project officers were seen as risk averse. They would not support S&T.[37]

Recalling that NR's budget was nearly all R&D, most of it from the AEC and quite stable overall mission funding, controlling the dollars available then became an issue. In NR, the project officer had no money. He had to concur with plans of the technical branches. The technical area director had the money and covered the spectrum in his technical area. For example, reactor engineering covered current production, operations, and technology development, both to fix current problems and for the next generation. The project officers crosscut the technical directors. They were critics. Otherwise, inertia would be in control, and the technical branch would just keep working down a particular line. This implied that the advanced technology project officer was often in the position of arguing, "You guys are 'polishing the cannon ball'; it's time to shift money to

something else." These money shifts could take place across technical branches.[38]

Rickover ". . . held that it took years to train a man to be proficient in the peculiar kinds of technical and management problems faced in the nuclear project. . ." In particular, he viewed the idea of rotating officers after a 3-year tour, ". . .as the height of folly. Virtually all his senior staff agreed that the navy's rotation system. . . made adequate control of technological development [impossible].[39] Building and maintaining a management team for the long term was a major objective—one that was achieved to a large degree.

For example, a head count taken as of 1982 indicated that there were 21 section heads (technical groups, project offices, and support sections) at NR headquarters. Of these, 12 had joined NR in the 1949—1959 decade and the remaining 9 had joined in the 1960—1970 decade.[40] Because of this continuity, NR had a stable of strong advocates in its technical directors. They knew they were responsible for the whole spectrum, including the next generation, which had to be better than the last one. Furthermore, they would still be in NR to take the responsibility. In NR, the technical director had a much longer life than the technical leader in a normal Navy organization.[41]

While the issue of tenure in NR ended up being a positive with respect to S&T management, controversy continued throughout the life of the program about the negative impacts of Navy rotation policy (applied to officers outside the NR program) on the program generally. For example, in 1960 Congressman Price observed, "With the attitude of the Navy in regard to. . .it would indicate to me that perhaps they are considering nuclear-powered submarines and Polaris-type submarines as conventional a little too early. . .which might adversely affect you." Rickover responded, "Nuclear power has brought many novel problems with it. The people in the Navy rotate very quickly. Nuclear power is hard to understand so they try to force it right back into the old system, which they do understand.[42]

In the years 1949—1959, judging top-level government executives' support of naval nuclear propulsion R&D (as contrasted to their support for shipbuilding plans, personnel decisions, and other matters that were related to, but different from, R&D) is difficult

because of the many and tangled threads that ran through the decade.

In The Politics of Innovation: Patterns in Navy Cases, Vincent Davis took strong issue with account[s] in which [Rickover] is generally portrayed as the clear-cut hero, and all others in the plot are either his helpful accessories or his villainous opponents. . .which made it appear as if [Rickover] had been forced to wage a one-man campaign against a Navy high command generally unenthusiastic about developing nuclear powered submarines.[43] Davis saw the decision to send the team to Oak Ridge in 1947 as, "...representing the triumph of the nuclear power enthusiasts within the Navy with respect to a firm Navy commitment to press ahead into research and development on nuclear propulsion for submarines. All remaining problems were ultimately resolved, in large part because the highest officials in the Navy Department, including the Secretary and Chief of Naval Operations consistently gave this project their strong support."[44] Others emphasize the difficulties in getting and keeping the highest officials engaged.

In January 1947 [the Chief of Naval Operations, Fleet Admiral] Nimitz himself had approved a recommendation supporting development of a nuclear submarine. . . Two years of planning and discussion had. . .all but stifled the idea that seemed so promising. . .No one in a responsible position in the Navy really opposed the idea of nuclear propulsion. . .In a larger sense the issue was. . .whether the potential impact of nuclear power on the Navy warranted more than routine development.[45]

The judgment was made more difficult by the fact that two organizational superstructures stood over NR. Also, top managers in this management structure changed over the years as it coalesced and later evolved. Rickover was a masterful bureaucratic politician and played the two parts of the organizational superstructure over him to marshal support for the nuclear reactor program. Generally, the DoD superstructure was instrumental in overcoming early AEC reluctance and inertia to begin serious R&D into nuclear propulsion. Later, the AEC superstructure became far more important for NR R&D—most R&D funding flowed through it—while relations with the DoD superstructure were often acrimonious over matters other than R&D. However, by the end of the decade, Rickover could bypass both legs of the superstructure to a large degree, at will, and was empowered

by Congressional connections, primarily with the Joint Committee on Atomic Energy, in R&D and many other matters.

The success of NR from 1949 through 1959 was demonstrated by the performance of its product—the nuclear submarine—and speed with which it was developed and built. This success was even more impressive considering that the nuclear reactor technology and several supporting industries did not exit and had to be developed starting from almost zero. The reasons for such an astonishing achievement were many. This review has not attempted to account for all the factors that played a role. It has focused on NR's S&T research, which was a major factor in the success achieved during the decade. What seem to be the key relevant considerations in NR's management of S&T research are summarized below.

- Based on its reliance on individual responsibility as a central management principle, NR regarded hiring highly qualified people as a central task. The training and education of its HQ personnel was given first priority. By June 1949, NR sponsored a course in nuclear engineering and physics at MIT for the Navy engineering duty officers. In March 1950, NR opened the Oak Ridge School of Reactor Technology, which provided basic fundamentals as well as reactor-specific training to hundreds of engineers for the nuclear power industry.
- NR, in its management of government-owned/contractor operated (GOCO) laboratories, universities, and contractors performing research, was a demanding customer
- Clear definition of program performance goals and systematic, strict evaluation of the projects led to well-defined technology gaps, focusing research where it was most important to the overall goal. The NR program benefited immensely from having highly qualified personnel set technical requirements in sufficient breath and depth to ensure that research products would meet its performance objectives.
- In addition, these highly qualified NR personnel were able to use sound technical judgment in evaluating project results and determining its progress. S&T project progress

and results were scrutinized frequently and judged on technical grounds, after often tough, sometimes bruising debate.

- Clear program technical and schedule requirements were set early and, in turn, drove S&T project decisions on how much research was enough. Requiring research to support development schedules was instrumental in delivering working systems on time.
- NR, in its quest for solutions to an entirely new set of technical problems, maintained a strategy of pursuing several technologies simultaneously, thereby reducing long-term technical risk. The strategy was applied at several levels, from overall concepts to specific materials and from fundamental research through engineering development and operations at sea. Best known is the search for the best reactor cooling configuration, in which parallel efforts on PWRs, liquid metal (sodium), and gas-cooled reactors were conducted. Another example of this strategy is simultaneous work on Hafnium and Silver alloys for control rod material applications.
- NR R&D (including the S&T component) also benefited from stable budgets, most of which came from the AEC.

ENDNOTES

1. This article is based on one of several case studies in, "Science Technology in Development Environments - Industry and Department of Defense Case Studies," IDA Paper P-3858, November 2003, reporting research performed in the institute for Defense Analyses for the US Missile Defense Agency. The author would like to thank CAPT John W. Crawford, Jr., USN(Ret), Dr. Francis Duncan, Dr. Francis Duncan, Dr. Richard Van Atta and Mr. Andrew W. Hull, who reviewed the case study report. *Submarine Review* readers interested in the entire NR case study can request a copy from Bob Bovey at rbovey@ida.org.
2. Richard G. Hewlett and Francis Duncan, *Nuclear Navy*, University of Chicago Press, 1974, p. 267.
3. Ibid., p. 16.
4. Vincent Davis, "The Politics of Innovation: Patterns in Navy Cases," Vol. 4, No. 3, University of Denver, 1967, p. 24.
5. Vice Admiral Harold G. Bowen, USN(Ret.), *Ships, Machinery and Mossbacks*, by Princeton University Press, 1954, pp. 182-3, cited in *Politics of Innovation*, p. 24.

6. Hewlett and Duncan, *Nuclear Navy*, pp. 38-9.
7. Joint Committee on Atomic Energy, Various Subcommittees, "Progress Report on Naval Reactor Program and Shippingport Project," 85th Congress, 1st Session, 7 March 1957, p. 10. Hereafter referred to as JAEC 3/7/57.
8. Ibid., p. 93.
9. Ibid., pp. 7-8.
10. Discussion with Captain John C. Crawford, Jr. U.S. Navy (retired).
11. Francis Duncan, *Rickover and the Nuclear Navy: The Discipline of Technology*, Naval Institute Press, Annapolis, 1990, pp. 194-8.
12. James A. Lake et al., "Next-Generation Nuclear Power," *Scientific American*, Vol. 286, No. 1, January 2002.
13. Joint Committee on Atomic Energy, 86th Congress 7 March 1957, hereafter referred to as JAEC 3/7/57.
14. JAEC 3/7/57, p. 26.
15. JAEC 4/15/59, p. 30.
16. Francis Duncan, Rickover: The Struggle for Excellence, Naval Institute Press, Annapolis, 2001, p. 113.
17. JAEC 3/7/57, p. 32.
18. JAEC 4/12/57, p. 89.
19. JAEC 4/15/59, p. 30.
20. Hewlett and Duncan, *Nuclear Navy*, p. 137.
21. Ibid., p. 136.
22. Ibid., p. 139.
23. Ibid., p. 58.
24. Ibid., p. 59.
25. Ibid., p. 145.
26. Joint Committee on Atomic Energy, Various Subcommittees, "Progress Report on Naval Reactor Program and Shippingport Project." 85th Congress, 1st Session 12 April 1957, pp. 48-9. Hereafter referred to as JAEC 4/12/57.
27. Hewlett and Duncan, *Nuclear Navy*, p. 140.
28. Hewlett and Duncan, Nuclear Navy, pp. 123-126.
29. Ibid., p. 137.
30. Crawford, discussion.
31. Ibid.
32. Ibid.
33. All correspondence noted is included in the record of JeconC 1/28/82, Part 6.
34. JAEC 3/7/57, pp. 24-25.
35. Crawford, discussion.
36. Extracted from "An Assessment Concerning Safety at Defense Nuclear Facilities: The DOE Technical Personnel Problem," March 1996 (DNFSB/TECH-10). It was written by John W. Crawford, Jr., who was among the first dozen men in NR. He served there from 1950-1963 and was deputy director 1960-1963.
37. Anonymous sources, discussion.
38. Ibid.
39. Hewlett and Duncan, *Nuclear Navy*, p. 390.
40. Duncan, *Discipline of Technology*, Appendix 2.
41. Anonymous sources, discussion.

42. JAEC 4/9/60, p. 10.
43. Davis, *Politics of Innovation*, p. 27.
44. Ibid., p. 27.
45. Hewlett and Duncan, *Nuclear Navy*, p. 51.

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COLLISION SUBMERGED: SSBN-610 v. DD-689

by CAPT Frederick H. Hallett, USNR(Ret)

***Foreward:** The Board of Investigation report of this incident has just been declassified. This account started out to be a purely personal recollection of an event long past, but as I began to do some research to fill in a few gaps, I found that quite a lot of other now-unclassified official information was available, not to mention several DD 689 crew members willing to tell their side of the story. I've been assisted in my efforts by Doris Lama of OPNAV, Rachel Weir, Phyliss Shaw and Douglas Gibbons of JAG, Barry Zerby of the National Archives, George Bowley, Fred Ohleth and Joe Murphy of WADLEIGH and most of all Rex Wellman and David Metternick, former WADLEIGH sonarmen. My thanks to all of them.*

-F.H.H.

April, 1962... The Cuban missile crisis was still six months in the future. John F. Kennedy was in the White House and Nikita Khrushchev was in the Kremlin. The Cold War balance of *mutual assured destruction* had taken a sharp tilt toward the West with the deployment of ballistic missiles which could be fired submerged from GEORGE WASHINGTON class Fleet Ballistic Missile Submarines. Pioneer FBM skippers like Jim Osborn, Hal Shear, Bob Long and Pappy Sims and their Blue and Gold crews were settling into a new routine of patrols and refits at *Site One*, Holy Loch in Dunoon, Scotland alongside USS PROTEUS (AS 19).

Second generation ETHAN ALLEN-class boomers were coming on line, and I was aboard USS THOMAS A. EDISON (SSBN-610) as Electric Boat's Guarantee Engineer during her shakedown cruise, having been around the circuit once before with USS PATRICK HENRY (SSBN-599). The incredible marriage of nuclear submarines and 1200-mile solid fuel Polaris A1 missiles engineered by RADM *Red* Raborn's Special Projects office gave the U.S. a huge Cold War advantage. The Soviets were attempting to retaliate by secretly working with Castro to place medium and intermediate

range ballistic missiles in Cuba just a few flight minutes away from the U.S., although no one on our side knew that in April. We did suspect that they might be planning to set up a submarine base at Cienfuegos, Cuba, and ever since 29 May 1959 near Iceland when USS GRENADIER (SS525) had photographed the first Soviet submarine known to be operating in the Atlantic, the Navy was well aware that Russian submarines were operating in our home waters and that we were going to have to get much better at anti-submarine warfare.

Admiral Robert L. Dennison, once CO of CUTTLEFISH (SS-171), had been Commander in Chief, Atlantic (CINCLANT), Commander in Chief, Atlantic Fleet (CINCLANTFLT) and Supreme Allied Commander, Atlantic (SACLANT) since February. As SACLANT, a NATO command, he was responsible for monitoring and deterring Soviet submarine operations in the Atlantic. Coordinated ASW task forces were practicing in the GIUK (Greenland-Iceland-United Kingdom) gap setting up barrier patrols designed to prevent deployment of Russian boats from their northern bases for Atlantic operations. The SOSUS web of hydrophones was being expanded and was rumored to have successfully tracked the first U.S. fleet ballistic missile submarine, SSBN-598, most of the way across the Atlantic. S2F-1, P2V-7 and the brand new P3V aircraft were being equipped with MAD (magnetic anomaly detection) gear which could confirm suspected submarine contacts with a low flyover. But while money and talent were being poured into some ASW programs, too often destroyer sailors had to make do with leftovers from WWII. Fletcher-class destroyers designed and built twenty years earlier were still the workhorses of the fleet. Maintained with limited funds, sometimes upgraded with new equipment but often plagued with reliability problems, these great little ships were manned by tough proud officers and men eager to show how good they were. Designed to fight diesel electric subs with limited battery capacity, they knew they were now facing nukes. . .or soon would be. But they were determined to come out on top.

They weren't the only ones with tough problems. The new breed of FBM navigators was faced with an absolute need to maintain an incredibly accurate position plot at all times, with very small tolerance for error, while remaining submerged. This was certainly

useful for safe shiphandling but it was absolutely essential for precise Polaris missile targeting. Satellite navigation systems were still in the early prototyping stage and, of course, GPS was far in the future. Mast-mounted Loran C antennas, periscope sextants and automatic dead reckoning plotters could give a consistent position within a half-mile or so, but that wasn't nearly good enough.

The Ships Intertial Navigation System (SINS) was part of the solution. The late RADM Walt Dedrick, later to command SSBN-610 (GOLD) but then CO USS Halibut (SSGN-587), was officially the first to take SINS to sea in a submarine in March, 1960. [TRITON (SSBN-586) had a prototype SINS unit aboard a month earlier for her submerged circumnavigation but it stopped functioning a few days after departure.] The SINS concept worked but the gyro drift rates were high enough to produce unacceptable degradation of accuracy in a fairly short time. It needed to be reset frequently from a navigational fix obtained elsewhere. This was hard to do without potentially giving away the boat's position. Many ideas were floated. Among them was to use a radiometric sextant, a device housed in a large retractable mast-mounted dome which could get a precise sun sight at periscope depth using radio frequency energy even through dense clouds whenever the sun was above the horizon.

The operational prototype of this monster was installed aboard USS THOMAS A.EDISON (SSBN-610) at Electric Boat. One of our tasks on shakedown cruise was to evaluate it. Operating in the Western Bermuda OpAreas, the Blue Crew under CAPT Charles M. Young, spent the first week of April, 1962, exercising all our navigational capability, frequently at periscope depth. In our case, this meant hoisting not only periscopes and various small antenna masts, but also the huge radiometric sextant dome. It made an interesting sight for any observer on the surface.

Cy Young was the only officer I ever met who wore both gold Dolphins and Gold Wings. He was uniquely qualified. There was probably no submarine CO at the time who was so experienced in surface and air ASW. He had served in a destroyer, escorting WWII convoys in the Atlantic before Submarine School, then made eight war patrols in DRUM (SS 228) in the Pacific before being given command of S-23 at San Diego and serving as a training submarine for the Sonar School until the war ended. He went to flight training

and was designated a Naval Aviator in December 1946 and served as a pilot and Executive Officer in VA-1E, a carrier-based ASW squadron. In 1951 he returned to Submarines, serving as XO of TORO (SS 422) before becoming CO of REDFIN (SSR 222). After Armed Forces Staff College and service in CINCLANT staff, he served as Operations Officer on guided missile heavy cruiser CANBERRA (CAG 2) during a major NATO exercise in the northeastern Atlantic before starting his FBM training as a Prospective Commanding Officer. In view of what was about to happen in April, 1962, it was ironic that his broad experience may have proved to be a handicap.

