THE SUBMARINE REVIEW
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EDITOR'S COMMENTS

As the submarine community approaches this season of critical decisions by the Congress, **THE SUBMARINE REVIEW** features several different viewpoints on the future of the Submarine Force. The immediate future is tied to Congressional action on the Navy's submarine building program, while the more distant future—out about 15 years—seems dependent on both new technologies and innovative operations.

Our first feature in this issue is the address by the Undersecretary of the Navy to the Annual Symposium in June. Mr. Danzig presented his view of the state of play as well as a sound endorsement of the need for nuclear attack submarines. His observations are encouraging and the dedication of the Administration to the submarine program is noteworthy. Admiral Long's welcoming address to the NSL/APL Technology Symposium in May carried a somewhat different message of operational challenge and technological opportunity in the near future. Referring to a major school of current defense intellectual effort, he characterized nuclear submarines as "the heralds of the military technical revolution" and also cited the new book by Admiral Bill Owens as a look at the requirements for submarine warfare in the next decade or two.

Admiral Owens' book, High Seas, is also treated as a feature of this issue for just the reasons given by Admiral Long. As Vice Chairman of the Joint Chiefs of Staff, Admiral Owens has the advantage of a uniquely wide perspective that is a most unusual opportunity for the application of submarine expertise to the generation of a specific review of the future. His recommendations for the direction the Navy should take into the next several decades are provocative and bear careful consideration. Admiral Owens also met with this editor and Commander Sam Tangredi, who authored the commentary on High Seas, to discuss the book and that interview precedes the article.

Vice Admiral George Emery's address to the Annual Symposium is also featured. His focus, of course, was on the present state of the Submarine Force and he emphasized both operations and the personnel in the boats. A different, and very important view was given by Mr. Ron O'Rourke in his address to the Technology Symposium. Mr. O'Rourke is the highly respected Congressional Reference Service expert on major naval procurement actions (esp. carriers and submariners). As such he is extremely well informed and in his frequent writings he serves the

nation well by his comprehensive, cogent, and always objective reporting of the issues involved. Mr. O'Rourke has addressed the submarine community before on this subject and his update here is most useful.

The articles in this issue also reflect this present/future nature of our concerns and potentials. Both the article by ex-Congressman James Courter and Loren Thompson of the Alexis de Tocqueville Institute, and the next by Scott Truver, deal with the problem of current achievement of submarine building that will guarantee the U.S. an ability to continue to produce the submarines that give our nation **control of all the seas.** They both outline the Navy-backed program and the issues that are being raised in opposition.

In addition, three articles derived from the Technology Symposium give a glimpse of what submarines soon will be using, how they will be training, and the quality of the adversaries they will be facing. A constantly heard theme throughout this past year has been about the importance of unmanned undersea vehicles (UUVs) to our future, so an update on that technology is included. A most interesting piece concerns the combined use of simulation and instrumented ranges to provide realistic training in much the same way as the aviators do it with aggressor courses in Nevada. Using ranges in shallow water also serves to authenticate submarine capabilities and proficiencies in those environments. A third technology article treats the growing ASW capabilities of the Third World and offers a caution for the continued attention to all the details of stealth.

Technology in the large sense is also the subject of three book reviews. General submarine design has been treated in books by American, British, and Russian authors and the reviews by American experts provide an excellent survey of the current field of observation and comment on submarine design.

Finally, as the 50th anniversary of the end of World War II approaches, we publish our last in the series of reprints of war patrol reports from that period. Appropriately, the last one concerns the integration of new technology in a mine detection sonar with coordinated operations of a multiple submarine force. *Operation Barney* was launched by Admiral Lockwood as a mine submarine foray into the Sea of Japan. Commander E.T. Hydeman in SEA DOG was the leader of the wolf pack and his story is told through the report of the ship's fourth war patrol.

Jim Hay

FROM THE PRESIDENT

As this issue of **THE SUBMARINE REVIEW** goes to press, we can look back with a great deal of pride and satisfaction at a spectacular quarter. We are on-line, on the Internet. Our first ever venture into the world of big-time industry shows, the Navy League's Sea-Air-Space Exposition, was a super success. The interactive CD-ROM, Submarines Force - Past-Present-Future, is spreading the submarine gospel and has netted a number of new members for the League.

The Submarine Technology Symposium at The Johns Hopkins University Applied Physics Laboratory was once again a winner. The meeting provides a classified forum in which emerging technologies with the potential to enhance submarine performance or submarine design and construction, can be examined. This year, we looked at technologies under development not only within the Navy, but in other services, at the Advanced Research Projects Agency, and overseas. In this issue, you will see a sampling of unclassified versions of several significant papers that were presented.

The Annual June Symposium was well attended, with the membership privileged to hear from Admiral Bill Owens, Vice Chairman, JCS; the Honorable Richard Danzig, Under Secretary of the Navy; Admiral Hank Chiles, CINCSTRAT; Vice Admiral Joe Lopez, DCNO Resources, Warfare Requirements and Assessments; Vice Admiral Skip Bowman, Chief of Naval Personnel; Mr. Gerry Cann, former Assistant SECNAV; our two Force Commanders, Vice Admiral George Emery and Rear Admiral Mike Barr; Rear Admiral Denny Jones, Director, Submarine Warfare Division, OPNAV; and an additional six-pack from Who's Who in Force Leadership, both out in the field and those here in town laboring in the vineyard.

The June Symposium should have reaffirmed for the attendees the noble blessing we enjoy in the quality of our people. You could not be unmoved by the citations read during the awards ceremony, nor could you be unimpressed by the individuals who strode forward to receive their honors. Although the Navy's well thought out and mature submarine acquisition plan was being dismantled by misguided folks even as we met, knowing that the future Force, whatever its shape and size, would be in the hands of these young, dedicated superstars provided some solace.

Recently, while thumbing through back issues of **THE SUBMARINE REVIEW**, I became aware (a revelation?) that I have served as President for five years! Time really does pass quickly... I have enjoyed every minute, but it is time to pass the baton. Carl Trost, who has served as our Chairman for the same period, experienced a similar revelation. Thus, at the Board of Directors meeting immediately following the Symposium, we tendered our resignations. The Board then selected a new and vibrant slate of officers: Chairman, Admiral Bill Smith; President, Vice Admiral Dan Cooper; Vice President, Rear Admiral Larry Vogt; Secretary, Vice Admiral Al Burkhalter; and Treasurer, Captain Mickey Garverick. Captain John Vick, who makes it all happen, was reconfirmed as Executive Director. Rear Admiral Al Kelln was appointed a Director, Emeritus, and was elected to the League Hall of Fame, a well-deserved honor for all his long and faithful service.

The leadership of the League is in good hands to continue our support of the Force, to increase our membership, to bring to fruition our initiative for a first-class submarine museum at the Washington Navy Yard, and other ventures as we approach the next century. I thank you for your support.

Bud Kauderer

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ADDRESS TO THE ANNUAL SYMPOSIUM

The Honorable Richard J. Danzig
Undersecretary of the Navy
June 7, 1995

It is an absolute delight to be here, to see a vibrant collection of distinguished people filling a room who care so much about a topic that matters in such a critical way. I must say it is a special delight for me to see Frank Kelso here. Frank, as Chief of Naval Operations, had as one of his collateral duties, breaking in a new Secretary and Undersecretary. He had some experience in that role, but I can tell you he performed it absolutely superbly. I think I can say that every one of my vices has been mitigated by being around Frank and every one of the Secretary's virtues has been enhanced. (You see in my description here something of a division of labor between a Secretary and an Undersecretary.) I really am grateful, Frank, for everything you did for us and so many people in this room are grateful to you for so many things related to the submarine world and the Navy generally.

I note many others figures within the community here...Admiral Long, and too many people to mention and recognize. Admiral Trost—it's a great pleasure to be here and to have this opportunity.

When I last had occasion to speak separately with this community, it was some nine months ago at the National Security Industry Association Symposium in Groton. At that point I sounded a theme that was for me fundamental and continues to be fundamental for the time ahead. That theme is that it is critical for us to stop and take a longer term perspective about what is really important. My basic proposition then was that we could get at that theme by asking ourselves what it was that our predecessors had done that we thought was important, and how we measured and assessed them. My suggestion was that there were messages and morals in that for the rest of us about how we would be judged by our successors and what we really ought to care about.

My central observation in this regard is that our predecessors have bestowed upon us a great, and truly exceptional gift. The gift is that, at the moment, for all of our troubles, travails and controversies amongst ourselves, we have received from our predecessors a world in which the national security of the United States in the most basic sense is not at the moment threatened.

There is no enemy out there that is now preparing to attack us. There is no country out there that threatens to dominate us on the international scene. In that sense we stand in a fundamental way at peace; and that is a gift which was of the people who came before us enjoyed in the whole half century, indeed in some measure in the whole century, preceding us.

It seems to me the most fundamental question for us is how we continue that. How we sustain that over the time ahead. It seems to me there are a number of risks. But I want today to simply focus on one and continue the line of thought that I began with some of you in Groton nine months ago. My suggestion and deep belief is that we start at square one with the proposition that whoever has declared achievement of *peace in our time* comes to regret it. Particularly if they believe that peace is some kind of enduring condition that continues of its own momentum. The 20th century has been the bloodiest in the history of mankind. Why would we really expect the next century would be different? Certainly we can't rely on the hope that it will. Things change, circumstances evolve.

Immediately relevant to the concerns of this audience and very high on the congressional agenda today is the question of the role of submarines in this respect. My observation is that we are largely free of national security threat because there is no power out there that could be described as a major competitor of ours. No nation can challenge us in ways that might lead us to believe that it could achieve a measure of military dominance or intimidation.

The question for us is how we diminish the likelihood of the evolution of such a competitor. How we retard the tendency, inevitable in my opinion, of other countries in other times and other circumstances, to think that they can threaten us or endanger us or compete with us. To my mind a strong submarine community is fundamental in that regard. It is fundamental for an exceedingly simple reason, which is that subsurface warfare is a major domain in which nations compete and in which nations exercise military leverage on one another. It is also fundamental, increasingly in the time ahead, because it is the domain in which we and other nations have determined that we are going to put our main strategic resources, our strategic strike capability, and the ability to protect that depends in substantial measure on submarine warfare.

It is fundamental again because in a technologically sophisticated world, stealth and the reduction of casualties are major areas of critical investment. The submarine continues to represent the stealthiest, the most potent capacity in which men wage war. This is therefore, in my view, an area in which we ought to invest.

I'm not saying anything new to this audience, indeed there is extraordinary irony—and no one knows it better than this group—that I offer you a civilian. For me to layout these particulars to you would be as if I were to appear in front of the National Symphony Orchestra and propose to play a harmonica solo. You all know it better than I do. I've learned it from many of you.

I think, though, that there is a debate that matters going on in this country in which all of you need to participate, and in which we the civilian leadership must be counted. That is the debate about the magnitude and the character of the investment in this arena. How it is made and to what extent we invest during times that have the benefit of the great gift of peace and in which there is a lot of pressure for budget reduction.

My own judgement in this regard is that we see a strong measure of the significance of this investment in what other countries are doing. We see it in the continuance of the Russian submarine program; its investment in improved Akulas and its plans to build another generation beyond that. We see it in the Chinese building and in purchases in the submarine area. We see it in Iranian purchases of Kilos from the Russians. We see it, in fact, in the ships that other countries are making with the scaresest of their resources.

Against this backdrop, I am delighted to report that we see emerging a broad consensus within the United States Congress and within the Defense establishment that we need to invest in submarines. Whatever the degree of contention that exists at any particular moment we have to step back and recollect that some two or three years ago, before the Bottom Up Review, during the time of change-over of Administrations, a lot of these issues were up for grabs. I think there is now clearly a basic consensus that we ought to move ahead in this area and make substantial investments.

There is also, I am pleased to report, a large preponderance of support for the notion that we ought to sustain two nuclear capable shipbuilding enterprises. That in fact the national security is best

served by investments in two yards. Our calculus within the Navy suggests, indeed I think reasonably demonstrates, that the premium that's paid in that regard is at approximately the three percent level in our submarine building costs in the period between now and the year 2012. In my view it is a very well warranted expenditure to buy the capacity and the safety that comes from having two yards. A capacity that's useful should we want to expand the submarine building program, a capacity that generates a hedge against all kinds of risks, natural and otherwise, and further, a capacity that generates price restraints by all participants because of the potential for competition continued across the scene.

This is the common understanding that underlies the issues of the moment. The contentious issues of the moment—real and important issues—are about how to get there. We have agreed I think amongst all of us that the new attack submarine is the rational place we want to be. The *how to get there* is the issue of the moment, as you all well know. My view is that this is not a terribly complicated issue, though as with any issue, it has literally hundreds of secondary considerations that can be placed into play.

My sense in this regard is that one plays the ball where it lies. Where it lies is that we have $900M invested in a third Seawolf. For an additional expenditure of $1.5B we can achieve that third submarine. **And I view that expenditure as eminently sensible. It's sensible for three very basic reasons.**

One, this is the world's best submarine. It is extremely useful to have the world's best submarine in these kinds of circumstances where we know that in some circumstances that matter, Russian submarines lack capacities that the Seawolf would not.

Two, at the moment, it is the least expensive submarine that we can buy. It represents in its incremental cost to us an acquisition that has a remarkably high value in performance as against its cost. Particularly when we take account of the fact that very substantial costs, in ranges approaching $1B, are inflicted upon us if we don't follow through.

And three, the Seawolf represents to us a sensible way of sustaining our submarine building capacity at the same time as we are evolving towards the new attack submarine. It sustains for us the two yards and it sustains for us submarine crafts and production abilities which once stopped are extremely difficult to restart. Now it is the natural experience in all leaders in the

defense community, undersecretaries as well as everyone else, that one encounters increasing disagreement as you move from general propositions to particular ones and more particular ones. Men and women of good views and good sense on the Hill and elsewhere are naturally disputing some of these kinds of these propositions. I know this is of great concern to everybody in this room. My own view is that in fact the logic of the situation and is exceedingly strong, will prevail in the discussions that are likely to occur in the course of the rest of the Congressional debates. This is a debate which is continuing and in which the Navy is persevering. I want to emphasize the magnitude of that perseverance to you and I want to urge all of you to contribute to that. You represent an extraordinary wealth of experience, an exceptional pool of good sense, and a great reservoir of credibility and intimacy of knowledge. You have a contribution to make in that regard that we very much need in the time ahead. I want to urge participation from all of you, not just in the context in which today and yesterday we talked to one another, but in the context in which tomorrow you have opportunities to talk with the appropriately ultimate decision makers—the members of Congress.

To return to my original theme; we have been given a gift by our predecessors and it is a great and extraordinary gift. It is the gift of an exceptional degree of national security. It is the gift of being at peace. We have an obligation and a challenge to sustain that gift. I take it terribly seriously. The Secretary of the Navy takes it terribly seriously. The Chief of Naval Operations and the Commandant of the Marine Corps, I know, live by it everyday. On this issue we need to sustain that effort and, we need your help. I'll be very grateful as we receive it in the time ahead.

Having said that, I thank you very much. ■

ADMIRAL LONG'S WELCOME TO SUBMARINE TECHNOLOGY SYMPOSIUM

Welcome, on behalf of the Naval Submarine League. Vice Admiral George Emery, Commander Submarines, U.S. Atlantic Fleet, we are particularly pleased that you, our sponsor of this symposium, are here with us. You speak for the requirements of the Submarine Force and we are looking forward to hearing what you have to say.

Let me remind everybody that we are entering a new era. The old Soviet threat is gone; our budget is going down; the threat has not disappeared. We still see a very healthy proliferation, not just of weapons of mass destruction, but also of high-tech weapons, ballistic missiles, and cruise missiles. We also see ourselves faced with what may be some major contingencies in places such as the Gulf again, and also North Korea, with the very unstable political situation that exists today. We have heard from the Director of Naval Intelligence, and he has reminded us that although the Russian military forces are diminishing, we continue to see an increase in op-tempo and capability in the Russian submarine force. We also are seeing a proliferation of submarines around the world—diesel submarines, certainly, for the most part.

Now, what does all of this mean? Let me just remind you what the Secretary of the Navy said the other day. He said that attack submarines are the prerequisites to our ability to carry out the Navy's strategic mission. I would call nuclear submarines the heralds of the military technical revolution. I think the bottom line of all this is that the United States must have a strong Submarine Force and I believe the Submarine Force will play an increasingly vital role in our national security strategy.

I just finished reading Admiral Bill Owens' book. It is titled High Seas and published by The Naval Institute Press. *[Editor's Note: See Commander Sam Tangredi's article in this issue.]* He says some interesting things in the book and that is why I bring them out. In my opinion, Bill Owens is probably the most influential military officer on active duty, and I am pleased that he is a submariner. Let me pick a few of the points he makes in his book. He sees a Submarine Force playing in three roles: (1) strategic deterrence, (2) sea control, and (3) battlefield support. He sees the need to look into the future of the Submarine Force for expanded communications, a greatly upgraded surveillance

capability whereby submarines should be able to monitor all aspects of the electromagnetic spectrum to process that data and provide it immediately to any command mode, from battle group commander all the way to the National Command Authority. He sees that we will have an expanded use of unmanned undersea vehicles and unmanned aerial vehicles. He anticipates that we will have even more advanced weapons to support the land war. He also believes that we need modularity in submarine construction—modularity to be able to support special forces, unmanned vehicles, and launch tubes for literally hundreds of weapons. Admiral Owens also cautions (and I think it's a very important caution) that we will need to provide counters to technical breakthroughs that could compromise our submarine stealth or threaten our own submarines.

Now, someday this might be an annual symposium, but this is simply the Eighth Submarine Technical Symposium. I want to remind everyone that this symposium is designed to support the technical development of things that will support the operational requirements of our Submarine Force. I want to thank all of you for participating. It is very important that we have this opportunity to share observations, because we need a vital Submarine Force that is able to continue to contribute to the nation's defense. Thank you all very much for being here. ■

KEYNOTE ADDRESS TO ANNUAL SYMPOSIUM

by VADM George W. Emery, USN
COMSUBLANT
June 7, 1995

Admiral Trost, Admiral Kelso, Admiral Long, Admiral Smith, Admiral Shear, Admiral Kauderer, distinguished guests, members of the Naval Submarine League, ladies and gentlemen, good morning. It's an honor to be here today speaking to this distinguished crowd.

I was told once that traditionally, in the early days of seafaring when a sailor finished his nomadic days of sea duty and was looking for a place to drop anchor for good, many an old salt would row ashore, put the oars over his shoulder, and walk inland. He would walk and walk, meeting and greeting many people along the way as he searched for his new home away from the sea.

His journey would take him further and further inland. And it wasn't until he met someone who inquired what those long skinny wooden things he was carrying on his shoulder were, that he would drop those oars and know he had found his new home. No more sea duty for him!

As usual, however, word about the submarine proves to be especially difficult to spread. For example, take your basic submariner who is seeking a safe haven ... well inland ... by the classic method I just mentioned. Dress him up in his grease poopie suit, stick a periscope training handle under his arm, fit him out with a Steinke hood, and launch him on his search. The poor guy, doesn't even get out of the building before somebody associates him with a costume party. It would be unusual for him to get out of town, despite being dressed in all of his glory, before someone questioned his get up.

You doubt me? Last week my operations officer, the legendary Captain Rocky English, retired, and he still lives in Virginia Beach! Look around you: there are a lot of other submariners in this room who didn't get very far from the water. I rest my case.

It's hard to believe, but even in today's information age you don't have to go too far to meet people who don't understand what submariners are all about. When we fail to capitalize on the unique capabilities or our submarines, because of this lack of understanding, we hurt the Navy and the Nation.

I would be the first to admit, that we, those of us born and raised as it were in the cold war, are partly to blame for the lack of understanding and recognition of many outside the submarine community. The *silent service* had a necessary purpose as we squared off against the Soviet Union in the high stakes undersea arena. But today, this moniker, the *silent service*, hurts the Submarine Force as we vie for scarce resources with our contemporaries from more traditional and familiar military platforms.

One of my priority missions, like that of the Naval Submarine League, is to ensure that the country, armed with the proper information, makes the right decisions in regard to the future of the Submarine Force. Note that I didn't specify what the right decision is—but I will before I'm done.

Putting ourselves in the position of our customer, the people of the United States, as represented by the Congress, is necessary to arrive at the right answer. To put it in the right perspective, elected officials must detect the right course of action in submarine programs in an environment with very high background noise and many interfering contacts. It is our job to help them—to improve their recognition differential. The biggest issue controlling the process is the budget deficit. The Congress is committed to eliminating it and it is perfectly understandable that we are pressed hard to explain the need for ships that cost over a $1B a copy. The defense budget has become a zero-sum game and expansion in one area will lead to shrinkage in another. Educating the public on the importance of maintaining superiority in undersea warfare when few countries are pushing hard in that arena, outside Russia, a country with which we are working hard to improve relations, requires careful explanation. The best way to confront these competing requirements is with facts.

Here are the facts as I see them. The number one mission of the Department of Defense is—to defend the United States of America. Within that broad perspective that mission is shouldered primarily by submarines assigned to the operational control of CINCSTRAT, Admiral Hank Chiles. We do it with fewer ships, fewer warheads, and fewer people than any time since the early 1960s. The basic method is unchanged—we maintain an overwhelming nuclear force to deter aggression. What has changed is the potential threat. The Soviet Union is gone, but the landing for the successor states of that Union, including Russia, has been a hard one. We hope they successfully complete the transition to

democracy and capitalism. We provide a good reason for them and any other nation with weapons of mass destruction not to waste precious resources on nuclear brinkmanship.

Fact #2: The Submarine Force maintains the only ability to fight and win in the undersea SSBN bastions of the world if the need arises.

Fact #3: We maintain the only capability in the fleet to conduct tactical nuclear cruise missile strikes.

Fact #4: We have much to offer in low intensity conflict with our extremely flexible attack submarine force. We maintain observable but unlocatable forward presence. The value of this tool is becoming apparent to some for the first time only now. The ability to monitor a situation, to deploy special forces, to launch tactical strikes in a hot spot without fanning the flames by providing a force which is present on the evening news is invaluable. A submarine can be deployed to a hot spot, while the situation is still fluid, without implying anything. No political capital is expended until, and unless, the decision is made to strike.

When the situation calls for a Joint Task Force, we have much to offer. We carry the brunt of the ASW mission, a large share of the Strike Warfare mission, and a share of the ASUW, mining and special warfare missions. We can operate without logistics support or an air protection umbrella and, with the benefit of recent communications improvements, we can and do maintain continuous tactical communications with the Theater Commander, Task Force Commander, and Strike Warfare Coordinator.

How do we ensure that we will be dominant in these roles ten years from now? The answer is: we invest now. We invest in quieter submarines with better sensors that maintain the flexibility to conduct a wide variety of submarine missions. The evolutionary nature of technology requires substantial investment in hardware to gain the next increment in performance. We still see no revolutionary change that can alter that fundamental paradigm. We continue to explore alternatives, as do other countries. But, for the foreseeable future, acoustic stealth defines submarine stealth.

However, some of the paradigms we hold sacred may have to fall in order to lower the cost of our product. As in the past we, and I mean we, the Navy, must continue to develop better ways of doing business if we are to stay in business.

The question remains whether or not we will continue to develop the submarine's untapped potential to meet our foreseeable needs. As quieter submarines approach background noise levels, can we make a breakthrough into more fruitful detection means than acoustics to improve our anti-submarine abilities? Can the marriage of submarine stealth and ability to deliver precision munitions reduce the costs we bear to establish air superiority during power projection? Will the ability to launch the Army's Tactical Missiles (ATACMS) from submarines, while remaining invulnerable to shore launched cruise missiles like Seersuckers and Silkworms, relieve surface ships of part of their fire support burden?

Would conventional SLBMs allow us more rapid crisis response without paying the price to increase forward presence? Could the submarine's ability to covertly lay a minefield be utilized to reduce the cost of embargoes and blockades? Will the combination of submarine stealth and unmanned vehicles, whether airborne or underwater, open the floodgates of battlespace information available to joint force commanders? All this and more is possible: all it takes is the right kind of commitment.

How the force of the future develops is largely related to cost. It provides no savings, for example, to obviate the need for air superiority if we are determined to establish it anyway. Likewise, the ability to use mines in situations short of war isn't very useful when mining is considered an act of war, and so on.

National defense is expensive. Submarine warfare is expensive. But if the opposition has a detection advantage, we may be sending our crews into harms way without a fair chance to fight and win. So the first step in our future victories is to buy, as economically as possible, the right submarine, one quieter than all others, with the world's best sensors. Call it a quality of life. Call it a matter of readiness. But do not fail to call it the first principle of war fighting: Provide sailors with tools that allow them to fight and win!

Using the chronicles of the U.S. Naval Institute Proceedings as a guide, one can draw some parallels to our own times and their possible consequences. Nearly a century and a quarter ago, the Naval Institute came into being to air the concerns and correspondence of the Naval officers who took issue with the *doldrums* into which the Navy had drifted following the Civil War.

The great Civil War fleet that had maintained the blockade and

fought the river battles had been rapidly dispersed and deactivated, and the Naval Establishment reverted to its pre-war mood and technology, weary of the burdens of war. Advances in steam propulsion came slowly, sometimes reverting to sail; and advances in gunnery stagnated. The technological advances demonstrated in the development of the MONITOR and proliferated by the Industrial Revolution were not actively pursued in the United States. Instead, they were seized upon by European nations who subsequently passed us by.

The end of the Cold War has brought some similar pressures. Our ability to dominate the undersea battlespace is threatened when we talk about facing the future with our only attack weapon, the Los Angeles class submarine. These wonderful ships will serve us well in the near future, but they do not dominate the fourth generation submarine technology being build by Russia today. Russia has seized the undersea initiative. The question of whether or not we should chose to build advance technology submarines like the SSN 23 and New Attack Submarine could be asked in its more basic form: whether or not we choose to dominate the future undersea battlespace.