All ship collisions, like many other accidents, depend on a chain of events. If one link in that chain—one event or circumstance—had not occurred, the accident would not have happened. The EDISON/WADLEIGH collision was no exception. Among the most important links in this particular chain were these:

1. EDISON'S active sonar transducer was flooded out. She could not transmit a sonar *ping* to get a range on a ship in the vicinity. She had to rely on her passive (listening) arrays for target information while submerged. Those arrays had a blind spot aft. A target was said to be "lost in the baffles" while astern. That's where WADLEIGH was at one critical moment.
2. EDISON's No. 1 periscope, the *high* scope, had jammed optics and was out of commission on April 9th. If it had not been, the CO would have been able to observe WADLEIGH close aboard from a deeper depth. As it was, EDISON had to come up to a keel depth of 64 feet to use the No. 2 scope, bringing both the top of her *sail* (the periscope and mast fairing) and her topside rudder to a more vulnerable depth.
3. It never occurred to CAPT Young that EDISON might be considered *an unidentified submarine contact*. Though he knew he was operating independently, his boss (Commander Submarine Force Atlantic) knew where he was if anybody asked. And he was certain that EDISON's actions when *buzzed* by the ASW aircraft were those of a friendly submarine—he did not evade, did not lower masts and antennas, did not change course or speed-and, having flown ASW aircraft himself, had no reason to

believe that the aircrews involved thought otherwise.

4. It never occurred to CDR Kiley (CO Wadleigh) that EDISON might be a *friendly* submarine. His mindset was such that even *after* the collision when communication was finally established his first question was "Does that sound like an American voice?"
5. There was no accepted and mutually understood procedure for demanding that a submerged submarine identify itself, i.e. no "IFF (Identification Friend or Foe) system.
6. Stung by reports that ASW forces had been able to track early FBMs as they left port, COMSUBLANT (Admiral E. W. Grenfell) had decided to take them off the "Daily Submarine Summary" (a list of our submarines and their locations) which was distributed to every command with a *need to know*. This deletion was done for two reasons - first, to see how the ASW people would do detecting FBM's if they were not alerted in advance. Second, to provide valuable training to FBM crews in avoiding detection by surface and air ASW units. COMSUBLANT accepted responsibility for keeping his own *unlisted* submarines apart, but there was apparently not much thought about what might happen if unalerted ASW forces *did* detect a transiting FBM.

So waiting on the path from Bermuda to Norfolk there was a big bear trap. And we were about to step right into it.

On the morning of April 8th in the vicinity of 32-35 N and 66-11 W, we finished up in our operating area and headed for Norfolk for a planned visit by President Kennedy (later postponed). Several times en route during daylight we went to periscope depth, snorkeled and raised the radiometric sextant. Operating at periscope depth far more than normal, maintaining a safety watch on the scope while steaming along with a large dome in the air, we made a substantial wake that any passing ASW aircraft just couldn't miss.

At sea many miles to the northwest, Task Group 83.3 was the designated Ready ASW Group, Atlantic Fleet and under the operational command of Commander, Second Fleet while preparing for a Presidential Demonstration, and not coincidentally, sweeping the Norfolk approaches to ensure that no unwelcome guests join the President's party. The Task Group Commander was Commander,

carrier Division 18, (Rear Admiral Christensen) aboard LAKE CHAMPLAIN (CV-39), an ASW carrier. He had several escorting destroyers assigned including WADLEIGH (DD-689) and JOHN HOOD (DD-655) as well as fixed-wing ASW aircraft and helicopters of Composite Search Squadron 64.

Four of those aircraft, Grumman S2F-1 Trackers, were flying search patterns from LAKE CHAMPLAIN the following afternoon. At about 1400 we came to periscope depth for a LORAN C fix and to compare the Radiometric Sextant readings with the optical sextant in the 1 periscope. For more than an hour we had various combinations of masts raised, and sure enough, at about 1500, April 9, 1962, we were spotted.

The CO was on the scope and saw four S2Fs making low passes over us and dropping practice depth charges (PDC's), which are small explosives charges about the size of hand grenades often used in exercises. He thought they were using us as a *target of opportunity* to practice ASW tactics. I think he said "they're playing with us" and invited the navigator to take a look through the scope. He said he hoped we hadn't blundered into someone else's exercise, and then became concerned that there might be another submarine in the area. Though it is not in the official Board of Investigation report, I remember that he made a call on Gertrude (UQC Underwater Telephone) to *unknown submarine*, trying to determine if there were another sub nearby, but got no response. (The UQC is the communication device of choice between submarines nearby, since its sonar signal is fairly short range and much more secure than radio communication. Destroyers are equipped with UQC but it is often in the Sonar Room rather than on the bridge, so there can't be a direct conservation between conning officers. Destroyer sonarmen also hated using it because it blanks out all other sonars and they fear losing contacts.)

Let's freeze the problem right here.

Captain Young is faced with conflicting demands on his time. He knows he is behind his PIM (position and intended movement), the moving box where COMSUBLANT expects him to be at any particular time - as much as thirty-two miles at one point - but he can easily make that up later in the day. It is a sunny afternoon with calm

seas—perfect for direct comparison of optical and radiometric sextant readings which is part of his assigned mission. And he's got a Reactor Scram drill to get out of the way—that could put him further behind his PIM. He does *not* know he's been checked out of the Navy's routine Movement Report System. He does *not* know he's been omitted from the Daily Submarine Summary. At 1433, after his navigator worked out the Loran C fix, he changed course to 278 deg. T. to head for Norfolk (which he maintained until the collision occurred.) He is personally minding the store this particular afternoon and getting on with his business.

The senior S2F pilot on the scene also has problems. He is looking at a bewildering array of masts, antennas and snorkels unlike anything he has ever seen before, with a wake as long as a football field, heading for Norfolk. He starts tracking his contact and reports the sighting to LAKE CHAMPLAIN. They check the Daily Submarine Summary and decide there aren't any friendly submarines in the area. It apparently does not occur to anyone airborne or afloat that this guy is steaming along with everything in the air in broad daylight on a sunny afternoon and if they want to talk to him, all they have to do is pick up the nearest radio handset. A call on the Fleet Common frequency or even the international hailing and distress frequency might have solved the problem instantly. Of course, EDISON could have talked to the aircraft if he wanted to, but he didn't know they had a problem, and FBM skippers are inclined to mind their own business.

What happens next? Well, someone remembers that somewhere he's seen a procedure for directing a submerged submarine to surface. I suppose he said "Yes, I've got it, right here in the back of FXP-1". Fleet Exercise Publication One is the prescribed set of rules governing fleet exercises within the U.S. Navy. This particular procedure is also covered in AXP-1(A) for use in NATO exercises. If a commander conducting an exercise between friendly forces wants to have a way to direct his submarines to surface and he can't reach them any other way, he can have his aircraft or surface units drop a series of small explosive charges at short intervals (sometimes 4 or 5 at one second intervals). FXP-1 or AXP1(A) would be cited in the Exercise Operation Order in such a case so everyone would know about it. But the procedure provides that in no case are such

explosives to be dropped on FBM submarines. And how a submarine *not* involved in the exercise is supposed to know if it is in the exercise OpOrder is unclear.

While COMSUBLANT later said Captain Young should have known that the S2Fs were trying to communicate with him (even though he wasn't involved in their exercise), it is certainly arguable that he might have decided they were trying to communicate with another submarine that *was* part of their exercise. In any event, we all heard the PDCs and nobody aboard noticed any particular pattern and we certainly didn't get their message. Only a handful of people on board even knew such a procedure existed.

Just two months later, CINCLANTFLT sent to all Atlantic Fleet units an interim directive covering Submarine Identification Procedures. This grew into the Submarine Surfacing and Identification Procedure which was ultimately sent to the Soviets and figured prominently in the intense Cuban Missile Crisis ASW operations recounted in The Submarines of October (National Security Archive Electronic Briefing Book No. 75).

As noted previously, it seems strange to have tried using this crude way of contacting an out-of-touch submerged submarine when EDISON was at snorkel depth and available to anyone with a transmitter of any sort. But having tried and failed to surface for identification his submarine contact, CTG 83.3 sent out a contact report at 1531. COMSUBLANT got the message five minutes later and was on the phone to Commander, Anti-Submarine Forces, Atlantic at 1545 to tell him that his contact was EDISON in-bound for Norfolk. ASWFORLANT sent a message to CTG 83.3 at 1559 that his contact was friendly. *But* that message was routed through the Naval Communication Station at Norfolk for delivery by on-line broadcast and was not received by CTG 83.3 until 31 minutes after the collision. And not having received it, CTG 83.3 sent out a second *unidentified submarine contact* message at 1633, one minute before the collision.

Meanwhile, having finished the navigational evaluation, at 1527 EDISON went deep and began making speed toward Norfolk, catching up with its PIM. Traveling at high speed submerged impairs performance of listening sonars and at this point, all surface contacts and aircraft noise were lost. At 1606, the reactor *scram* drill

commenced. A *scram* is an automatic shutdown of the reactor, normally triggered by exceeding a normal limit of temperature or pressure somewhere in the system. This was simulated from time to time to train new engineering watchstanders in promptly dealing with the consequences of loss of reactor power and a gradual loss of steam pressure. Propulsion is shifted to an electric motor while the reactor is restarted. On this day, it went smoothly and steam propulsion was restored to normal. And during the quiet moments after reactor shutdown, EDISON's sonarmen heard both ships and helicopters in the area.

At 1530, just three minutes after EDISON had gone deep, CTG 83.3 had dispatched a Search and Attack Unit (SAU) consisting of USS WADLEIGH (DD-689) and USS JOHN HOOD (DD-655) to investigate the unidentified submarine contact. The SAU commander was WADLEIGH's CO, Commander Donald W. Kiley, USN. He was ready when the order came.

He said "I heard the Task Group Commander say to get going on the unidentified submarine contact at 090 degrees 34 miles. Before he even got all the message out, we took off with left full rudder and went to 25 knots. I received a report that the S2Fs had sighted a submarine periscope and the submarine dove."

If Hollywood were doing this show, this is the point where funnels would belch black smoke, ship's sirens would be wailing and bugles would be sounding *Charge*. En route to the area, CDR Kiley told his Executive Officer to take the dummy hedgehogs off the spigots and to have live ammunition ready to mount. (The hedgehog is a sort of depth charge which can be thrown out in a pattern ahead of the ship.) WADLEIGH went to Condition 1AS, which is General Quarters, Anti-Submarine. Gun mounts and directors are manned, with live ammunition in the hoists, a special sonar tracking party is set up, and the ship is ready to fight. The SAU received a report that the S2Fs were maintaining MAD contact and that helicopters were on the way.

The SAU commander was preparing himself to take charge at the scene. He asked his Combat Information Center "What is the signal for surfacing submarines with explosives?" and as he later described the situation to the Board of Investigation "I called down again and said I hadn't got a report - had the checks been made, what was the

story on the explosive charges. They reported four or five. I misunderstood, I thought they didn't know. They said well it's either four or five, so I picked up the phone and in certain words (sic) I told them they had 20 minutes to find this, and I said I wanted a definite answer, and they said they had checked everything they could find and it was not clear, that they didn't know, they said that was the way it was written that four or five, I said 'aye, aye' and then I turned and said . . . (interrupted by a Board member). He later continued, "Admiral, this is how I understand it. This is what is specified in FXP-1. It is not clearly indicated that this is the signal that is to be used on a condition of investigation of unidentified sonar contact - submarine contacts. The best of my knowledge, well, the 4 or 5 hand grenades or a thing of this sort on a table of explosive charges 4 or 5 means it is clear to surface in ten minutes." His main concern, he said, was to determine if this contact were really a submarine because he thought it might be fish noise. "I did not think at this time it would be a friendly submarine. Then I got a report that he was maybe backing down and streaming a noise maker." (This may have been the loss of propulsion during the reactor scram and the sound of the electric propulsion motor).

At this point, Rex Wellman, SO2, WADLEIGH's lead sonarman can continue the story:

President Kennedy was onboard the aircraft carrier we were chasing around the Atlantic Ocean off the coast of Virginia. I heard later that he wasn't onboard yet but would be there later. The task force was to line up and pass in review past the carrier so we could show off our Navy to the President.

The "Sonar Shack" was located directly behind the bridge on the WADLEIGH. Someone opened the door to the sonar shack and announced we'd received a message that a submarine had been spotted by an aircraft and it had submerged before it could be identified as friend or foe. We were being assigned to go search for the sub and, if possible, identify it.

I immediately felt the enormity of our assignment with our President just a few miles away. (Whether he was really there or not doesn't really matter. I thought he was there.) My mind raced through all the possibilities and flashed the worst

scenario as a warning that we'd better have all our skills, expertise and proficiencies together on this one. A flurry of activity ensued as we felt the screws digging to get us up to speed.

We put our best "stack operator" on the sonar console and our best fire control system operator on the computer system. We loaded a new audiotape on our tape recorder and opened the microphone so that every sound in the sonar shack would be recorded. I took a position in the middle of the sonar shack where I could observe and, if needed, supervise all activity. I was also positioned to operate the underwater telephone (Gertrude) when/if needed.

Over the years of my experience hunting submarines, (approximately three at this time), I had learned that the odds were against us ever finding this guy on our sonar. Our average acquisition range was not very far and the way we were steaming, our target would hear and avoid us long before we could be in position to acquire him. We had in our favor, a relatively calm sea and little or no marine life noise to mask our reverberations when we sent out our sonar signal (ping).

As I remember it, we were steaming on a northerly course when we had maybe the best echo return I'd ever witnessed. It was well beyond our average range for acquiring a contact and was loud and much higher pitched than our transmission. It was bright and elongated on the CRT. (Also one of the best in my memory). [Cathode Ray Tube - an electronic display]. As a matter of procedure, the stack operator was required to go through seven steps in classifying a sonar contact. Although I hadn't gone through the steps, I knew immediately we had us a sub and that it was a nuke. I waited until the operator had completed his steps and informed the bridge and CIC that we were classifying this contact as a possible sub.

I knew from the high pitch return that this target was headed toward us at a high rate of speed. After four or five "pings" our fire control system operator confirmed my assessment. It was about this time that our Skipper (CDR Kiley) stuck his head through a partially open Sonar Shack

door and asked me what I thought we had. I relayed my firm suspicion that we had a nuke. The skipper instructed me to try to communicate with the contact using the underwater telephone and closed the door. I tried several times with no answer returned. We passed over our target a couple of times and maintained contact with it. We continued our attempts to communicate using "Gertrude" with no response.

[Author's note: During my discussion with WADLEIGH'S sonar operators, one of them volunteered that the muting relays on their "Gertrude" sometimes malfunctioned and that they'd rarely been able to make it work satisfactorily.]

The late David Matternick, SO3, was also in WADLEIGH's sonar shack at the time:

When we were dispatched to investigate the contact, I was the "Stack" operator. Our gear was designated SQS-31 with RDT (rotating directional transmission) added. When the ship came to speed, all ahead flank, we began transmitting on the bearing given us by the aircraft. Due to the sea conditions, I decided to employ the RDT. The RDT allows the operator to reduce the transmission arc from the normal 300 degrees to as little as 10 degrees. I set the RDT on 15 degrees and began "pinging". After each transmission, I altered the transmission bearing by 5 degrees to port and then to starboard. After a few minutes we received an outstanding echo return. The range of this acquisition is the longest we had ever had as it was about 22,000 yards. The sea conditions must have been very favorable.

In EDISON's engineering spaces, the scram recovery had gone like clockwork. Sixteen minutes after reactor shutdown we had steam for main turbine propulsion again, changed speed to ten knots and went up to 100 feet. Sonar reported the sound of helicopters hovering. It was 1632.

By this time it was easy to hear fast screws overhead through the

hull and the sound of PDCs. If we had inadvertently gotten involved in somebody else's ASW exercise, we were right in the middle of it.

I was six feet away when Captain Young decided he wasn't going to be able to go about his business and needed to find out what the hell was going on up there. He indicated he was going to pull away far enough to stick up a VHF antenna to talk to whoever was making runs on us. He told the diving officer to get a good trim, and when that was done, cautioned him to use minimum angles and not to overshoot 64' keel depth. He had Sonar do a complete sweep with the BQR-7 to report any close contacts. They reported the nearest contact (which was probably JOHN HOOD) was on bearing 272 deg. 6000 yards. And then he checked to verify that the BQR-2C sonar display at the conning station was clear.

The SAU Commander had relieved the aircraft commander as Contact Area Commander about 1545 and had been using three helicopters with dipping sonar to track us until WADLEIGH herself made sonar contact at 1620. They had been tracking for about ten minutes, changing course as the bearing changed. EDISON was still on course 278 deg. but just before losing contact due to minimum range, CDR Kiley remembered passing 340, and his sonarmen told him the target had started a left turn. He was nearly astern and lost in our baffles.

Captain Young, mistakenly certain that there were no close contacts, ordered periscope depth. The diving officer maneuvered the 7,900 tons of submarine deftly, momentarily overshooting the ordered depth by one foot, then quickly settling back to 64 feet with zero bubble (trim angle), or perhaps one-half down bubble. On the way up, the CO raised the No. 2 scope trained nearly dead ahead on the bearing of the nearest known contact. He started his sweep as it broke the surface but was only part way round when we felt an impact, a strangely mushy impact, that rolled the boat to starboard eight or ten degrees.

He swung around and saw a ship close aboard with a large port angle on the bow and a helicopter. Very calmly, he ordered the Collision Alarm sounded. As the watertight doors clanged shut, the Executive Officer, who had been in the Engineering Spaces critiquing the scram drill, sprinted all the way aft, quickly reporting no flooding and no apparent damage or injured people. As we

secured from Collision, he came to the control room and, at the direction of the captain, called repeatedly on the UQC.

WADLEIGH had transmitted "Mark on top" to HOOD and the helicopters just seconds before impact. Theoretically, there should have been no impact. In absolutely calm water, WADLEIGH drew about 14 feet at the bow, and at 64 feet with a half degree down bubble EDISON's topside rudder should have been at about 16¼ feet deep. But the motion of ships at sea can easily account for the difference and the starboard bow of DD-689 hit the top of our rudder with sufficient force to bend it jauntily to starboard. The collision occurred at 1634 local time in position 36 deg. 56.7 min. N, 71 deg. 44.2 W.

Commander Kiley, feeling the impact, remembers wondering if someone had inadvertently dropped a depth charge, and then thinking "that sub just hit me with something." He first looked to starboard but then heard "there it is!" from the port side. From the bridge he could see the top of the sail with a periscope sticking out of it about a hundred feet away, headed aft and moving away. He had Sonar call on Gertrude with no response, but then heard EDISON's XO calling "Unknown station from Vermont". Combat quickly identified "Vermont" as EDISON's call sign. EDISON asked if WADLEIGH had dropped any depth charges, then "Are you working with any other submarine?" Reassured that there were no other submarines, they concluded they had hit each other. EDISON was underway checking rudder response and opening the range as they spoke. WADLEIGH's Gunnery Officer reported "Main Battery locked on" ready to fire on the retreating periscope. His Captain was asking Sonar if they were sure they were hearing a distinctly American voice.

After firing a yellow flare, we surfaced a safe distance away. Our damage was all external and we had no trouble with steering. WADLEIGH had flooded a peak tank through a hole in the starboard bow plating about 48" long and 14" wide plus a 2" wide crack that extended down under the keel. After being assured that they were having no serious trouble controlling the flooding, we left for Norfolk and tied up at the Naval Operating Base. They came in the next day.

A Board of Investigation consisting of a Rear Admiral and two

Captains convened in Norfolk from 16-19 April 1962. After their deliberations, they recommended that "no disciplinary action be taken against any person in the naval service as a result of this collision." They also recommended that EDISON's passive sonar be tested to determine if a design deficiency or equipment failure caused the failure to detect WADLEIGH at close range. They recommended that higher authority determine the requirement for and feasibility of a Navy-wide signal of general application to direct an unidentified submerged submarine to identify itself. They further decided that higher authority needed to make sure every one knew that the FXP-1/PDC procedure was for exercise use only. And finally, they recommended that the practice of not notifying the Ready ASW Group Commander of friendly submarines passing through his area be re-evaluated.

Several of these recommendations could have been read to reflect some culpability ashore. They were not popular with higher authority. COMSUBLANT and COMASWFORLANT both decided that Captain Young hadn't really done all he could to deal with the situation and had negligently hazarded his ship. He should have changed course to *clear his baffles*, i.e. search the blind spot astern, before concluding, based, based on a passive sonar alone, that there were no close contacts. He should have fired a yellow flare before coming to periscope depth with ships nearby. And he should have tried calling on the UQC *before* the collision. Finally, he might have avoided the whole problem by talking to the S2Fs when they were making low passes overhead.

Commander Kiley almost emerged unscathed, but not quite. COMASWFORLANT thought he also should have used UQC before the collision (although his sonarmen recall that they had tried and failed) or directed HOOD to do so. He shouldn't have passed over his target, which ensured that he would lose sonar contact, before ensuring that HOOD was holding contact, and he used *poor judgment*.

No disciplinary action was taken against Commander Kiley. Captain Young received a letter of admonition but completed his tour as Commanding Officer (Blue).■

EPILOGUE:

During repair of collision damage on April 11, 1962, EDISON had one of the most unusual emergencies ever recorded - a fire in the rudder. Flamecutting the damaged top of the rudder off ignited the plastic foam inside the structure. It was put out with no serious problem. Regrettably, this was not EDISON's last collision. After completing 54 deterrent patrols, on November 29, 1982 during an ASW exercise, she surfaced under USS LEFTWICH (DD 984) about 40 miles west of Subic Bay in the Phillipines, demolishing her bridge, fairwater planes and part of her sail. She never submerged again. After temporary repairs at Subic, she returned home and was decommissioned December 1, 1983.■

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SEA RESCUES OF S-17 AND PAMPANITO

by Chief Mike Carmody, USN(Ret)

Mike Carmody enlisted in the Navy December, 1941 at the age of 17. He never went to Submarine School. During World War II he made 11 war patrols as a machinist mate. He rates the submarine Combat Pin with 4 bronze stars. He also made peacetime Cold War patrols. He was Chief of the Boat on DIABLO (SS479). He is a hard hat diver second class and was scuba instructor at the Escape Training Tank New London, Sub Base. He retired after 22 years active duty. He has had over 15 true stories published to date.

During WW II the two submarines I served in had the good fortune of making several sea rescues on three separate occasions. Unfortunately, all of the rescues were not successful. Being in the water and apart from your ship can be scary. You can experience this feeling if you ever fell overboard or went on swim call in the ocean. First you hope the riflemen are keeping a sharp lookout for the dorsal fin that always seems to appear. When you are eye level with the water surface and looking up at the ship you realize how vulnerable you are. It's also surprising how fast the wind and tide carry the boat away from you when you are in the water.

RESCUE #1

My first rescue experience came in the north Atlantic during the worst winter weather recorded in 50 years. It was my fourth war patrol in the old submarine S-17 (SS122). We were U-Boat hunting in mid-January of 1943. We really felt the cold more because the three previous patrols were tropical, Pacific Ocean and Caribbean Sea. I was a Fireman First Class but I also had to stand lookout watches on a rotating basis.

The watches were one hour on and four hours off because of the bitter cold. The icy wind was causing the waves to crest at about ten feet. I was ascending the ladder to relieve a lookout when a freak

wave swamped the boat. Our bathtub-type conning tower filled with water and washed two lookouts overboard. Captain Harrel was on the bridge with the O.D. and they managed to hang on. The Captain backed the boat down with full left rudder and came almost alongside the two men. Just then, a large swell deposited one of the lookouts almost on deck and the other one nearby. We managed to lift them both aboard. This rescue took only between ten and fifteen minutes, but neither of the lookouts could be revived. Both of these young men died on deck from exposure and shock. It was a miracle that no one else was washed overboard during the rescue. Our deck was only six feet above the water and in those days we had no life lines or safety harnesses.

RESCUE #2

The next rescue took place on September 12, 1944 in the South China Sea, about 30 miles off the Japanese island of Hainan: but the story really started many months earlier in a prison of war camp in Tamark, Rangoon. The bridge over the River Kwai was just completed by allied POWs thus making the final connection to the 265 mile railroad through Burma and Thailand. Now Japan wanted 10,000 allied slave laborers sent to Japan to work in the coal and copper mines. 2250 were selected from the River Kwai Bridge area. Of the 61,000 white POWs on the railroad project, 12,600 had already died. Asian and coolie laborers already lost 100,000 due to the harsh treatment and cruelty. The white POWs then started on the 1800 mile trek to the docks of Singapore. Upon arrival they were divided into two groups and put into the stifling cargo holds of the oceanliners RAKUVO and KACKIDOKI MARU. Water and food were next to nonexistent. Sanitary facilities were benjods (toilets) that hung over the side of the ship in full view of the passengers. These ships also carried over 1500 Japanese civilians, and 275 dignitaries, all fleeing Southeast Asia. The KACHIDOKI MARU had over 200 wounded Nippon soldiers and over 500 boxes of ashes of their war dead. The military cargo was bales of raw rubber, tin, scrap iron and bauxite. Other ships were 2 loaded tankers, 2 loaded cargo freighters, and the destroyer SIKINAMI and 3 destroyer escorts.

The ten ship convoy got underway at 0700, September 6, 1944.

On September 11th they merged with a convoy from Manila of 3 freighters and three more escorts, now 16 ships. The Japanese merchant marine code had been broken and this secret was called *ultra*. Admiral Lockwood's staff was plotting the convoy and alerted 3 U.S. submarines of the convoy's course. The Ultra message never mentioned that the ships had 2250 allied POWs aboard.

Early on the morning of September 12th, the submarine GROWLER attacked the convoy and sank 3 ships, including the destroyer SKIKINAMI. On the evening of the 12th, the SEALION II attacked the convoy and sank 3 ships, including the prison hell ship RAKUYO MARU. The convoy, in a panic, had scattered, thus putting PAMPANITO way off course. After 18 hours, at 2200 on the 12th of September PAMPANITO headed in on the surface at full speed.

Just before firing, we had a hot run in #4 torpedo tube. This is when a torpedo accidently starts running inside the tube, a very dangerous situation. Ignoring the hot run, Captain Summers fired the 5 bow tubes, then turned 180 degrees and fired the 4 stern tubes. Seven hits were observed: the captain and bridge crew watched in fascination the exploding ships: the prison ship KACHIDOKI MARU got hit twice and sank. The freighter SKINKO MARU got hit twice and sank, the tanker ZUIHO MARU got hit with two fish and exploded, the freighter KIMIKAWA MARU took one hit. We departed the area at flank speed while reloading and expelling the hot running armed torpedo from #4 torpedo tube. Suddenly the boat was rocked by a devastating explosion close aboard. Unknown to us, a radar equipped Japanese aircraft dropped a five hundred pound bomb, missing us by about one hundred feet. This explosion caused considerable damage and forced us to dive and stay down for three hours. We surfaced and again persued the convoy, making contact just before daybreak. We fired three torpedoes at the convoy, all missed and we were again forced to dive by the escorts. Three days later we returned to the area of our night surface attack and observed smoke on the horizon. It was September 15th in the late afternoon, visibility unlimited, but radar showed a storm approaching. Planes forced us to dive twice and when we finally surfaced we entered the debris field of thick oily sludge where we observed the still burning tanker ZUIHO MARU finally slip beneath the waves. The wreckage

floating by included many benjos (toilets), bales of raw rubber and many bodies. Then a lookout spotted a half-sunk life boat with people in it. We armed the men on deck and approached with caution to take a few prisoners. You can imagine our amazement when someone started calling out in English when they saw the American flag. They were white men but we couldn't tell because they were covered with thick crude oil. We started taking them aboard. We cut off their rag-like clothing and as best we could, we cleaned them up with rags soaked in clean fuel oil. More wreckage and men were sighted. They were all weak and near death. They averaged about 80 pounds in weight. Our men were diving into the water to assist in getting them alongside. They were all starving, diseased, and many were badly burned, several injured and two were blind. Some were in a crazed state. We broke radio silence and called other submarines that were in the area. In two hours the SEALION II came into view and started the rescuing effort. With darkness coming up and the sea getting choppy we were forced to terminate the rescue. We took count and found that we had 73 POWs aboard. The final total rescued was 159, but 7 died enroute to Saipan and were buried at sea by the four submarines.

Post war records show that a large Japanese factory whale ship named KIBIBI MARU and escorts rescued around 600 allied POWs and around 900 Japanese civilians. All were sent to Japan on the whaling ship. In Admiral Nimitz's speech he said that this rescue by PAMPANITO was the first real proof of the atrocities that were being committed against Allied prisoners by this barbaric enemy.

RESCUE #3

We were in the 55th day of patrol #4 with our new four striper Cap'n Mike Fenno. He was a naval legend because of his exploit in 1942 when he escaped from Corregidor with tons of gold. There was hardly any visibility and the waves were 15 footers. We didn't know it then but this was the beginning of typhoon Cobra. The lookouts had reported that we were leaving an oil slick. Fuel oil soundings of #4 fuel ballast tank indicated that it was many thousand gallons short of its recorded reading. We figured a broken flange topside from the last depth charging. The captain explained to Chief Merryman and

me, as fuel king, that this had to be repaired. We decided to convert the tank back to a ballast tank while we were at it, about a forty five minute job. First we had to remove a 4x8 steel deck plate aft of the conning tower. I couldn't wear my life belt because it could easily get snagged on the maze of piping under the deck, but I had it with me in case I had to make a hasty egress. The chief sat on the deck opening, handing me the tools. I just completed the job when I plainly heard the lookouts shouting that a big one was coming—it was a 35-foot wave. The next thing I knew I was under water and fighting my way to the deck opening. When I stood up the chief, the deck plate and the bag of tools were gone. I climbed out and took hold of the antenna line and ran aft. I could see the chief on a wave crest. The captain kept calling for me to return to the conning tower-he didn't want another man in the water, but I was the only one who could see the chief. Whenever he rose on a wave I pointed to where he was. The boat maneuvered within range of the chief and he was able to grab a life ring that was thrown to him. He was pulled alongside and was really getting beat up against the ballast tanks before we could get him on deck. The captain said it was a miracle we were able to retrieve him in such bad weather and limited visibility. His life belt was torn when he was washed overboard and wasn't much help in keeping him afloat. We both got a double shot of medical brandy to steady our nerves. We then all rigged ship to combat Typhoon Cobra.■

THE LAST TORPEDO FIRING OF WORLD WAR II

by Captain Roy Werthmuller, USN (Ret)

By the end of 1944, most of the Japanese merchant ship fleet had been sunk, primarily by submarines and naval air forces. This merchant fleet was vital in supplying Japan with oil and other materials of war.

The Sea of Japan was the only place that the Japanese merchant ships could operate with little fear of opposition. Japan was receiving significant support from China and Korea via the Sea of Japan. Since there were only two entrances and both were guarded by extensive mine fields, it was not feasible for allied warships to enter.

The Submarine Force commander heard in 1943 that a mine detecting sonar had been developed for the mine force, but was judged not suitable for minesweeping. At first he saw no use for that sonar in submarines. However, by mid-1944 the admiral saw the mine sonar as a possible key to enter the Sea of Japan through the guardian minefields. He importuned the authorities in Washington to make available some of those sonars to Pacific submarines. By mid-1945 sonar units were available for nine submarines all of which entered the Sea of Japan successfully and sank ships. Unfortunately, one of the submarines was sunk after torpedoing a Japanese merchant ship.

A second group of submarines was equipped with the sonar and entered the Sea of Japan in early August 1945. I had the good fortune to be the Executive Officer of TORSK (SS 423) which was in the second group and fired the last torpedoes to be fired in World War II.

A captured document made the southern entrance through the Tsushima Strait a little easier by indicating that there were 4 lines of mines and stated the distances between mines and their depth.

The mines were the moored type and were set at depths to sink surface ships and submarines. We entered the Tsushima Strait on 10 August, 1945 and submerged to 150 feet at 4:20 a.m. We were, of course, a little apprehensive, but knew that the preceding group entered safely and we had good training so we were not too worried.

It took about 16½ hours to complete the transit. We encountered the four mine lines about as advertised. However, the range of sonar detection was not nearly as great as we experienced in practice because the extensive amount of kelp in the water caused many false contacts and tended to mask the mines. We had some scary moments, but penetrated the field without scraping any mine cables like one or more of the previous group of submarines did.

The morning after we entered and while at periscope depth we noticed a strange apparition on the horizon. None of us could figure it out until we came up higher in the water. Then we discerned seven Japanese men clinging to debris. We approached them and at first they were reluctant to come on board. We found out later that their small ship had been sunk by U.S. airplanes and they had been in the water for several days.

We succeeded in getting six of the men aboard, but the seventh tried to swim away. When he saw that his shipmates were being given good treatment, he finally allowed us to pick him up. He was so weak that our crew had to pick him up and carry him below. We were having breakfast at the time and the crew tried to give the prisoners pancakes, but the survivors were intelligent enough to mainly drink the syrup which was probably best for them in their starving condition. We put three of the prisoners in the forward compartment, three in the aft compartment and the seventh in the galley to help the cooks. The one assigned to the galley was only 16 years old and he had been the cook on his ship. He indicated that he had been on two previous ships which had been sunk. This boy became the favorite of the crew and learned a lot of English before he left the ship. More about him later.

The second morning after entering the Sea of Japan, we patrolled off an island in the southern part and sank a small merchant ship. The next day we sank another merchant ship and the fourth day August 14 we had quite a busy day.

Early that day we saw a merchant ship escorted by a single frigate. We decided to sink the frigate first with a new type of torpedo which homed in on a target's screw noises. Our submarine was one of the first to get this new, secret Mk. 28 torpedo. We fired one torpedo which we saw hit the target's stern and lift it up 45 degrees. We also saw a number of lifeboats pick up the survivors and

luckily for them they were only a few miles from shore.

We then turned our attention to the merchant ship which was heading toward a nearby port at full speed. Before we could get in a good position to fire torpedoes at the ship, it entered port. Our captain, Commander Lewellen, said maybe we should surface and fire at it with our 5 inch gun, but fortunately decided against it when a Japanese warplane appeared headed to our area. We started to depart the area, but soon heard more ship sounds and soon saw another frigate bearing down on us. The aircraft apparently saw us and called in the frigate. The frigate apparently saw our periscope because he was headed directly toward us. We decided to fire another of the acoustic torpedoes at this frigate even though the acoustic torpedoes were designed to be fired from aft the target's beam and our present target was heading directly toward us. We fired when the target was about 2000 yards away and went deep to evade and hoped our torpedo hit. After what seemed to be an eternity, we heard a loud explosion very close to us and then breaking up noises. If that torpedo had not hit, we would have had a very bad time. They sent another frigate out to try to locate us, but we evaded it quite easily after it had dropped a few depth charges-fortunately not close.