Do we choose to be overtaken by the rest of the world, to enter the *submarine doldrums* if you will? Do we choose to keep our head above water and ignore what goes on below the ocean's surface...at our own future peril?

Things have obviously changed a bit from our post Civil War doldrums. We now see ourselves as members and leaders of the world community. We are irreversibly linked to world events by economical, political, and humanitarian concerns. The idea that we are an island nation, dependent upon the sea for sustenance is fairly well understood, as is the importance of the Navy in the execution of our national policy.

The content of that national policy will be an ongoing debate as we lead, follow, and accompany the rest of the world into the future, and what sort of Navy we need to be, in order to execute those national policies will be determined by similar debate. How will we grow, what will we develop, for what shall we train?

It is my contention that the inherent strengths of the submarine will continue to serve our country well in the future, and gain in relative importance. Stealth is our basic reason for being; it is what makes us such a powerful military tool. Our means of propulsion yields superior mobility and endurance, and certainly

enhances our stealth; and it also makes us uniquely capable of operating under the ice, hence the submarine has the widest range of operating theaters of all the Navy's vessels. These are our basics: stealth, mobility, and endurance. No platform does it better.

To get this message out, we are not just telling people—we are showing them. In addition to well over 400 OLA briefings to staff delegations, 44 members of Congress and their staffs have been underway on submarines in the Atlantic Fleet alone in the last year. One hundred forty-two have visited a submarine in port. In May 1994 we hosted 29 groups totaling 560 people to tours of Norfolk based SSNs alone. What a difference a year can make. Last month, we hosted over 2000 visitors including several Fortune 500 CEO's at the Norfolk piers. We have introduced ourselves as constituents within the community to the local offices of Congressional members. You have seen submarines featured on CNN and on Joan Lunden's *Behind Closed Doors*, and they have been featured on many local TV stations in places like Atlanta, Jacksonville, Toledo, Scranton, and Norfolk. We have put together an interactive CD-ROM about the Submarine Force and are circulating it nation wide. If you need a copy, come see me. We circulate a submarine newsletter to ensure that our people are able spokesmen and, as Skip Bowman described, we are detailing submariners to joint billets to broaden their experience while ensuring joint commanders are aware of the tools at their disposal.

I could not be more pleased with the way in which the Navy is working together on submarine issues. The Secretary of the Navy and the Chief of Naval Operations are leading the charge, making every effort to get the word out to the right folks. As you are well aware, the effort is ongoing and I'm sure Vice Admiral Lopez and Rear Admiral Natter will bring you up to speed. The role that you, the members of the Naval Submarine League, are playing in the process by spreading the word about submarines is important and I urge you all to keep up this most important work.

Today the world is radically different for me as SUBLANT than it was in an earlier day. Those changes aren't cosmetic; they're real. I seek your advice, your criticism, your counsel, and your support through these demanding times.

Thank you. ■

BANQUET ADDRESS
SUBMARINE TECHNOLOGY SYMPOSIUM
May 11, 1995

by Ron O'Rourke
Naval Analyst
Congressional Research Service
Library of Congress

I am glad to have a chance to speak to you tonight and share some thoughts concerning submarines. I'm especially pleased to be here this year given the fact that this is such an interesting and critical time for submarines on the Hill. Submarines, as you no doubt know, are one of the top two or three defense acquisition issues on the Hill this year, maybe the number one issue.

In that regard I want to talk about three things with you tonight. First, I want to speak a little bit about the situation on the Hill and about the Fiscal 1996 budget request. Second, I want to share some thoughts with you regarding the New Attack Submarine in general, not necessarily connected to the Fiscal 1996 request itself. And third, I want to return to a topic that I have spoken about on the two previous occasions when I have appeared before the symposium, which is about Congress' and the public's understanding of the roles and missions of submarines, that is, the value of submarines in the post-Cold War era.

Regarding the first of those topics, Congress this year is facing three important and interrelated issues as it looks at the Fiscal 1996 budget requests for submarines. The first is whether to approve about $1.5 billion in new budget authority to complete funding for the third Seawolf. The second is whether to continue with the New Attack Submarine program, for which about $1.2B has been requested this year, including about $700M in advanced procurement funding for the program. And the third is who will build the New Attack Submarine—whether it should be Electric Boat or Newport News—and whether that should be decided by administrative allocation or by some use of competition.

If Electric Boat is the builder, we will wind up with the so-called two-yard strategy for acquisition of nuclear-powered warships, where Electric Boat builds the subs and Newport News builds the carriers. If Newport News becomes the builder of the New Attack Submarine, we will wind up with the so-called one-

yard strategy under which Newport News will be the builder of both submarines and carriers. The Navy, as you know, wants to allocate production of the New Attack Submarine to Electric Boat while Newport News and its supporters want the issue to be decided on the basis of a one-time, winner-take-all competition.

At this point, I don't think anyone can be in a position to make a high-confidence forecast about how all this is going to turn out on the Hill this year, for at least three reasons. First, there are many possible courses that Congress may take on these interrelated issues. There are a wide variety of options that are open to the imagination and to pick any one of those as the most likely is a very difficult thing to do.

Second, as a result of the shift to a Republican-controlled Congress, there are a lot of individuals on the Hill this year, both Members and staffers, who are becoming involved more deeply in submarines for the first time and whose views on the issue may not yet be fully formed, even at this stage in the process. In fact they might not be fully formed until they actually have to cast a vote one way or the other.

And third, there's a sizeable number of Members, both those who have been in Congress for some time and have followed defense issues for a number of years, and those who are relatively new to defense issues, who have no direct stake in submarines per se. So there is a large group of people out there that are open to be persuaded on the issue one way or the other.

What does seem clear to me is that the debate has become focused primarily on the third of the three questions that I just mentioned. That is to say, the defense oversight committees have spent the most time focusing on the question of who should build the New Attack Submarine and how should that be decided, whether by allocation or by competition.

The fact that Congress has focused more on this third question rather than explicitly or individually on the other two has in my view had two important effects on the debate. First, the argument made by Newport News and its supporters that the builder of the New Attack Submarine should be selected by competition has among other things made it in my view more likely, other things held equal, that the SSN 23 will be funded. That is because advocates of such a competition have to be prepared to show that such a competition would feature a level playing field. Since the stakes of this competition would be enormously high, it is difficult to advocate a competition of this kind unless you are prepared to

show that support taking those steps that are necessary to level the playing field. Leveling the playing field requires that Electric Boat be a healthy competitor in fiscal 1998 and that in turn probably requires funding either SSN 23 or some other form of submarine construction work in the Fiscal 1996 column.

The second important effect that has come about as a result of the fact that Congress is focusing mostly on the question of who should build the New Attack Submarine is that this in effect implies a pre-existing answer to the question of whether we should build a New Attack Submarine. That is to say to the extent that Congress is focusing on the *who* question, the implication is that we have already in effect moved beyond the issue of whether we should move the New Attack Submarine into the procurement phase.

At the beginning of this year, my assessment was that the third Seawolf was very much endangered, and that the New Attack Submarine program was by comparison in a much stronger position. Four months later, my assessment is somewhat altered in two respects. First, I don't think that the third Seawolf is as deeply endangered as I did at the beginning of the year. I'm not saying that the 23 is out of the woods by any means. It's still very possible that Congress will in the end decide not to fund the boat. But odds against the 23 to me don't seem as great today as they did at the beginning of the year.

Secondly, I don't think that the New Attack Submarine is in as strong a position as I did at the beginning of the year. That may sound paradoxical because I just said a moment ago that Congress this year is focusing on the *who* question and that the debate has skipped over the question of whether we should be building it. But that is precisely why I don't think the New Attack Submarine is in as strong a position as I did at the beginning of the year, because Congress has indeed in effect moved beyond the question of whether we should build a New Attack Submarine without really spending much time considering it in detail.

That leads me to the second of the three topics that I wanted to talk to you about tonight, which is the New Attack Submarine program in general, independent of the Fiscal 1996 request. On the New Attack Submarine program I have two general concerns at this point. The first, which I just mentioned, has to do with the foundation of support in Congress for the program. Three years ago, when I first spoke at this Symposium, I said that the challenge with the New Attack Submarine program wasn't so much

getting it started, but getting it finished. My argument then was that it would be important to the long-term success of the program to develop early on in Congress a strong sense of participation and involvement in the New Attack Submarine program, so that Congress could understand where the design came from and have a sense of ownership and stakeholdership in the program.

Today, three years later, other than those who have a direct financial stake in the New Attack Submarine program, I don't think much of a sense of participation and involvement has been developed. As a consequence, the foundation of support in Congress for the New Attack Submarine program does not appear very broad, and this may have adverse consequences for the program if and when something eventually causes the program to come under intensified scrutiny.

This situation is not something I would blame the Navy for. The Navy three years ago issued a very useful report to Congress on conceptual design considerations for the New Attack Submarine and since then the Navy has given many briefings to Members and to congressional staffers on various aspects of the program. So the Navy in my view did make the effort, did undertake to reach out and try to connect with people on the Hill on the New Attack Submarine program.

In spite of that effort, however, three years later Congress is in a position now where it is about ready to act on the request to approve the start of the procurement phase of the New Attack Submarine program without holding to my knowledge a single oversight hearing focused primarily on that program. Until now, the absence of focused review in the program in Congress has made it relatively easy for the Navy to continue with the program. There weren't any hearings on it so there weren't any extended question and answer sessions, and the program could keep going.

From here on out, however, the very limited record of congressional debate and consideration up until this point will in my view become a source of vulnerability to the program's smooth continuation in the future. That is to say, sooner or later something may draw more attention to the program and at that point someone's going to ask: How did we arrive at this point anyway? How did the program get started? What was the rationale? And at that point, there's not going to be much of a record to point back to, to help answer that question. And that is why the current focus on the Hill on the issue of who should build the New Attack Submarine and the implicit skipping over of the question of

whether we should be building it, whether it's the right boat to build, is something that gives me cause for concern.

My second concern about the New Attack Submarine program, is one that I've had for some time and in fact is one of the things that might begin to draw attention to the program sooner or later once it's underway, namely the issue of affordability, particularly in view of possible future budget levels and the competing demands for modernization funding that will be in place after the turn of the century. As many of you know, I wrote a short report last year that discussed the issue of the affordability of the New Attack Submarine program in terms of the share of the shipbuilding budget that would be required to procure the boat and the numbers that the Navy wants. That report had a conditional conclusion. First, it concluded that a procurement rate of 1.5 boats per year would not require a share of the shipbuilding budget that was much larger than the 20 percent average share that attack submarines had during the cold war, provided that the Navy is successful under the recapitalization plan in its effort to increase the size of the shipbuilding budget by the turn of the century to a figure of about $9.5 billion in Fiscal 1998 dollars, and also provided that the New Attack Submarine doesn't exceed the $1.5 billion cost goal for the follow-on boats in the class. Secondly, the report concluded that a procurement rate of two boats per year, which is the Navy's planned rate, would be affordable if a third additional condition was met, namely, that a decision is simply made to give attack submarine procurement a share of the shipbuilding budget that is about half again as large as that 20 percent historical share—that is, a share on the order of 30 percent.

The appropriations committees last year in their conference report on the defense appropriations bill expressed very strong concerns over the estimated cost of both the lead ship in the New Attack Submarine program and the follow ships. They suggested that their future support for the program would be contingent on the Navy making tangible progress towards the goal of reducing the estimated follow ship cost from the $1.5 billion figure down to about $1.2 billion, which is a 20 percent reduction. To emphasize this point I'm going to read to you the language out of the Fiscal 1995 appropriations conference report in compressed form: "The conferees agree to provide full funding for NAS but maintain strong reservations with the current program. Over the next five years the Navy wants to spend nearly $7.1 billion for

continued development and to initiate production of the NAS. The conferees do not believe the Navy's budget will sustain this level of investment...The conferees continue to believe that the Navy should seek ways to reduce costs below the $1.54 billion plan with a goal of producing a $1.2 billion submarine. The conferees are not convinced that Congress will support the purchase of a $1.5 billion attack submarine should that price be achieved...In its FY1996 budget, the Navy will be seeking nearly $1.2 billion for the NAS program. The conferees do not anticipate providing this amount unless the Navy has demonstrated a commitment to reduce costs and can cite concrete evidence of its ability to produce the NAS program in a streamlined, efficient, and cost-effective manner. The Navy can expect the Appropriations Committees to propose alternatives in conjunction with the FY1996 budget if the Navy ignores this guidance."

It's fairly strong language. Although some of the people involved in the issue have shifted since last year as a result of the shift in the majority control of Congress, many of the people who were involved in looking at the program closely last year are still doing so this year. So it's not clear that this language can necessarily be ignored because we now have a Republican-controlled Congress.

There are a couple of other things that I want to mention to help round out my discussion of the affordability situation. The first is to note that the defense spending levels that are emerging out of the House budget resolution process and the Senate budget resolution process suggest that, given competing Republican priorities for balancing the budget, for reducing federal spending and the size of the government, and for cutting taxes, the potential for increasing defense spending in real terms may be somewhat limited. That is, the difference in size between a Republican defense budget and a Democratic defense budget may not necessarily be as substantial as some people might have anticipated perhaps earlier this year or late last year.

Lastly, it has become increasingly clear over the past year that procurement bow waves are currently building up in various parts of the Navy and in the other military services as well and that this is setting the stage for an intense competition for modernization resources that will occur soon after the turn of the century. Elsewhere in the Navy we are beginning to build up a bow wave in surface combatant procurement and in certain kinds of carrier-based aircraft. The same kind of thing could happen with tactical

aircraft in the other services. There has been now for the better part of a year an issue about Army modernization and a parallel issue regarding Marine Corps modernization. Just a couple of days ago, before the Seapower subcommittee of the Senate Armed Service Committee, there was a hearing on the Navy's littoral warfare requirements and the Marine Corps witness, General Wilhelm, toward the end of that hearing made mention of the fact you can't modernize the Marine Corps on pocket change. That's the sort of situation we might be getting into across the board.

And that's what leads me to the third and final topic that I wanted to speak to you about tonight, which concerns Congress' understanding of the potential value of submarines in the post-Cold War era. As I mentioned at the outset, this is something that I've spoken on to you in the past, and as I said back then, it is something that in my view could play an important role in determining how submarines might fair against other modernization priorities in a competition for modernization resources that now looks like it will take place just after the end of the FYDP.

Three years ago, when I first spoke at this symposium, I argued that the submarine community needed to expand its outreach efforts and begin talking more about missions other than anti-submarine warfare that can be performed by submarines, and about the contribution that submarines could make in post-Cold War scenarios involving adversaries other than the Russians. Today, three years later, I think a lot of progress has been made in this regard. Submarines are much less frequently dismissed outright as Cold War relics. There is also a wider awareness of the value of submarines in missions other than ASW and the potential role of submarines in non-Russian-oriented contingencies. For me, the most vivid example of the submarine community's successful efforts in this regard, the culmination of it for me personally, was a television segment that was broadcast a few months ago on an ABC show entitled *Behind the Scenes*. On this segment, the host, Joan Lunden, was aboard a 688 and it was really striking how the value of the boat was being explained to the audience not in terms of anti-submarine warfare, not in terms of fighting the Russians, but mostly in terms of surveillance, in terms of Tomahawk strikes, and in terms of inserting special operations forces—all that being for regional contingencies. As I sat there watching I thought: "Wow, we're really a long way from where we were three years ago, and from the perception that submarines are basically just ASW platforms that go out and fight

the Russians—the sort of thing that you get when you see movies like *The Hunt for Red October* that focus on that old Cold War scenario." When I was watching the television I thought: "That is a lot of progress from where the Navy and where the submarine community was three years ago."

But there is another side to the story as well. About a year ago, it was becoming apparent that a divergence was developing between the public and private justifications for the New Attack Submarine. The public rationale stressed the need for the New Attack Submarine in connection with littoral operations. But the private rationale focused much more on the need to counter the reduced but continuing Russian submarine modernization effort. This growing disjunction between the public and private rationales was potentially corrosive and was something that needed to be redressed. The only way to do that was to begin talking publicly about the Russian submarine program, even though that meant going against the prevailing wisdom at the time about the collapse of Russian military activity in all aspects, and even though the focus of U.S. defense planning had shifted away from the Russians and was focused now on potential regional adversaries. The Navy began to close this disjunction by speaking more about the Russian side of the justification in public. A key component of the effort, as you'll remember, was the widely disseminated briefing, *The Bear Still Swims*.

This effort in my view succeeded in altering the conventional wisdom that Russian military production had collapsed across the board and it also succeeded in breaking down the apparent taboo that was in place against citing Russian military construction activities as a basis for planning part of U.S. general-purpose forces. It was no small accomplishment for the Navy to buck the tide in that regard and start talking about something that really went against the prevailing tide of opinion and wisdom.

The problem is that this effort has now gone so far that all we're hearing now is Russia, Russia, Russia. It makes me think of Jan Brady from the Brady Bunch always complaining about her sister—"Marcia, Marcia, Marcia!" My concern is that the emphasis on Russia has gone so far that it threatens to undo the progress that has been made to date in breaking down the old stereotype about submarines being primarily ASW platforms. I'm not second-guessing the Navy for choosing to stress Russian submarine production to help make its case for Seawolf-level-stealthy boats, including the third Seawolf. It is a very simple and direct

argument to make. It can be easily understood and it appears to have registered. But if the Russian side of the justification continues to dominate the discussion much longer, then the general image of the submarine might wind up not too far away from where it started three years ago. That is, as something that is perceived primarily as a platform for anti-submarine warfare against now-Russian submarines. Such a one-dimensional image of submarines would not be an advantage in a competition for scarce modernization funds against other procurement priorities that can show direct relevance to meeting needs in regional contingencies. In this connection it is perhaps symbolically a coincidence that tomorrow we are going to witness the opening of another submarine movie, *Crimson Tide*, which based on its trailers appears to be something that very much represents a return to the older stereotyped image of what submarines are and what they do.

I want to close by mentioning one other thing that may pose a challenge to submarines in the future competition for modernization funds, and that is the relationship that submarines have to the revolution in military affairs. Three or four years ago, when the New Attack Submarine was only a general concept, a lot of innovative ideas were in circulation about how submarines in the future might be considerably different from what they are today. And those ideas are still there. You are talking about them at this symposium,. But they appear to be less prominent among the people that I work with now that the New Attack Submarine has become more of a clearly defined entity, and as a result, the arena of submarine design and development now looks less exciting and dynamic then it did a few years ago.

The technologies spoken of a few years ago were not meant for the New Attack Submarine. They are meant for a follow-on generation. So it's not as if the New Attack Submarine is somehow less revolutionary than it was expected to be. I'm not saying that. But I am saying that the emergence of the New Attack Submarine as a more clearly defined design has put it in contrast to certain other modernization areas which, if only by virtue of still being at an earlier stage of development, appear to retain more of a sense of dynamic possibility for how they could form a part of the revolution in military affairs. Within the Navy, the two examples that I think of in particular are the Surface Combatant 21 (SC21), which carries with it the possibility of a revised fleet architecture—something I think a lot of people are

going to be interested in—and the JAST program, which promises to produce an advanced ASTOVL plane—something that could significantly alter the shape of sea-based aviation. People looking at those programs can develop a sense of excitement. They are not going to get that in submarines anymore, because the New Attack Submarine is now a known quantity rather than a general concept into which desires and preferences can be poured.

Developments like UUV's and submarine launched ATCM offer interesting possibilities for expanding the capabilities of the submarine in ways that are very consistent with and will help bring about something that someone might call or be interested in viewing as a revolution in military affairs. Even taking this into account, however, the submarine's current connection to the revolution in military affairs at this point appears to some degree to be rather a passive one. That is to say, submarines stand in relation to the revolution in military affairs as platforms that would inherit a larger share of the Navy and a larger share of Navy force structure if it turns out that surface ships cannot meet challenges to their survivability posed by advanced anti-ship weapons and advanced underwater weapons. In other words, if surface ships drop the ball, submarines can pick it up and thereby become a more dominant part of the fleet. That's a passive way for submarines to be in on the revolution. It might turn out that surface ships won't be able to demonstrate their survivability against advanced weapons. But the submarine community would be in a stronger position in the coming competition for resources if it can show that the submarine will play a key role in bringing about the revolution in military affairs even if surface ships do succeed in demonstrating that they'll be survivable against these advanced weapons. In short, and in conclusion, when it comes to the revolution in military affairs, supporters of submarines should strive to be in the same position that U.S. submarines are in when U.S. naval forces enter into a hostile operating area. That is to say, they should be out in front, leading the others, and not simply waiting for others to fail. Thank you. ■

LIVING IN A TIME OF CHANGE: A CONVERSATION WITH VCJCS

by James C. Hay
and Sam J. Tangredi

In a speech published in the October 1990 SUBMARINE REVIEW, then-Rear Admiral Bill Owens identified five characteristics as imperatives for our strategic offensive forces if they are to keep their relevance in the 21st century: survivability, operational flexibility, targeting flexibility, cost effectiveness, and room for growth. Some might argue that these are also among the personal traits that Admiral Owens has had to master in meeting the challenges of such evolving billets as N-8, the Deputy Chief of Naval Operations (Resources, Warfare Requirements & Assessments), and as Vice Chairman of the Joint Chiefs of Staff.

Dealing with change—both revolutionary and evolutionary—has been a constant theme in Bill Owens' thoughts and actions, and with the publication of High Seas, he has put into print some of his personal views about the changes facing the Naval Service.

While preparing this issue's review of High Seas, we had an opportunity to meet with Admiral Owens and discuss his motives in publishing the book and his evolving perception of the changes and challenges facing our national defense. The following is a summary of our questions and his comments.

Question: Since we represent a submarine-oriented audience, we would like to begin by asking about what you see as the factors affecting the future of our Submarine Force?

Admiral Owens: Two of the factors that submariners really need to consider—in addition to fiscal constraints and budget considerations—are, first, the subtle nature of change in deterrence, and second, the need for increasing jointness.

In looking at deterrence, we need to ask what is it in the *new world order* or disorder of today? Does the current policy of *engagement and enlargement of democracy*—as described in the National Security strategy—require us to maintain the same strategic deterrent as throughout the Cold War. Obviously, this deterrent has moved primarily to sea in our Trident fleet... but will nuclear deterrence be effective in deterring *new world* threats? What does that mean for Trident?

Submariners will continue to become more joint. We are

spending a lot more time at periscope depth. In years past we didn't express much interest beyond SEAL and other operations... but now must continue to think more about how we interact directly with the battlefield ashore.

Question: Talking about the *subtle nature of deterrence* leads to a question you discuss in the book: how long can *single-superpower deterrence* last?

Admiral Owens: That's a good question and one I worry about. The rules of deterrence were obvious in the Cold War. But will potential opponents question our willingness to use force in the future? If we stick to the rules for intervention as expressed in the *Weinberg Doctrine*—the requirement for always using *overwhelming force*—will potential aggressors assume we can't afford to resist their moves? Saddam Hussein obviously did.

That's why I challenge the Weinberger Doctrine's requirement for *overwhelming force* in the book... I think we can sometimes use force surgically and still minimize the risk to our forces. And I think that our willingness to use force in *other than overwhelming* fashion actually enhances deterrence.

I thought my challenge to the Weinberger Doctrine would be the most controversial part of the book, but thus far it hasn't raised much notice.

Question: About the *jointness* factor—what you refer to as the *practical meaning of jointness* in the book—is there a point where a focus on jointness inhibits the development of naval expertise?

Admiral Owens: No, I don't think so. In fact, if I was writing the book today, I'd be considerably more aggressive in promoting the need for jointness. Standing Joint Forces have much to offer; they could be the way we operate in the future. All Naval officers need to develop an awareness of how the other Services operate and how what they do complements our own capabilities. The only way we can develop this awareness is by living it. We would realize considerable benefit if we pushed jointness early in careers; I can envision all midshipmen spending a year at the Air Force Academy or West Point. I don't think we are preparing our junior people well for the adaptive environment of which they will be a part.

Question: What impact do these factors have on sub technology and operations?

Admiral Owens: An immediate problem area is the challenge to maintain our stealth strike capability and yet be able to send and receive intelligence information at the high data rates that current technology is developing. Right now, satellite data rates can't match what is going on in fiber optics and microwave technology... I don't know if that's solvable. If we can't get data to subs at the rates that fiber optics can get it to other joint command nodes—are we going to be out of the loop? Will submarines be able to respond to the calls for sub-munitions strikes ashore? Microwave transmission via UAVs might be one way. I can envision another possible solution involving stringing fiber behinds subs... maybe 200 nautical miles of fiber... but again, we have to satisfy the stealth requirements. Improving C^2 while maintaining stealth is the first technological and operational challenge.

Question: Some say that the Navy's success in getting the different warfare *unions* to agree on the hard downsizing and recapitalization choices of the past few years had more to do with circumstances and your personality and influence as N-8 than the organizational changes in OPNAV. Which is more important: the person assigned to fashion the consensus or the organizational structure?

Admiral Owens: It is not change in organization that is the key; it is change in the **process**. Organization structure doesn't get things done; the process does. The success we had in fashioning and running the R^3B [Resources and Requirements Review Board] was due to the fact that changes to the **process** of decision making were institutionalized. All the participants agreed on the validity of the process.

However, individual leadership is still **critical**. It believe that if you live in a time of change, effective change must be led from the top. There are three elements: you have to have the right people, spending the right amount of time, doing and thinking about the right things. And you must have perseverance and courage.

Question: A final question... given the fact that putting your personal views—as opposed to official policy—into print in book-

length form requires considerable effort and entails some element of risk to your career... why did you write this book?

Admiral Owens: When my son was at the Naval Academy, I saw that despite the ongoing changes following the collapse of the Soviet Union, he and the other midshipmen were still using the same Cold War era texts and studying Naval history and policy in much the same way I did. There wasn't anything written about naval matters in the post Cold War environment. So I decided that it was important to write about the post Cold War world from the perspective of someone who was living through it and dealing with the changes. Even if some of my ideas prove to be real mistakes, I hope that those who lead our Armed Forces in the future might take away some lessons about living in a time of change.