Since we had very little sleep for the past few days, the captain decided to go into deep water and rest for a day. The next morning we received a message that the war had ended and that there was a cease fire. We were of course happy with the news, but spirits were somewhat dampened by a following message which said that we would have to stay in the Sea of Japan until the mines had been swept from Tsushima Strait which took more than two weeks.

As you may imagine, after the hectic days before the cease fire, it was quite a change to have nothing to do. The crew started to clean the ship which had been neglected during the times at battle stations. The prisoners helped in this and because of their small size and agility cleaned places never cleaned before. Also, the prisoners had become quite acclimated to life on board. Once when an engineman had difficulty closing a valve when diving, a prisoner jumped in and helped without being asked. Another time, the boy in the galley warned a crew member about making noise when we were evading a frigate. The crew started to teach the boy English and he was a

quick learner. One morning a crew member asked me to come aft to see that Tanaka, the mess cook, had learned to say "good morning". I went aft and said: "good morning Tanaka." He said: "I hate marines." Of course, the marines would be taking him when we returned to port. I made certain that they told Tanaka of the joke, because the crew really liked him. The prisoners enjoyed life on board and all gained weight and did not want to leave. When we arrived in Guam 3 or 4 weeks later they left the ship with candy and cigarettes as presents from the crew.

We returned to the Submarine Base in New London via Pearl Harbor and Panama. We did not find out until later that we had sunk the last enemy ships of the war.■

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STRANGE SUBMARINE VOYAGES TO THE FAR EAST

by CDR David H. Grover USNR(Ret)

In addition to being a Commander in the Naval Reserve CDR Grover is a Chief Mate in the Merchant Marines. He is the author of five books of Naval/Maritime history and many articles in related journals. He makes his home in Napa, CA.

One of the little known aspects of early submarine history is the way in which the U.S. Navy's primitive and diminutive undersea craft managed to travel to distant operating areas. Vessels of the A series, only 63 feet long, and those of the B series, a mere 82 feet in length, served as early as 1908 in the Asiatic Fleet, the Navy's principal operating unit on the China Coast and in the Philippines.

Six of the seven-boat A series and the entire three-boat B series were assigned to serve in Manila Bay or Subic Bay as coastal defense, or, more accurately, harbor defense submarines. How they reached those distant locations is an interesting story, particularly in the way that the newly emerging technology of the submarine was nurtured at this critical point by another type of vessel of much lower technology whose prospects of survival had begun a downward spiral toward oblivion.

All of the A series submarines were built by subcontractors of the original John P. Holland Torpedo Boat Company of New York. That company's HOLLAND was the archetype, the first submarine in the U. S. Navy. Numbering and naming systems for submarines were pioneered within the A class, all of which were completed in 1903, with the A-1 being designated PLUNGER; the A-2 becoming the ADDER, etc. These submarines were built by the Crescent Shipyard of Elizabethport, New Jersey, followed by the A-4, the MOCCASIN; the A-6, the PORPOISE; and the A-7, the SHARK.

The intervening numbers, A-3, the GRAMPUS, and A-5, the PIKE, were built by Union Iron Works in San Francisco, California. Thus, the submarine construction program, although beginning on the northeast coast of the United States, was soon functioning on both the Atlantic and Pacific coasts.

With this early construction program a sequential numbering system was also put in place along with the numbering within each

type. The HOLLAND was SS-1, followed by the A-1 as SS-2, A-2 as SS-3, etc. That system soon became skewed when, between the A type and B type, the 105-foot C1 of 1908 was inserted with the number SS-9, so that system was never again a perfectly accurate measure of the seniority within the submarine fleet.

The B series came along in 1907. All three of the boats in this group were built by the Fore River Shipbuilding Company in Quincy, Massachusetts. The B-1 was named VIPER, the B-2 became the CUTTLEFISH, and the B-3 bore the name TARANTULA. The assigned successive numbers were SS 10 through SS-12.

It is interesting to observe that the naming system, as well as the numbering system, had irregularities at this early date. Although most boats were named after fish or seagoing mammals, three of the first generation submarines were named after snakes and another was named for a large spider.

When the Navy was ready to send the first submarines to the Philippines it cast around for a suitable type of vessel that might be used in transporting the submarines as deck cargo. As submarines, the vessels were tiny; as deck cargo, they were immense. The A type weighed in at 107 displacement tons, and the B type at 145 tons. No ship had heavy-lift gear that could accommodate that weight, nor did shore side or floating cranes exist in the Philippines which could lift that weight. So, a compromise was reached. The Navy would look within its fleet for a ship with ample deck space, upon which a wooden frame for the submarine could be built and from which the boat could be launched by gravity into the Philippine bays adjacent to the naval stations.

The type of vessel that best met this need turned out to be the collier. During the Spanish-American War the Navy acquired a large number of freighters to serve as coal-carrying replenishment ships to support the fleet, and many of these ships were still in service. Even though by 1908 the first signs of the superiority of oil-burning ships were evident, there was still enough demand for colliers that the Navy was planning the construction of 11 such ships in three basic types and sizes up to 550 feet in length. This group of ships would turn out to be the first and last ever built by the Navy for this purpose.

However, the new ships were several years away yet, so the Navy

turned to its older colliers for a candidate for the first voyage to the Philippines with submarines aboard. The ship that was selected was USS CAESAR. This ship had been built in England in 1896 as the KINGTOR, and had been acquired during the Spanish-American War. Eventually, when numbers were assigned to many of the colliers, she would become AC-16, CAESAR. During her early Navy service she proved to be a particularly sturdy and reliable vessel, making a number of trips to the Far East including one as a member of one of the great tandem towing jobs of all time, that of the Dewey Drydock which was taken out to Manila in 1906. There the drydock remained as a cornerstone of the Navy's ship repair efforts until she was scuttled in 1941 to keep her out of Japanese hands.

In 1908 the first two of the submarines destined for the Philippines, the A-6 and A-7, were loaded onto the after well-deck of the CAESAR by means of a shore crane at the Brooklyn Navy Yard. Contemporary photographs even show one of the bullet-shaped boats being lowered down onto four curved wooden chocks on the starboard side of the deck by heavy wire-rope slings, while the other boat already sits secure in its chocks on the other side of the ship, with the ship's after mast separating the two.

Going by way of the Suez Canal, CAESAR and her unusual cargo reached Manila after an uneventful trip. The submarines were launched in early July of 1908. Photographs of the launching show the submarine in mid-air with the wooden cradle still attached, an indication of how the launch was carried out from a greased slide, utilizing strong horizontal and downward forces but no lifting.

A year later CAESAR returned with two more submarines, the A-2 and the A-4 which had been loaded at the Norfolk Naval Station. The four submarines now at Cavite on Manila Bay comprised the First Submarine Division of the Asiatic Torpedo Fleet. They were essentially day boats, with the crews living aboard other larger naval vessels. It would have been virtually impossible to live aboard because of the primitive facilities on these tiny boats.

In 1909 a Navy doctor on the East Coast spoke of the problems of trying to keep crews aboard these vessels: "One officer and a crew of 10 or 12 men had been living, that is, sleeping, cooking, eating and answering the calls of nature aboard each of these boats in addition to performing their duty navigating them. Being small, they

pitch and roll considerably in a smooth sea, and about half the crew became seasick, due largely to the foul air in the boats; when the sea is moderately rough, practically the whole crew is seasick." He went on to recommend that cruises be limited to 36 hours and that when not underway the crews should live on a mother ship.

The next group of submarines did not come out to the Philippines until 1913. In that year the B-2 and B-3 were transported on the foredeck of the collier AJAX, AC-14. This ship was another of the vessels acquired during the Spanish-American War. Built in Scotland in 1890 as SCINDIA, she was, at 375 feet, somewhat larger than CAESAR, but had a considerably smaller fuel capacity so she must have made numerous stops en route. Inasmuch as the Panama Canal was not yet open, the long voyage was again made by the Suez Canal.

The final group of submarines were taken to the Philippines in 1915. By this time, one of the new built-for-the-purpose colliers was available, the USS HECTOR, AC-7. After loading the B-1 at Norfolk, she apparently went through the newly-opened Panama Canal, and stopped at the Puget Sound Navy Yard where she loaded the two A type submarines which had been built on the West Coast, the A-3 and A-5. Apparently, these two boats had been stranded on the West Coast by a lack of a suitable collier to take them across the Pacific. The three submarines were subsequently launched from the HECTOR at Subic Bay in northern Luzon in March of 1915, and a second submarine division was constituted within the Asiatic Fleet.

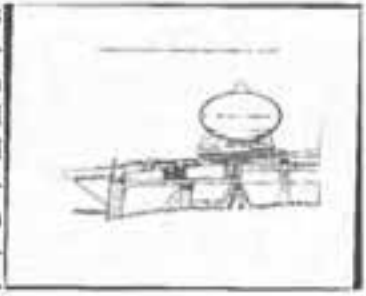
With the Philippine squadron of nine submarines now assembled at Cavite and Subic, it is appropriate to look at the rest of the Navy's boats to see what kind of progress they were making toward becoming true oceangoing vessels. The C-1 had ventured as far south as Guantanamo Bay in 1913, and eventually on to Panama during World War I. Two F-boats reached Hawaii in 1914-15, and E-boats and K-boats reached the Azores in 1917-18. L-boats, which were 167 feet long, were the first to cross the Atlantic during World War I, reaching the Azores, and then Ireland and England.

In the Pacific, K-boats were followed by the R-boats in reaching Hawaii and Midway during the war, but it was not until the S-boats well after World War I, that submarines finally reached the Philippines under their own power. Two submarine divisions made up of

that type of boat went out in 1921 and returned to Hawaii and the West Coast in 1924. During that three year period the old A and B boats were decommissioned and used for targets, without ever coming home.

Thus, the story of the strange sealift of submarines had come to an end. By this time the Navy was busily engaged in disposing of its colliers whose usefulness had ended in the post-war rush to oil as the fuel of choice. CAESAR became the merchant ship MOGUL in 1923, AJAX, which had become AG-15, was sold in 1925, becoming the merchant ship CONSUELO, while HECTOR had long since grounded and sunk off the East Coast in 1916 while still in the Navy.

The story has a happy ending in that the Navy had recognized that the submarine was an evolving vessel that needed constant updating and new challenges. It also recognized that the collier had special capabilities which had immediate use in developing the full potential of the submarine, even though these ships would soon be useless to the Navy in their original role. Before that happened, however, they were tried in one other sealift, this time carrying aircraft. They proved to be even better in this new talent than they had been at carrying submarines, and before long several of them had been designated as seaplane tenders. One of them, JUPITER, even graduated to an exciting new designation as the Navy converted her to its first aircraft carrier, LANGLEY. But that's another story. . .



This cross-sectional diagram shows how the early submarines were mounted rigidly to a set of supporting wooden blocks which, when released, gravitated down a greased wooden launching ways inclined from the hatch coaming to and beyond the edge of the deck. Inasmuch as the colliers carrying the submarines had a full load of coal, the freeboard of the ship was only eight or ten feet, the distance that the submarine would drop in reaching the water. The bulwark around the main deck has been removed, and a supporting bracket added to the ways outboard of the side of the ship.■

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SUBMARINE NEWS FROM AROUND THE WORLD

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From the August 2005 Issue

CHINA-Future of Naval Aviation

In early August 2005, photos from Dalian Shipyard revealed the ex-Russian aircraft carrier VARYAG was sporting a new coat of paint on the hull after a two-month long dry-docking period. The paint scheme is in standard Peoples Liberation Army—Navy (PLAN) colors and may indicate that China cold be moving toward introducing its first aircraft carrier into service.

At the time of sale to the Chong Lot Tourist and Amusement Agency in 2001, the carrier was reportedly destined to become a floating casino in the then Portuguese colony of Macau. However, it was later learned that the Macanese authorities (now under Chinese control although a special economic zone (SEZ) did not receive or has yet to receive a request for a casino on an aircraft carrier within the SEZ. Likewise, the waters surrounding Macau are far too shallow to accommodate a vessel the size of VARYAG. Additionally, investigators in Hong Kong revealed that two of Chong Lot's directors were actually PLAN officers.

In July 2004, the People's Liberation Army-Air Force (PLAAF) ordered an additional forty-eight Su-30MKK2 carrier capable aircraft from Russia. Currently the PLAAF operates thirty-two of the carrier capable aircraft and have been conducting short take-off and landing (STOL) operations at bases near Shanghai, presumably in preparation of near-term carrier operations.

PLAN naval engineers have studied the ex-Russian carrier extensively and have even purchased the blueprints, according to sources in Hong Kong, as well as hosting numerous visits from Russian carrier design and operations experts.

On the outside it appears that the PLAN is attempting to put its first aircraft carrier to sea in the very near future., and the VARYAG appears to be the candidate. In the case of the VARYAG, like with

the Russian Navy in the 1970s, China seems to be taking the evolutionary step in developing a sea-based aviation force that could eventually lead to a full fledged aircraft carrier capability. AMI has been receiving information over the past several years indicating China's intention on building an aircraft carrier, and if in fact the VARYAG puts to sea, would confirm the PLAN's interest in moving forward with its power projection plans as a regional power and possibly a global naval power through the use of sea-based aviation forces.

The VARYAG would simply act as the training carrier while the PLAN moves forward with plans to construct its own first generation aircraft carrier.

SPAIN - LOCKHEED MARTIN CMS FOR SPANISH S80 SUBMARINE PROGRAM

On 26 July 2005, the Spanish Government announced that it had selected Lockheed Martin as the supplier of the combat management system (CMS) for the S80 submarine program. Although the deal is not expected to be completed until the end of the 2005, Lockheed Martin and its Spanish partner Navantia Faba Sistemas will develop the new CMS. The CMS is based on a Spanish industry design with Lockheed Martin collaborating on command and control equipment, weapons control and sonar part.

Navantia Faba Sistemas will be the prime contractor with 55% of the work share and Lockheed Martin with the remaining 45%. The Lockheed portion is estimated to be worth around €200M (US$245.3M). The intensive competition for the S80 CMSW included Lockheed Martin, Raytheon, Thales, Kongsberg and Atlas Elektronik.

The decision to select Lockheed Martin over its European counterparts was expected as the Spanish Navy utilizes many US-supplied combat systems and interoperability within the Spanish Navy as well as with the US Navy being a prime consideration. In addition, politics may have had a central role as the US and Spanish Governments have been attempting to mend a rift between the two nations that developed over the Iraq War. However, it appears that the relationship has been improving and the Lockheed Martin

selection may be yet another sign of the improving atmosphere between the two countries.

The S80 program could include up to eight submarines in two batches. The first unit of Batch I began construction in 2004 at Navantia's Cartegena yard and is scheduled for commissioning in 2008 and will be followed by three additional units through 2011. A second batch could begin by 2014 if the Spanish Navy decides to maintain a force of eight units over the long-term and is satisfied with the performance of the S80 design.

FROM AMI's NAVAL REVIEW 2005 OF SEPTEMBER 2005

Introduction

This special edition of *Naval Forum UK* includes our annual review of the future of the United Kingdom's naval shipbuilding programmes, along with projections for future orders and construction.

A lack of recent significant successes in the military export markets, with small prospect of that changing, means that the Ministry of Defence (MoD) and the Royal Navy are now the sole major customer for warships and auxiliary ships constructed in UK shipyards.

The ships and submarines procured by the MoD tend to be large, sophisticated and expensive, with limited export potential. The designs can realistically be built by only a small number of specialist shipyards that have adapted themselves to meeting the MoD's high standards and demands. The focus of this review is thus unavoidably on the few, but often very high value projects grouped into the defence Procurement Agency's (DPA) 'Maritime and Shipbuilding Cluster'.

Just two years ago, the government and the MoD were concerned that the UK's naval shipbuilding industrial base lacked the capacity to deal with the expected *feast* of MoD orders that was anticipated by 2008, particularly in connection with the Future Aircraft Carrier project. It thus commissioned several studies by the RAND Corporation to look into these problems. The reports were only delivered to the MoD last year, but have already been partially overtaken by the fact that many of the projects considered have since been delayed, cut back, or effectively cancelled. RAND's work has

informed an attempt by the MoD and Department of Trade and Industry to develop, in consultation with industry, a Maritime Industrial Strategy (MIS), which is part of the MoD's broader Defence Industrial Strategy. It's hoped that the MIS will provide a degree of coherency and consistency into the MoD's warship shipbuilding programmes. However, its development has become a very long drawn out exercise, which may be completed by the end of this year. Also, initial enthusiasm for industry consolidation and joint ventures has been dissipated by economic realties and an inability by the MoD to make the long-term commitments needed to guarantee the commercial viability of proposed new companies. However, emphasis remains very much on establishing partnerships and alliances for managing and delivering large projects.