HIGH SEAS: THE NAVAL PASSAGE TO AN UNCHARTED WORLD

by Admiral William A. Owens, U.S. Navy
Annapolis, MD: Naval Institute Press, 1995
188 pages, $27.95, ISBN 1-55750-661-2

Reviewed by Sam J. Tangredi

> "The best way of coping with change will always rest with the imagination and perceptiveness of those who happen to be there when it occurs."

That understated quote—from one of the very last pages of Admiral Bill Owens' High Seas—is the key to understanding his purpose in writing this remarkable and readable volume, the first book-length narrative on the making of post-Cold War naval policy.

High Seas is an unusual introduction to how the Navy took the initiative in adapting to the changes in the world environment

following the collapse of the Soviet Union. It is unusual in that it is a literary hybrid: not quite a history, not quite a memoir, not quite an official policy pronouncement, and not quite an unofficial forecast. Rather, it is a mixture of all the above; nine chapters that promise to reveal how the current Vice Chairman of the Joint Chiefs of Staff *really thinks* about the policy issues facing America and shaping the Navy.

Therein lies the very factor that makes this book remarkable. Bill Owens is an active-duty Admiral, at the mid-way point in his tour as Vice Chairman, with considerable potential for continuing his naval career as a unified CINC (again), CNO, JCS Chairman, or in another high-level policy position. High Seas—though undoubtedly passed without too much dispute through the security and policy review process (after all, he is the second highest ranking U.S. military officer)—is not meant to be official. Rather, the Admiral claims that it represents his personal views on recent and current issues affecting military strategy.

Such candor (as alluded to in the previous interview) entails at least some small degree of professional risk. As any experienced staff officer will admit: once alternatives or disagreements (however small) to official policy are put into print, they frequently have way of polarizing opposition and generating hostility within a decision-making bureaucracy that routinely prizes anonymity. This is particularly true if such unofficial musings appear to conflict with the current political consensus within—or beyond—OSD. As John Collins writes in his classic survey Grand Strategy, "few [military] prophets of change reach print before they retire". Admiral Owens' decision to publish openly at book length indicates an intellectual boldness that is in itself quite admirable.

But is he a prophet of change? Since the theme concerns change, and since the Admiral makes more than a few recommendations about the shape of naval forces to come, it would, at first glance, seem easy to answer in the affirmative. But, as the author modestly admits, the book is more about **dealing** with change than prescribing particular changes. Similarly, the author freely acknowledges his intellectual debt to key members of the leadership who fashioned the current Navy force structure program, particularly the other members of the OPNAV Resources and Requirements Review Board (R3B). As one of the participants—some would say the key intellectual participant—in these strategic and organizational debates, Admiral Owens decided that it was

important to record what he saw and did over the past five years—a task that is as much practical as prophetic. An environment of change was handed to him; his primary objective is to tell the reader how he handled it.

Practical might likewise be an apt description for the Admiral's efforts because, by focussing his book on the impact of the post-Cold War world on recent naval policy, he also frames the questions that naval planners have debated and will continue to debate throughout history: What is the threat? What are our objectives? What should our forces consist of? And how much is enough? His patient treatment of these questions makes the book a good supplemental text for naval planning courses. The issues themselves may have been continuously debated throughout the Cold War, but there remained a rough consensus among American decision-makers. With the collapse of the Soviet Union, the operational consensus known as the Maritime Strategy no longer seemed to make sense in a world where there would be only one global naval power.

Enter Bill Owens the doer, who *happened to be there*. During his prior assignment as Deputy Chief of Naval Operations for Resources, Warfare Requirements & Assessments—N-8 in OPNAV-speak—the author was the head of the R3B and, de facto, the top architect of naval force structure at a time viewed as critical for the very survival of the Navy. The Cold War had just ended; the Bush Administration had unveiled its *reconstitution strategy*; the media, and perhaps even the public, was clamoring for a *peace dividend*; and the events of Desert Storm seem to indicate a need for a new type of maritime strategy. Admiral Owens, as he modestly describes it, may have been but one of a number of officers at the scene, but it was a scene that also included a staff reorganization that broke the power of the *platform barons* and made N-8 second only to the CNO in wielding bureaucratic authority.

Thus, it fell to Admiral Owens to help develop and support the CNO's new vision and at the same time integrate the competing priorities of the formerly *all powerful* warfare specialty *unions*. In effect, his choices became the Navy's resource strategy for air, surface and undersea warfare. Whatever the final result, it was him who sounded the alarm that a defense budget *train wreck* was coming and that the Navy needed to accelerate ship decommissionings and unit disestablishments in order to set the course for recapitalization.

High Seas details these events (and some of the follow-on policies that the Admiral continues to advocate as Vice Chairman) in a deductive manner from strategic theory to specific program. The first chapter begins with the author's theory of post-Cold War deterrence. Middle chapters describe politico-military concerns, technology and current military operations. The final chapters detail the resource decisions behind "Force 2001," the currently programmed Navy structure for Forward...From the Sea, and outline ideas the author calls Force 2021, which is best described as the Navy Admiral Owens would build if he was still N-8 (or CNO) and that he advocates from his tangential position as Vice Chairman. Needless to say, it is his Force 2021 recommendations that are likely to collect the most critical comments from active duty readers.

That is not to say that Admiral Owens shies away from other controversies. On the contrary, there is much to debate in this book. The author admits deliberate provocation in taking on some of the tenets of the Weinberger (some might call it the Weinberger-Powell) Doctrine—primarily the concept that the United States should use overwhelming force whenever we employ military force.

However, his articulated differences with Weinberger-Powell actually appear more semantic than dramatic. *Overwhelming force* can be defined in many different ways by many different beholders. Since the whole point of the Weinberger-Powell Doctrine was to avoid a Vietnam-like open-ended quagmire, and since Admiral Owens expounds on the need to deter such potential quagmires from happening, primarily through superior military technology, the differences appear less pronounced on paper than in the author's perception. Admiral Owens is clearly not in favor of quagmires, even if he would not be as cautious as Admiral Crowe or General Powell in supporting overseas intervention.

Interspersed among the chapters are a number of short fragments of personal observation—appearing somewhat like flashbacks in a movie. These short fragments tie the book together by revealing slices of the author's personal motivation for writing the book and identify the experiences that have shaped the Admirals judgement, particularly his experiences as Commander of the Sixth Fleet. These pithy asides prove to be some of the most engaging portions of the book... sea stories that are anecdotes of impending world changes.

But to fully understand the tone and impact of the book, one

must see it as an exposition in deductive reasoning. Throughout, the author is building his case for why the Navy's recent force structure decisions are correct and why they lead inevitably to his further proposals. Even those who might disagree with these proposals must admire the logic of his approach.

First, the opening chapter lays out the author's view of how to continue deterrence in a *single superpower world*. He posits, as a working definition, that the objective of post-Cold War deterrence is to "dissuade potential opponents from developing or using their military forces in ways the United States finds objectionable".

In itself, that definition might call for the United States to maintain military superiority over potential opponents—begging the question of *how much* superiority? The author pursues this question by initially reversing the perspective and assessing the strategies that an aggressor might use to negate U.S. military superiority. He comes up with four strategies that an aggressor might use: to conduct fait accompli aggression, to threaten high U.S. casualties, to threaten a protracted quagmire, and to split any U.S.-led coalition.

Obviously, these are from Gulf War *lessons learned*—all of them being strategies attempted, albeit ineptly, by Saddam Hussein. Assuming that other potential aggressors may have learned from Hussein's ineptness, Admiral Owens proposes a deterrent posture to counter each. It is only a little simplistic to say that his solution rides on the common elements of: forward military (primarily naval) presence, willingness to use force, information warfare capabilities, and continuing American superiority in military technology.

His second chapter *zeroes in* on the use of military force and the requirements for overseas presence. It is not by chance, to quote that old Soviet introductory line, that the author uses the term *overseas* presence, vice the term *forward* presence. *Overseas* presence is an acceptable joint term that is considered all-Service inclusive; *forward* presence has a decidedly naval ring to it, even if the Air Force is attempting to *virtually* steal it. Nevertheless, Admiral Owens makes the case that post-Cold War/post-budget cuts/right-sized overseas presence is, by definition, primarily a naval task.

He modifies this somewhat by supporting a view—similar in concept to Admiral P.D. Miller's *adaptive force packages*—that the Navy should also serve as a *bridge for other Services*. The

most obvious example is how the Army got to Haiti: in Army helos flying from aircraft carriers. But in essence his arguments follow the Department of the Navy's Forward...From the Sea logic. Given the fact that the ocean is the best internationally-unrestrained anti-gravity platform on which to base military forces near an opponent's territory, his logic is pretty unassailable. Admiral Owens also makes the argument, based again on his experience as commander of the Sixth Fleet, that most nations prefer to have U.S. warships nearby, rather than any other form of foreign military presence.

It is in the area of the commitment to use force that Admiral Owens attempts to take the greatest exception to past doctrines. But as previously discussed, his reasoning for opposing Weinberger-Powell remains unclear. As an alternative, he suggests a "dual doctrine for the use of military force" that accepts most of the Weinberger-Powell criteria but couples it with a "pragmatic view" that "credible, proportional" force can be utilized without risking "heavy casualties". However, an additional feature of this *pragmatic view* is that "a commitment of U.S. forces to conflict can be revoked with relatively small political cost".

Despite the author's claim of a radical departure from Weinberger-Powell, the *dual doctrine*, at its core, still looks pretty close. Weinberger-Powell was developed when the Soviet Union could still play patron in prolonging a Vietnam-type conflict. In Admiral Owens' post-Cold War version, U.S. forces would rely on technological (read overwhelming) superiority; would seek to minimize casualties; and would get out if involvement appears a quagmire. Since the *dual doctrine* does not express support for McNamara-style *body counts*, *signaling* via attrition warfare, or open-ended commitments, it just doesn't seem much of refutation of Weinberger-Powell.

But at the same time, the Admiral's pragmatic view that the United States can revoke commitments and disengage with but *small political cost* remains highly questionable. Quite frankly, the book provides a less than thorough examination of this facet. The Admiral again invokes America's superiority in the military technological revolution and our *sole superpower status* as reasons why it has become easier to disengage from ongoing commitment gone bad. But his argument ends there. Does he mean domestic or international *political costs*? Our recent involvement in chasing warlords and being chased out of Somalia would not appear to be a sterling example of disengagement.

In chapter three, the author discusses the *political leverage of advanced military technology* through a brief look at the potential future of sea-based Theater Ballistic Missile Defense. This is followed by an even briefer chapter on *political-military coordination* that concludes that the State Department should give more cooperation to what DOD is doing via military-to-military contacts.

The fifth chapter is entitled Operations, and it is here that the author discusses the doctrinal change to ...From the Sea; jointness; inter-service rivalry; and Navy-Marine Corps integration. If the reader is confused by his use of the term NETF (Navy Expeditionary Task Force) in the place of the traditional Carrier Battle Group (CVBG) or Amphibious Ready Group (ARG), it's only because the newer term is utilized for program planning, but is still rarely seen in the public media.

It is also in the fifth chapter that Admiral Owens has his first discussion, albeit brief, on submarines and submarine warfare. His conclusions correspond to current wisdom: subs need to get better in operating in the littorals, yet at the same time, need to continue their dominant roles in sea control and deterrence. While there is no discussion of the Seawolf/industrial base issue in the book, the author does argue that submarines can conduct the *stealthy strike* mission faster and more efficiently than B-2 bombers.

Having worked through theory and doctrine, the sixth chapter, entitled Building a New Navy, and the seventh, Force 2001, provide the nucleus for the book's *insider's view* of the initial ...From the Sea-era program planning process. This is the best *unofficial* explanation of these decisions to be found in print, and it will remain of value to naval historians and future program planners as they assess the success of these programs. The author does not attempt to provide the individual program details that appeared in the official pamphlet/monograph Force 2001: A Program Guide to the U.S. Navy (1994 edition), published under Admiral Owens' guidance as N-8. But the overview provided in High Seas fills in the gaps and answers the question of how the program developed within the minds of its proponents.

Finally, the author provides a brief glimpse at his more radical ideas of what might be included in Force 2021 and wraps up with a conclusion of what is needed to forge "the passage ahead"—an ability to deal with constant change. His Force 2021 vision is buttressed by his two controversial platform proposals: mobile sea

bases and the littoral supremacy ship.

The conceptual mobile sea base—a impressive model of which appears in the E Ring not too far from the Admiral's office in the Pentagon—is essentially a series of offshore oil platforms linked together to form a giant air base. This joint-Service air base and arsenal, roughly the size of overseas land bases and capable of handling aircraft as big as the C-5, would be towed or motored (5-10 knots) to a suitable area offshore of a crisis region. Admiral Owens calls the base a *war-fight carrier*, and refers to our current-style aircraft carriers as *presence carriers*—implying that current carriers have a role in peacetime presence, but can not handle the increasing requirements for information warfare/high-tech combat in the littorals. This is premised on a the existence of a *duality* between warfighting and peacetime presence.

The proposed littoral warfare ship is a rough combination of DDG-51 combatant capabilities with the amphibious lift of the LX (future LPD-17 class). Impetus for this design includes both the littoral warfare focus and the resulting consolidation and savings of our shipbuilding dollars.

A third element of Force 2021 is Admiral Owens' proposal to optimize future submarines for battlefield support by designing them to carry specialized, but interchangeable payload/weapons modules. These would consist of interior sections—land attack missile tubes, special operations modules, etc.—which could be physically inserted into a hull that consisted primarily of the reactor and propulsion plant and self-defense systems.

These proposals are intriguing, but their brief treatment in the book leaves a number of potential disadvantages unanswered.

In the case of mobile sea bases, the author's choice of the term *presence carriers* for current CVNs is unfortunate, since it has the potential of alienating the aviation community—the very critics he needs to win over. His discussion of a future Navy with three mobile sea bases and only ten large carriers will require some salesmanship if it is to get off the blocks. As Admiral Owens admits, there is nothing remarkable new about the concept of building a *floating island*. Nor has it been technically prohibitive; the problem remains defensibility. With an integrated air and missile defense, ASW perimeter, and supporting surface fleet, the *war fighting* carrier-island might make the need for overseas land bases completely moot. But defending a stationary platform against a determined opponent may not be as easy as defending a moving CVN. There is also the inevitable inter-Service control

question, reminiscent of the 1960s Air Force demand, as the strategic Service, to operate SSBNs.

His proposal for a one-size-fits-all littoral supremacy ship—potentially 100 of which would replace all combatants and small deck amphibs—also carries the disadvantage of deliberately placing the 500 or so Marines aboard in the midst of combatant-versus-shore or combatant-vs-combatant fire-fights. Admiral Owens admits this drawback, but does not quite wrestle it to the deck.

By contrast, the module submarine concept seems to present the best proposed solution currently being discussed as to how we can optimize subs to conduct littoral and power projection missions while at the same time retain our dominance in sea control and deterrence. Hopefully, the two pages outlining this concept will generate many pages of discussion within the submarine community.

Perhaps that is the greatest strength of High Seas: it can generate a heated discussion of the future at the same time it documents a participant's view of the recent past. You can take exception to the assumptions or particular proposals, but you've got to admire the mosaic.

Given the complexity of the subject matter, the book is remarkably spry. The issues described may seem ponderous to some, but the prose is not. The pace is maintained by sprinkling an occasional controversial idea amidst a patient explanation of why the resource decisions, required to implement a ...From the Sea vision for the Navy, were adopted. There is plenty in this book that Naval professionals and analysts *up-to-speed* with decisions within the Beltway might already know. But for those far removed from OPNAV and JCS who want to know *what in the world is the Navy doing and why is it doing it?*, this book is the open source. The tone remains personal enough to reveal the nuances of Admiral Owens' own reflections about what became (or might become) official policies. At the same time, it is also refreshingly modest.

In short, High Seas does exactly what the author says it does: provide a high-level, inside perspective on the Navy's voyage to an uncharted world. It reflects a passage during which Admiral Bill Owens, more than any other still-serving officer, stood the watch as navigator.

■

IN MEMORIAM
VICE ADMIRAL VERNON L. LOWRANCE

by Austin Scott

Word comes that one of the finest gentlemen the Submarine Force has had the privilege to include has gone. Rebel Lowrance died in Coronado on May 12, 1995. Although I learned from them all, none of my mentors, I think, captured my total admiration and respect to the extent that the Admiral did.

I wasn't his TDC operator in KINGFISH nor his Exec in SEA DOG, but I wish I had been. Instead, I was his token (only) nuke on the staff at Norfolk when he moved from Deputy to COMSUBLANT in 1964. It was my job, among other things, to go with him to explain stuck rods and other arcane nuclear maladies to people like Admiral Page Smith, who was then the Fleet CINC. On Saturdays my collateral duty was golf pigeon.

Toward the end of a long and productive career, Rebel was called upon to preside over the Atlantic Sub Force at a time of explosive change. The 598s were almost ready for an overhaul, the 608s were hauling the water and a new 616 was commissioning almost every month. How the FBMs would take their place with the Air Force in the strategic rack up was not a matter of great consensus, even within the Navy, and the divisive nuke versus non-nuke bickering threatened to pull the force into two unproductive factions.

It took a great professional with infinite patience to hold it all together until the Force could assimilate the change and find its new role and purpose. He was the right individual at the right time and place and it could have gone a lot differently had it not been for Vernon L. Lowrance.

Later, after he and Claire had settled into retirement in Gales Ferry, it fell to him the chore to explain the mysteries of Connecticut politics to Jim Hay and me and a lot of other COs, Subases, and Group Twos. He was always available and, as far as I am concerned, always right.

Personally, he was the complete gentleman, refined and almost regal in stature. Except maybe once one Saturday morning on the Sewells Point Golf course in Norfolk.

Rebel had been needling me without mercy about my golf all morning. I was frequently included in his foursome, but for some

reason (that finally dawned on me) I never seemed to be his partner. On 17 he pulled his drive into the trees on the left. So did I. He had to punch something like a 5-iron out through the trees toward the green. It was on the way to my ball so I drew up my pull cart nearby.

He tried for too much distance. He pulled it again but this time it hit a tree dead on and the ball zipped back past him, away from the hole, maybe 25 or 30 yards, still in the trees.

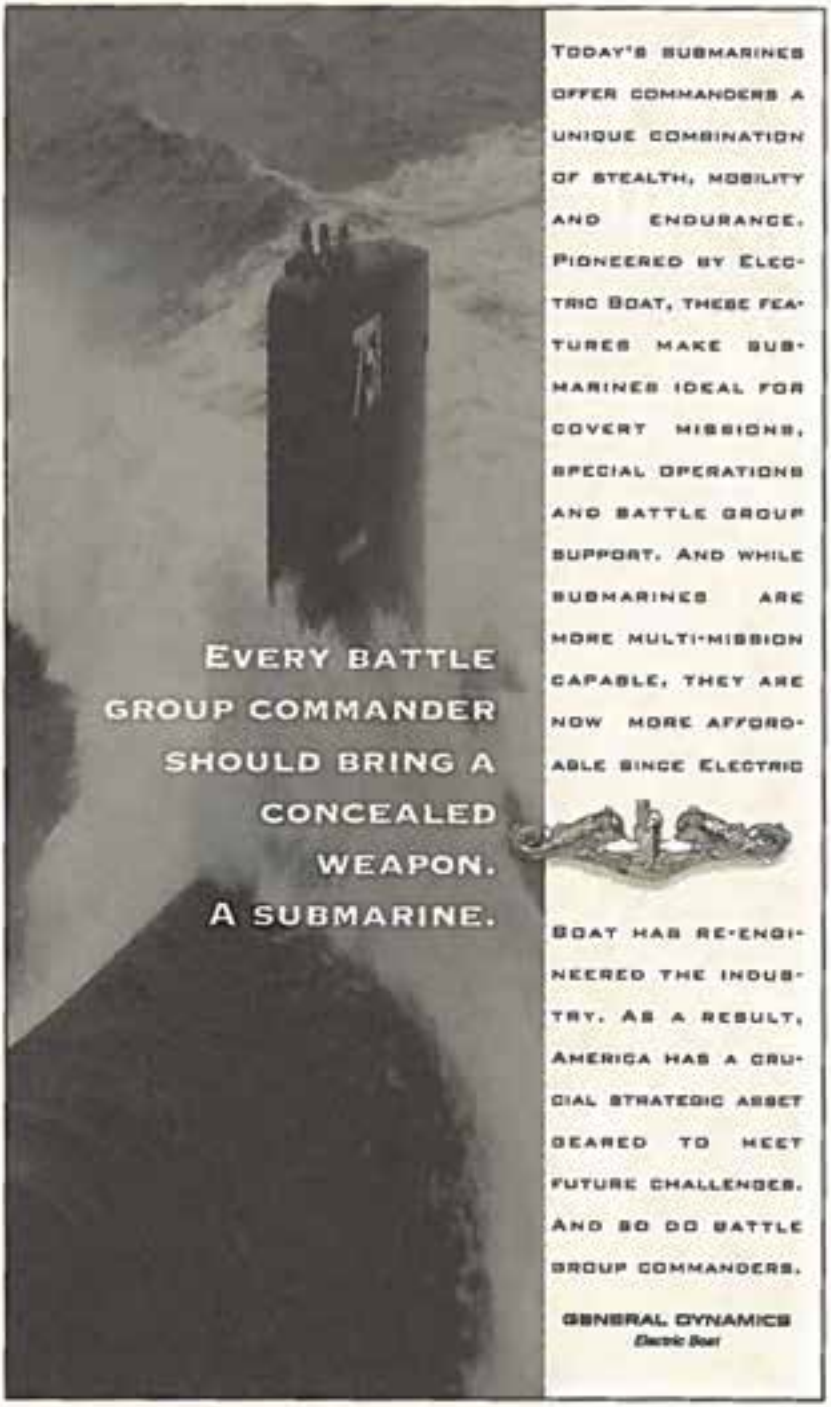
Now I had been at sea for about 10 years by them. I was qualified and had served in destroyers, cruisers and submarines, and I had heard Navy men swear. But I never had heard anything like that. Whoo! It also goes without saying that I survived the severest test of self control I can remember. It goes without saying because I don't today have the imprint of a 5-iron in my forehead.

A superior record in combat, a superb post-war career, a complete professional with the skill of a seasoned diplomat, a fine gentleman; Rebel Lowrance touched our lives—many of us—and we will always be in grateful remembrance of him for it. ■

LOST SHIPMATE

I am trying to locate an old friend that I have not seen in years—E.J. (Jack, Jr.) Welk. If you have any information, please contact me at the following address:

Edward W. Devinney
1002 Eagle Lane
Doylestown, PA 18901



TODAY'S SUBMARINES OFFER COMMANDERS A UNIQUE COMBINATION OF STEALTH, MOBILITY AND ENDURANCE. PIONEERED BY ELECTRIC BOAT, THESE FEATURES MAKE SUBMARINES IDEAL FOR COVERT MISSIONS, SPECIAL OPERATIONS AND BATTLE GROUP SUPPORT. AND WHILE SUBMARINES ARE MORE MULTI-MISSION CAPABLE, THEY ARE NOW MORE AFFORDABLE SINCE ELECTRIC BOAT HAS RE-ENGINEERED THE INDUSTRY. AS A RESULT, AMERICA HAS A CRUCIAL STRATEGIC ASSET GEARED TO MEET FUTURE CHALLENGES. AND SO DO BATTLE GROUP COMMANDERS.

GENERAL DYNAMICS
Electric Boat

THE NEXT SUBMARINE—AND THE ONE AFTER THAT

The Navy Needs the SSN 23—*And* the NSSN

by James Courter and
Loren Thompson

[Former U.S. Representative James Courter was chairman of the 1993 Base Closure and Realignment Commission (BRAC93) and now chairs the defense program of the Alexis de Tocqueville Institution; Loren Thompson is the Institutions's executive director. Reprinted with permission from SEAPOWER, the official publication of The Navy League of the United States.]

In the years since the fall of the Berlin Wall, the future of the Navy's submarine construction program has become somewhat uncertain. The service has taken several steps to adjust to the diminished threat, including scaling back the program to build Seawolf class nuclear powered attack submarines (SSNs). In the late 1980s the Navy was planning to build as many as 29 Seawolfs; the program now has been cut back to a mere three boats. Meanwhile, the Navy has initiated the design of a less expensive follow-on attack submarine, and has concentrated its new submarine construction work at the General Dynamics Electric Boat (GD/EB) shipyard in Groton, Connecticut.

Despite these efforts, critics in Congress and elsewhere have argued that additional changes are needed. Some favor termination of the third ship of the Seawolf class. Others believe that all construction of nuclear powered ships, aircraft carriers as well as submarines, should be carried out at one location. And still others argue that the Navy should build at least some diesel electric submarines rather than the more expensive nuclear boats.

Despite the critics, a careful examination of recent history, current technological trends, and prospective geopolitical developments builds a compelling case for the continued production of SSNs as a reasonable trade-off between future military requirements, current geopolitical uncertainties, and continuing constraints on resources.

Back to the Future

Although the United States fought two world wars prior to the full emergence of Soviet military power in the late 1940s, many policy makers apparently believe the earlier threats of this

century—including the Soviet threat—have no relevance to current or future U.S. security needs. But there is, in fact, a common thread that links all the great military threats of the 20th century to all of the others, and to the equally imposing challenges that America may face in the foreseeable future.

That common thread is geopolitical uncertainty. Three times in the 20th century, anti-democratic coalitions sought to dominate Eurasia. The imperialist threat posed by Germany and Austria Hungary was followed by fascist aggression mounted by Germany and Japan, which gave way to communist-sponsored subversion and political upheaval emanating from the USSR and Communist China. These three challenges largely defined U.S. defense policy and spending patterns in the 20th century.