This year the MoD awarded the first warship order since 2001, which was for one patrol vessel that will be leased. Unfortunately, UK naval shipyard over-capacity rather than under-capacity has become a serious problem—aggravated by continuing uncertainty as to the timetable and size of future orders. For example, Swan Hunter Ltd faces a particularly difficult battle to survive, lacking any orders to replace the two Bay-class landing ships whose much troubled build process has undoubtedly disadvantaged the yard in regards to tendering for new work. MoD officials and Swan Hunter managers are scheduled to hold talks about the future of the Wallsend shipyard. However, there are serious fears that the recently launched RFA Lyme Bay may be the last ship ever built there.

ORDERED Astute-class Submarine

The Astute-class of nuclear attack submarines (SSN) is the replacement for the Swiftsure and Trafalgar-classes. Although intended as a relatively low risk low-cost approach to providing a next generation nuclear submarine for the Royal Navy, the prime contractor, BAE Systems, has encountered serious delays and problems. Estimated total costs for the first three boats have increased by nearly a billion pounds from the original £2.5 billion, and that excludes a contribution by BAE Systems of £250 million announced in 2003.

However, good progress has been made in the last year, and a recent programme highlight was the third unit—HMS ARTFUL—

being ceremonially laid down by BAE Systems Submarines at its Barrow facility on 11 March 2005.

Looking forward, the lead boat HMS ASTUTE, is now expected to begin sea trials in March 2008 and be delivered by November 2008. The ASTUTE should become fully operational in 2009—about four years later than forecasted when the initial order was placed.

Contracts worth £70 million in long-lead items for a fourth boat have already been placed and it's expected that it will be firmly ordered in 2006. Additionally, it is possible that one or two additional units will also be ordered at the same time.

Until last year it had been expected that nine of the 7,800 tonnes (dived) Astutes would eventually be ordered and enter service by 2022, but that has now been cut to no more than eight and some officers are quietly predicting an eventual force total of just six or seven units.

A modified and enlarged variant of the Astute design seems increasingly likely to eventually replace the Vanguard-class nuclear ballistic missile submarines (SSBN). Studies are believed to be currently underway as part of the work of the secretive Maritime Underwater Future Capability (MUFC) project. The Astute design can apparently be readily altered to incorporate a vertical-launch missile system—either sixteen small tubes sized for the launch of Tomahawk equivalent cruise missiles, or alternatively, a smaller number of large tubes for Trident D5 ballistic missiles or possibly a new Submarine Launched Intermediate Range Ballistic Missile (SLIRBM). The studies are currently at an early stage, but some key and expensive decisions on the future of Britain's nuclear deterrent will have to be made before the end of the decade in order to meet the required in-service date of 2024. Four or five modified-Astutes would seem to be needed, however, if costs can be controlled there are capability advantages associated with introducing the new variant at the earliest possible stage in the Astute build programme

From the September 2005 Issue

SINGAPORE — More Swedish Submarines

In late September 2005, press reporting indicated that the

Republic of Singapore Navy (RSN) made the decision to procure Sweden's final two Vastergotland (A17) class submarines for US$128.3M. Commissioned in the late 1980s, the two submarines (VASTERGOTLAND and HALSINGLAND) could be decommissioned and transferred as early as 2006.

These two submarines will supplement the RSN's four Challenger class (former Swedish Sjoormen - A12) that we procured from Sweden in the late 1990s (a fifth unit was procured but used for spare parts only).

The final two A-17s (VASTERGOTLAND and HALSINGLAND) are being decommissioned from the Swedish Navy in order to meet the reduced Submarine Force level prescribed in *Defense Resolution* of 2004. The submarines are expected to be overhauled and modernized in Sweden prior to delivery to Singapore, very similar to the transfer process that took place with the four Sjoormen class when they were transferred to Singapore beginning in the late 1990s.

Singapore apparently has been very satisfied with the Sjoormen class since the master plan for the RSN was to operate used submarines first on a trial basis and only if successful, would it consider procuring the next generation submarine and maintain a Submarine Force. With the decision to acquire two more submarines, it is clear that the RSN has decided that submarines are now an integral part of the fleet. Furthermore, with six total active units, the RSN could operate its force in the standard rotation of having two vessels operational, with two in the maintenance cycle and two in the training cycle. This procurement also deepens Singapore's ties with Sweden and improves the chances for Singaporian collaboration in the Nordic Viking project.

CHILE

On 13 September 2005, the Chilean Navy received its first of two new construction Scorpene class submarines from the DCN shipyard in Cherbourg, France. The O'HIGGINS is expected to be commissioned by the end of 2005. •

INDIA — Scorpene Deal Done

On 08 September 2005, the Indian Government formally approved the purchase of six Scorpene class submarines from France's Armaris. The transaction valued at US$1.8B involves the construction of six submarines at India's Mazagon Dock Ltd (MDL). The approval follows delays that began following the November 2002 announcement that the Scorpene design had been chosen.

Construction will probably begin on the first unit by mid-2006 with commissioning expected by 2010. Units two through six will probably begin at one-year intervals with the sixth unit of the batch being commissioned by 2015.

The Scorpene program calls for options for up to 24 additional units although the Indian Navy will probably only build 12 of the optional units for a total class of 18. Indian naval requirements call for up to 24 conventionally-powered attack submarines (SS) and five nuclear submarines. The nuclear-powered submarines will be satisfied by the Advanced Technology Vessel (ATV) Program and the SS requirements with 18 units of the Scorpene class as well as six units of the Amur class (Project 78 - SS/SSG), which could begin in the next decade.■

DISCUSSION

A LITTLE CLOSER LOOK AT TODAY'S SUBMARINE OFFICER FOR OUR SUBMARINE FOREFATHERS

by CDR Mike Bernacchi, USN

CDR Bernacchi is the PCO of USS ALEXANDRIA (SSN 757). He has recently completed the PCO pipeline and prior to that was the Special Assistant for Officer Matters in the Line Locker at Naval Reactors. He has graduate degrees in Nuclear Engineering and Industrial Engineering from the University of Michigan.

In the July 2005 Submarine Review, CAPT Clautice wrote an article about lessons to be relearned after the SAN FRANCISCO grounding. I want to start by saying that I have nothing but the utmost respect for our submarine forefathers, they are the individuals who made us who and what we are today. There were, however, some points in his article that I thought should be amplified and some paradigms that might no longer exist. I would also like to point out this article is directed to those retired submariners who have given us our great legacy. The following opinions are solely my own and are meant to give our retired submariners a perspective from a submariner about to take command and my experiences to get to this point.

There are two general themes that need to be addressed, one is the background and qualifications of our current officers and the second is the training program and how it has recently been altered.

No one can argue that the United States Navy asks more of its nuclear trained officers than any other Navy in the world. Only in the United States are officers who command nuclear powered warships expected to be nuclear trained. This means that our Submariners, Nuclear Trained Surface Warfare Officers, and Nuclear Trained Aviators have to do the job of two officers in every

other nuclear navy. These officers are expected to be warriors and nuclear operators. The other nuclear navies always separate these functions so officers can concentrate on either tactics or engineering. This sounds like a great plan – right? The officers have more time to dedicate to their one area of expertise and so they should be twice as good, right? – WRONG!

After having the exceptional opportunity to be the duty/student captain on a high end Australian diesel submarine and observing their navigation using the pool-of-errors method I can tell you that there are some great practices we can take from them – and I plan on doing exactly that. However, I also came away thinking "Wow, they could use some of the things we do well to help them." When I look at our British Submariner perisher Navy brothers – they have collisions and groundings just like we do yet their culture is completely centered around Navigation where ours is centered around Engineering – so what is the key? What Navy in the world does not have collisions and groundings, can operate nuclear vessels all over the planet and be ready to respond to any tasking? The answer as we all know, is, there isn't one.

So, is it a good idea for our officers to be required to be experts at both nuclear power and operations? The answer after seeing many different Navies is absolutely - YES. This combined knowledge that our officers have provided a level of backup and redundancy that is not possible in other Navies. So, why the long diatribe about engineering and navigation cultures? The answer has to do with the comment from CAPT Clautice when he said "*I suspect the best path to nuclear submarine command is still through engineering assignments and our COs are much better trained in engineering than navigation. The top performing officers are most likely assigned as Engineers Officers. Perhaps this should be evaluated and if so, compensated for by even more emphasis on safe navigation training and practices.*"

I respectfully submit that this perception is just simply not true and this is NOT just because I was a Navigator as a department head. My point of comparing us to the other Navies is to drive home the fact that we expect our more senior officers to be good and knowledgeable in **all** things NOT just the area they were a department head in – non or partial understanding of any part of

your ship is simply not acceptable. In the command pipeline, we are not allowed to think of ourselves as Navs, Eng, or Weps, we are trained throughout our careers to be submarine officers first and foremost. So what does this really mean and how do we put these flowery words into practice would be my next question if I were reading this article. The best way to describe it is with the use of numbers (I know, very nuclear of me):

- The CO/XO selections boards are truly blind to what department head job you served in—all that matters is how you performed in the job you did have.
- In my PCO class, there were thirteen of us: Nine going to command and four going to COSS Squadron Deputy jobs. There were ONLY two PCOs who were straight stick ENGs and two more who split toured as ENG and NAV. That left nine of thirteen PCOs who never served as ENG (the break down was eight NAVs and one STRAT WEPS). At least for my class, you can clearly see there was no preference given to ENGs in selection to command or deputy. This is not a fluke, the classes today are very evenly split.
- The Nuclear side of the house is expecting more and more of those officers who did not serve as Engineer. In the Line Locker at Naval Reactors there are two post XO O-5 jobs and two post CO O-6 jobs. When I was there two of us were not ENG served! So, half of the senior jobs were filled by non-ENGs which allowed the ENG served guys to go get a joint tour or explore other shore duties.

My point in all these examples is that there is a standard that must be met and you are expected to meet that standard throughout your career. Gone are the days when preferential treatment is given simply because you are the ENG. Whether it is the Type Commander looking at operations or Naval Reactors or Fleet Commander looking at engineering—there is one, high standard and you are expected to meet it—period. In today's Submarine Force, it is the sustained superior performance at sea that matters, not which department head you were (or are).

The second point in CAPT Clautice's article I would like to expand upon is the role of training and how catastrophes at sea might be avoided. In his article he stated, *"despite all the modern trainers and updated training, we are still having these terrible accidents as we had in the early 60s ... caused by faulty navigation."* He is absolutely right that there are no new lessons to be learned in our recent collisions and groundings. However, there is this sense that since our training continues to improve we should never have mistakes at sea. While I completely agree that this would be the ultimate measure of training effectiveness, it is not realistic. Using my background in Industrial Engineer I want to try and compare apples to apples when looking at human factors in the training process. Twenty years ago, we had the most modern submarines and training program in the world. Our training was cutting edge just like our ships—yet we still had problems. Today our ships are the most advanced on the planet and our training has never been better or more advanced, we have simulators and ship based training that could not have been dreamed of just 5-6 years ago—yet we still have problems. Twenty years from now, the follow on or advanced version of VIRGINIA, I am sure, will be the most advanced submarine ever built and I am sure our training will keep pace—will we still have problems? Taking a look at the human factors part of this, when you compare the complexity of the ships with the training of their time period I think that you will find that they are pretty close. Our submarine forefathers really didn't have it any easier or harder; it was different, but if you look at the level of effort required you will find that the demands were very similar. So what can we do that is different to help prevent potential disasters or just to continue to improve the effectiveness of our Force?

After just completing the PCO pipeline I am convinced the answer is that we have to teach our officers to make good decisions at all levels in the chain of command. We are taught in the PCO pipeline that we have to continue to grow our database of mental models so we can apply them in our daily decision making process. *Here* is where we are doing things somewhat differently. The Submarine Commanders Course (SCC) and the Naval Reactors PCO course not only demand a high level of knowledge but

they force you into making decisions when you are the most uncomfortable and stressed (which they always seem to be able to provide at no extra expense). This new method of *how* we train not *what* we train is definitely having an impact. In the last couple of years over 15 officers have failed, rolled back, or resigned from the course—compared to about 2 in the 18 months previous to the "new" course. PCO's are openly and honestly evaluated during the courses and as you can see from the numbers this has had an effect—again it goes to the point that there is a standard and it must be met no matter what your background is.

The concept of meeting a standard in navigation (there really has always been one for Engineering in our Submarine Force) is being pushed down to the lower levels of our training pipelines. Our junior officers are now required to maintain an officer experience log so senior officers can see where there are potential weaknesses and immediately direct training resources as necessary. Our SOAC (Submarine Officer Advance Course) graduates now have to go to sea and prove they can successfully navigate a submarine at sea. The Command Qualification requirements are now more stringent than ever. The point of all this is – from my experiences, the Submarine Force takes navigation very seriously just like nuclear power and is putting the resources necessary to back that up with training and crucible events throughout the officer's career which is not matched by any other warfare community. I once had a CO who stated, "There are two areas I will not tolerate an error in—Reactor Safety and Safe Navigation," I submit that after my PCO training this is, without a doubt, the truth of today's Submarine Force.

The article also stated: *"In nuclear power training, we are taught to trust our instruments and make professional judgments based on what they tell us. But navigation, despite all our modern devices, is still an art, and the prudent and experienced navigator will always have a healthy skepticism towards his equipment and especially his charts. The vast majority of our charts are based upon surveys taken long before it was possible to accurately fix the position of the survey vessel. And yet, far too many mariners believe that their charts are accurate. As such, the Navigator must*

learn to develop an approach to his task with a mindset that is almost the direct opposite to that of the nuclear plant operator."

I appreciate this quote right up to the last sentence, if applied correctly, our rigid, methodical approach to nuclear engineering can pay HUGE benefits if applied to navigation. One of the instructors in the PCO pipeline was a former Tactical Readiness Evaluation team senior member and as the PCO instructor is responsible for much of the Navigation doctrine for the fleet. He was extremely knowledgeable and talented in navigation and taught us an incredible amount of information. When I asked him which ship he was Nav on he laughed and said he was an Engineer (I know – what was I thinking especially since I just gave the one standard speech!) My point is, that during our nuclear power training we are trained to question everything, believe our indications knowing their limitations and what else we should see to corroborate them, and provide forceful backup. All of those hold true when applied to navigation. In the case in question, you would look at the chart datum for all of the charts of the area, see where data is plotted, compare the different datum, transfer when necessary, question what is an estimation and what is fact (the type of chart will tell you this), see what updates have been made, check the electronic data base... This solid *nuclear trained* approach with the navigation procedures *already* in place works – we just have to be *nuclear* in their execution.

I predict CAPT Clautice would ask, "If this is true, why do we still have navigation incidents?" In CAPT Clautice's article, he spoke of the Collisions and Groundings as part of the PCO course. We still do this, only now, we are expected to present the data from a command perspective and how our daily decision making process (read operational risk management) might have prevented some of these accidents. What I will tell you is that we learned that we still sometimes live in what the instructors call *quadrant 3*, which is; we don't know what we know. This means that in many of these accidents all of the information necessary to prevent them was on board but was not recognized or understood by the crews at the time i.e. we don't know what we know. Every ship we study had great crews who were well trained and wanted to do great things—no one wakes up and says I want to have an

accident today. In fact, in the case of SAN FRANCISCO what the crew did after the grounding was nothing short of heroic and deserving of our admiration and a thank you to the fantastic submarines our country builds for us that they could survive such an event. This leads me to my point that from studying the data you quickly see that sometimes it only takes moments for things to get out of control but this could be mitigated by Operational Risk Management.

We will continue to have at-sea incidents until we can train ourselves to not be in *quadrant 3*, which is a constant struggle. I know that my classmates and I will strive very hard not to live in *quadrant 3*. Our training was hard but effective, now it is up to us and the incredible men and ships we are entrusted with to keep our ships and crews safe, remain undetected and complete our mission. If we can do this successfully—maybe we will not be reading a similar article in 35 years. ■

Editor's Note: Captain Bill Clautice had an opportunity to review CDR Bernacchi's article as a member of the magazine's Editorial Review Committee. He has submitted his further reflections.

Great article! As I said in my piece published in July 05, I am in awe of the current submariners I meet at NSL functions and elsewhere... and this article reinforces my opinion of them. I am delighted to learn that "gone are the days when preferential treatment is given simply because you are the ENG." I was also pleased to learn of the increased emphasis in Navigation training. We all agree, there are only so many hours available in ones life and we want a CO to have done it all. The Officer Experience Log should certainly help track this. The answer, as always, is to maintain high standards in all vital areas while training smarter and making use of better technology. It appears this is recognized and being practiced by COMSUBFOR and the Submarine Learning Center. I also agree that skepticism serves one well in both nuclear plant operation and navigation. My point was that too many were not skeptical enough... trusting their charts too much.

Yes, the dates were there but too few looked at them and understood the limitations of that era. It appears this also is recognized. The Quadrant 3 concept of "not knowing what we know" (the info was on board, just not used) is not unique. The FBI had much of the info required to stop 9/11 but the MIS system was (and still is) inadequate. This is why we can't just say there always has been collisions and groundings...why we review them in great detail and make improvements where required. Everyone, active duty or retired, would expect nothing less of the Submarine Force. Finally, why does one submit his personal thoughts for publication and rebuttal. I submit the answer in the case of these two articles is to make a contribution to the body of knowledge and provide a means of communication between the generations. And, if we can do this successfully, we most likely will not be reading similar articles in 35 years.