Such threats were not unanticipated in the 19th century. Geopolitical theorists such as Halford Mackinder and Alfred Thayer Mahan had noted the disproportionate concentration of people and material resources in Eurasia, and correctly concluded that insular powers such as the United States must posses the political, economic, and military strength needed to ensure their access to what Mackinder called the "world island". To allow one power, or a coalition of powers, the theorists argued, to control the Eurasian landmass might set the stage for domination of the whole world. During the Cold War, the strategy of assuring access to Eurasia—and of preventing Soviet and Chinese control of it—was christened *containment* by George Kennan. But the basic geopolitical roots of the Cold War containment policy differed little from the strategic considerations that in earlier times had drawn the United States into global conflicts against imperialism and fascism.

American seapower played a central role in enabling the United States to execute its containment strategy, just as it played an important part in the efforts of U.S. foes—Germany and Japan in World War II and the USSR in the Cold War—to defeat that strategy. Even after the advent of intercontinental aircraft, control of the sea lanes remained essential to U.S. economic prosperity and national security. In fact, the relevance of seapower has increased dramatically as the U.S. economy has become increasingly linked to the economies of Europe and Asia—and, not incidentally, also has become more and more dependent on energy resources, such as Middle East oil, and other vital raw materials available only, or primarily, from foreign suppliers. The breakup of the Soviet Union into numerous republics—four of them armed

with nuclear weapons—has not significantly altered this reality.

What it has altered, though, is the sense of urgency among U.S. decision makers about the need to preserve naval forces adequate to safeguard freedom of the seas and to protect U.S. interests overseas. The United States is currently engaged in its third great demobilization of the 20th century—and, although this one has been more gradual than those following the world wars, it seems to be based on the same assumption that great-power threats to U.S. national security are a thing of the past. The current U.S. defense posture thus is predicated in large part on the expectation that U.S. forces will face no future military challenge more imposing than regional conflict. The budgetary result has been a massive demobilization and downsizing of the force structure. As an ancillary consequence, the U.S. defense production base, including the shipbuilding and aerospace industries, and their suppliers, also has been seriously weakened.

The Relevance of Submarines

Nowhere is this fact more apparent than in the building of nuclear submarines. Thirty years ago, there were half a dozen public and private shipyards in the United States capable of building submarines. Today, there are two—and soon there may only be one. The Navy's current submarine construction plan calls for building a single nuclear powered attack submarine at GD/EB every other year into the next decade. This minimal production rate, combined with the accelerated retirement of boats now in the active fleet, will, by the turn of the century, reduce the navy's SSN fleet to a force of only 45 to 55 ships. (The Clinton administrations's Nuclear Posture Review also has recommended retention of 14 Trident ballistic missile submarines (SSBNs) to serve as the core of the nation's nuclear deterrent.)

Many defense analysts have pointed out that the presently contemplated rate of submarine construction is not sufficient to sustain even the much reduced operational now force planned. Assuming a service life of 30 years for each boat, a build rate of one new submarine every other year would eventually produce a fleet of only 15 submarines. However, because the current inventory of operational SSNs exceeds the established requirement, the Navy does not plan to address the production rate issue until early in the next century. For the time being, its main concern is simply to ensure that a submarine design and production base is preserved. And concern is warranted: if even one submarine is

dropped from the current minimal construction plan for replacement SSNs, the production base for nuclear powered submarines may indeed collapse.

The relevance of attack submarines to future U.S. national security requirements is based primarily on the continuing requirement to guarantee U.S. access to Eurasia, and recent history suggests that major new threats to the stability of the world island could emerge in the relatively near future—initially, perhaps, in the form of regional aggression. The question that arises in that context concerns the future role of nuclear powered attack submarines.

Instability and Persistence

The most obvious such role revolves around the traditional mission of maintaining control of the world's sea lanes. By countering enemy submarines and surface combatants, attack submarines assure the safe ocean transit of U.S. and allied naval and merchant vessels. Because of the general decline in Russian military power, that mission may seem to be perhaps less critical in the mid-1990s than it was during the Cold War. But U.S. naval intelligence officials have warned that *the bear still swims*, and have backed up that statement with hard evidence. The Russians continue to build several new submarines per year, and they have made significant progress in matching—in some cases surpassing—the stealthiness of U.S. submarines, even while they cut back drastically on many other components of their military power. The present instability of the Russian regime, and the persistence of anti-Western, anti-democratic political attitudes in Russia, both strongly suggest that the United States should not allow itself to fall behind Russian's technological achievements in the underwater arena.

A related and potentially more ominous development to which the Russians, and several U.S. allies, have contributed is the rapid proliferation of non-nuclear submarine technologies to developing countries. There are now over 600 submarines deployed around the world, operational in the navies of more than 40 countries. Not all of these submarines pose a direct threat to U.S. use of the sea lanes, but a growing number do. In recent years, Russia and various Western nations have agreed to sell diesel electric submarines to, among other countries—not all of them friendly to the United States—China, Egypt, India, Iran, Pakistan, and Syria. In addition, several of the more developed nations of the Third

World have begun or are beginning to develop an indigenous capacity to produce diesel electric or even nuclear powered submarines.

The problem posed by the proliferation of submarine technology is today more embryonic than urgent, but the pace of proliferation, combined with the strategic location of several recent purchasers of modern submarines, is worrisome. It would require only a few submarines to close the Straits of Gibraltar of the Straits of Hormuz—which would be likely targets of Libya and Iran, respectively, in the event of future conflict. Continued U.S. access to Middle East oil, and to Asian and European markets, demands that the U.S. Navy be prepared to deter or counter major new submarine threats. The current U.S. submarine program is for that reason aimed primarily at developing and building the submarine platforms, sensors, and weapons needed to track and destroy submarines that in the future will be faster, more lethal, and above all, increasingly stealthy.

Land-Attack SSNs

A second key role that attack submarines will in all likelihood be assigned in the future is the delivery of precision firepower against land targets ashore. The precedent for this mission is well established in the fleet of SSBNs, which have for so long been the most survivable *leg* of the U.S. strategic nuclear triad, and which have as their primary if not exclusive mission the destruction of enemy ICBM (intercontinental ballistic missile) silos, air bases, and other strategic land targets. In the future, though, the parallel capability of SSNs to launch conventional cruise missiles against land targets may play a greater role in U.S. naval strategy and tactics. Because of the loss of U.S. bases overseas and the need in recent years, as a result of budget cuts, to *gap* forward-deployed Navy battlegroups in waters adjacent to areas of potential crisis, it may become increasingly necessary for the Navy to rely on submarines to compensate for the absence of surface combatants and tactical naval aviation.

The vulnerability of surface ships to the increasingly sophisticated cruise missiles, land based as well as sea based, possessed by so many Third World nations and regional powers also will require submarines to play a growing role in the land attack mission. A recent war game at the U.S. Naval War College in Newport, Rhode Island, demonstrated that a U.S. surface fleet could suffer severe losses to land based cruise missiles.

There is nothing hypothetical about this threat; it is already a very real and increasingly difficult problem. A long time U.S. ally, France, currently is developing a stealthy, long range cruise missile called the Apache that will be able to use a direct link to reconnaissance satellites for guidance. While the French have no plans to export the new missile, it is clearly only a matter of time before all of the key technologies—stealth, cruise missiles, real-time satellite reconnaissance—are available to other industrialized countries and, probably, to some lesser developed nations as well.

Such trends in the capabilities of weapons will require parallel changes in the operating tactics and battle doctrines of all the world's navies. As it becomes increasingly necessary for major surface combatants and auxiliaries to remain further offshore, the ability of submarines to elude detection will enhance their usefulness in the land attack role. Indeed, some observers already believe that the capacity of submarines to remain stealthy will make the attack submarine the true capital ship of the next century.

Submarines probably also will retain the various ancillary missions, such as reconnaissance and the insertion of special operations forces, that they assumed, or were thrust upon them, during the Cold War. While such roles may not in themselves justify spending a billion dollars or more for a nuclear powered attack submarine, they are a useful complement to the submarine's primary mission and thus, by helping to amortize the SSN's operating as well as initial construction costs, would be a key factor in the overall cost/benefit equation.

Maintaining an Adequate Force

Despite recurrent reports throughout the Cold War that new technology was about to render the oceans transparent, U.S. submarines have remained exceedingly difficult, if not impossible, for adversaries to track and target, thanks primarily to the Navy's long term and continuing effort to improve the stealthiness of its submarines. Although the sensitivity and signal processing capabilities of potential adversaries' sonar systems have improved significantly, they have not managed to match the pace of *quieting* U.S. submarines. Experts are nearly unanimous in believing that American submarines can remain ahead in the survivability race—but only for as long as the Navy continues a reasonably vigorous technology program to maintain—or, preferably, enhance the stealth of its own submarines.

Unfortunately, the survivability of U.S. submarines is only half of the combat equation. The other half is the survivability of enemy submarines, a matter about which the U.S. Navy has good reason to be worried. The newest Russian submarines have actually surpassed the quietness of the most advanced, quietest, and most survivable boats, the Los Angeles class SSNs, now in the U.S. active fleet. The threat posed by Russia's stealth Akula class SSNs imposes new and unprecedented demands on U.S. sensors and weapons. Thus, despite its temporary surplus of nuclear powered attack submarines, the U.S. has two compelling reasons to build new and even more advanced SSNs: (1) it must preserve the stealthiness of its own submarines, and (2) it must overcome the stealthiness of the most advanced foreign built submarines.

The Seawolf SSN program, and the follow-on new attack submarine (NSSN) scheduled to begin construction in 1998, are intended to meet both of these needs. The NSSN will incorporate the advanced quieting, sensor, and weapons technology of the Seawolf in a less expensive hull that is more compatible with anticipated future budgetary limitations. Although it will cost considerably less than the Seawolf, it will be able to accomplish all of the post Cold War missions, including the land attack mission, envisioned for U.S. attack submarines.

The pace of development for the NSSN will not allow construction of the first of the class to begin any earlier than 1998, however. The Navy already has committed $900 million to the construction of a third Seawolf submarine, and in the fiscal year 1996 defense budget is seeking the remaining $1.5 billion needed to complete it. That common sense economic rationale is not, of course, the only reason the Navy wants to complete construction: the third Seawolf will contribute significantly to future seapower capabilities, and will help satisfy a Joint Chiefs of Staff requirement for at least 10 to 12 submarines with Seawolf quality stealthiness by 2012.

The Budgetary/Risk Tradeoff

A recent study of the U.S. submarine production base by the RAND Corporation concluded that little money would be saved by allowing a production gap to develop in the construction of new submarines. The risks, through, would be considerable. The third Seawolf illustrates this finding clearly. The cost of the boat will be $2.4 billion, of which $900 million is already obligated.

Since it will cost at least that much more to terminate contracts and shut down production of the third boat, the Navy faces the choice of spending: (1) nearly $2 billion, with nothing to show for it, or (2) $2.4 billion, to get a very capable submarine.

Its decision to embrace the latter option is driven, though, not only by the budgetary arithmetic, but also by the urgent need to preserve the nation's ability to build submarines. Consolidation of all nuclear ship production at Newport News Shipbuilding—builder of the Navy's nuclear powered carriers and other surface combatants, as well as more than three dozen SSNs and SSBNs—would not only reduce the U.S. nuclear shipbuilding industrial base to one yard, but also would deprive the nation of the pre-eminent submarine integration facility at GD/EB, and of a highly skilled work force as well.

It might at some future date be considered necessary, for strictly budgetary reasons, to consolidate all nuclear construction at one yard, but to do so would mean a loss of flexibility and of surge capacity, and would entail some serious national security risks as well.

Fortunately, that decision does not have to be made this year. The overwhelming case for completing the SSN 23 gives the Navy and Congress the time needed for a detailed and much more comprehensive study of the cost/benefit tradeoffs involved in making what would be an irreversible change in the long term U.S. submarine construction program. For at least the time being, though, the Navy itself apparently has concluded that it makes more sense to keep nuclear submarine production at its preferred source GD/EB, while maintaining the construction of nuclear powered surface ships at Newport News Shipbuilding.

The near term costs of such an approach are outweighed, the Navy says, by the overriding national security need to ensure the preservation of an adequate industrial base. The Navy's industrial plans for submarines are in that respect similar to its military plans. Both focus on the long term, because it is assumed that the long term is when major new threats to national security may arise. A long term approach may, of course, create certain near term budgetary pressures, but those pressures reflect the service's unwillingness to sacrifice its enduring requirements in order to address the more transitory concerns of the moment. Considering the evidence of the recent past and the global trends evident today in technology and politics, it is hard to argue with such an approach. ■

COMPETITION AND SUBMARINES: THE THREE PERCENT SOLUTION

by Dr. Scott C. Truver

[Editor's Note: Dr. Truver is the Executive Director, Center for Security Strategies and Operations, TECHMATICS, Inc., Fairfax, Virginia. He is a noted commentator on naval affairs and is a frequent contributor to the U.S. Naval Institute's Proceedings.]

Three percent! That's the premium the nation must pay to ensure that the ability to design, engineer, and build highly sophisticated nuclear powered submarines will be available at two nuclear shipbuilders in the future. And yet, judging from the row before Congress in the spring and early summer 1995, the Navy's *three percent solution* will be a questionable expense at a time when extreme austerity is demanded as we struggle to rein in the federal deficit, redefine government, and ensure our economic competitiveness in the future. Or so it seems.

The President in February requested funds for the third Seawolf class attack submarine (SSN 23) and long-lead funding for the new attack submarine (NSSN), scheduled to begin construction in 1998. Long controversial in some circles, the *Seawolf issue* has now taken on an added drama, with industry and congressional proposals for killing the SSN 23 and opening up the NSSN program to competition much sooner than the Navy had planned. These pose significant implications for the Navy's near term ability to meet operational requirements against an increasing—not decreasing—undersea threat, as Secretary of the Navy John Dalton acknowledged in late March. More troubling is the fact that these decisions will determine the future of the nation's nuclear shipbuilding industrial base, and whether the U.S. submarine industrial base will continue to meet national policy objectives. Indeed, the two nuclear capable private shipyards, Electric Boat Division of General Dynamics and the Newport News Shipbuilding and Drydock Company, are locked in an increasingly bloody political struggle for survival into the next century.

National Policy in Doubt?

U.S. policy for the nuclear shipbuilding industry was outlined in the Department of Defense's 1993 Bottom Up Review. The BUR required that the U.S. maintain two nuclear capable ship-

yards to ensure the future health of the American nuclear shipbuilding industry. The Navy is also committed to regaining and sustaining U.S. undersea superiority to hedge against recent developments and future threats to U.S. and allied naval forces. To achieve both goals, the U.S. drew up a Solomon-like plan calling for a division of labor between Electric Boat which will build SSN 23 and the NSSN, and Newport News which will continue to be the sole source shipyard for nuclear aircraft carriers. This program was launched in 1994, when Newport News received the contract for the ninth Nimitz class nuclear powered carrier (CVN 76) and Electric Boat began the design of the NSSN.

The need for nuclear powered submarines (SSNs) has not diminished with the fall of the Berlin Wall, although many people in the Administration, Congress, and the public remain unconvinced about the real dimensions of the undersea threat to U.S. interests and forces. The unique capabilities of the SSN give it a pivotal role in U.S. military strategy, doctrine, and operations. The SSN's stealth and multi-mission flexibility; its multi-warfare arsenal of weapons, including Tomahawk missiles, mines, and torpedoes; its ability to respond rapidly and covertly to crises without aggravating political situations; and its ability to remain on station in important world regions almost indefinitely, without logistics support, combine to give SSNs a versatility found in few other warships.

The SEAWOLF and NSSN were designed to ensure that the U.S. sustains the undersea superiority our Submarine Force has enjoyed since the 1950s—a superiority that we are in danger of losing. Russian submarine designers have stated that they have as their primary goal to design the practically invisible, undetectable submarine. This ambition is underscored by the fact that they have developed, tested, and deployed *fourth generation* quieting technology intended for this new design submarine, identified as the Severodvinsk class, which the U.S. intelligence community expects to join the fleet by 2000. New construction Akula SSNs have already taken this technology to sea, with six Russian SSNs demonstrating greater stealth—the critical factor in undersea warfare superiority—than the U.S. Navy's improved Los Angeles (SSN 688I) submarines in many acoustic domains. Additionally, analysts expect that a *fifth generation* SSN is under development for the first decade of the 21st century and a new design Russian

SSBN will begin construction by the year 2000. Finally, two new, advanced, conventionally propelled submarines are ready for building should customers materialize.

Russia, among others, is also selling submarines on the world market, offering to practically any country the means to counter U.S. *from the sea* strategies and operations directly. Indeed, the regional submarine threat to U.S. and friendly naval forces is expanding, with nearly 45 countries operating more than 600 submarines, while surface and airborne threats continue to evolve. Not all of these submarines constitute even a potential threat to U.S. military operations or commercial shipping for a variety of reasons: training and crew proficiency, material readiness, and basic system/platform capability. **But some clearly do,** while mines, torpedoes, precision-guided munitions, and cruise and tactical ballistic missile systems are increasingly available to friendly and not-so-friendly nations alike. Iran, for example, has reportedly acquired from China the EM-52 rocket-propelled, rising naval mine, patterned after the Soviet/Russian GRVM, that can be deployed from the two or three Kilo submarines (perhaps armed with wake homing torpedoes) it is acquiring from Russia. This development, coupled with an Iranian military buildup on several islands near the Strait of Hormuz, has exacerbated concerns about Iran's threat to international shipping in the Arabian Gulf. Similar concerns are focused on other strategic waterways and regional naval arms buildups.

Access to sophisticated airborne and space based sensors, once the province of a few technologically advanced countries, will ensure that more regional powers will have the capability to detect and target surface ships, almost at will. If you can be seen (or heard), you can be targeted, and in many cases, attacked. This is a troubling aspect, or what some in the U.S. defense community are calling the Revolution in Military Affairs (RMA). Although the RMA is usually described as the panacea for many U.S. operational shortcomings, advanced technology may *cut* in ways we cannot predict, and not always to our advantage, as Rear Admiral Dennis Jones, Director Undersea Warfare (N87) acknowledged at the June 6 session of the Naval Submarine League's Annual Symposium.

The U.S. naval intelligence community has thus concluded that Russia has retained its ability to build and operate technologically advanced submarines, some of which are aggressively marketed

for foreign sales. Furthermore, regional navies continue to enhance their own largely sea-denial naval capabilities that could challenge U.S. naval strategies. For these reasons, Secretary Dalton, in a May 4, 1994 letter to Senator Sam Nunn, then-Chairman of the Senate Armed Services Committee, concluded that the Navy's submarine programs, especially SSN 23, were well grounded:

> "The third Seawolf...provides significant military capability. It will support littoral operations [in] regional conflicts, including covert delivery of Special Forces, as well as sustain undersea battlespace superiority and joint-integrated regional dominance. Seawolf's inherent stealth, large payload and advanced combat system provide a necessary hedge against the Russian threat and capability... [T]he Seawolf fulfills a valid military requirement that by the end of the next decade we must have 10-12 submarines with Seawolf stealth (quieting)."

Thus, the U.S. must continue to maintain a modern, advanced Submarine Force, as well as other elements of 21st century naval force, to counter these and other growing threats.

<u>An Atrophying Industry?</u>

This Submarine Force cannot be supported without an equally modern and sophisticated industrial base. The threat to U.S. undersea superiority is accompanied by another challenge, one that could have equally severe implications: the threat that America's submarine industrial base could vanish. The national objective to preserve a robust nuclear shipbuilding industry will not be met without procurement of SSN 23 in 1996 as a *bridge* to production of the NSSN in 1998. Nearly 40 nuclear submarines were approved during the 1980s. The Navy authorized only two submarines in 1991 and one since then. Without SSN 23 there will be a seven year drought in submarine authorizations which could have a devastating effect on the whole range of suppliers and producers who support our submarine programs.

Certain components are unique to nuclear submarines and have only one market—the U.S. Navy. More than 600 major equipment vendors and 3000 other companies in 43 states contribute to the U.S. submarine industrial base. Some of these are large and

divers firms; many others are more highly focused and specialize in submarine work. For example, there are only a few firms in the nuclear propulsion business, and the Navy's nuclear propelled ship programs are currently the *only* nuclear new construction projects underway in the country. Moreover, the knowledge and skills required for submarine design and construction are unique and perishable. Without exercising these skills through actual shipbuilding, they will rapidly erode as trained workers find jobs in other fields and are not replaced by a new generation. Given the degree of specialization involved in submarine construction, the submarine industrial base would be extremely difficult to reconstitute in the event of a shutdown.

The Navy's decision to build submarines at Electric Boat and aircraft carriers at Newport News will preserve the critical design and production components of the *total* nuclear shipbuilding industrial base in the most efficient and effective manner. Although Newport News and Electric Boat will specialize in different types of ships, they will share a basic nuclear engineering capability that will provide a *hedge* in the event of disasters, natural or otherwise—witness the 1993 World Trade Center and 1995 Oklahoma City bombings—that could render one of the shipyards incapable of carrying out work. Retaining two nuclear shipyards is needed if we are to retain the ability to increase submarine production in response to future threats and developments that can be discerned only dimly, if at all, in 1995. It also is the most practical means to ensure healthy and fair competition for *future* nuclear submarine construction.

Procuring the NSSN through a single source contact will not lead to decreases in production efficiency or significant price increases due to the lack of competition. Electric Boat has instituted a comprehensive program for rationalizing its facilities and enhancing the flexibility of its workforce to meet the anticipated future low rate production workload and will reduce its workforce by 70 percent from 1993 to 1998. The Navy has embraced the numerous lessons learned from the Seawolf program and designed and structured the NSSN program to be a *partnership* between the Navy, Electric Boat, and key subcontractors throughout the U.S. The close working relationship has already reduced disruptions common at the start of such a complex program and will help ensure affordability cross the board. Through a Revolution in Manufacturing Approaches—integrated

design/production teams and the use of highly sophisticated electronic visualization design tools—to match what the Defense Department is calling the RAM, the design of the NSSN is specifically tailored to the design, engineering, business, and construction practices at Electric Boat. Electric Boat has unrivalled expertise in structure acoustics, propulsors, and other critical areas of submarine design. Like Newport News for nuclear carriers, Electric Boat is a national asset that must be preserved for future generations of nuclear propelled submarines. And, as Navy leaders have acknowledged recently, a close reading of the BUR admitted the likelihood that submarine construction would be opened up for competition, when it made sense to do so.

Under Attack!

However, the nation's plan has come under attack, with some, like Senator John McCain (R-Az) and, not surprisingly, Senator John Warner (R-Va), calling for the NSSN program to be opened to competition between the two nuclear yards. In Congressional testimony in March and May 1995, Newport News told Congress that between $5B and $10B could be saved by killing the SSN 23 and, through a competitive procurement, building the lead and *all* follow-on NSSN at Newport News. Such claims apparently energized Representative Duncan Hunter (R-Ca), who called for killing the SSN 23, providing additional funds to modify the SSN 22, already about 40 percent complete, for special operations tasks, providing funds to Newport News to enable the firm to participate in the design of the NSSN, undertaking additional submarine R&D to ensure the NSSN ultimately incorporates the best available technologies, and open up the NSSN program to competition. The proposed House Defense Authorization Bill, H.R. 1530, specifically directs the Secretary of the Navy to "to select on a competitive basis the shipyard for construction of each vessel for the next generation attack submarine program".

The Navy has responded that such proposals, while intriguing on the surface, have several serious flaws that, rather than saving billions, could produce significant long term costs for the U.S. That was the essence of then-Assistant Secretary of the Navy (RD&A) Nora Slatkin's testimony of May 16 before the Seapower Subcommittee of the Senate Armed Services Committee. (Others appearing at the hearing acknowledged that some savings were possible, but not to the extent claimed by Newport News. The

General Accounting Office, for example, stated that Newport News' claims could not be validated and concluded that "several questionable assumptions and computational errors" could have resulted in higher estimates of efficiency savings than were really likely.) Representative Hunter's proposal would put submarine suppliers at significant risk by killing near-term construction *and* delaying—although that is not intended, of course!—the start of the NSSN. We would end up getting one fewer submarine than currently planned, without saving *significant* resources in the process, as the proposals promise.

Introducing competition at this time would be different. There is simply too low a rate of production to sustain work at two yards simultaneously, at least in the short run. The lead NSSN will be requested in fiscal year 1998 and the second in fiscal 2000. Low rate production of two submarines per year will begin, under current planning assumptions, in fiscal 2002, and that may be optimistic! At that time competition would make sense, but only then. Competing the lead ship would jeopardize the survival of Electric Boat, and put the national policy at risk. Second, the proposal is also contingent upon a minimum commitment to Newport News of five NSSNs, a commitment that the Navy is unable to make at this time, or ever, as the history of the Seawolf program bears out. Originally 29 Seawolf SSNs were to be acquired. Now, at most only three will be built. Despite planning factors that show 30 NSSNs, no one truly knows how many are in the offing.

Furthermore, the Navy believes that the competition proposal entails hidden costs for the nation. It ignores the costs the Navy would incur if Electric Boat were to close, costs which, in the short term, would include a serious disruption in the NSSN design/build process, unbudgeted design rework and transfer costs, and paying for environmental clean up. In the longer term, by allowing Electric Boat to close the Navy would be foregoing any possibility of future competition. The Navy would have no alternative source should Newport News fail to meet cost, schedule, and performance specifications; in essence it would be held *hostage* to a single supplier for a critically important element of U.S. military power.

The proposals are also based on assumptions about significant cost savings from killing the SSN 23. This would ignore the compelling near term requirements for advanced nuclear subma-

rines in the fleet. But, more importantly, it would impose severe cost penalties and the loss of nearly $1B in prior year investment, in addition to other costs, including additional funding to modify the SSN 22 and to bring Newport News up-to-speed on the NSSN design process.