IN MEMORIAM

SGM Stephen Slavicheff
Dr. and Mrs. Edward S. Eby

CDR Robert G. Pearce, USN(Ret)
Judge Stephen B. Ables

ETERNAL PATROL

CAPT Marshall H. Austin, USN(Ret)
CAPT John Clair Bajus, USN(Ret)
RADM David B. Bell, USN(Ret)
CAPT Warren P. Chase, USN(Ret)
RADM Walter Nicholas (Buck) Dietzen
TMCM(SS) Alfred Friedrich, USN(Ret)
CAPT L. Patrick Gray, USN(Ret)
CW04 Larry J. "Sandy" Harless, USN(Ret)
CAPT Billy Lee Heid, USN(Ret)
CDR Glen C. Merritt, USN(Ret)
Mr. Stephen Slavicheff
CAPT George Townsend Smith, USN(Ret)
RADM Norvell G. Ward, USN(Ret)
CAPT William M. Wolff, USN(Ret)

A FURTHER COMMENT ON COLD WAR SUBMARINES

by Norman Friedman

Mr. Friedman is a noted author on naval topics. One of his books is U.S. Submarines since 1945, published by the Naval Institute in 1994.

Mr. Polmar's assertion that U.S. Cold War submarines were inferior because the United States adopted a Stalinist design practice, compared to the open competition practiced by the Soviets, is certainly arresting–and almost certainly very wide of the mark. It has two basic flaws. One is the erroneous impression that, from NAUTILUS on, Admiral Rickover had an iron grip on U.S. submarine design and construction.

The Admiral often said that he had designed one submarine or another, but he was using the term in the sense that naval engineers (machinery designers) always did–that they had designed the ship's machinery. That was hardly the whole submarine. In much the same way, the sound lab at New London once claimed that submarine designs had been dominated by advances in the sonars it developed (particularly the bow sphere). Even given Admiral Rickover's role, it should be remembered that he lost some important battles. He vigorously opposed the use of rafting for silencing–and lost (he wanted to use turbo-electric drive instead; he did win to the extent that GLENARD D. LIPSCOMB was a full-size submarine instead of the proposed SKATE derivative).

He lost a major fight to build a U.S. SSGN (Admiral Zumwalt had the Tomahawk strategic missile adapted to anti-ship operation instead). Available documentation does not make it at all clear whether he was behind the demand for increased speed that led to LOS ANGELES, although it is clear that submarine reflected his, rather than the naval architects', approach to higher speed (he took the classic engineer's approach, which is to add horsepower rather than to refine hydrodynamics). I always thought that LOS ANGELES approach could be traced back to a major World War II embarrassment in which the new SUMNER class destroyer failed to make anything like its predicted speed, i.e., in which it seemed that the naval architects' approach was faulty. Nor was Admiral Rickover apparently involved in the decision to make

SKIPJACK a fast submarine by combining a more powerful reaction (vice SKATE reactor) and ALBACORE hull form. Perhaps Admiral Rickover wished he were Stalin (many do) but he does not seem quite to have made it.

Then there are the Russians. Just how much competition was there? I have the impression that there was remarkably little, rather that different design organizations tended to specialize. After the November class, Rubin, for example, developed ballistic missile submarines and diesel submarines; Malakhit did most of the later attack submarines. You find very few parallel designs (Sierra and Akula may be the only important example). I would suspect that much of what looks like competition comes from Russian accounts designed to emphasize the competence of the firms now seeking foreign orders, and de-emphasizing the role of whatever preliminary design organization was buried in the Soviet naval staff or in its special Institutes (NIIs). That ought not to be terribly surprising. You find Electric Boat claiming credit for numerous Cold War submarine designs. But you will find, if you dig deep enough, that the basic designs emerged fairly completely formed from the Preliminary Design organization in BuShips/NAVSEA. That is where the Chief Designer of SEAWOLF was to be found. Electric Boat did extremely important work bringing the sketch to the point at which the ship could be built–but, at least in the Cold War past, it did not do the basic design (it actually did preliminary designs before 1919).

No one actually operating a submarine would be foolish enough to summarize all submarine design, as Polmar and Moore virtually do, in hull performance (speed and diving depth, essentially) and armament, without reference to what is inside the submarine or to its reliability. The Russians did have a lot more kinds of torpedo, for example–but is that a plus or a minus? If you have a load of say thirty weapons, and only ten of them are the ones you need, is that better than having thirty multi-purpose torpedoes? Were the 650cm torpedoes effective, or does KURSK incident suggest that perhaps they were not such a good idea? Does a fleet including specialized submarines firing anti-ship missiles do better than one in which torpedoes can be mixed with, say, Sub-Harpoons? I have the distinct impression that our sonars

were orders of magnitude more effective than what the Soviets had, because we had much better computers. I am not sure how one could tell. And of course we cannot say much about silencing, except that we seem to have done far, far better for a very long time.

And we got what we had for a very small fraction of our overall naval budget. The submarine program absolutely dominated the Soviet naval budget–as some ex-Soviet officers have rather clearly complained. The point in the end is not just to have excellent submarines (or destroyers, or carriers) but an effective navy which combines all of them. We were far more successful at that, I think.

One other point deserves mention. Since about 1990 there has been a flood of material from Russia, including a wonderful history of Malakhit submarines (up to 1974), a rather less complete Rubin history, and an ocean of articles. Little has been translated into English, but a few years ago you could buy adequate Russian translation software for about $1000. Remarkably little of this literature is cited in the Polmar-Moore book, and they miss some of the more dramatic stories which have come out, such as that of the conception of the Alfa (Project 705) class. The Russian material is not as complete as we might like, in that it still gives little insight into how programs were assembled and into what overall programs were, but surely it deserves more attention. Polmar and Moore do cite some Russian sources, but they are drops in a vast ocean. For example, in recent years the magazine Taifun has published what amount to design histories of most Cold War Soviet submarine classes (and of many surface ships, too). As for sonars, the main Russian sonar developer produced a remarkable in-house history (from which you learn, among other things, that when they decided to develop a digital sonar they had to write the operating system of its computer). There are now reputable histories, again in Russian, of the organization which developed the submarine reactors (and it was single organization, like Rickover's, not a series of competitors) and of the submarines' weapons. None of this seems to have been used. There still seems to be a place for a good history of the Cold War Soviet Submarine Force.■

MORE ON KURSK.... FOR ALL "SUBOPHILES" (Particularly Operators, PMs and Budget Defenders)

by Captain W. G. Clautice USN(Ret)

This is not intended to be a book review but rather an encouragement for operators and everyone who plays a role in procuring funds for submarines, to read Cry from the Deep... the story of the 550-foot KURSK's needless loss of all aboard in 350 feet of the Barents Sea five years ago (seems like 5 months). It could well have been titled "Penny Wise; Pound Foolish" or "Building a Hollow Force".

I say *needless loss* of all aboard for several reasons cited below, but also recall Admiral Crowe relating a true story of a 150 foot diesel boat in the 1920s sinking in 120 feet of water off Block Island. With no one injured, the skipper blew after ballast and drilled a one-inch hole above the water line for air. He then poked a tee shirt on a broomstick through that hole and a passing ship rescued the crew. What an interesting parallel ... about 75 years ago!

Based on Mickey Garverick's excellent book review in the last Submarine Review, and a signed copy I received from the author (a friend of a close friend), I launched into Ramsey Flynn's labor of love with many questions. I was impressed immediately with his easy reading style (meeting the players in a chronology of current events) presented in bite size paragraphs and short chapters. You never felt bogged down.

My first question was quickly answered in the Preface. How could the author, a non-military, non-Russian linguist, zero in on this topic and pull it off in a credible manner? Quite simply, he read the same newspaper articles we all read and, given the well known deceit of the Russian government, approached his publicist on day two with the concept and need for an accurate chronicle of the rescue (which didn't happen). As an independent journalist for 18 years, his "stock in trade was to untangle complicated stories until I could present the truth." After 5 trips to Russia in three years with many hundreds of interviews and dedicated translators,

he had the Russian side of the story. Our own RADM Tom Evans followed up as his technical reviewer.

Credibility is established by 40 pages of *Notes* at the end, keyed to chapter and page. These give the origin of practically every statement of consequence in a convenient style (vice the cryptic rigor of Turabian footnotes). After referring to the first dozen or so *notes*, one is convinced that the author has done his research in spades and here is the definitive real story behind the scenes of KURSK. You can then read the *Notes* in one sitting as icing on the cake.

The primary reason you should read this book is for the lessons to be learned as consequences of cutting funds. This book is full of how not to do it. Most of us understand and appreciate what it means to have been a *nuc* but we should all pay homage to Admiral Rickover for setting the standards of quality control and showing the Navy how to make Congress *your best friend*. Now we need to teach the lessons of KURSK to our friends in Congress.

On a personal note, the manning situation in the Russian Navy reminds one of our own difficulties during the rapid buildup of the 60s. The difference was their cover-ups. As XO of an FBM after an overhaul, shakedown, PSA and patrol, I saw the crew stability required for these evolutions give way to a mass of *normal* transfers. This resulted in departure on next patrol with a dearth of qualified watch standers that would require us to be 6 on and 6 off for at least a month. Also, our CO was brand new. Despite being as ready as possible, the Commodore deserved to be aware of our situation and I suggested a letter basically saying we were ready for sea, but our readiness would be marginal for a month, while we put max effort into watch standing quals. This could have been considered a CYA letter, but it was not offered or taken as such. The squadron appreciated our situation and helped in any way they could. All's well that ends well and we felt good returning from patrol with the broomstick signaling clean sweep. I suspect a letter like that would never have been written or considered acceptable in the Russian Navy. This was just a lesson from the required Rickover Reports.

Reading about the consequences of reporting *bad news* in the Russian Navy, I couldn't help but give thanks for the training we

had to report the truth (as well as the tolerance and understanding of our mentors). Again, a personal story came to mind. As CO of NOTU, down at *the Cape* in FL, I recall noting an unfavorable trend when 2 of my 40 *In Tube Conversion* specialists requested return to sea duty. This was after lengthy (and costly) factory training, followed by constant deployments to convert our Trident missiles to test configuration for DASOs and OTs. While underway on a DASO workup with our In Tube Conversion Officer, *a few questions* resulted in an all night session building a *time-line* of requirements on our troops.

Now, understanding why this duty was more arduous than sea duty, we made a list of 10 fixes. Next was a call to my boss (Director of SSP) for an opportunity to brief him on a matter that I felt could jeopardize our mission if not corrected. Not only was the Admiral there, he had assembled his entire Board of Directors and other key players. After the brief, he asked why we couldn't bring the Charleston boats to the Cape for conversion. I felt it would be a disservice to the ships crew, taking them from homeport to make life easier for our troops. After consulting with his BOD, he not only took our 10 fixes but added his own, *taking the mountain to Mohammed.*

That was the last transfer request I saw. Just last evening, 25 years later, I met a salesperson at the local Home Depot near the Cape, who had the demeanor of a 4.0 sailor. When I asked what he did in real life ... you guessed it ... an In-Tube Conversion team member. A few more questions revealed that my 10 fixes were still in place and life was good. The moral of the story ... the opportunity and encouragement to tell it like it is, has been a prime ingredient to making SSP the model program office in DOD for 50 years. What a great opportunity to work in that environment vice the Soviet style Navy.

Both of these personal examples were mirrored in the conduct of our contractors. I once read an *internal book* written by Dr. Daryl Stewart, President of Lockheed Missiles and Space Corporation to his employees detailing his values and the way he wanted business conducted. One chapter was a parable of the Walrus on the top of the rocks who only wanted and would accept *good news*. Slowly but surely the walrus tribe was whittled away by a

nearby tribe without a single bad news report. Later as CO of 3 separate commands, I made that required reading for my troops with occasional reminders that *walrus behavior* was unacceptable. Someone once asked me what walrus behavior was. Time to reissue the parable. Thanks for the lessons, Dr. Stewart.

Back to KURSK, the problems with loading the infamous Fat Boy torpedo (lack of maintenance and training with no loading facilities in their home port), was a contrast to my tour as CO of SWFPAC in Bangor, WA. However, even we had a constant bout with the crane keepers and I'll never forget one incident that occurred after a year with no leave. Taking off a few days to ski the slopes of Whistler, I called in the first afternoon to check on things. My extremely competent X.O. asked if I wanted the good news or bad news first. While installing the loading hoist on top of a Trident missile, a Marine guard noted a whiff of smoke from the overhead crane and sounded the fire alarm that in seconds reached back to the CNO in the Pentagon. The whiff of smoke was quickly established to be from a locked up brake cylinder. Fortunately everyone had responded correctly. The training program was declared fully satisfactory but the failure of a simple solenoid had triggered *the perfect test*. Those things happen but you never know when.

Recognition of the tactical problem and willingness to act were critically missed by the Russian hierarchy within the first 2 hours of *the blast* and are detailed in three pages of *if onlys* ending with one word ... *If*. Summarized, these lessons are:

- Think *worst case* from the beginning and *believe your indication*.
- Share your info.
- Worry about deteriorating conditions (e.g. weather).
- The *commander* must be where he gets the best info and can *command*.
- Understand your own *tested* capabilities and get needed help early from all sources.
- Give proper value to human lives.

We've heard it all before but what is so interesting is reading the flesh on these bones, e.g., the possible use of the commercial

sector's little known *hot tap* penetration of the hull, using a *Cox bolt gun*. And, if only the Russian fleet had summoned their diesel rescue sub with 2 mini subs, but ... they had scrapped it in 1995 due to budget cuts... which again is the primary lesson (and ammunition) for our procurement folks when they need to make their case. The KURSK is the example.

A few other interesting quotes and details (well documented) were:

- The Russian divers' statement, "We're 20 years behind" made onboard the Norwegian dive boat.
- Missing brass buckles taken by precious metal scavengers rendered the escape equipment useless.
- Commodore David Russell (British Rescue Commander) and his team "vent over this seemingly homicidal xenophobia."
- KGB Major Putin's low point occurred when he requested help from Moscow as his Dresden HQ was targeted by revelers following the breach of the Berlin Wall, and hears: "Moscow is silent." Disillusioned with Moscow, he returns to St. Petersburg to become a full time taxi driver. Ten years later when the Kursk is in trouble, "Putin is Moscow."
- The KURSK wives view: "The government is deceitful, incompetent and inhumane."
- KURSK was the second choice for this exercise since the first choice had too many deficiencies and now can't even join in the search since she has been so cannibalized by the KURSK.
- When the Russian government would not release the sailing list of those on the seabed, a Russian Naval Officer sold it to the press for $650.
- When CSL (VADM Grosenbacher) was first notified about KURSK, not trusting landlines, he called his neighbor ADM Gehman (head of NATO submarine ops) for a sunrise meeting on the street between their homes. (This latter vignette is typical of the insight conveyed re the communications between the White House, NSC, State, JCS and other interested parties.)

- An on-scene transmitted list of missing consumables (basic but needed) from the Russian rescue vessel resulted in the statement that anything not welded down was fair game.

Funny how these stories hit home. The last one reminded me of a missing spare magnetron for the Support Ship radar we used to track the British Trident missiles at the Cape. The ship was contracted from MSC by the Air Force but SSP had supplied the spares. Turns out the AF had transferred our magnetron to support their own similar land based radar without informing us. This resulted in a *scrub* and unhappy UK customers. I won't embarrass anyone with the gist of my letter as CO NOTU to the AF but it was endorsed all the way up and down the chain. Needless to say the problem was quickly fixed and a very valuable agreement was forged. Similar letters would be written, but not sent, if they fixed all future problems in a timely manner. From that moment on, the local AF commanders were my best friends and their support markedly improved.

It is clear from reading this book that the lack of training, manning problems, and pressure to meet commitments, all caused by funding deficiencies, lined up perfectly to destroy the hopes of returning a hollow Russian Submarine Force (and government) to credibility.

While the original purpose for writing this article was two-fold...to highlight what happens when you build a hollow force, and then encourage the use of KURSK lessons when defending our budgets, another thing happened. I discovered there is great fun in relating one's own sea stories and reflecting on how fortunate we were to have such astute and respected mentors!■

THE SUBMARINE COMMUNITY
DOGS AND PONIES ... AND A SHARK

by LT Ross Shealy, USN
Instructor of Naval Science
University of South Carolina

Every submariner who has spent a summer at sea knows the high premium the sub community places on quality midshipman cruises. This is especially true for CORTRAMID, which is most midshipmen's first exposure to the Silent Service. The goal, as many know, is to encourage as many midshipmen as possible to choose to train on submarines during their subsequent summers. As the Midshipman Training Officer aboard USS WYOMING (SSBN 742)(BLUE) during the summer of 2003, I was tasked to coordinate the boat's entertainment of legions of rising college sophomores. That summer, WYOMING inaugurated 200 midshipmen into the ways of deep.

Being the Midshipman Training Officer wasn't a ride in the hay. First, I had to face the enmity of my fellow junior officers for being removed from the watchbill. "Cruise Director Julie"—I believe that's what they called me. Second, sailors were routinely displaced from their bunkrooms so the mids have a nice warm pillow on which to rest their heads. Further, the crew's off-watch sleep was certain to be interrupted by the large up and down-angles the middies enjoyed so much. I was the obvious lightning rod for crewmember grievances about such things.