The Three Percent Solution

Maintaining the vital U.S. nuclear industrial base should not require such a draconian choice. Both Electric Boat and Newport News offer strong capabilities and are critical to the future of the nuclear shipbuilding industrial base. According to Navy data released by former Assistant Secretary Slatkin, the *premium* for keeping both yards in business amounts to about three percent of the Navy's nuclear shipbuilding programs.

Nuclear powered attack submarines are at the heart of U.S. military power. The third Seawolf, SSN 23, and the NSSN will provide the U.S. with the necessary capabilities to ensure our Navy's historical dominance under the seas is continued. Retaining two nuclear capable shipyards by building new submarines at Electric Boat and nuclear carriers at Newport News will protect the industrial base needed to construct these ships while also providing the nation with the highly capable, modern submarines needed to counter the enhanced abilities and the proliferation of submarines throughout the world.

The Navy's strategy will ensure that the nation will maintain the submarines industrial base that can meet our force level and operational requirements at an affordable price. And it will ensure that U.S. excellence and superiority in undersea warfare can be preserved to meet future operational needs. As the Defense Department looks to garner about three percent of the nation's gross national product for military requirements in the 2000, the *three percent solution* for nuclear shipbuilding industry, an insurance premium as a hedge against bald uncertainty, looks to be an attractive bet. ■

SUBMARINE HISTORY IN NORTHERN NEW JERSEY?

by R.J. Pellegrino
New Jersey Naval Museum

Pondering through the annuals of your mind, the last thing you could ever imagine is that there is a large amount of submarine history in the great state of New Jersey. Places like Groton, Norfolk, San Diego and Pearl Harbor conjure up images of famous naval vessels, but Paterson, Totowa or Hackensack, New Jersey? These places bring thoughts of silk, guns, textiles and other post-revolutionary industrial history. Believe it or not, the City of Paterson is where the modern submarine began.

John Philip Holland, *The Father of the Modern Submarine*, started his career as a school teacher in Paterson, but was always fascinated with the concept of the submerging vessel. In 1878 Holland completed his first design which was simply named HOLLAND 1, and was 14 feet 6 inches in length. The submersible weighed 2.25 tons. She was first tested by Holland in the Passaic River that runs through Paterson. During her trials, she ran at approximately 3.5 knots, and could remain submerged for about one hour with a crew of one.

Unfortunately, HOLLAND 1 was not of the caliber the inventor wanted, but this vessel did teach Holland many different things that would be incorporated into his later designs. Each submarine that Holland created was really a learning experience until HOLLAND 6, which was finally purchased by the United States Navy in 1900 to become the first vessel in the American Submarine Force.

Holland was afraid of competition after the testing of HOLLAND 1. The submersible was scuttled secretly in the Passaic River and was not found until a few years ago by complete accident. To this day the small sail is still missing, waiting for the day it shall be recovered.

HOLLAND 1 and her sister ship, HOLLAND 2, are on permanent display at the Paterson Museum in the Thomas Rogers Building at 2 Market Street, Paterson, New Jersey. The phone number is (201) 881-3874. The museum is open to the public Tuesdays through Fridays from 10 AM to 4 PM, and Saturdays and Sundays 12:30 PM to 4:30 PM.

HOLLAND 2, also known by some as *The Fenian Ram* is on display next to her sister. It is from this design that we could see

creation of the modern submarine—a vast change in design in only a three year period. The *Fenian Ram* is 31 feet long. She has a gross weight of 19.5 tons, and was capable of sustaining a crew of three for varying amounts of time. Her maximum speed was approximately 9 knots.

This vessel gave Holland the direction he needed to sell his first submarine nine years later. The museum also has the most complete collection of notes, letters, drawings, diagrams and specifications belonging to John Holland on display anywhere.

Not far from the museum is the Church of the Holy Sepulcher, located in Totowa, New Jersey. Next to this beautiful old church is the final resting place of John P. Holland. The grave is looked after by the members of the Submarine Vets, Inc. of Northern New Jersey. A few years back funds were raised to give Mr. Holland a memorial tombstone with the famous copy of him emerging from one of his designs wearing his distinctive derby. This cemetery is also open to the public and is located approximately 10 minutes from the Paterson museum.

Unlike the Paterson museum, the New Jersey Naval Museum does not receive funds from any municipality, state or federal entity. This museum, which is located along the banks of the Hackensack River in the City of Hackensack on the corner of River and Court Streets, is home to the World War II submarine USS LING (SS 297). This museum is open from 10 AM to 5 PM Wednesday through Sunday, but the facility is used by veteran and reserve organizations after hours. Any funds used by the museum are a result of tours, grants or donations of money and materials.

The most unlikely sponsor, but the most recently generous to our cause has been the Home Depot store #909 located in Rosbury, New Jersey. Their concern for history and maintaining a permanent record of our American past has been unmatched. With their help LING and our missile collection have gotten a much needed facelift, making this museum not only enjoyable to history buffs but to American's youths, inspiring several to enlist in the Navy's Submarine Force.

The museum had a beginning unlike most others. Members of the Submarine Memorial Association of Hackensack, New Jersey asked if they could have a vintage World War II submarine torpedo to set up a memorial to all the fallen submariners. The request came back from Washington approved, but the torpedo would come with the submarine also. To everybody's amazement,

USS LING (SS 297) was coming to downtown Hackensack from its last tour of active duty as a training submarine at the Brooklyn Navy Yard. This happened as a result of an act of Congress, 28 June 1972, and on 13 January 1973 LING arrived at Borg Park for her current berth.

It was almost fate that brought LING to New Jersey. Any avid fisherman could tell you that SS 297 was not named after a famous Chinese battle but after a fish also known as *red haddock* found off the coast of New Jersey.

Funds were raised and LING was brought back to pristine vintage condition, as it is in today. Today efforts are underway to personalize the interior of the boat by including pictures, bed rolls, cookware, etc. All contributions, whether financial or of authentic memorabilia, would be greatly appreciated. Remember this is a non-profit, tax exempt organization that relies solely on donations and fund raising. Please call (201) 342-3268 or write: Submarine Memorial Association, P.O. Box 375, Hackensack, New Jersey 07862.

LING comes from a proud family of submarines. She was one of the 119 Balao class submarines that made up the bulk of the American Submarine Force up until the 1960s when nuclear power became the choice of propulsion. This class was not much different from the previous Gato class except that the Balao class (thick skin) had a high tensile steel hull compared with the mild steel of the (thin skin) Gato class. This helped the submarine reach an operating depth of 400 feet compared to the previous 300 feet and helped the submarine while being depth charged.

The building yards for these submarines were: Portsmouth-44, Electric Boat-40, Manitowac-14, Cramp-10, Mare Island-9, and Boston-2. The Balao class was built with eight compartments and the conning tower giving them an overall length of 311 feet 8 inches and a maximum breadth of 27 feet 3 inches. Submerged they displaced 2415 tons compared to surfaced 1525 tons. They had a rated fuel capacity of 116,000 gallons helping them obtain an endurance for a 75 day patrol period.

The Balao class had four main generator engines which gave them a maximum submerged speed of 8.75 knots and a surface speed of 20.25 knots. At 10 knots they had a surface cruising range of 11,000 miles while carrying a crew of 10 officers and 70 enlisted.

These formidable weapons of war had 10 torpedo tubes—6

forward, 4 aft—while carrying a loadout of up to 24 torpedoes or two mines for every one torpedo. Topside these vessels had either one 4"/50 cal. or 5"/25 cal. originally.

Unfortunately for LING, she was completed too late for a tour of duty in World War II against the Japanese due to construction problems at the Cramp Shipyard of Philadelphia. Her keel was first laid on 2 November 1942 and she was launched on 15 August 1943. With the problems of Cramp construction, the Navy removed LING and three other boats, USS LANCETFISH (SS 296), USS LIONFISH (SS 298) and USS MANTA (SS 299) and sent them to be completed at the Boston and Portsmouth shipyards.

LING was completed and commissioned at the Boston Shipyard on 8 June 1945. She sailed, under the command of Commander G.G. Molumphy, to the Caribbean Sea headed for the Panama Canal when the atomic bombs were dropped on Japan, ending World War II. LING returned to New London until she was decommissioned on 26 October 1946.

LING slept quietly until she was brought back into service as a reserve training vessel for Naval Reserve Division 2-23 and 3-55 at NRT Brooklyn, New York from March 1960 through 30 June 1971. On 1 December 1962 she lost her designation of (SS) and received her (AGSS) designation. After training numerous reserve submariners for duty aboard a submarine, she was finally stricken from the Navy roster on 1 December 1971.

LING might not have the same historical significance as some of the more famous submarines of the past, but LING is here today as a reminder of what was accomplished by submariners of the past and what shall be done by submariners of today and tomorrow.

To give you an idea of what submarines did during World War II, the U.S. Submarine Veterans of World War II published these statistics:

> "Many U.S. submarine veterans feel that their activities were not made public enough to let the population know how much they accomplished during World War II. Less than two percent of U.S. sailors served in submarines, yet that small percentage sank 201 Japanese warships, including: 1 battleship, 4 large aircraft carriers, 4 small aircraft carriers, 3 heavy cruisers, 8 light cruisers, 43 destroyers, 23 large submarines and 1113 merchant ships of more than

500 tons.

In all our submarines sank more than 55 percent of all ships sunk. More than surface ships, Navy air and the Air Corp combined. Our submarines did all that plus they laid mines, hauled ammunition, transported troops, rescued refugees, deployed secret agents, delivered guerrilla leaders, and rescued 504 fliers, including President George Bush. The worst statistic of all is that submariners had the highest loss rate of any Navy unit."

It is for these reasons that these submarine memorials need to be maintained and preserved. These vessels symbolize the unselfish accomplishments of submariners and the proud history of not only the Submarine Force, but that of the entire United States Navy. Every time you pass through Northern New Jersey I hope that you remember that it all started here with John Holland, the father of the modern submarine.

On 4 December 1994, a Pearl Harbor memorial service was held at Borg Park, where LING is moored, honoring the fallen during the sneak attack upon Pearl Harbor. The two main guest speakers, Rear Admiral A.H. Konetzni, Jr., COMSUBGRU SEVEN, and Commander D. Govan, Commanding Officer USS COLUMBIA (SSN 771), were very surprised at the submarine history of Northern New Jersey, and the condition of LING and her collection of vintage missiles. Chief Warrant Officer 4 J. Donaldson, COMSUBLANT, a former crewmember of LING, was also taken aback at the great condition of the boat he served on for many years. I hope that the readers of this article also have their interests peaked to make the trip to see where it all began.

Feel free to call me or any of the staff of the New Jersey Naval Museum at (201) 342-3268 or fax (201) 927-4645 if you have any questions, want to make donations, wish to talk or wish to use the facilities for your organization. ■

SHALLOW WATER UNDERSEA WARFARE TRAINING RANGES

by Robert E. Janiesch
NUWC, Division Newport

Tactical training ranges provide the capability for measured performance and feedback in a realistic environment. During a training exercise, the positions of all the participants are measured, time-tagged, and recorded in real-time. Training analysts review the data in both real-time and post-exercise modes. Additionally, real-time display of the track data is used to provide range safety during the exercise. At the end of the exercise, the analysts provide debrief packages to the participant crews using a variety of methods. In some cases, such as for the air ASW crews training at the Southern California Offshore Range (SCORE), the analysts provide a live debrief to the crew—complete with playback of the exercise data. This is the most effective training, with the crews getting feedback immediately after the exercise while it is still fresh in their minds. On other occasions, only a debrief package containing plots or a videotape is mailed to the crew. The latter case is most typical of submarine crew debriefs.

An important part of making a training exercise realistic is to provide a target or an opponent for the crews. On undersea warfare (USW) training ranges, typically a submarine or a mobile target is utilized for this purpose. Exercise torpedoes are fired by the participants both to gain experience performing this function, and to allow evaluation of weapon employment. The tracks of the weapons and the mobile targets are measured and recorded by the range system to allow a complete picture of the exercise.

The decline in resources will have a direct impact on how these Navy exercises are conducted. Fewer mobile targets are going to be utilized, and the number of actual torpedo firings will decrease. Additionally, as the fleet decreases in size, submarines will experience increasing difficulty in providing live-target services. However, training—with its ability to serve as a *force multiplier*—will be more important than ever.

The integration of a simulation/stimulation capability into an underwater training range provides a cost-effective means to increase training realism in the face of declining assets. Additionally, other techniques to improve data collection and mission

playback serve to further enhance the training value of an exercise.

The world, and therefore the types of conflicts in which the U.S. could potentially be involved, has changed in recent years. Previously, the Soviet Union was our primary adversary, and most of our naval operations occurred in open ocean, deep waters. As a result, the underwater training ranges that have been developed over the last 30 years have been in deep water, typically 3,000-15,000 feet. These ranges include the Barking Sands Tactical Underwater Range and its expansion (BSURE) off Kauai, Hawaii; the SCORE; and the Atlantic Fleet Weapons Training Facility Underwater Tracking Range in the Caribbean.

Today, the Navy is much more likely to be involved in regional conflicts that will require it to operate in shallow, littoral waters. Currently there are no shallow water ranges suitable for training on the same scale as provided by the current deep water ranges. In response to this shortage, the Navy has developed and approved a Mission Need Statement for a Shallow Water Undersea Warfare Training Range (SWTR).

The Navy currently has several programs in various stages of realization to address its future tactical training system needs. The three systems most applicable are the Battle Force Tactical Training (BFTT) System; the Joint Tactical Combat Training System (JTCTS); and the major focus of this paper, the SWTR. All of these systems utilize simulation techniques in a shipboard setting to enhance the training received by the crew.

The BFTT system supports pierside training for surface ships and submarines. Future onboard trainers (OBT) that provide simulated targets by stimulating the ships' tactical sensor systems will have external control interfaces. Scenario generators located at the Fleet Combat Training Centers will be networked to the OBTs via the control interfaces, providing the ships with a common synthetic environment and threat scenario. Feedback from the ships (simulated weapon employments, evasive maneuvers, etc.) will be input to the scenario generators for realistic threat response and appropriate kill removal. Submarine shore-based trainers will also be integrated into BFTT. The onboard submarine systems used to support BFTT will also be required for the simulation capability of the SWTR.

The JTCTS is the Navy's and the Air Force's premier program for integrating a simulation capability within a range system. This

program is primarily focused on surface and air combatants, with the SWTR providing the real-time connectivity for the submarines at locations where the JTCTS supports littoral warfare on the east and west coasts. The JTCTS will provide radio frequency (RF) links to the participants, interfacing with the tactical systems to allow simulation of threat targets onboard the range participants. Conceptual operation is similar to that described for the BFTT, except that the participants are flying or underway as opposed to being pierside.

The SWTR will consist of a large area (500 square nautical miles) with underwater instrumentation providing tracking of range participants that may include submarines, torpedoes, mobile targets and other future undersea vehicles (such as unmanned underwater vehicles (UUVs)), as well as support simulation capability for the submarines. Water depths will typically be 120-1,200 feet. Two SWTRs are budgeted to be built, one on each coast.

The primary function of a training range is to provide ground truth position of all participants. All current ranges, both deep and small-area shallow, use a tracking technique referred to as multilateration. Three or four receive hydrophones are required to be within the hearing radius of the acoustic pinger mounted on the undersea vehicle to be tracked. The distance between the pinger and each hydrophone is calculated based on a time of arrival measurement. The position of the vehicle is then calculated based on the known position of the hydrophones. This technique provides high accuracy in deeper water for a reasonable investment in hydrophone quantities.

The major cost driver of any undersea range is the in-water hardware that consists of the sensor nodes, the cable, and the installation associated with the hardware. This cost factor is particularly acute in the harsh shallow water environment where the sensor node structures and cable are typically more expensive because of their required ruggedness, and the installation is more costly because of the potential need to bury the cable. The number of sensors required for a particular sized area is greater in shallow water than in deep water because of the shorter acoustic propagation paths that are supported in shallow water.

The goal is to minimize the number of sensors, and therefore the overall cost of the SWTR. The design of the SWTR will require only one sensor node to be within hearing range of the vehicle to obtain its position. There are a variety of techniques

that are currently under development for single sensor tracking.

One technique requires the acoustic telemetry of positional data from the underwater vehicle to the hydrophone. Almost all undersea vehicles have some type of navigation system, spanning from simple dead-reckoning schemes to complex inertial systems. Data from these systems would be tapped into and transmitted by the pinger to the hydrophone. Combining these data with single-axis range to the hydrophone using a Kalman filter, results in an accuracy that meets the training range requirement.

Another technique that can be employed is the use of a multimode hydrophone that provides a measurement of bearing angle. That measurement, combined with the single axis ranging and telemetered depth (measured onboard the vehicle by the pinger), yields a position.

In Figure 1, the equipment onboard the submarine, an OBT that is an integral part of the submarine, outputs the proper stimulation signal to the front end of a particular tactical system based on the target being simulated. The OBTs are typically capable of generating a number of *canned* scenarios. The crew operates the tactical systems, and reacts based on the target's actions.

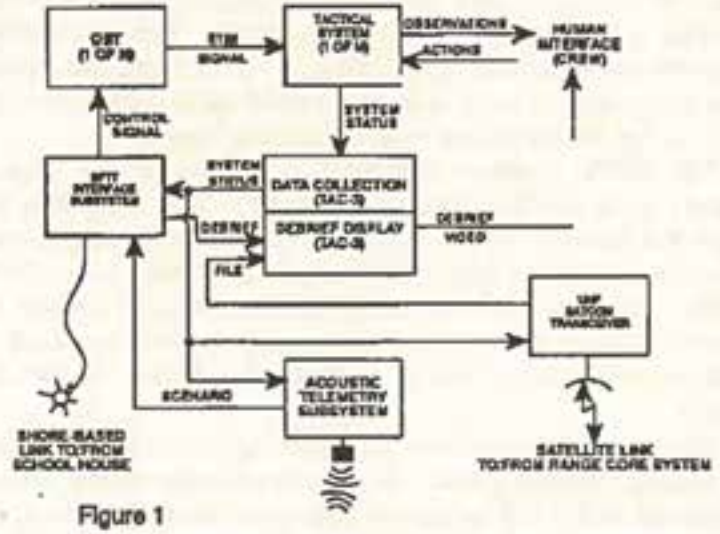


Figure 1

Figure 1. Submarine On-Board Subsystem for Tactical Training Ranges

The status of the tactical systems is recorded by a software module within the Submarine Fleet Mission Program Library (SFMPL), which resides on the submarine's TAC-3 computer. These data include sensor contacts, navigation information, fire control solutions, and weapon firing presets. Another module within SFMPL provides the capability to replay the data on a debrief display that is nearly identical to those used at the current undersea training ranges.

The data collection and the replay functions are currently being added to 688/688I submarines as part of another training range program initiative. In this program, the problem of timely debrief for the submarine crews has been addressed. It is very impractical to get the crew off the submarine and into the Range Operations Center (ROC) for a debrief by the training analysts after an exercise. Typically the crew gets a debrief package containing plots and, possibly, a videotape several weeks after the exercise. The training impact is largely lost at that point. The onboard debrief capability within SFMPL, coupled with a data link to the ROC, allows the training analysts to construct a debrief package using both data from the submarine and from other range sources. The package is transmitted back to the submarine for replay within hours of the events and shows the submarine's tactical picture overlaid with ground truth from the range. This more timely approach provides meaningful feedback to the training participants. This capability will be an important part of the training experience both on the SWTR and on existing training ranges.

The BFTT interface subsystem will serve as the external control point for the submarine's OBTs. This subsystem will allow the OBTs to simulate targets based on offboard generated scenarios, instead of only on the canned runs contained within the OBTs. When the system is used pierside in the BFTT mode, the scenario input and the tactical system output will be provided via a land-based linkage such as a fiber-optic cable or a RF data system.

The data link to a submarine exercising on the SWTR will be an acoustic telemetry link. A number of bidirectional acoustic transducer nodes will be located throughout the range area so that at least one node will be within the hearing radius of the submarine at any one time (Figure 2). The nodes are connected together and to the ROC using undersea fiber optic cable. To minimize the amount of cable required, and therefore the expense associated

with the in-water hardware, a number of the nodes will be multiplexed on the same fiber optic cable using time-division multiplexing techniques similar to those used in the telecommunications industry.

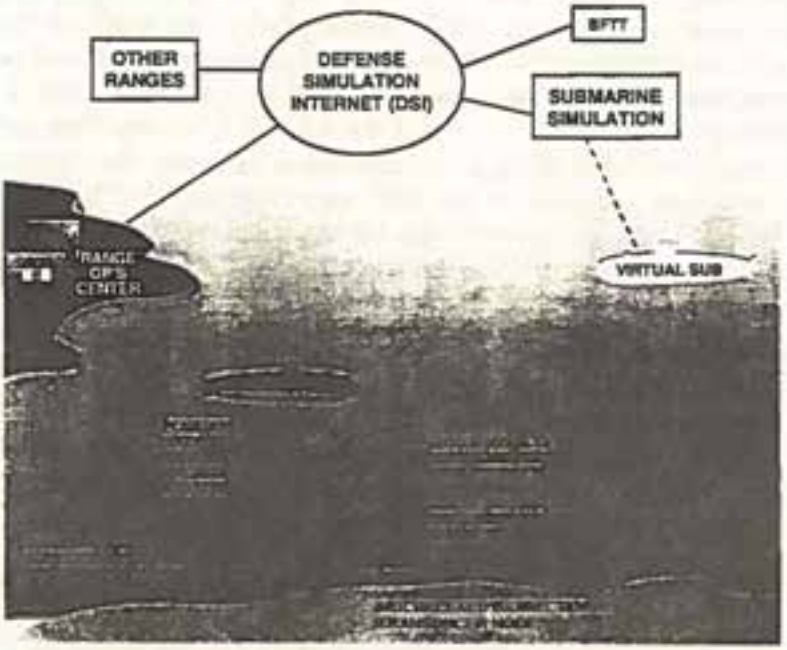


Figure 2. Shallow Water Undersea Warfare Training Range Concept

The data transmitted from the ROC to the submarine will consist of the messages necessary to queue the BFTT interface to control the OBT. For example, the queue message might provide the target type and initial parameters for range, bearing, course, and speed. The BFTT interface subsystem would run that scenario based on the initialization, plus any updates that are received. The OBT is then responsible for generating the high-fidelity target signal required for the simulation. In this way, the data-rate requirement for the acoustic telemetry link, with its inherently narrow available bandwidth, can be minimized. The acoustic transmit capability of the nodes will support other functions, such as range safety information, (i.e., the ground truth positions of other live participants on the range) and cost-effective underwater telephone (WQC) voice communications.

The data received via acoustic telemetry from the submarine

will include position data and portions of the tactical system data collected within the SFMPL module. The data will be used to support simulated weapon firings. When the submarine is operating against a simulated threat, a real weapon firing will probably not occur. Instead, a water slug will be fired, and then the weapon preset data will be downloaded to the ROC via the acoustic telemetry link. At the ROC, a torpedo simulation will be run, and appropriate hit/miss criteria will be applied. A torpedo simulation is currently in use at the Atlantic Undersea Test and Evaluation Center using a similar method; however, the weapon preset data is passed to the ROC post-exercise on a RF link. Again, to minimize acoustic data rate requirements, tactical system data not necessary for real time range operations will be stored and transmitted post-exercise via the ultra-high frequency (UHF) satellite communications/RF link to the ROC. The tactical system data will be used by the training analysts to help them assess what occurred during the exercise. Similarly, the debrief package will be sent via the UHF link, not the acoustic telemetry link.

There are many sources for the simulated target data. The easiest one to conceive of (although probably the hardest to implement with realism) is a computer-generated simulation located at the ROC. The simulator would generate the scenario, and would react to the on-range submarine's actions in a realistic manner. However, a much more versatile solution would be to implement a ROC interface with the Defense Simulation Internet (DSI). This would be accomplished by making the computer systems in the ROC compliant with the Distributed Interactive Simulation (DIS) communication protocols. DSI/DIS allows simulation systems at diverse locations to operate in a common synthetic environment as depicted in Figure 2.

The use of DSI/DIS literally opens up a whole world of target/opponent sources to be used by the SWTR. The computer-generated simulation discussed previously could reside anywhere; for example, at a Navy laboratory like the Naval Undersea Warfare Center Division Newport (NUWCDIVNPT). More realism could be obtained by using shore-based trainers connected to the DSI; a submarine crew at the trainer in Groton, Connecticut could oppose a crew operating a submarine on the SWTR. The realism would be enhanced because there would be a man-in-the-loop on both sides, with the simulation serving only to collocate the crews in the same environment. The submarine's sensor

systems would indicate the presence of the trainer's *submarine* based on the initial offset parameters, and the actions that the trainer crew would execute. Similarly, the trainer's sensor inputs would be based on the submarine's movements and actions on the SWTR.

Ships and submarines participating in BFTT exercises could also participate in a manner similar to the land-based trainer example. Another scenario might have two submarines on separate SWTRs, one on each coast. The simulation capability would allow them to operate in the same environment with any initial parameter configuration desired. The two ranges would be overlaying each other in the virtual world. The combination of live vehicles (underway on the same range, different ranges, pierside in BFTT, land-based trainers, etc.) that could exercise in this synthetic environment is almost limitless.

There are several advantages to using simulation in a training range system. This concept combines the best features from each type of system. The SWTR in itself supports training in a realistic environment typical of future threat locations. The range allows real submarines to operate in conjunction with other live assets, and to fire exercise torpedoes. The added capability to provide for simulated targets/vehicles further enhances the training experience. Simulation not only helps to make up for the shortfalls caused by declining resources, but also has additional benefits.

Simulation in conjunction with the training range allows exercise scenarios that cannot be accomplished exclusively with real participants. For example, simulation provides the ability to increase threat densities to realistic levels that are too costly to implement using real targets. Additionally, simulation allows the creation of scenarios that may be too dangerous to execute with only real participants. With a simulated target, there is no restriction as to how close it can come to the submarine on the range. Finally, simulation can supply targets/threats that may be otherwise unavailable, such as Kilo class submarine.

Simulation onboard the submarine while underway on the SWTR can provide a much higher-level of realism and stress than would be available strictly using a shore-based trainer. It can provide the crew with experience using their ownship equipment configuration. The SWTR will allow a mix of real and synthetic participants to maximize the value of the training received.

The NUWCDIVNPT is currently conduction investigations,

developing prototypes, and demonstrating and validating the concepts necessary to construct the new SWTRs. Production of the first SWTR will commence in FY97 for the East Coast, with an Initial Operational Capability (IOC) of FY99. This range will be located in the Onslow Bay area off Camp LeJeune, North Carolina, in support of the Littoral Warfare Training Complex. Installation of the West Coast SWTR will begin in the Southern California area in FY98, with an IOC of FY00. The IOC for both of these ranges will occur with an initial instrumented area of 125 nmi^2 each. Expansions scheduled through FY01 will increase the area at each location to 500 nmi^2. ■

UPDATE ON UUV TECHNOLOGY

by Frederick M. Cancilliere
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In response to Congressional tasking, the Office of the Chief of Naval Operations (OPNAV N85), in February of 1994, promulgated a draft Strategy and Priorities for unmanned undersea vehicles (UUVs), which identifies the following four basic mission areas for which the utility of UUVs has been substantiated:

- Mine Warfare and Mine Countermeasures (MCM)
- Surveillance
- Intelligence Collection
- Tactical Oceanography

Mine warfare has been established as having the most immediate need for UUVs. "The proliferation of mines, and the willingness of nations to use them, challenges the free movement of U.S. and international shipping, and can impede or deny U.S. power projection in the littoral environment" (Navy Technology Needs Document, 9 September 1994).

Each UUV mission area requires a unique payload. For example, mine countermeasures might require a sophisticated synthetic aperture sonar with computer aided detection and classification. There are many technologies, however, which are common to all four missions. These include critical technologies for endurance, communications, precise navigation, low speed hydrodynamic control, command and control, stealth, and launch and recovery. The use of these technologies allows the Navy to use a common design for undersea vehicles while enabling the insertion of mission-unique payloads.

A UUV MCM mission scenario can be conceptualized to begin with the launch of the UUV from a submarine. Delivery of the UUV by an SSN will be covert, and will conserve energy by placing the UUV closer to its target area. The mission objective will be to determine a path or area devoid of mines. The UUV will communicate data and images to the host platform, and receive instructions, using either a fiber optic link or wireless acoustic communications now under development. At the completion of the mission, the UUV will return to the host platform and be recovered.

UUV systems feature a high degree of technology interdepen-

dence and changes to one technology area affect others. For example, the increased endurance resulting from progress in developing higher density energy storage/propulsor technology will tend to drive needs for longer-range communications, more sophisticated adaptive controllers/robotics, and more self-contained/independent navigation techniques/systems. Supporting disciplines and technologies, such as fault tolerance and signature reduction (magnetic and acoustic) must be incorporated as a UUV system is developed, and cannot be easily *added on* later. All technology candidates must be studied for system trade-offs before they are selected for incorporation into a UUV system.

The Near-Term Mine Reconnaissance System (NMRS) is a mine detection, localization and classification system for deployment from a fast attack nuclear submarine (SSN). It is expected to provide the fleet with an interim clandestine mine reconnaissance and surveillance capability for use during littoral warfare engagements. NMRS, which is currently being developed by Westinghouse Electric Corporation, is scheduled for its initial operational capability (IOC) in March 1998. NMRS includes two UUVs that are equipped with forward looking and side-scanning sonars, along with appropriate navigation, data processing and communications capabilities. The UUVs are being designed for launch and recovery from an SSN 688/688I class submarine's torpedo tube; they will be controlled and operated from the SSN through a fiber optic tether system. The SSN will also have associated data processing and communications capabilities to provide battle group commanders with a real-time assessment of the mine threat in the area surveyed by NMRS. It is expected the NMRS, which relies almost exclusively on the use of existing technology, will have a service life of about six years, and that it will provide an interim capability until the **Long-Term Mine Reconnaissance and Avoidance System (LMRS)** is developed and delivered to the fleet.

LMRS is currently in the conceptual development stage of definition. As with NMRS, LMRS will be deployed from an SSN, either via a torpedo tube or from a deck-mounted dry-deck shelter; LMRS may also have the capability for use by surface ships. It is expected that LMRS will provide very significant improvements in sensor performance (swath width, range, and probability of detection), vehicle endurance and control, and in data processing and communications capabilities. LMRS will

constitute a major procurement action, and will be acquired through a series of competitive contracts, with the first contract to be issued in late fiscal year 1996. LMRS is scheduled for an IOC of early fiscal year 2004, and will have a life expectancy of about 20 years.

NMRS & LMRS are two present and future programs which demonstrate how the Navy is meeting UUV mission requirements, specifically the MCM requirement. Other mission requirements such as surveillance, intelligence collection, and tactical oceanography are the key drivers behind the UUVs for system capability requirements: covert launch and recovery; signature reduction; fault tolerance; and supporting technologies and disciplines. These mission and system requirements can be further defined by examining the UUVs critical enabling technologies.

Energy Storage

The baseline for UUV energy storage is the rechargeable zinc-silver-oxide (Zn-AgO) wet-cell battery. This battery is currently used in the ASW Training Target Mk 30 Mod 1, which has been in the fleet since 1975. The mid-term goal is to increase UUV energy density to three times that of Zn-AgO, and the far-term goal is ten times that of Zn-AgO. In addition to energy density, other important attributes include affordability, safety, environmental impact (*cleanliness*), and rechargeability.

The Navy is exploring advances in secondary battery systems in the areas of energy density as well as number of cycles and ease and speed of rechargeability. Secondary battery systems currently under development include improvements to Zn-AgO and advanced rechargeable batteries. The Mk 30 Mod 2 Target Program has set a battery improvement goal of reducing the lifecycle cost of Zn-AgO batteries by a factor of two through increased reliability, cycle life, and wet life. The advantage to improving the current Zn-AgO batteries is that they can be easily and immediately swapped into current systems. The most promising advanced rechargeable batteries include lithium cobalt dioxide ($LiCoO_2$), lithium ion, and molten salt. $LiCoO_2$ has been demonstrated to 100 ampere-hours and has a projected energy density of two times that of Zn-AgO. Other lithium and metal hydride rechargeables and molten salt chemistries are under development.

Candidate advanced primary batteries include lithium thionyl chloride ($LiSOCl_2$), aluminum hydrogen peroxide ($Al-H_2O_2$) and

zinc-oxygen ($Zn-O_2$). These would have more energy density, but are not rechargeable. Low rate $LiSOCl_2$ has been demonstrated to three times that of Zn-AgO, and developmental and commercial units are available. $Al-H_2O_2$ has been demonstrated on a laboratory scale, and has a projected energy density three to four times that of Zn-AgO. $Zn-O_2$ batteries are being developed for the portable electronics market and have been demonstrated on a small scale. When combined with dense solid oxygen sources, $Zn-O_2$ is expected to achieve two times that of Zn-AgO energy density in a UUV configuration.

The most work in development of fuel cells for UUVs has been accomplished under ARPA sponsorship. Their concentration has been on aluminum oxygen ($Al-O_2$) semi-fuel cells and on proton exchange membrane (PEM) fuel cells. The ARPA program will culminate with a 15 KW land based demonstration of an $Al-O_2$ power plant, with approximately three to four times that of Zn-AgO energy density. The significant accomplishment of the PEM cell effort was demonstration of a 7.5 KW, high reliability fuel cell assembly. The PEM fuel cell was run over 2,000 hours without a failure. Fuel cell energy density can range from four to ten times that of Zn-AgO, and is mostly dependent on the gas storage methodology.

The wick combustor, coupled with the Stirling engine, is being developed by ONR at the Applied Research Laboratory, Pennsylvania State University. This thermal energy system has a potential density of greater than ten times that of Zn-AgO. The wick combustor contains molten lithium, which is wicked up to an oxidant, sulfur hexafluoride (SF_6), where heat is generated. The combustor part of the system has been successfully run over 75 hours. The Stirling engine has a higher efficiency (40-50 percent) than Rankine systems (20-30 percent), but it has a higher mass per horsepower. When compared to the Stored Chemical Energy Propulsion System (SCEPS) power plant, the wick-Stirling is safer because the molten lithium is at a lower temperature and is separated from the combustion area. It is also more affordable, because the power plant can be stopped in mid-cycle and restarted, while the SCEPS cannot. More development work is necessary to marry the heat source with the Stirling engine. An in-water demonstration of a Wick/Rankine power plant aboard a UUV is scheduled for FY 1997-98.

Acoustic Communications

High data rate, low bit error rate acoustic (wireless) communications with UUVs can eliminate reliance on fiber optic lines. The goal is to transmit data at a rate of 300 megabits per second. The Navy is approaching the development of this technology in two ways: by reducing the amount of data which must be transmitted, through preprocessing and compression; and by increasing the capabilities in acoustic transmission from 1 kilobit per second (kbps) at 1 km to 30 kbps at 5 km. Using this dual approach, an underwater modular network is being developed which is somewhat similar to a cellular telephone system. The cells are oriented to independent transceivers which are the size of A size sonobuoys, so the loss of one node does not interfere with data transmission.

Using a low risk approach, the Navy has improved the data rate to five times that of the baseline, in real time. This has been accomplished by designing around multipath and reverberation, using frequency hopping, guard bands, noncoherent detection and averaging, and multiple frequency shift keying, and by designing around frequency smear and Doppler by sparsely populating the spectrum, leaving additional tonal spacing, employing Doppler sensing and tracking, and by widening spectral resolution. Temporal and spectral diversity are being used for redundancy. The ONR system with these features was tested during the summer of 1993 at Seneca Lake, New York. During this test, a data transmission rate of five kbps at five nautical miles was demonstrated. This technology development has stopped since there is little room for future expansion of capability.

The approach now being pursued was developed by the Woods Hole Oceanographic Institution, with funding from ARPA and ONR. This approach features coherent processing, instantaneous channel characterization and spatial diversity in the acoustic channel. Hydrophones are separated to maximize the potential for location outside the shadow zone. The power sum of all the elements (transducers) results in a greater signal-to-noise ratio. During deepwater testing off the California coast in 1991, a rate of 1000 bps over 100 nautical miles was demonstrated. Testing in Buzzards Bay, Massachusetts during 1993 demonstrated a rate of 30 kbps over 9.5 nmi. These tests originally required a supercomputer for processing. Advancements in technology have reduced the required computer to the size of an A size sonobuoy

container.

In November 1994, at the American Defense Preparedness Association semi-annual symposium held at the NUWC, Division Newport, high data rate acoustic communications was demonstrated live using the Large Diameter UUV (LDUUV) as its platform. The demonstration acoustically transmitted pre-recorded object detection data from the LDUUV, which was located in Narragansett Bay at the Gould Island shallow water test facility. The signal was transmitted via a RF link to the presentation at Spruance Hall at the Naval War College. The acoustic signal was transmitted through the water over a distance of 2.5 kyds at a rate of 30 kbps.

Using these high data rate acoustic communications techniques, images such as sonar displays, laser linescans, and television images can be transmitted to all players in a mission. The system would allow two-way communications so that, in addition to receiving data, stations could transmit instructions to the UUVs.

Robotics

The next generation of UUVs must be able to interact with the environment using robotics. UUVs with on-board robotic mechanisms will be able to perform such tasks as tagging objects, taking soil samples, hooking up cables, and performing other undersea work. Early robotics demonstrations will involve wire or fiber optic connections, but data transfer will be limited to acoustic communications parameters for realism. This will include limitations on bit rates and delays due to propagation of sound waves. Later demonstrations will utilize actual acoustic transmission of data and commands, and still later, instructions will be carried out autonomously. The script for early demonstrations will include simple tasks, such as moving an object. More advanced scripts will require complex work such as connecting cables, object recovery and sampling.

Navigation

The baseline accuracy of autonomous navigation is contained in the Target Mk 30 Mod 1, which uses a ring laser gyroscope (RLG) Guidance and Control System for an accuracy of 22,250 meters circular error probability (CEP) (worst case). The UUV goal is 50 m CEP, irrespective of length of run. A more accurate traditional system, consisting of an inertial navigation system (INS), a correlation or Doppler velocity sonar (CVS/DVS), and a

Kalman filter, will have significant error with long endurance. For example, the Large Diameter Advanced Test Vehicle (LDA-TV), during demonstration runs in FY 1992, exhibited a projected 2,800 m CEP for a six hour period based on observed one hour real data. The LDATV was equipped with a RLG-based INS and a simple Kalman filter.

The Large Diameter UUV (LDUUV), now being used by NUWC for demonstration runs, will use the LDATV system, improved with a better Kalman filter and DVS. It is projected that it will attain an accuracy of 150 m CEP over a six hour run time. More accuracy (down to 50 m CEP) during longer runs will require updates of the system during a mission. These system updates can be obtained through the Global Positioning System (GPS) or through non-traditional techniques. GPS requires getting an antenna out of the water, possibly compromising stealth or taking time away from the mission to get a fix. Non-traditional techniques may overcome these limitations. These techniques include: terrain/contour following, bottom-mapping/map matching, geophysical (magnetic or gravity), video, zero velocity update, or acoustic communications.

Hydrodynamics

Many UUV missions require platform stability in very shallow water to ensure proper operation of sensors and payloads. Certain sensors and payloads require specific speeds for optimum operation. During recovery by a host platform (particularly a submarine), the UUV will require fine control. The basic UUV hydrodynamic control system includes an adaptive, nonlinear controller with advanced effectors, including tunnel thrusters, fins, variable ballast, and propulsor. Thrusters work best at speeds from zero to three knots, and fins at speeds over three to four knots. The low speed control system will have to operate the vehicle over all speeds, zero to twelve knots, including the transition zone.

Vehicle Controller

Control of the vehicle, its components, subsystems, and payloads is coordinated in the control computer. While early autonomous systems had unique designs, the current emphasis is on standardization. UUVs under development at NUWC contain a high percentage of COTS items, including the control computer,

the rack, and the interfaces. ONR and ARPA have adopted standard industry interfaces for the UUV systems, including ethernet, RS-232, and -422, small computer standard interface (SCSI), and fiber optic links.

As the endurance of UUVs grows, control systems must be improved to include fault tolerance and planning and replanning of missions based on unforeseen events. Intelligent controllers will be developed which can preserve the mission and withstand system faults. UUV systems must be designed for robustness and fault tolerance from inception.

Signature Reduction

Covertness, reliability, and self-preservation require that particular attention be paid to the reduction of acoustic and magnetic signatures of UUVs. Many sensors, such as magnetometers, are degraded by the presence of magnetic interference. Excessive acoustic or magnetic signatures can cause detonation of mines. Remote enemy sensors may be alerted to the presence of UUVs if they detect magnetic or acoustic energy. NUWC has been designing systems which incorporate acoustic signature reduction for some years. The Torpedo Silencing Research Vehicle and the LDATV served as testbeds for silencing hardware and techniques. Noise reduction hardware designed for the LDATV include composite, coated hulls; vibration dampening mounts; and methods of decoupling machinery from the outside water column.

Technology Demonstrations

A 21 inch UUV, now in the design stage, will demonstrate, in water in a tactical size vehicle, the more advanced critical technologies discussed in this paper, including advanced energy storage, acoustic communications, robotics, navigation, low speed hydrodynamic control, vehicle and system control, and signature reduction. These ONR developed technologies will be available for Navy acquisition programs. ■

FOREIGN ASW TECHNOLOGY DEVELOPMENTS

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The most dramatic examples of *rest-of-the-world* countries acquiring advanced undersea technology are occurring in the Asian-Pacific region. Many of the Pacific Rim nations currently possess booming economies and associated rising defense expenditures, in contrast to most of the world. Much of the military emphasis is related to acquiring advanced naval and undersea warfare capabilities; in fact, it is believed that 40-60 percent of the naval export market in the coming decades will be from these Asian countries. Acquisition of advanced submarines is also receiving priority. China, India, North Korea, and Japan already have large submarine inventories, and South Korea and Taiwan are in the process of acquiring large submarine fleets (a dozen or more). Smaller submarine orders-of-battle can be found in Australia, Indonesia, and Pakistan and will eventually be acquired by Malaysia, Singapore, and Thailand. All of this submarine activity is causing these same Asian nations to reassess and upgrade their overall ASW capabilities, creating an opportunity for both Russian and Western suppliers to sell their advanced ASW equipment.

The cause for worry by the U.S. Navy is evident from even a cursory review of various exercises which suggests that the U.S. Navy (including our Submarine Force) is not *bullet-proof*. It is important to make our Navy as *bullet-proof* as we can afford, because incidents, which from a military perspective might seem small, can have big policy implications. This has been illustrated by a fire-fight in Somalia, a single mortar round in a Sarajevo marketplace, and a terrorist attack on a Marine Barracks in Lebanon. What impact would a single ship sinking with high combat deaths have on U.S. policy? It would be better not to find out.

Mines

Some of the most advanced bottom mines in the world are being acquired by *rest-of-the-world* countries. Russia alone is offering customers a half-dozen or more varieties, typically with warheads equivalent to 1500-3000 pounds of TNT. British,

French, Italian, and Swedish suppliers are also exporting large-warhead, advanced bottom mines to their clients. In addition, Russia is selling ASW-capable mines such as the PMK-l and MSHM types that feature rocket-propelled projectiles and warheads. Even China is exporting a rocket-propelled (vertically) rising mine designated EM-52. Iran is reportedly acquiring a variety of bottom and moored mines (including rocket-propelled) to potentially control access to the Persian Gulf by both shipping and naval forces.

As an example of the advanced mine technology that is being transferred, it is interesting to note that microprocessor-controlled target detection devices (TDDs) are included in advanced bottom mines being supplied by the West. These can be programmed for sophisticated signature matching. Can Russia be far behind in this area? What target types would mines deployed at the approaches to the Chah Bahar submarine base be programmed against in a future contingency? A final disturbing note is that advanced TDDs are available in retrofit packages (including at least one Third World supplier today) to *modernize* older mines for a fraction of the cost of a new mine.

Submarine Systems (Sensors, Torpedoes)

The recent sale of Agosta 90B submarines from France to Pakistan provides a good illustration of where diesel submarine hull, propulsion, and combat system related technologies are heading. The Agosta 90B features advanced silencing, high strength steel hull construction, and reportedly an air independent propulsion (AIP) system. If the latter occurs, it could represent the first export sale of modern AIP technology to any country. This submarine will also include the new French combat system that is also going on their own Amethyst class submarines. With these submarines, Pakistan is also expected to get SM-39 submerged launch Exocet cruise missiles (first such sale to the Third World) and F17 Mod 2 heavyweight torpedoes with combined acoustic and wake homing capabilities.

The advanced combat systems on modern diesel submarines are very impressive. Atlas Elektronik of Germany and Thomson Sintra of France are two of the leading exporters. Their systems are fully integrated and feature advanced signal processing, data fusion, and information management techniques to support automatic tracking and fire control, e.g., that allow the firing and

wire guidance of 4-6 torpedoes simultaneously. These combat systems, which also have surface ship counterparts, can integrate the contact information from a variety of acoustic and non-acoustic sensors. In the future flank arrays, towed arrays, and nonpenetrating optronic masts will be standard capabilities on export diesel submarines. It is not hard to also imagine user-friendly workstations in submarine combat spaces that are no harder to operate than a complex video arcade game. In the far future, even in-situ wake detection sensors (e.g., on submarine sails) are possible for *rest-of-the-world* submarines, perhaps similar to those technologies that Russia reportedly has been pursuing.

Shifting to the business end of the submarine, the major ASW-capable heavyweight torpedo suppliers in the world today are the U.S. (NT-37, Mk 48), the U.K. (Tigerfish, Spearfish in the future), France (L-5/7, F-17 series), Germany (SUT, Seehecht, Seahake in the future), Italy (A184), Sweden (TP-62/Type 2000 in the future), and Russia (Test-96, Test-71ME).

Two of the most advanced Western torpedoes under development are the German Seahake Mod 1 (DM2A4) and the Swedish TP-62 (Export Torpedo 2000). The Seahake design is compatible with the early German torpedoes and allows use of upgrade kits to convert SUT/SST-4/Seehecht torpedoes (in numerous *rest-of-the-world* inventories) to the more advanced Seahake model. This allows an affordable means of acquiring state-of-the-art acoustic homing, wire guidance, and quiet operation capabilities in heavyweight torpedoes. The Swedish TP-62, which has been certified for bottom launch, also features significant counter-countermeasures (CCM) capability and low radiated noise plus high maneuverability (reportedly about 45 degrees per second).

Undersea Surveillance System Developments

Two ASW technology areas that bear watching in the future are related to fielding undersea surveillance systems. The first is acoustic and/or non-acoustic bottom surveillance sensors, i.e., employed on the seabed in harbor approaches, straits, or other littoral choke points. Russia and the U.S. have pursued this technology, e.g., the current U.S. Advanced Deployable Surveillance program. Other Western suppliers are also developing similar systems, but only on a smaller scale. The Canadian firm C-Tech Ltd. offers for export a seabed active sonar-based harbor surveillance system (CSAS-80) for detection of midget submarines

or swimmer delivery vehicles. On a larger scale, the Italian WELSE consortium has been involved in the development of an advanced seabed-based ASW area system (ASWAS) capable of use in 150 meter water depths. ASWAS is fitted with both acoustic (active/passive) and non-acoustic (e.g., magnetic) sensors. In the future, seabed surveillance technology could shift to covert E-field and DC magnetometer sensors.

The second undersea surveillance technology area that needs to be monitored is low frequency active acoustics (LFAA). In addition to tactical LFAA possibilities for ASW aircraft (dipping sonars, sonobuoys) and warships (hull and variable depth sonars, towed receivers), both fixed and large mobile surveillance-related LFAA technologies are also being pursued by Russia, the U.S., and a few other countries. This represents a long-term concern in terms of proliferation of LFAA surveillance systems in the *rest-of-the-world*.

Inhibiting the transfer of this LFAA surveillance technology is the complexity of integrating key components (projectors, receivers, signal processors, communications) into a viable overall system. Many countries are developing LFAA projectors and high gain acoustic receive arrays for various applications. However, combing projectors and receivers with the required signal processing and communications (particularly for bi-static/multi-static concepts) remains the key challenge to LFAA system designers.

Coastal or Shipboard Radar and ESM (SIGINT) Systems

Why should coastal (or shipboard) radars or electronic support measure (ESM) systems capable of signals intelligence (SIGINT) be of concern to U.S. attack submarines? It is because U.S. SSNs are spending much more time at periscope depth with masts/antennas exposed in order to facilitate communications with other naval units participating in joint task force operations in places like the Adriatic Sea off Bosnia. In recognition of this trend for SSNs to be more integral members of joint or combined coalition operations, ARPA and others are investigating *stealth sail* concepts for future submarines. Just as important in this regard is the tracking of commercial and military coastal surveillance technology developments (e.g., by Marconi Radar Systems of Italy), so that the susceptibility of an exposed mast or sail to adversary counter-detection is well understood. In addition to horizon-limited systems (capable of 20-40 nmi detections against

small surface targets depending on coastal terrain and elevation), Marconi and others are continuing to develop advanced over-the-horizon, high frequency radars with even greater detection range potential. In the future, coastal surveillance radar technologies could evolve away from monostatic systems making *hard body* detections to bi-static systems (e.g., using unmanned air vehicles as receive platforms) that are capable of detecting surface wakes or other effects under certain conditions.

Similarly, a comparison of current submarine communication frequencies (ship-to-shore, ship-to-ship, ship-to-aircraft) with the frequency coverage of current surveillance receivers, communications intelligence equipment, and electronic intelligence equipment suggests a significant amount of overlap. Thus, the ability to detect and localize SSN communications also needs to be assessed.

Aircraft Systems (Sensors, Torpedoes)

There are over 1800 ASW-capable aircraft in the world with slightly over half being helicopters (equally divided between large and small helo variants). If the U.S., the former Soviet Union, and China are excluded, that still leaves about 850 ASW-capable aircraft, with about two-thirds being helicopters (and over half of the helicopters being of the small variety). The U.S., Europe, and Russia offer medium weight (9-14 tons) or large helicopters. The main Russian export version is the KA-28 aircraft with dipping sonar, sonobuoys, lightweight torpedoes, and other underwater ordnance (rockets, bombs). The same helicopter suppliers (U.S., Europe, Russia) also offer lightweight (5-7 tons) or small ASW-capable models that have reduced payload and vehicle endurance.

Shifting from ASW helicopters to ASW-capable (or potentially ASW-capable) maritime patrol aircraft (MPA), we see that they also come in two *flavors*, i.e., long range MPA (10-12 hours endurance) and medium range MPA (6-8 hours endurance). Although more rare in Third World militaries than helicopters, remember that it was an Argentine fixed wing aircraft that harassed the HMS CONQUEROR after it sank the BELGRANO. India has the highly ASW-capable Russian Bear F MPA, and other countries, including South Korea, have the U.S. P-3C. Medium range MPA are more plentiful than long range MPA, and most can be configured for either ASW or ASUW missions (not always easily reconfigurable), depending on the interest of the particular country.

Peeling the onion a little further, many ASW helicopters are equipped with dipping (or dunking) sonars. These systems have, in various past ASW exercises, proven to be a nemesis for submarines, often working well in littoral environments and being difficult for a submarine to disengage from once the helicopter gains contact. Both ASW helicopters and fixed wing aircraft employ acoustic sonobuoys of the LOFAR/JEZEBEL, DIFAR, and CASS/DICASS generic types. These dipping sonars, active/passive sonobuoys, and associated advances signal processors are widely exported by several nations with the U.S., the U.K., France, and Russia being the biggest suppliers. In the future, user-friendly bi-static systems (e.g., with impulsive sources) could be widely exported by Russia and/or the West.