A "dog and pony show" was one euphemism I heard for our two-day stints with prospective Naval Officers. While still on the surface, in transit to the dive point, we had them use markers to decorate Styrofoam cups— later to be stuffed into a mesh bag and left in the sail (outside the pressure hull) to experience sea pressure at test depth. When we re-surfaced the next day, the cups were returned to the students, now much smaller and more solid due to the air that had escaped. "I bet we're the only community to give you guys shot glasses!" I joked to the mids, who also trained

with the Surface Warfare, Aviation, and Marine Corps communities during the summer.

Pizza and hamburgers comprised their meals, hard-pack ice cream their desserts. Each midshipman got the chance to *dive the torpedo tubes* and man the periscope, as well as an opportunity to assume the role of helmsman/planesman under instruction. Before we debarked our young men and women, we administered a survey to each to find out the highlights of their encounter—so we could make the next group's ride that much better. Most cited the food, meeting WYOMING's sailors, or *angles and dangles* as their favorite aspect of the submarine experience.

But the undeniable highlight, what made the experience worthwhile for the crew, the wardroom, and the midshipmen alike, was the swim call. Acrobatic leaps from the turtleback resulted in considerably sizeable splashes, followed by quick scurries up the Jacob's Ladder to do it all again. At any given time there were no fewer than two-dozen midshipmen, crew, and officers treading in the lee created by the sub, in water deeper than a thousand swimming pools. The skipper, smoking a cigar in his lounge chair in a Hawaiian shirt, called it, "My own personal steel beach. My two billion dollar steel beach."

Naturally, I felt obliged to put my pasty submariner skin to the test and join in the fun, and occasionally rein in a wayward mid who strayed too far from the boat. Footballs made their appearance from below decks and were tossed to high-flying students as they leapt through the air and down to the ocean many feet below. The experienced sailors, those with many swim calls under their belts, performed deft feats such as cannonballs and *flying squirrels*, commanding the rapt attention of all who were topside and in the water. Such was your average swim call aboard a nuclear submarine – a pleasurable diversion from an arduous business. But not every swim call was all fun and games.

It started when I, treading in the Atlantic on the starboard side of the hull, diverted my eyes—away from the next daredevil jumper and towards the sail. There, I saw the rifleman (a fixture for a Navy swim call, and we shall see why) pointing out into the water off the starboard bow. His hand was on the shoulder of the Officer of the Deck, who peered critically through his binoculars.

With his free hand, he spoke into his handheld radio. The XO, topside with the Captain, listened intently.

"Everybody out of the water!" the XO yelled down to the swimmers, myself among them. Several people looked up towards him.

"Shark!" an eavesdropping petty officer, by the XO's side, added emphatically. Those who had missed the Executive Officer's order were now fully tuned in. I looked back towards the sail, and the rifleman was still pointing – this time with his M-16 and much closer to the boat. Other extended fingers from those topside converged on a position I estimated to be about a hundred yards away in the water.

Anyone skeptical of the critical nature of chokepoints to naval strategy need only to witness what happens when a one-man rope ladder is the only way out of shark-infested waters. The clambering would have been much worse had our crewmen not yielded to the midshipmen first, or if some midshipmen hadn't thought the many yells of "Shark!" from topside were an orchestrated prank. I knew better. I demanded calmness from the midshipmen jostling for position at the ladder, and I assured the unbelievers that the XO was not a jokester when it came to safety. Of course, any of my pleas for calmness were negated when I turned my attention to the rifleman and, in my next breath, shouted "Shoot the @%#%!" The fingers and rifle were pointing closer still – thirty yards away, at best.

Eventually, order broke out and most of the swimmers stood, dripping and panting, on the missile deck. First the midshipmen climbed, then the crew, until a fellow Junior Officer, "Ponch," and I were the last two in the water. Well, partially in the water. We had grasped the edge of the superstructure and hoisted ourselves in a way that left only our posteriors immersed. By this point, I may as well have had a fin on my back; the fingers were pointing that close to our position. My heart was pounding so hard and fast that I was sure the sonar men on watch took notice. I would later joke to Ponch that I considered punching him in the nose and leaving him as bait to ensure my own safe ascent. But, of course, we made it onto the submarine unscathed.

The Officer of the Deck would later tell us that the shark was a hammerhead, about the size of a person. Of course, others had

vastly different impressions of the fish's size, some ichthyologically suspect. The XO recounted the repeated requests for permission to fire, all of which he denied, and apparently wisely so. Several other crewmen reminded me of the running joke that the purpose of a swim-call rifleman is to shoot the person closest to the shark so the rest can swim to safety.

When the time came, we bid farewell to the latest honorary "Wyoming-ites" and sent them ashore, fat with pizza and sliders, to Norfolk via tugboat. We were well aware that the next batch would arrive in due course. As I reviewed the questionnaires the midshipmen had filled out, I noticed several of the same answers we received so far that summer. The best part of the experience, for some, was the food or the angles or the crew. But the majority had a different answer. Their two-word reply, when asked to name the best aspect of their submarine experience, was simple: "The Shark."■

*The Naval Submarine League extends its sincerest apologies to RADM Meinicke for placing him on the Eternal Patrol list in the July 2005 issue.

FIRST THINGS FIRST

by CAPT John F. O'Connell, USN(Ret)

It was sometime in the mid-1950s and USS PERCH (ASSP-313), a troop transport submarine based at San Diego, was in the middle of an Operational Readiness Inspection. The division Commander was putting the boat through a series of drills and trials to test crew readiness for operations. The boat was submerged at periscope depth and at battle stations, navigating in shallow water toward launch point for her embarked Marine reconnaissance force.

Suddenly the DivCom declared an emergency-PERCH had been run over by an undetected enemy patrol craft, and her conning tower was breached and flooded. Attempts at communication produced no response. The diving officer, Lt. Bev Jakimier, responded instantly and correctly. He ordered safety tank simulated blown to compensate for the flooded conning tower, had steering shifted to the control room, went deeper and set a course for the open ocean in order to clear the area. All hands in the conning tower including the captain, the executive officer, and the navigator, were presumed dead. Bev got on the 1MC circuit and told the crew about the casualty and the loss of their shipmates, and the fact that as senior surviving officer he had succeeded to command of USS PERCH.

After he finished speaking the DivCom looked at him and said, "Mr. Jakimier, is there anything else you need to do?" presumably thinking about a urgent message to the submarine operational commander reporting the casualty. Bev looked at him, nodded, and turned to the Chief of the Watch. "Chief, have the steward move my things into the CO's stateroom."

The DivCom was speechless!■

DECOMMISSIONING THE "SWAMP FOX" SQUADRON GONE BUT NEVER FORGOTTEN

by Noreen Martin

Ms. Noreen Martin lists herself as an "ex-shipyard worker." She contributed several articles to THE SUBMARINE REVIEW in 1996 and 1997.

While cleaning out some old papers, I came across a story which I had written for the Charleston Naval Shipyard Pride and the history part of the article was in the Goose Creek Gazette in 1995. This year marks the 10th anniversary of the closing of the squadron. Hopefully, you will enjoy the squadron's history and the wonderful war stories of Submarine Squadron Four Submariners.

Sixty-four years of *defending freedom* came to an end on 17 Mar 1995 at Charleston Naval Station Pier Mike with the deactivation of Submarine Squadron Four.

The ceremony was held pier side and topside USS L. MENDEL RIVERS. Vice Admiral George W. Emery, Commander Submarine Force U.S. Atlantic Fleet, Commander Submarines Allied Command Atlantic, Rear Admiral Winford G. "Jerry" Ellis, Commander Submarine Group Ten and Captain Stanley R. Szemborski, Commander Submarine Squadron Four were the distinguished guest speakers.

Guests include Mrs. L. Mendel Rivers, members of the community, current and former squadron personnel and Submariner Veterans of World War II who represented several states.

Rear Admiral Ellis praised the squadron's *spirit of volunteerism* to community projects to include trips and donations to local schools, food drives for charity and participation in the *adopt-a-highway program*. The squadron's generosity was worldwide with the time donated to orphanages in other countries.

The principal speaker, Vice Admiral Emery, reflected on what submarines are all about, stressing four key points:

1. Submarines are ambitiously conceived and are among the most complex machinery built by man. Their complexity includes nuclear propulsion, sophisticated weapons, metallurgy, mobility and stealth. Our submarines are the best in the world.

2. Our submarines are operated and supported by the finest young people in the nation. They sacrifice much and operate in an unforgiving environment.

3. Our young people are lead by a magnificent core of Chief Petty Officers and Officers.

4. What do we do with a wonderful team and with outstanding people who man the submarines? With wonderful machines and great personnel we grow, develop and train.

We do what we do, better than anyone else. Vice Admiral Emery saluted all for a job well done and for the pursuit of peace to the nation for six and one-half decades. It was an era of unequaled excellence and commitment by thousands of men and women.

Captain Szemborski retold some humorous stories from the squadron's past, one being the famous letter from a submarine commander to the supply department during World War II who was having trouble with a requisition for one-hundred-fifty rolls of toilet paper. Eleven and one-half months after the initial request, came the reply that their request was canceled, cannot identify item. The commander sent a letter back to the supply department with a sample and asked what they were using as a sample for something that was once so well known to this command. The commander stated that this was a necessary item to have on board especially during depth charge attacks by the enemy. In the mean time the submariners would comply with the directive to eliminate unnecessary paperwork and thus kill two birds with one stone! Captain Szemborski also touched on the history and accomplishments of the past 64 years.

Following the ceremony was an impressive luncheon on the pier and beautiful, artistic, life-like, ice sculptures of the dolphin insignia of a submariner were displayed.

USS L. MENDEL RIVERS and USS SAND LANCE graciously hosted tours for interested personnel.

Submarine Squadron Four was established in Pearl Harbor, Hawaii in 1930. During World War II, the squadron sunk thousands of tons of Japanese merchant ships, evacuated refugees and POW's, landed troops, rescued downed pilots, participated in shore bombardments and photographic reconnaissance and supplied guerrillas in the Philippines.

In 1946 the squadron was moved to Key West, Florida, thus acquiring the nickname *Sunshine Squadron.*

On 28 Jul, 1959, thanks to the efforts of our great and honorable Congressman L. Mendel Rivers, Squadron Four was relocated to our historic city. The squadron's new nickname was the *Swamp Fox Squadron.*

Between 1964 and 1965, Charleston entered the nuclear age with two attack submarines and in 1975 all our submarines were nuclear. During the 1980s and 1990s, the squadron's mission adapted to world changes and the end of the cold war.

During the 64 years of operation, one-hundred and fifty-four ships were assigned to the squadron which included the following:

NUMBER	LETTER	TYPE
6	AS	Submarine Tender
6	ASR	Submarine Rescue Vessel
2	TWR	Torpedo Weapon Retriever
1	ARDM	Auxiliary Repair Docking (Medium)
1	AM	Minesweeper
1	SM	Submarine Minelayer
1	AT	Ocean Tug
1	DD	Destroyer
106	SS	Diesel Submarine
25	SSN	Nuclear Attack Submarine
4	SSBN	Nuclear Ballistic Missile Submarine

One DSRV (deep submergence rescue vehicle) was available for rescuing crews from downed submarines. The rescue vessel is

shaped like a torpedo and is capable of being transported anywhere it may be needed.

Turning the last page of the history of Submarine Squadron Four, we mustn't forge the *Silent Submarines* with crews on eternal patrol:

S-26 (SS131) sunk 24 Jan 1942 after colliding with submarine chaser PC-460 in Gulf of Panama.

USS SHARK (SS174) sunk by Japanese warship 11 Feb 1942 east of Menado, Celebes.

USS Pickerel (SS177) missing off northern Honshu, Apr 1943.

USS POMPANO (SS181) missing east of Honshu, Aug 1945.

SS-44 (SS155) sunk by Japanese destroyer 7 Oct 1943 off Paramushiru.

USS SCULPIN (SS191) sunk by Japanese destroyer YAMAGUMO 19 Nov 1943 off Truk.

S-28 (SS133) failed to surface during training off Pearl Harbor 4 Jul 1944.

USS SEAWOLF (SS197) sunk by mistake by destroyer escort RICHARD M. ROWELL 3 Oct 1944 off Morotai.

USS SWORDFISH (SS193) missing south of Kyushu, Jan 1945.

One submarine, S-27 (SS132) was lost by grounding on a reef on 19 Jun 1942 at Amchitka Island, Aleutians. However, the men managed to escape.

Data was taken from U.S. Warships of World War II by Paul H. Silverstone.

Before and after the Deactivation Ceremony, I had the pleasure to speak with many of the World War II submarine veterans. They proudly wore vests which displayed their name, state chapter and colorful patches of submarines and vessels which they served aboard. They were proud and eager to tell their war experiences. To place in perspective when these veterans served our country, the following were the current events on 7 Dec 1941: Franklin D. Roosevelt was President and Henry A. Wallace was Vice President. Joe Lewis was the heavyweight champion of the world. Top songs of the day were Blues in the Night, Chattanooga Choo Choo and by the Light of the Silvery Moon. The top movie was How Green was My Valley, starring Walter Pidgeon and Maureen O'Hara. A 5 pound bag of flour was $.23, half gallon of milk was $.27, pair of boots $5.85 and a pair of pants were $4.98. News headlines of 1941 included: The Establishment of the USO, Germany Invades Russia and the United States Declares War on Japan.

Mr. William Jones from St. Stephens, S.C. was aboard USS ESCOLAR (SS294) bound for Pearl Harbor. He reached his destination and went ashore. When the submarine went out again, it sank with a loss of 72 crewmen. Mr. Jones also served aboard USS BARB (SS220) and USS SENNET (SS408). He stated that is was wonderful to be around shipmates again.

Mr. Bruce Wright from Aiken, S.C., was assigned to USS BASS (SS164), USS QUILLBACK (SS424) and USS SELFRIDGE (DD367). On the evening of 6 Dec 1941, USS SELFRIDGE returned to Pearl Harbor from a 30 day cruise. They were low on fuel, ammunition, food, water and supplies. On Sunday, 7 Dec 1941, the Japanese bombers flew near USS SELFRIDGE on the way to their targets. During the bombing attacks, the destroyer was restocked and it dropped depth charges near Diamond Head Point for 24 hours. It then joined USS SARATOGA (CV3) and the Joint Task Force and proceeded to Midway and Wake Island.

Terry and Oliver Thompson are residents of Charlotte, N.C. Mr. Thompson is a past commander of the Tarheel Chapter of Submarine Veterans of World War II. He served aboard USS SEA LEOPARD (SS483), USS MEDRAGEL (SS480) and the U-2513

German U-boat (U-2513). In August 1946 the U-2513 underwent an extensive overhaul at the Charleston Navy Yard. We obtained possession of it and our crews manned the U-boat and studied the German technology. The snorkel was an advancement that we didn't have but our electronic and sonar equipment was superior.

Mr. Thompson and the crew of U-2513 had the honor of taking President Truman for a cruise to show him the U-boat and areas of our technology that needed to be updated.

Mr. Thompson also told about the time that he was serving on USS SEA LEOPARD on a cruise in the Bermuda Triangle. USS DOGFISH (SS350) was also in the same vicinity. They were supposed to be 2 miles apart. Somehow USS SEA LEOPARD rammed USS DOGFISH. This mishap knocked USS SEA LEOPARD's hydraulic power out and caused their buoyancy tank to flood. The submarine was sinking out of control. They went past their test depth before they could reverse the screws, bring the sub back up and get the hydraulic accumulator working again. Both submarines proceeded to port for repairs. USS DOGFISH sustained only minor damage.

In Nov 1994 Mr. Thompson and 9 fellow World War II Submariners had the privilege to go on a 3 day trip aboard USS TENNESSEE (SSBN 734). All the men were required to requalify, pull mess duty, find the ship's bell and the ship's goat (garbage compactor) and fire torpedoes. One of the men celebrated his 74th birthday while on board and the crew presented him with a cake. They also fulfilled the last request of a World War II Submariner—burial rites were performed at sea.

Dot and Dana Raley made the trip to Charleston from Rome, GA. Dana Raley is the Georgia State Commander of U.S. Submarine Veterans of World War II. Mr. Raley served aboard USS NARWHAL (SS167), USS CHIVO (SS341), USS CORPORAL (SS346), USS CUTLASS (SS478), USS TRUPETFISH (SS477), USS SEA LEOPARD (SS483) and USS CONGER (SS477).

Mr. Raley had numerous stories to tell of rescue missions by USS NARWHAL of pilots, soldiers, families and agents. He told of the rescue of Mr. Bill Williams from the Philippines. Mr. Williams was aboard a B-17 *Flying Fortress* that had crashed-landed on the island sustaining over 1,200 bullets. One crew member was

killed and four were wounded. They were taken prisoner at an enemy hospital where Mr. William managed to escape and hide in the jungle for a year before he was rescued.

On another rescue mission, USS NARWHAL took aboard an American family, Mr. McKinley, his wife and three daughters who were ages 4, 9 and 13. Mr. McKinley had been the President of Spellman University in the Philippines when the war broke out.

He and his family successfully hid from the Japanese for 27 months until being rescued on 8 Feb 1944.

Mr. Raley explained their rescued personnel were taken to Australia for extended periods of debriefing and were not allowed to tell what had happened to them or how they were rescued.

One of the saddest stories that he relayed was about a Japanese cargo vessel with approximately 700 POW's on board. USS PADDLE (SS263) was on patrol and spotted the cargo vessel. She fired her torpedoes and the vessel sank. Only 82 of the POW's survived. They were rescued and one radioman was returned to the Philippine Islands to continue with the war effort.

The final story that Mr. Raley retold was the rescue of 10 aviators from a downed B-17. The flyers had been picked up when USS NARWHAL discovered an unescorted Japanese freighter virtually on top of them. USS NARWHAL sank the freighter which brought the attention of a Japanese sleeper (small sub chaser). The sleeper unloaded her depth charges, ten in all. The noise was extremely loud and nerve racking. Light bulbs were exploding and lights were going out aboard the sub. After surviving the attack, the next morning, the pilots told the commander that they wanted off the sub. They would rather take their chances back on the island fighting the Japanese!

After witnessing today's ceremony, hearing the veterans' war stories, and seeing the camaraderie of this elite group, it was indeed evident that the Submariners' Pride Runs Deep! We owe a great deal of gratitude to these men, the *Silent Heroes*, who sail the seas to protect our freedom.■

THE SUBCOMMITTEE: SUBMARINE MODELERS

by Mr. James F. Butts

Mr. Butts is a submarine modeler and is a member of the Subcommittee.

The SubCommittee is an organized network of submarine modelers, historians, and enthusiasts from across the USA and overseas. People interested in submarines, of all ages and professions, have come together in sharing this unique hobby. Among the members of The SubCommittee are many of the worlds most highly recognized names in submarine modeling, both amateur and professional. The roster includes historians and authors, modelers and memorabilia collectors, and active and retired submarine sailors, officers and enlisted alike. Along with individual members, The SubCommittee also finds the spirit of camaraderie with many submarine related institutions such as museums, libraries and archives, and other organizations. Direct contact between members is encouraged, by phone, letter, email, and through the quarterly magazine, *The SubCommittee Report*. The SubCommittee is, at its core, an information network of friends helping friends. Additionally, local model submarine regattas are held by a number of the local chapters, culminating in the annual international SubRegatta.

The SubCommittee is a non-profit organization and is not affiliated with any vendor or manufacturer, although many vendors and manufacturers have joined as ordinary members. The SubCommittee stands to promote the art of submarine modeling, both static display and radio control, and the study of the history and design and development of submarines from all nations, and all eras. Also popular with many members are the science fiction, fantasy, and movie type submarines, such as NAUTILUS from 20,000 Leagues Under the Sea and SEAVIEW from Voyage to the Bottom of the Sea.

The SubCommittee began as the vision of a few dedicated modelers and historians, in the late 1980's. Ken Hart, Marshall Clark, and Fred Chang began contacting each other with information on newly released submarine model kits, history, and gener-

ally anything else submarine related. Marshall took this interest to the next level, a small, photocopied *newsletter* containing the pooled information, first distributed to a small mailing list in April 1990. This small group was quickly joined by such submarine model pioneers as Skip Asay, Mike Dory, David Merriman, and others who led the way and shared the information required for the model submarine hobby to grow to where it is today.

Since the formation of The SubCommittee, we have witnessed the art of submarine modeling evolve in all forms. The static modeler has available a wide variety of kits of submarines from all nations and eras, both plastic and resin, in all scales and price ranges. There are photo etched detail parts for kits available from many manufacturers, and accurate decals and markings also.

The radio control side of the hobby has evolved from the days of carved wooden hulls and rudimentary controls, to the point where the average model now is frequently of museum quality in detail and appearance, and is equipped with a fully functional operable ballast system and other systems to allow operation much like the actual ships. Some modelers have equipped their boats with systems which allow them to fire torpedoes, and others to fire missiles (unarmed, of course).

Membership in The SubCommittee brings with it a subscription to our quarterly publication, The SubCommittee Report. This 60 plus page quarterly magazine is a well prepared source of information which contains many features, photographs and articles by many of the truly knowledgeable individuals in the field. *The SubCommittee Report* is recognized as one of the finest hobby publications available. It is published in the months of March, June, September and December. Sample issues of *The Report* may be obtained from the Membership Chairman.

We also have a great website at www.SubCommittee.com. This web site's message board is THE place to ask questions about getting started in model submarining. The SubCommittee web site also has lots of photos and information submitted by members that show R/C submarines in action and how to build them. There is also a 'vendor section' that can help you locate kits, parts and other items useful in the hobby of r/c submarines.

Current membership in The SubCommittee is approximately 1000 strong. We always extend a warm welcome to any who care to inquire or join us. A competent staff of officers and core members are at hand, as is the entire membership, to help with technical, historical, or general inquires. There are a number of local chapters of the SubCommittee. You will find that members of The SubCommittee are always eager and willing to share their experiences in building and running R/C submarines. Participating in a local chapter is a great way to make new friends and to see R/C submarines in action.

Dues in The SubCommittee are $26 per year in the United States, $30 per year in Canada, and $36 per year for the rest of the world. Payment of these dues will guarantee delivery of all four issues of *The SubCommittee Report* for the current year without regard to when during the year you join. To join, or for further information, please contact:

Don Osler
SUBCOMMITTEE MEMBERSHIP CHAIRMAN
P.O. Box 16578
Rochester, NY 14612

LETTERS

ABOUT THE "ACE OF ACES"

When I read Dr. Beynon's "Ace of Aces" (Jan. 2005, pp. 101-118) I was surprised by his statements that Rolf Mutzelburg, Albert "ADI" Schnee, Eric Topp, and Teddy Surhen ". . .led the force in ships sunk and total tonnage." And that Teddy Suhren was Doenitz's "ACE among aces" (p. 103). Maybe so. But the record differs.

As for ships sunk and tonnage totals, only Topp is listed under the 34 U-boat commanders who sank over 100,000 tons where he is ranked third with a total of 35 ships sunk for 197,460 tons.

Schnee, Suhren and Mutzenburg are listed under the 49 who sank over 50,000 tons where Schnee ranked third or 37 overall with a total of 23 ships sunk for 96, 547 tons; Suhren ranked fourth or 38 overall with 18 for 95,544 tons; and Mutzenburg ranked 13 or 47 overall with 19 for 81,987 tons. Hardly the leaders in ships sunk and total tonnage.

As for the ACE of aces among submarine commanders of all navies during WW II, it was Otto Kretschmer with 46 ships sunk for 272,958 tons.

And the greatest ACE of all was Lother von Arnauld de la Periere who sank 194 ships for 450,000 tons in WWI.

This data and much more can be found on the internet at: http://uboat.net/. Go to: The Men/List of all U-boat commanders/Most successful/Top U-boat Commanders/Commanders with Over 100,000 Tons sunk each and Commanders with Over 50,000 tons sunk each.

R.A. Bowling
CAPT, USN(Ret)

BOOK REVIEWS

TALES FROM DA BRONX SUBMARINER
by MMC(SS) Donald John Kamuf, USN(Ret)

Publisher: Iceni Books, Tucson, AZ 85705
ISBN: 587364891

Reviewed by CAPT James H. Patton, USN(Ret)

North Stonington's Babcock Road in rural southeastern Connecticut runs east-west about a mile and a half to connect two slightly more significant thoroughfares. Telephone and cable TV lines are strung through the middle half-mile, but both ends have separate electric power leads. On the west end are sixteen houses and a retired submariner who has written a book. On the east end are eighteen houses and a retired submariner that has read, and is now reviewing that book.

Chief Machinist Mate (nee Engineman) Don *Muff* Kamuf, at the urging of his three adult children, sat down about three years ago to tell his story from growing up as the child of immigrants in the '40s and '50s Bronx, through submarine service on diesels, SSBNs and SSNs, associated tours ashore, and after retirement, work in the Engineering Department of General Dynamics Electric Boat Division.

He succeeded in crafting a credible story about *him*—Don Kamuf, but more significantly, and perhaps without even intending to do so, he captured the essence of *us*—submariners of his vintage who were around for the beginning and lived and worked through the heart of the Cold War. No one of us who were there can escape noting many aspects of Chief Kamuf's experiences that resonate loudly with our own observations and personal histories.

It is well, but not elegantly written—a fact that actually enhances its authenticity. Told in the non-politically-correct vernacular of the messdecks and of the Goatlocker , it can be rough, sometimes raw and occasionally even crude—just as life and duty aboard submarines was during this period. His story highlights that the makings of a good submariner then (and perhaps even now in what externally appears to be a somewhat more genteel

outfit) were sometimes a unique *witches brew* of native intelligence, perseverance, ego, pride, physical and mental endurance, and sheer stubbornness.

It was mentioned that Muff's contemporaries would recognize and identify with many of the characters and much of the action. At the other extreme, younger readers would benefit by noting universal truths contained between the covers such as good and bad examples of leadership—how Kinnaird McKee as CO of DACE commanded Don's lifelong respect and admiration just through a brief and informal chat, and how other individuals did precisely the opposite through carelessness or indifference.

In the last analysis, it is a book about the kind of people that made the boats run and kept such as I, alive and promoteable for several decades. I thank them for doing that, and I thank him for reminding me to do so.■

THE SUBMARINE REVIEW

THE SUBMARINE REVIEW is a quarterly publication of the Naval Submarine League. It is a forum for discussion of submarine matters. Not only are the ideas of its members to be reflected in the **REVIEW**, but those of others as well, who are interested in submarines and submarining.

Articles for this publication will be accepted on any subject closely related to submarine matters. Their length should be a maximum of about 2500 words. The League prepares **REVIEW** copy for publication using Word Perfect. If possible to do so, accompaning a submission with a 3.5" diskette is of significant assistance in that process. Editing of articles for clarity may be necessary, since important ideas should be readily understood by the readers of the **REVIEW**.

A stipend of up to $200.00 will be paid for each major article published. **Articles accepted for publication in the REVIEW become the property of the Naval Submarine League.** The views expressed by the authors are their own and are not to be construed to be those of the Naval Submarine League..

Comments on articles and brief discussion items are welcomed to make **THE SUBMARINE REVIEW** a dynamic reflection of the League's interest in submarines.

Articles should be submitted to the Editor, SUBMARINE REVIEW, P.O. Box 1146, Annandale, VA 22003.

BENEATH THE SURFACE

by Mr. Bill Lightfoot
Published by: Cordillera Books, Vancouver, B.C., 2005
325 pages, $31.95
ISBN-1-895590-31-0
Reviewed by Jim Christley, EMCS(SS) USN(Ret)

Good submarine books which cover the history of the development and deployment of boats are few. Great ones are fewer. Some of the great ones are Friedman's Illustrated Design History (2 Volumes), Alden's "The Fleet Submarine in the United States Navy and Clay Blair's "Silent Victory". I would like to introduce you to a book which will sit on my bookshelf equal to those mentioned above. Mr. Bill Lightfoot's "Beneath the Surface" is the story of submarines built in Seattle and Vancouver from 1909 to 1918. It is published by Cordillera Books out of Vancouver and is available from outlets stateside.

This book conveys the history of the boats, their builders and their deployments. Not only are the boats themselves described in detail, but their engines, radios, periscopes and sonars. The research is impeccable, the detail complete and the explanations clear.

This is not a dry technical history. It is the story of the early part of our Force, the beginnings of the Submarine Force of our Canadian bretheren and the boats destined for Russia in the early days of WWI. It is told with a wry good humor that submariners the world over would recognize and appreciate.

I don't often feel compelled to review or to tout a particular submarine book, but this one is a most excellent addition to a collection of submarine books and a fun read. See Mr. Lightfoot's website http://beneaththesurface.biz/ for information on purchasing.■

USS GEORGE WASHINGTON CLASS REUNION AUGUST 2006 in GROTON, CT

Dear Shipmates and Family Members,

At the request of many our shipmates and other shipmates from 598 Class Boats, I have decided to combine the 2006 USS ABRAHAM LINCOLN (SSBN 602) Reunion with the other boats of the class. As you are aware many of our shipmates served on more than one 598 Class boat. I think that it will be a unique opportunity to have a reunion that will probably be the largest and best reunion we have ever done. Those shipmates that served on the 598 Class were the seed for the SSBN and SSN fleet, which was responsible for the USA to ultimately win the COLD WAR. A 598 Class Reunion website (www.598Class.us) is in the process of being set up by Tim VeVard from the USS Robert E. Lee (SSBN 601) as I write this letter. When the web site is ready you will be able to see who is going to attend and from which boat. It will be a great opportunity to see old steaming shipmates, and just think of the sea stories that can be told.

Therefore, everything is all set for the USS GEORGE WASHINGTON CLASS REUNION, August 24, 25, 26, 27, 2006 in good old Rotten Groton, at the Groton Motor Inn & Suites (GMI). Check it out at www.grotoninn.com. The Home Port location will be at the GI&S located on Route 184 just off I-95 on the Groton side of the Gold Star Memorial Bridge. Registration will be in the Amber Room (the hospitality room) on Thursday or when ever you get to the GMI.

When calling for reservations tell the Desk Clerk that you are with the USS George Washington Class Reunion reservations and you will get the reduced rate of $109.00 + tax. The first date that you can call for reservations is October 23, 2005. Those of you arriving by plane should consider using the "T. F. Green Airport" in Providence, RI, because it is far more convenient than "Bradley Airport" Hartford, CT airport.

The purpose of this letter is to provide everyone with early relevant information concerning the reunion. We want to welcome all our shipmates, wives, widows, and especially their children and/or grandchildren. The wives and children that attended the last reunion really seemed to enjoy the festivities as much as the shipmates themselves.

The hospitality room will be set up and ready to go late Thursday afternoon. We will have an open bar with beer, hard and soft drinks and snacks in the hospitality room.

There will be two 50/50 raffles, and a regular raffle. An auction to benefit the future reunions will be held on Friday evening during the no host cocktail party. If you have an item that you would like to donate to the 602 Boat Auction or Raffle, please let me know ASAP. I have started to put the auction and raffle items list together and need to know before the reunion if there are any items that you would like to donate to the auction or raffle.

The current estimated cost for the reunion activities is $75.00 per person. The price includes the hospitality room and refreshments, "Channel Fever Night" (Thursday evening) at the Groton Base Sub Vets Clubhouse, welcome

aboard cash bar no host cocktail party (Friday evening), Reunion Banquet (Saturday evening), and Sunday Brunch (Sunday a.m.). Make your check payable to the (To Be Determined).

- On Thursday evening (1700-2100), August 24th we have a "Channel Fever Night" at the Submarine Veterans Clubhouse in Groton where you will enjoy beer and wonderful chili (subject to change). You will not want to miss this fun event. Groton Base clubhouse is a virtual museum not found anywhere else in the submarine force. It is definitely a memorable site to see.
- On Friday morning (0930), August 25th we have scheduled a The Lincoln Crew Returns to Submarine School for an enlisted graduation class, "Tolling of the 52 WW II Lost Boats" and tour of the Submarine School.
- On Friday evening, at 1800, there will be a welcome aboard cash bar cocktail party with hot and cold hors d'oeuvre in the GMI ballroom. The auction and 50/50 raffle will be held starting at 2000.
- On Saturday evening, at 1700, August 26th we will have a sit-down banquet dinner in one of the GMI ballrooms. Your entrée selection will requested at a later date or can be made at the registration. Dress for the banquet: Dress Blue Uniform (or better), Coat (tie optional). I plan to wear my uniform. Group and individual reunion photographs will be taken at the banquet.
- On Sunday morning, 0900 to 1300, August 27th we have planned a brunch in the GMI ballroom. We are looking at this to be the farewell event for this our sixth reunion.

All of the planning surrounding the Submarine Base is tentative and subject to change due to strict security conditions which change from time-to-time.

With over 1100 shipmates on the Sailing List, we are looking forward to at least 250 shipmates and family members and friends to attend the reunion. A copy of the Sailing List will be provided at the reunion and a limited number of copies will be available.

WHY SHOULD I ATTEND THE 602 BOAT REUNION?

- If you don't attend the reunion you will miss all of the following great activities!
- Listen to more sea stories and lies than you ever heard (even while on active duty)
- Thursday evening visit the Groton Base, Submarine Veterans Club, for chili and beer (all reunion attendees are invited).
- Friday morning a Sub School Graduation, Tour Sub School Trainers.
- Visit the Historic Ship Nautilus (SSN 571) & Submarine Museum located at Goss Cove where we will convert the 598 Boat Sail (the upper 25% of which is from the 602 Boat) to the 599, 600, 601 and 602 Boat (Saturday morning).

Leisure time:

- Visit a casino (Mohegan Sun or Foxwoods)
- Visit Mystic Seaport
- Fort Trumbull State Park
- Golf at any of six or seven local golf courses

Please bring any relics/memorabilia left from "the good old days" for all of us to enjoy. I continue to seek the following items for display in the hospitality room at the reunion, i.e., a CO absentee pennant or any others that may have found their way into your possession. All memorabilia items will be returned before you leave the reunion.

Reunion Coordinators	Warm regards, Your Shipmate and Coordinator/Host,
Ken Szablewski 598 Boat	W. T. "Doc" McCance
(Pending) 599 Boat	16 Chapman Lane
Jim Irwin 600 Boat	Gales Ferry, CT 06335
Tim VeArd 601 Boat	Telephone: (860) 464-6758
Doc McCance 602 Boat	E-mail address: 11doc@comcast.net

NAVAL SUBMARINE LEAGUE HONOR ROLL

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