Shifting from acoustic sensors to non-acoustic sensors, a survey of standard equipment on most current ASW-capable aircraft indicates that the following four technologies are prevalent: high resolution surface search radars including inverse synthetic aperture radar types (with varying capabilities to detect submarine masts and periscopes), forward looking infrared, ESM, and magnetic anomaly detection. In the future, we can expect to see advanced magnetic systems (e.g., extreme low frequency electromagnetic), light detection and ranging systems, and other electro-optical systems (e.g., bioiluminescence).

One of these future aircraft-based non-acoustic technologies, LIDAR, can be illustrated by two systems, one commercial and one military. The Hawk Eye LIDAR system is a joint Swedish/Canadian commercial effort. This helicopter pod-mounted system conducts surveys at nearly 1000 feet altitude and is capable of detections 20-35 meters beneath the sea surface (2.5 attenuation lengths), depending on the associated optical clarity of the waters. The Amethyst blue-green laser is a military system employed on Russian Bear F Mod 4 MPA. The aircraft flies at 328 feet (100 meters) altitude and 200 knots airspeed and is capable of searching a 100 meter wide swath for targets in a portion of the first 100 feet of the water column (how large a portion depends on specific conditions).

The ASW-capable aircraft survey would not be complete without a review of air deployed ASW ordnance. Although aerial bombs (50-200 kg) and depth charges are available, including some advanced models that feature active homing (e.g., Saab Missile's *intelligent depth charge*), lightweight ASW torpedoes

remain the weapon of choice against large submarines under most situations. The primary lightweight torpedo suppliers in the world today are the U.S. (Mk 46, Mk 50 in the future), the U.K. (Stingray), Italy (A244, MU-90 in the future), France (MU-90 in the future), Sweden (TP 43X0), TP 43X2), and Russia (APSET-95, APR-2E). The Italian A244 series has been provided to about 15 countries and has demonstrated performance in shallow water conditions (e.g., 150-200 feet of water). The Italian A290 and French Murene programs have been combined in the joint MU-90/Impact torpedo development effort. All three programs have advanced counter-countermeasure features and are capable of being air dropped in water at least as shallow as 100 feet. It should be noted that, in the future, some of these lightweight torpedoes could become the payloads for advanced ASW standoff weapons (typically 5 to 30 nmi range). Several countries have developed or are currently developing surface-launched ASW torpedo missile systems; these include the U.S. (ASROC, Vertical Launch ASROC), France/Italy (Milas), Russia (Silex, Medvedka), and China (CY-1).

Surface Ship Active Sonars

ASW-capable surface ship developments parallel many of those already discussed for submarines and aircraft, e.g., passive sonars and combat systems similar to those for submarines, and lightweight torpedoes similar (if not virtually the same) as those for ASW aircraft. The main way that surface ship ASW developments are truly unique is in the area of active sonars, particularly systems being designed for use by surface vessels prevalent in many *rest-of-the-world* navies. Three examples being developed by Thomson Sintra and other are: 1) the very low frequency (about 1 KHz SLASM system for frigates/destroyers that combines a variable depth sonar towfish and activated passive receive arrays clipped onto the same towfish; 2) the active toward array sonar (ATAS) system suitable for small ships (> 250 tons) that combines flex-tensional transducer source technology to activate a towed linear receive array (in an approximate 3 KHz monostatic configuration); and 3) the *Gudgeon* compact ASW sonar designed for shallow water use (in hull-mounted and/or VDS configurations at about 13 KHz). It should be noted that Taiwan, Oman and Pakistan have reportedly already placed orders for the ATAS system. ■

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 content of articles is of first importance in their selection for the **REVIEW**. 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. Annually, three articles are selected for special recognition and an honorarium of up to $400.00 will be awarded to the authors. **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. In those instances where the NSL has taken and published an official position or view, specific reference to that fact will accompany the article.

Comments on articles and brief discussion items are welcomed to make **THE SUBMARINE REVIEW** a dynamic reflection of the League's interest in submarines. The success of this magazine is up to those persons who have such a dedicated interest in submarines that they want to keep alive the submarine past, help with present submarine problems and be influential in guiding the future of submarines in the U.S. Navy.

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

THE STORY BEHIND THE CD-ROM PROJECT

by LCDR Charles H. Church, Jr., USN
Director
Submarine On Board Training

The Navy recently made available to the public a multimedia product named Submarine Force: Past, Present, & Future. This CD-ROM initially started as a training technology demonstration, but it has evolved to a finished product ready for national distribution. It demonstrates how text, graphics, voice, video and animation (2-D and 3-D) integrated together into a multimedia presentation, help make information easier to assimilate. The lessons learned from this project are used for many computer based training products developed for the Submarine Force.

The Submarine On Board Training (SOBT) office at Submarine Group Two in New London, Connecticut, had some experience with multimedia. After a five year development the Trident submarines were issued a training system, in 1993, that combined two touch screen monitors, a 387 Intel-based computer with a video laser disc player that allowed video and computer software to be integrated into one presentation. Each lesson represented an individual subject area as defined by the enlisted requirements for submarine qualification. This training system quickly became a vital part of both junior officer training and the enlisted submarine qualification program. The system standardized the ship qualification process and kept the sailor engaged in the learning process. The ship qualification period was reduced by 50 percent and the sailors retained the material for longer periods.

Over time, some drawbacks of the system became apparent. Since the system ran on proprietary software and hardware, maintenance of the system became challenging. The dual touch screen distracted from the learning process because the sailor's hands became fatigued from constantly interacting with the touch screen. The software was not able to run on the standard shipboard computers thus limiting the additional training sites. Since the system was not portable, the sailor could not take the training into his actual work environment.

Concurrently, the SOBT office was exploring the role of multimedia based computer training for the Seawolf class submarines. The Seawolf training program, due to the small number of

submarines of this class, is relying heavily on computer based training for use onboard the ships. Based on some of the lessons learned from the Trident Ship Qualification program, the computer-based training programs for Seawolf class submarines are being made with commercial off-the-shelf (COTS) authoring tools. The training programs can run on multi-purpose COTS computers as they require no unique computer hardware for digital video playback. Since COTS hardware will be available onboard submarines, using COTS will enable the sailor to train anywhere and anytime. If additional computers are needed, they can be purchased affordably.

The SOBT office became concerned, after listening to many different contractors and reading trade journals, about the future direction of multimedia and about how it would affect computer based training. After much discussion, it was determined that an in-house computer software programmer was needed. The programmer's role in the SOBT office would be to provide software expertise. After interviewing many people, we contracted for Mike Rydene to be our software programmer. While awaiting security clearance approval, Assistant SOBT Director, Lieutenant Tim Allen, assigned Mike Rydene to explore the digital video capabilities of QUEST 4.0, a MSDOS-based authoring language used for multimedia. Mike converted the Submarine Force brochure Around the Clock, Always Ready to multimedia. The initial results of his efforts were impressive.

A few months later, Susie Silverstein of the Navy Museum at the Navy Yard in Washington, DC contacted the SOBT office to find out if we had any computer based material that could be used in their new submarine display scheduled to open in 1995. Our discussion revealed that both of our organizations could benefit from a computer based program on submarines. The Nautilus Museum also showed interest in participating in this project.

The museum project kicked off in the Fall of 1993. It was expanded from the original theme of the Around the Clock, Always Ready to include more history of the Submarine Force and to explain the general concept of how a submarine works. The objective was to educate the public on the many contributions made by the Submarine Force in support of national security and the continual need to build and maintain a robust Submarine Force. The SOBT office agreed to produce the multimedia software and each individual museum would provide the computer

hardware to run and display the software. Lieutenant Commander L.B. *Bat* Barton (Nautilus Museum Executive Officer) and Stephen Finnigan (Curator, Submarine Force Library and Museum) and the Nautilus Museum staff provided historical information and pictures along with aiding in the development of the original idea of the user interface and topical organization.

The museum project's first milestone was a presentation of the project prototype to the Nautilus Museum Association in April 1994. Because of limitations with the DOS based authoring language QUEST, the project had to be redone with the Microsoft Windows-based authoring language ICONAUTHOR. Based on the experience of this project, we are also using ICONAUTHOR for all other training products under production. Upon viewing the presentation, the Nautilus Museum Association agreed to provide the funding for the computer hardware to display the project in the Nautilus Museum. The project was moving from an idea to reality. The Naval Undersea Museum in Keyport, Washington and the Hampton Roads Naval Museum (located with the Nauticus Museum) in Norfolk, Virginia also agreed to display the project within the next year.

As the project grew from a training technology demonstration to being hosted in different museums, COMSUBLANT's Public Affairs Officer, Lieutenant Commander Greg Smith joined the project team. The first public display of Submarine Force: Past, Present & Future was at the Nautilus Museum on September 30, 1994. Observing public interaction with the display enabled SOBT to study how this medium could be used to better convey information. The display appealed to all age groups. People requested information on how they could obtain a copy of the program.

Two demonstrations were arranged in November 1994 for CHINFO, Rear Admiral Pease, and the Naval Submarine League Board of Directors. The goal of these demonstrations was to decide if there was an interest in making this program available to the public on CD-ROM. After these demonstrations, the decision was made to put this project on a CD-ROM.

In December 1994, work began on the revision of the Submarine Force: Past, Present & Future program to be delivered on CD-ROM. The user interface was totally overhauled from the original and the topical organization was re-engineered. The information was reformatted into five modules to allow easier access to the information. They are: Submarine History, How

Subs Work, Modern Day Submarines, Submarine Roles, and Building a Submarine. Every screen was tailored to have a narration and much more 3-D animation (Beth Morriaty was brought in to assist). Heidi Rydene (Mike's wife), who narrated the original text, continued her role as the narrator. Having a female narrator proved invaluable since many sound speakers on computers attenuate the male voice resulting in poorer sound quality. As new text was written, Lieutenant Commander Greg Smith edited it to ensure concert with Submarine Force goals.

Submarine Force: Past, Present & Future CD-ROM premiered in April 1995 as part of the Naval Submarine League exhibit at the Navy League's Sea, Air and Space Exposition. It is available free to any member of the Naval Submarine League. The Submarine Force is using this product to help express to the public and to government decision makers the importance of a robust Submarine Force. Recently at the Commander in Chief (CINC) conference, each CINC was given a copy by Rear Admiral Pease. Additionally, a copy has been provided to each group, squadron and submarine commanding officer. Submariners aboard Task Groups are using this product to help educate personnel on the importance of submarines. In the future, many more museums will also be displaying this product to help present that importance to the public. The marketing and distribution of the Submarine Force: Past, Present & Future CD-ROM is still evolving. As the Submarine Force has done in the past, we continue to lead the way on technology applications for the future. ■

BETTER CAN BE CHEAPER!

Submarine Survivability

by C. Clifford Ness
CEO
Manta Research

Submarine design, for the past several decades, has sacrificed safety for speed, the enhancement of electronics, noise reduction, and depth. Recent efforts to increase performance resulted in a 9000 ton attack submarine. Dr. Heller asked *What Price Depth?* (USNI Proceedings, December 1975), wherein he defined the price of increased structural weight and its impact upon design. The elimination of multiple pressure holding bulkheads was among the give-aways. Are we now prepared for the payback? In the January 1994 issue of **THE SUBMARINE REVIEW**, Captain Khudyakov, Doctor of Technical Services, Russian Navy, carefully reviews the design and operation of submarine ballast tanks in his paper *Is the Middle Group of Ballast Tanks Really Necessary on Submarines?* The Los Angeles class is singled out, quote, "The quantity of sections in this class is reduced to three, which makes it impossible for her to stay on the surface when even an insignificant area of it's section is flooded." Several other high risk scenarios are also noted that would appear to demand amidships as well as fore and aft ballast tanks. In particular, the difficulty in controlling pitch in shallow water and at slow speeds. This causes one to question if such designs are appropriate for littoral missions. More to a point, he asserts, "The design should provide a balanced, stable, surfaced position if one of the main ballast tanks, in one of the ends of the submarines, is damaged. (This type of damage can occur at any time, for example, during a collision)". He closes with three questions: "1) Is it possible to do without the middle group of ballast tanks? 2) Is it necessary to design single hull submarines with their main ballast tanks located in the extreme ends of the hull, and having only a small buoyancy reserve? (20 percent or less), 3) Is it worth considering increasing the effectiveness of the pressurized air system?" I believe the answer to these questions to be negative in all cases. Side saddle ballast tanks, applied to the Los Angeles class submarines, would have reduced their length by as much as

60 feet and the wetted surface by 15 percent. The potential for increased operability is evident and the negative impacts appear to be acceptable.

The apparent end to the Cold War provides a window of opportunity for the application of creative design and innovation to fully answer these questions, and restore survival and safety in the process. Increased compartmentation is restricted by the enormous weight of full diameter bulkheads. Even with the super strength metallurgy now being employed, greater displacements would normally be anticipated to accommodate them. Technology is at hand however that will allow a reduction of hull structural weight, add compartmentation, restore amidships ballasting, and effect cost reductions in many ship systems as well as achieving a better submarine at a lower cost.

What design change can bring about such significant advancements? Several alternate pressure hull designs have been suggested which avoid many of the design problems common to most single hull submarines. They have significant potential for greater structural efficiency. Toroids and elongated ellipsoids have nearly twice the structural strength. The spheres used for most research submarines are capable of twice the depth for an equal plate thickness of identical material. This use of these compound curved surfaces is a means to achieve current operating depths with 50 percent less structural weight, and also cut welding costs by a similar proportion. This would make this an affordable submarine.

The realization that the Soviets were able to exceed the Trident's displacement by as much as 60 percent in a hull of equal length suggests a new dimension of undersea architecture. This is accomplished by the broadened beam of the Typhoon with two parallel pressure hulls enclosed within an outer protective hull. The smaller length/width ratio provides a reduction in drag, primarily through a decrease in wetted surface. A flattened oval cross section results in a reduced vertical profile. In addition to accommodating amidships ballasting this arrangement reduces the risk of pressure hull penetration. The greater structural weight, twin propulsion plants and added reserve buoyancy, all increase displacement but this can be substantially counteracted by innovation. Preliminary testing suggests that a hydrodynamic hull form

similar to this has superior stability, and is also more maneuverable. Further tests are scheduled and should establish this to be a better submarine.

The agility to maneuver out of harm's way has long been important to the safety of submarines. This capability is determined by the static and hydrodynamic design of the vessel. Its control surfaces establish the rate of response but also contribute to its resistance drag. Greatest control is required for slow speed maneuvering but only minimal control is required at higher speeds, suggesting retractable surfaces. The reported tendency for snap roll in high speed maneuvering is endemic to current design practice. Elimination of the fin shaped sail can reduce this contributing source but also adds a requirement for a surface to counter the screw-induced roll. The introduction of an elliptical cross section would resist this torque without an increase of appendage drag. This problem is discussed by Henry E. Payne III and William P. Gruner, Naval Institute Proceedings (July 1992), and also by Theodore L. Gaillard Jr. in the **SUBMARINE REVIEW** (April 1993) *Submarine Design: Aeroengineering Dimensions*. In his article in Naval Institute Proceedings (April 1993), *The Albacore: Back to the Future*, Mr. Payne illustrates the difficulties of length in the shallow water environment. It is evident that a greatly shortened, flattened ellipsoid design with a Los Angeles displacement would embody the advantages of both and the limitations of neither. The next generation submarine must embody the goals of survivability, safety and performance at a lower cost.

A neglected aspect of submarine safety is accented by the Soviet submarine KOMOSOLETS having an escape chamber able to bring survivors up from the floor of the Norwegian Sea. Despite their difficulties with its separation and with toxic fumes, the pod withstood the pressures and bottoming impact and returned them to the surface. This type of ejection system has not been attempted by others and is long overdue. We do not send aviators into combat without parachutes. The finality of uncorrectable negative buoyancy is an unacceptable risk when crew escape is achievable. The next generation submarine must disregard price when the cost is in human life. This indeed will be a safer submarine. ■

UPS ONBOARD?

by LT Jeffrey P. Brown, USN

[Editor's Note: This essay was the winning entry for the Naval Submarine League sponsored contest for the Submarine Officer Advanced Course at the Naval Submarine School.]

> "Experience with naval machinery and equipment has emphasized the importance of instrumentation and the records kept of hourly readings."
> - Standard Submarine Operations and Regulations Manual

Complete, accurate, precise, consistent and legible records are required to enable watchstanders, supervisors and off-ship analysts to monitor the performance of increasingly complex interrelationships among a myriad of mechanical and electronic systems onboard today's and tomorrow's naval vessels. Computer technology, coupled with supervisory attention-to-detail, operational and technical knowledge and experience can assist in, and even relieve some of the analytical burden of making proper and adequate assessments of these complex relationships. The United Parcel Service (UPS) manufactures and uses an electronic notepad, called a Delivery Information Access Device (DIAD), a facsimile of which may be used as an interface between a watchstander and a shipborne local area network (LAN) to conduct computer analysis and/or graphical display of component or system performance.

UPS delivery personnel use the DIAD to store information on each package they take in their trucks to include address, route, account billing information, inventory, etc. A proposed shipboard scenario involves the use a DIAD-like *clipboard* on which each watchstander *enters* log readings via an alphanumeric keypad. Upon completion of his round, the watchstander would *download* the data to the LAN at a connection on his watchstation. Then, with a predetermined amount of control, the watchstander could recall the data in a spreadsheet and/or graphical format to view the past data and any trends on a screen at his watchstation. Supervisors would also have access to screens throughout the ship and perhaps greater levels of control for more thorough analysis. The DIAD also allows use of an electronic *pen* whereby supervisors could *initial* or *sign* for review of the records.

A review for trends, both manual and computer-aided, at the time of recording hourly readings may indicate a system change which can be diagnosed and rectified before the situation deteriorated into a casualty. Computer-aided analysis may enable the watchstander to catch a subtly degrading system trend, otherwise unnoticed.

The following example shows a comparison at current log-taking policy with the proposed computer analysis. Keep in mind, too, that logs are presently handwritten, and therefore, in varying degrees of legibility.

Table 1 depicts what might be a typical set of log readings over a 24 hour period for a generic tank level.

Table 1. 24 Hour Log of Tank Level

Time	Tank Level (Gal)	Time	Tank Level (Gal)
	Min 1000		Min 1000
	Max 2500		Max 2500
0000	1735	1200	2600
0100	1435	1300	2505
0200	1375	1400	2465
0300	1375	1500	2355
0400	1375	1600	2210
0500	1210	1700	2005
0600	1025	1800	1775
0700	900	1900	1300
0800	1000	2000	1200
0900	1725	2100	1000
1000	2225	2200	2000
1100	2600	2300	3000
		2400	3000

Assignment: Produce a mental picture of the trend in tank level over the 24 hour period. Compare your mental picture with the graph in Figure 1.

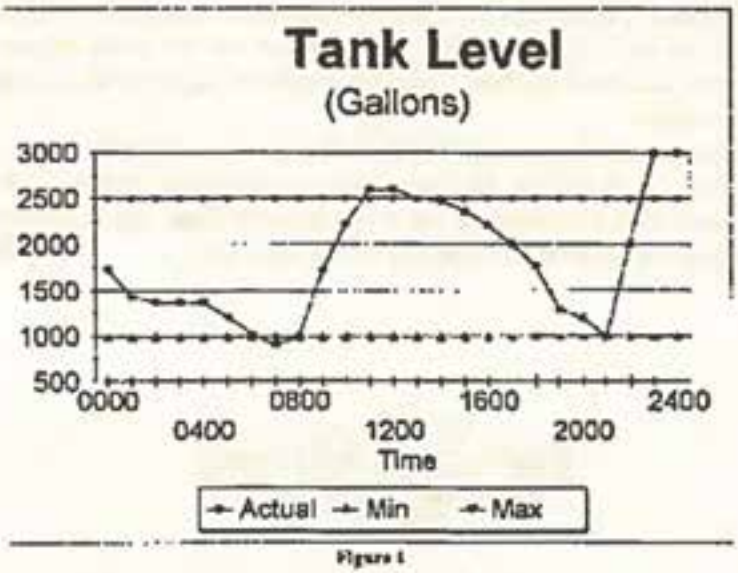

Figure 1

Figure 1 shows how the tank level varies over the 24 hour period and the minimum and maximum specifications allowed. Less mental exercise is required to *see* the trends and out of specification conditions.

How does your mental picture compare with the graph? Did you *draw* the minimum and maximum specification lines? How does the fill rate of the system compare with the capacity of the filling system? (Do you know the fill rate of the filling system?) Does the use rate exceed a mandated use rate? (Are there any onboard systems for which a mandated use rate might be applicable?) Using advance regression techniques, statistical process controls could be used to improve the performance of specific systems onboard.

With appropriate software, further analysis could be conducted on specific log readings and trends, which, in turn, could be compared with a periodically updated database of similar system or component performance(s) on other boats, or from DEVRON 12, for instance, to monitor for impending failure (tangent to

potential PMS periodicity changes).

By-products of this type system are abundant: more legible data recording, instantaneous comparative analysis between current and previous readings, immediate availability of all ship's systems' performance, both individual and collective, to supervisors, ability to send electronic records off-ship while at sea for more exhaustive and educated analysis, and reduction of paperwork, among many others.

Using a device similar to UPS's DIAD in conjunction with a shipwide LAN is just one step toward enhancing watchstander alertness and performance as well as providing for improved system performance and lifetime—a savings issue. ■

*** IN MEMORIAM ***

CAPT Charles W. Shilling, USN, MC(Ret.)

RADM James White Davis, USN(Ret.)

CHALLENGE OF YOUR FIRST COMMAND

by CAPT R.C. Gillette, USN(Ret.)

My first command was as skipper of a war patrol-bound submarine. The initial challenges in taking over command were rather intimidating as the submarine had recently undergone a severe flooding casualty and an outstanding damage control effort was required to save the boat. The submarine did not have the greatest record having accounted for one ship sunk on 12 patrols. At the end of this patrol the first four officers—skipper, exec, engineer, and one other—were being rotated to various assignments.

The war was winding down and it was pretty obvious that as a member of the PCO pool of 20 or 30 candidates, if I were to make a war patrol as CO, I had better press hard. Consequently, I kept pressure on to get command of a submarine bound for a war patrol.

Several events occurred which helped bring my number up. Several newer boats appeared unexpectedly from Southwest Pacific with damage that required return to the West Coast for repair. This peeled off several on the waiting list and some others from the boondocks. Then my future command became available and was turned down by others on the waiting list. Suddenly I found that my squeaking wheel attitude plus the age of the submarine and so-so record put me number one on the command list. I quickly volunteered and checked in with the staff to get ready to go on patrol.

The first step was to find reliefs for the three officers being rotated. My visit to the personnel officer to review records was quite a surprise. I was informed that the records were pretty much out of date and that I should look around on the waterfront to find potential candidates. The staff would then endeavor to order them to the boat. That evening I was sitting dejectedly in the Officer's Club trying to figure out a modus operandi to utilize on the waterfront to come up with candidates in the short time available. I was pretty discouraged on the prospect but after the second drink I became aware of the crowd of officers in the bar. An idea surfaced when I saw a ship's bell on the end of the bar which was used to announce the opening and closing of the bar. As a result of this observation, I had another drink, mounted the bar and rang the bell, announced that there was a submarine

leaving on war patrol in about two weeks. I was the CO and needed three officer volunteers with various capabilities, if anyone was interested in signing on I would be at a table in the corner of the bar with a pad for them to sign up. As a result I got about 12 volunteers, picked three and with them aboard made a successful war patrol ending up in Guam the day the war ended.

I recall steaming up the channel to the tender when everything erupted—whistles, fireworks, etc. I called down to radio to see if they could find out what was going on, telling them that the rescue of six aviators didn't merit such a reception. I was informed that the war was over and that the patrol was designated as successful. The crew, many of whom had not qualified for a combat pin previously, celebrated their new status. ■

USS BLUEBACK

Groups of students can have an *overnight adventure* on USS BLUEBACK in Portland, Oregon. Contact Erik Ortman at the Oregon Museum of Science and Industry (OMSI) at (503) 797-4632 for specifics.

SUBMARINE SQUADRON FOUR DEACTIVATION

by CAPT Stanley R. Szemborski, USN

The history of SUBRON FOUR had it's very beginnings in the 1930s when the submarine S-1 was in the squadron. History books will record that the ships of SUBRON FOUR played an important role in the defense of our nation during World War II, the post war era, and throughout the Cold War. What history books cannot do justice to however, is the *can-do* spirit, the vigor, and the lust for life of the individual SUBRON FOUR sailor.

Exactly 50 years before the squadron deactivated in March of 1945, it consisted of four submarine divisions, 23 submarines, and five surface ships. USS THRESHER (SS 200), USS SWORDFISH (SS 193), USS SEAPOACHER (SS 406), and USS SPRINGER (SS 414) were on war patrols in the Western Pacific. USS HOLLAND (AS 32), USS SKIPJACK (SS 184) and USS PARGO (SS 188) were conducting repairs in remote Western Pacific ports. In addition to sinking hundreds of thousands of tons of merchant shipping and many men-of-war, SUBRON FOUR ships also participated in shore bombardment, photographic reconnaissance, the rescue of downed aviators, the evacuation of personnel, and the landing of guerilla troops.

During this World War II era Alice Allen had a house near Waikiki beach which became a meeting place for many submarine sailors. Mrs. Allen sent me a copy of a World War II invoice from the SUBRON FOUR submarine USS SKIPJACK (SS 184). The invoice was for 150 rolls of toilet paper. Unfortunately, 11-1/2 months later, the supply officer at the Navy Yard returned the invoice with the stamped notation *canceled; cannot identify*. The Commanding Officer of SKIPJACK replied to the Navy Yard Supply Officer in a short letter. The CO stated that despite their best efforts, the crew was unable to await delivery of the subject material and that the situation was quite acute, especially during depth charge attacks. He enclosed a sample of the desired material and asked what the Navy Yard personnel were using in place of the unidentified material. He finally stated that his crew had become accustomed to using the vast amount of incoming non-essential paperwork and in doing so complied with the Bureau of Ships desire to reduce paperwork, thus in effect, killing two birds with one stone.

Shortly after the war, the squadron moved from Pearl Harbor to Key West, Florida. In March of 1955, the squadron faced a much different world. Forty years ago, prior to the Communist takeover in Cuba the SUBRON FOUR submarine tender USS HOWARD W. GILMORE (AS 16) visited Havana with USS SEA CAT (SS 399) alongside for a liberty call. About that same time, a National Geographic magazine article entitled *From Indian Canoes to Submarines* describes Key West as an island paradise in which submarines, tankers, supply ships, fishing boats, turtle boats and visiting yachts share the clear waters. The fishing from the Naval Station was so spectacular that President Harry Truman's winter White House was located there. The Navy and the Submarine Force were experimenting with various antisubmarine warfare techniques. The article describes in both pictures and words an ASW exercise in which a blimp attempts to keep track of a Guppy class submarine. The article also describes a marvel of modern technology called sonar which enables submarines to *see* underwater.

In 1959 the squadron moved to Charleston. Officially, this move was part of a dispersal plan to make the Atlantic Fleet less vulnerable to nuclear attack. Behind the scenes, a big reason for the move was the effort and the influence of Congressman L. Mendel Rivers. It is quite appropriate that the deactivation ceremony was held on board USS L. MENDEL RIVERS, the ship named for a man who did so much both for the low country and for the military. A historical note on the squadron's arrival in Charleston was passed on to me by the former chief engineer on USS GILMORE. The chief engineer stated that as the GILMORE and other SUBRON FOUR ships entered Charleston for the first time, Congressman Rivers was delivering a radio address to the low country in which he stated, "It took 20 years to do it and by golly I finally got them here".

Upon arrival at the pier, the GILMORE engineer was disturbed to find that there were absolutely no pier services available. He found the Naval Station First Lieutenant and asked for shore-power. The First Lieutenant replied that no power was available, but he could build a bar for the officers. The engineer asked for pure water—again the reply was no, but we can build a bar. Two days later, no services were available, but the bar was built and functioning. Times have changed. Rear Admiral (select) Froman, the CO of Naval Station, now provides many pier services. This

morning I asked her to build me a bar. She walked away giving me a puzzled look.

The 1960s brought big changes. The first nuclear powered ships joined the squadron. The Cold War became colder. ASW became a primary mission of the Submarine Force. Submarines from the squadron were on patrol throughout the world whenever conflict arose. For example, SUBRON FOUR ships were active in the Cuban missile crisis. But since the Cold War was for the most part a non-shooting conflict, life here in Charleston continued as normal. Mr. Vince Clifford, who served as an engineman and diver on board USS HARDER (SS 568) and USS DARTER (SS 576) wrote to me about an event in 1962. He and his wife attended the South Carolina Water Festival in Beaufort. At the end of the ceremony, the official party departed and walked in between Mr. Clifford's wife and the car door. After about 10 officials walked in between his wife and the car, one man stopped and opened the door for her. That man was L. Mendel Rivers.

In the 1970s the squadron was predominantly 637 class nuclear powered ships. These 637s were the backbone of the Submarine Force. Twenty years ago in March of 1975 the diesel powered USS TIRU (SS 614) had just returned from a Unitas deployment. The nuclear powered ships USS GRAYLING (SSN 646) and USS SAND LANCE (SSN 660) were on deployment in the Mediterranean. SAND LANCE is still attached to SUBRON FOUR and occupies the berth behind you. USS SUNFISH (SSN 649) had just returned from the Mediterranean and USS TUNNY (SSN 682) was conducting a workup for her upcoming Mediterranean run. USS L. MENDEL RIVERS (SSN 686) had recently arrived in Charleston following new construction at Newport News in Norfolk.

In 1981 the Squadron Commander Captain Tom Maloney instituted an annual exercise called Operation Swamp Fox. The newly commissioned USS FRANK CABLE (AS 40), which is the submarine tender you see at the end of the pier, went to the Caribbean and conducted open ocean recoveries of Mk 48 torpedoes fired by USS BATFISH (SSN 681), USS L. MENDEL RIVERS (SSN 686) and USS SUNFISH (SSN 649). Following this exercise, CABLE and the three SSNs moored off of St. Thomas for liberty. While there, CABLE also provided repair services for USS AMERICA (CV 66) and the USS SOUTH CAROLINA (CGN 37).

Ten years ago, in 1985, the Squadron Commander, Captain Mario Fiori, coined the phrase *You Defend Freedom* which can be seen to this day on the seaward side of the piers. Also in that year he hosted the crew of U 352, a German submarine sunk off the Charleston coast in 1942. The survivors were held in Charleston area POW camps until the end of the war.

That brings us to the 1990s, the end of the Cold War, and the end of Submarine Squadron Four. In the fall of 1993, I ran the last exercise Swamp Fox. In this operation the squadron returned to its World War II roots by emphasizing reconnaissance, search and rescue, delivery of covert special forces and shore bombardment utilizing cruise missile strikes. This last exercise also provided joint training opportunities with the participation of Army and Air Force units as well as naval aircraft, surface ships, SEALS and Marines. The squadron has come full cycle.

Although Submarine Squadron Four is officially inactivated, it will live on in the hearts and the minds of former SUBRON FOUR sailors. On the last morning, Vice Admiral Emery pinned on the last two sets of Submarine Dolphins, the last four sets of Surface Warfare pins, and presented the last Command Qualification certificates that will ever be given to the men of SUBRON FOUR. The squadron will also continue to live on as these men and others like them use their SUBRON FOUR training in seamanship and basic submarining to become the Navy leaders of tomorrow. ■

NAVAL SUBMARINE LEAGUE
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THE WHALE CAN'T COME HOME AGAIN

by Steven Slosberg
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of the New London Day

Kristina Irish and the two girls were WHALE watching last Thursday afternoon, parked in the grassy Nautilus Memorial overlook above the Thames River, waiting to pick up Daddy from work.

WHALE, on which Michael Irish serves as a petty officer first class, was steaming back to the Naval Submarine Base for the last time.

Mildred Dahl and her two girls were also there. David Dahl is a senior chief aboard WHALE.

The two Navy wives chatted about things domestic, particularly their daughters. Anastasia Irish turned 5 that day. Angela Dahl, 16, had her first day of driver ed.

It was late April in spring sun. Down the Thames, as WHALE and its pilot tug passed below the overlook and then the Nautilus, Coast Guard cadets were flocking onto the water in their two-sailor Flying Juniors. Around the park forsythia was doing it up in yellow. The dominant willow was beginning to leaf.

When their husbands return home again, it will be fall.

WHALE, with Irish and Dahl aboard, will depart the sub base May 9, heading out on what's grandly called a world cruise that is to end next September in Bremerton, Washington where the sub will be decommissioned.

It will be the longest separation for Kristina and Michael Walsh, who live in Navy housing on Charter Oak Drive, adjacent to the back rooms of the Best Western Olympic Inn in Groton.

"At least six months, maybe seven months," said Kristina Irish, gamely, wistfully.

She's 32, and was raised in Philadelphia. Her husband's 31 and from Michigan.

Some 20 wives of WHALE crew members, she said, will follow their husbands to the West Coast and resettle there. Not the Irishes or the Dahls. Both husbands have other assignments here.

"I didn't want to uproot the girls", said Kristina Irish, whose older daughter, Angela, is 8 and attends Mary Morrisson School.

Mildred Dahl has lived in Guam, California, Washington and

Connecticut since her marriage. She was born in Hawaii, a self-described Army brat. The Dahls live in Uncasville where Angela attends Montville High School and Jennifer, 13, Tyle Middle School.

She said she couldn't tolerate living in San Diego again.

Both women are Navy enough to endure deployments, but only Kristina Irish still follows the boats out. She takes the girls from base downriver to beneath the Gold Star Memorial Bridge and then down to Eastern Point Beach, eyes ever on the sail and wake.

Their husbands will be home for a couple of weeks. On Friday, the base is planning farewell ceremonies for WHALE, the second boat launched in the Sturgeon (637) class of attack subs. It was built by General Dynamics at Quincy, Massachusetts, and commissioned in October 1988.

Two weeks ago, WHALE was at sea from Monday to Friday, and last week for four days. In deployment time, that's 9 to 5. The women said they didn't know where WHALE had been. They said they never do.

Thursday afternoon, families of other crew members already had gathered by a pier on the base. Kristina Irish and Mildred Dahl and their daughters were a bit late, left driving upriver ahead of the sub and parking near the Nautilus for a good look. They could see sailors standing near the vessel's sail, riding the boat in.

"It's the last day WHALE's coming back to Groton," said Kristina Irish, from the front seat of the family van. "I was late because the kids didn't want to hurry up. It was too nice a day out."

Chances are the weather will be fine the next time Daddy comes home. Autumn is always lovely here. ■

ON PATROL FIFTY YEARS AGO

by Dr. Gary Weir

[Editor's Note: In the summer of 1945 COMSUBPAC, Vice Admiral Charles Lockwood, assembled nine submarines organized into three packs to test a new system for penetrating Japanese minefields to expose new targets. The system was the FM sonar developed under contract to the National Defense Research Committee's Division 6 (Undersea Warfare) by the University of California Division of War Research at Point Loma, near San Diego. This system formed the basis for the very successful QLA sonar that served the submarine fleet so well in the early postwar years.

In this case, with SEA DOG (SS 401) carrying the senior CO, the three packs did find a wide variety of targets. More importantly, the sonar worked very well and exposed the Japanese mines sufficiently to permit entry and exit through previously denied harbor entries and chokepoints. Lockwood christened the effort Project Barney.]

USS SEA DOG - Report of Fourth War Patrol
Period 27 May 1945 to 5 July 1945

PROLOGUE

During refit in Port Apra, Guam, alongside USS APOLLO (AS 25), a decision was made to remove the FM sound gear from USS SEAHORSE, due to damage to that vessel during previous patrol, and install it aboard SEA DOG. As a result, the NGA fathometer and the special clearing cables around hull obstructions were installed. The training period was extended to allow four days FM training. Excellent results and a good operational and plotting procedure were established during this training period (16-19 May). Regular training was conducted 21 to 24 May 1945; on the last day, the FM gear was tested and found inoperative. Returned to Port Apra, entered dry dock that night, and FM sound head was renewed. Underway for tests 25 May, results satisfactory. Loaded 26 May. Readiness for sea 27 May 1945.

NARRATIVE:

26-27 May 1945

Held conferences with COMSUBPAC and members of his staff, and commanding officers of all ships in Japan Sea Patrol Pack. Organization is as follows (Commanding Officer SEA DOG, Pack Commander):

Task Group 17.21 SEA DOG, SPADEFISH, CREVALLE (Commanding Officer SEA DOG, Group Commander).

Task Group 17.22 TUNNY, SKATE, BONEFISH (Commanding Officer TUNNY, Group Commander).

Task Group 17.23 FLYING FISH, TINOSA, BOWFIN (Commanding Officer FLYING FISH, Group Commander).

27 May 1945

1517(A) Underway from Port Apra, Guam, in company with SPADEFISH, CREVALLE. TUNNY group will depart tomorrow, FLYING FISH group the following day. Groups will make entry into Japan Sea at one-day intervals.

1 June 1945

1000 Surfaced. SJ and ST out of commission. This was a low in the life of SEA DOG; having been plagued with many minor material troubles throughout the ship since the day after departure, we now lose our radar just before a scheduled transit through the Nansei Shoto.

1200 Position Lat 29-25N, Long 131-54E.

1335 Sighted CREVALLE. Closed and made arrangements for her to run interference for us.

2300 Completed transit of the strait south of Akuseki. CREVALLE did an admirable job of leading the blind, and is continuing to do so. We are communicating by VMF, following her signalled course changes, and managing to keep her wake in sight most of the time. Rain poured during rest of the transit through the strait. Fortunately, no contacts were made by CREVALLE. Still working on the radars; have managed to get some results from the ST, but SJ refuses to revive yet. Informed CREVALLE that completion of repairs by tomorrow was improbable, and asked his plans. He gave details and promised to look us up after surfacing tomorrow night and resume his duties as a *seeing eye dog* for us.

2 June 1945

1200 Position Lat 30-48N, Long 138-48E.

2000 Surfaced, at battle stations. Still no luck on the ST and SJ.

2100 CREVALLE found us; secured from battle stations; fell in astern of her and headed for the pass between Danjo-Gunto and Fukue-Shima.

2300 ST and SJ back in commission. Good work by the radar officer and his technicians; there were nine deficiencies in the SJ, affecting all units in it except the high voltage rectifier. Followed

the CREVALLE through the pass anyway, to avoid confusion.

3 June 1945
0415 Dived for the day, west of Fukue-Shima, heading northward.
1200 Position Lat 32-55N, Long 128-22E.
2030 Surfaced. Headed for rendezvous. Supplementary orders had been issued to the group as follows:

(a) Rendezvous with SEA DOG at initial point Lat 34-00N, Long 128-38E, at 0000 Item, 4 June 1945.

(b) From Rendezvous, SEA DOG will set course 035T at 5 knots on surface. SPADEFISH follow, 4 miles astern. CREVALLE take this course, 4 miles on port beam of SEA DOG.

(c) SEA DOG will dive on FM contact after informing SPADEFISH on SJ radar (the latter has deck-mounted FM head). She will dive, in any case, at Lat 34-14N, Long 128-50E, at about 0300 Item. SPADEFISH and CREVALLE dive simultaneously, provided in approximately correct positions. Steer course 035T and made good 3 knots through the water after submerging. SEA DOG will surface at 2100.

2300 Radar contact on CREVALLE and SPADEFISH. They did some smart maneuvering, without further orders, to gain position on SEA DOG as previously agreed.
2400 Passed through initial point on time, commenced transit of Tsushima Strait, west channel.

4 June 1945
0130 SPADEFISH and CREVALLE apparently following in good order, though the latter has dropped somewhat behind. Informed SPADEFISH (by SJ) that SEA DOG had passed through initial point at midnight and assumed he was following; asked him to pass this to CREVALLE, whom we were unable to raise on the SJ. SPADEFISH, in reply, sent information of a radar contact bearing 290T, 16,000 yards. Being well into the entrance of the strait by this time, decided not to upset our carefully planned schedule by going back to join the show (if any), left them to avoid the contact—as they would have to do in order to make the schedule and not delay everybody a full day—and continued. Lost contact on SPADEFISH shortly thereafter, but CREVALLE had moved up almost to our port beam by 0210 and was coming along all right. Used ST most of the time here, after 0130.
1600 Cleared northern end of Hishi Suido, entered Japan Sea. Came to periscope depth; obtained fix on northern end of Tsushima Island. All hands breathed a little easier. The emotional

strain, especially on the officers, was very heavy, and its effects were not quite evident. Everybody was on their toes at all times, however; officers and men performed their duties in a manner deserving of the highest praise. The pack now has orders to proceed to assigned area, remain undetected, and do no attacking until sunset, 9 June, except on capital ships.

Just after submerging, the FM sonar gear was tested by maintaining contact on a False Target Shell, which was easily followed out to 500 yards. With the gear thus demonstrated to be in satisfactory condition, transit of the strait was made at 110 feet keel depth, ship trimmed with a two degree up angle.

During this passage, no FM contacts were made which could possibly have been mines. None of them had any tone which could be associated with a solid object of any kind, and none of the contacts were maintained for more than a few seconds.

Available time in Japan Sea prior 9 June was spent reconnoitering the approaches from Korean ports to Niigata pass north of Sato Island. No contacts. SJ and ST radars were out of commission from 1000 1 June to 2300 2 June. ST still considered unreliable for surface search.

9 June 1945

0315 Sighted Hime Sake light on east shore of Sado, burning with usual characteristics and visibility.

0324 Dived 15 miles east of north end of Sato. Headed into Ryozu Wan for a good look into the harbor.

1200 Position Lat 38-14N, Long 138-33.5E.

1455 Having completed a careful inspection of Ryozu Harbor and finding nothing, headed out. Took movies of the beach.

Attack #1 - Sunk: one AK 2,500 tons, Hozan Maru class (EC).

2000 While preparing to surface, about 10 miles northeast of Hime Sake light on Sado Island, in the *slot* between Sado and Honshu, QB contacted medium screws bearing 040T. Periscope sighted him almost immediately: a small freighter of about 2,500 tons, running along serenely on a steady course of 205T at 8 knots, his side lights burning brightly. Had only to swing the ST into action (surprisingly, it produced ranges from 3,000 yards in), got a good solution with four observations and swung to a course for a 90 track.

2015-18 Fired one torpedo, with gyro 20° right, 110 starboard track.

2015-45 Hit him forward. He sank with a diving time of about 60 seconds at a 10° down angle. Checked his length: about 250 feet by periscope formula; he appeared similar to Hozan Maru class

(page 151, ONI 208-J). Having opened for a short time, surfaced with stern toward position of target's sinking.
2023 Sighted two life boats astern.
Attacks #2 and #3 - Sunk: One AO, 10,500 tons, Nissyo Maru class (EC).
Immediately made SJ contact bearing 060T, 10,000 yards—a saturation pip. Headed in on this one. Tracked him on course 040, steady, at 9 knots.
2042 Sighted this second target from the bridge at range of about 3,400 yards. He was a heavily loaded large tanker; length by binocular, formula about 550 feet, similar to Nissyo Maru (page 273, ONI 208-J), of 10,526 gross tons. The conning tower reported a *no hands* solution had been obtained by this time; and visibility was quite good, so at
2044 Commenced firing three tubes forward, spread 200 feet between torpedoes, at range of 2,600 yards, torpedo run 2,400 yards.
2045-38 One hit, aft. One torpedo of this spread was seen to make a surface run, or nearly so, for most of its travel. Pulled away from the target and watched him for a while. Much flame aft for several minutes and many lights running about wildly on topside. He stopped and his pip grew smaller, but had soon gotten underway at 5 knots on approximately reverse course: 240T. The flames went out. Headed back in to finish him off.
2110-29 Fired one torpedo, gyro 011°, 95 starboard track. This one was seen to veer about 25° to the right on leaving the tube, and then settle on its course. It missed, so
2112-40 Fired another, with same target data, 8° right gyro, 114 starboard track.
2113-45 Hit him, just forward of amidships. This was a beautiful explosion his foremast toppled, bow broke off and sank, and his stern assumed a down angle of approximately 60 degrees. It floated for a while, but its pip disappeared at 6,000 yards. Hime Saki light on Sado had been burning brightly throughout the entire proceedings. All clear on the SJ; apparently no more targets are available here. The glare of the lights of Niigata is plainly visible against the sky to southeastward, with the occasional beam of a searchlight.
Set course for a patrol up the coast during the night, hoping to intercept traffic off Sakata and Akita on the way (if any of it goes out directly to Korea). Apparently none of it from Niigata goes directly across, north of Sado, judging from our lack of contacts there during the past three days. Consider most traffic is coastal; all contacts to date have been. Plan to dive off Oga Hanto

tomorrow.

10 June 1945
0320 Made SJ contact on two ships, bearing 089T, 14,000 yards; tracked them on a southerly course along the coast. Unfortunately it is now getting very light with good visibility; consider chances of a successful end-around very small in view of probability of having to close the coast several hours from now in order to get ahead of them. Secured tracking and continued closing Oga Hanto.
0343 Dived.
9650 Regretfully watched a medium AK standing down the coast, out of reach. We hadn't yet closed the cape sufficiently.
1200 Position Lat 39-56N, Long 139-37E. No further contacts today, except fishing craft. It appears we must get in early each morning here to catch anything.
2000 Surfaced. Patrolled during the night to a point northwest of Kisakata and northeast of Tobi Shima to cover inner traffic lanes up the coast, and returned to vicinity of Oga Hanto via the probable lanes outside Tobi Shima. No contacts except a few close ones on probable fishing craft.

11 June 1945
0325 Dived on 100 fathom curve south of Oga Hanto and closed that cape once more. Visibility was variable: shifting mist, fog, and occasional rain.
1200 Position Lat 40-05N, Long 139-38E.
Attack #4 - Sunk: One AK, 4,000 tons, similar to Osaka Maru (page 132, ONI 208-J), (EC).
1307 Sighted medium AK bearing 125T, range 8,000 yards. Attempted to close submerged until 1335, without success. When this sighting was made we were north of Oga Hanto. Opened out and surfaced at 1355. Visibility was poor at that time, and we surfaced after having lost sight of target in mist at about 8,000 yards. Commenced end-around to westward and northward. Target was tracking on 010T at 8-1/2 knots. The haze lifted at times and target was in full view a large part of the time at ranges from 11,000 to 14,000 yards; it is a mystery why he did not sight us and turn away. SJ is obviously not working at full efficiency: it lost the target completely at 13,000 yards, at which time he was hull down, with complete superstructure in view. The quartermasters did a fine job on the after TBT during this run. Both visual and SJ contact were lost at times, but he was always picked up again within half a degree of expected location.

1510 A fortunate light rain enveloped us, permitting turning in to close the track at just the right time.
1519 Dived. Closed track slowly, and when he came into good position (80 port track, gyro 6° right, range 1,280 yards), at
1555 Fired one torpedo.
1555-43 Hit, at MOT. Target broke in two, up-ending both the bow and stern. Got moving pictures as the last of this ship sank. Spent a few minutes giving some of the officers and crew a chance to see half a dozen Nips climbing onto floating wreckage and lifeboats, then resumed patrol to southward.

1758 Sighted a destroyer (probably Asashio class, though this is uncertain due to the haze) to northwestward, on a southwesterly course. He had a broad angle on the bow at all times while in sight, and was hull down or nearly so at all times. He was pinging on long scale at about 17.5kcs, and soon disappeared to southward.
2027 Surfaced. Patrolled on east and west course, 12 miles north of Nyudo Saki, during the night.

12 June 1945
0320 Dived, ten miles north of Nyudo Saki (on Oga Hanto) and patrolled to southward.
Attack #5 - Sunk: One medium engines-aft AK or AO, about 6,000 tons (EU).
0635 Sighted smoke bearing 084T. Headed for it. Closed on approximate normal approach course at high speeds for an hour. In the brief observations during this period, made out four ships in a rough box formation, well spread out. They had just rounded Nyudo Saki and were heading fairly well into shallow water along the coast between that cape and Henashi Saki. Two medium AKs were leading, with two medium engines-aft AKs on the after corners of the box. Attempted to close the leading AK of the left *column* but couldn't get in. Shifted target to the engines-aft AK on the left, and closed him. He still offered a long shot, but decided to chance three torpedoes on him because he appeared to be of fair size and there was a faint chance of hitting the far Ak with a remaining torpedo from that spread. At
0822 Fired three torpedoes, spread 150 feet apart along track, 130 port track, torpedo run 3,200 yards, gyros 1° to 2° left.
0824-10 One hit, slightly abaft amidships. Target broke in two and sank within two minutes. Did not attempt to get pictures during this approach due to very calm condition of the sea.
0825 The target's three friends were showing 180° angles on the bow headed in even closer to the coast, so turned away and

headed for somewhat deeper water, then patrolled southwesterly for remainder of day.
2010 Surfaced.
2240 Made two radar contacts bearing 080T, 8,000 yards. Tracking revealed them to be obviously two patrol craft making a sweep down from the northward off Oga Hanto. They tracked at 12 knots on southerly, then westerly, and finally northerly courses, before contact was lost.

13 June 1945
0315 Dived about six miles bearing 250T from southwest coast of Oga Hanto and headed up for this hunting ground again. No contacts today, however, except fishing boats, sea trucks, etc.
2010 Surfaced. Report immediately came up from the after torpedo room that a loud noise which sounded like an explosion, had been heard on starboard side while surfacing, and that the starboard propeller and shaft were making excessive noise and vibration. Our hearts sank into our boots; this pretty definitely indicated that the starboard clearing wire, one those just installed in Guam, running from the starboard propeller guard to the hull just forward of the stern tube bearing, had parted and fouled the starboard screw. This is 1-1/4 steel cable, and could really do some damage. Stopped, and by cautious testing at various speeds during the next hour, found that the starboard propeller had a fairly loud thump at slow speeds, at exactly the frequency of shaft rotation, and there was (at times) an irregular clanking noise on the hull just forward of the propeller. The shaft thump could not be heard at high speeds on the surface, for some strange reason, though ship vibration at high speeds is slightly heavier.
2115 Received CREVALLE's 131205, reporting sinking three Sugar Charlie Loves and being chased by three DEs off Henashi Saki, gunning two sampans off Motsuta Saki this morning, non-existence of shipping since Monday, and a plea to send him where there are targets.
2230 Received SPADEFISH dispatch: Four AKs and four sampans sunk, and recommending four more days where he is.
2350 Stopped and lay to, having pulled clear of the coast. Had made preparations for shallow water diving, and for various methods of removing or securing the parted cable. Attempts were made for over an hour to get divers down, but the rubber face mask of the shallow water diving outfit proved to be useless; leakage around the mask would immediately fill it with water as soon as the diver's head went under. Further grappling failed to grasp the cable ends probably hanging down from their fittings.

14 June 1945

0140 Forced to admit failure, got underway. It was immediately noted that the starboard shaft thump occurred only for short periods at low speeds, and performance at high speeds—up to 18 knots—was satisfactory. While feeling much better about this fortunate circumstance, it was considered possible that the cable might still be hanging, or be wrapped around the shaft, as a cause of future trouble. Set course to southwestward for day surface patrol across western approaches to Akita, Sakata and Niigata.

ST still unreliable; performs at short ranges only (5,000 yards maximum since entering area). SJ now developing a defect; ranging unit apparently shows one-tenth of actual range. Continued working on the former, and commenced trouble shooting in the latter.

2025 Surfaced, opened coast to transmit patrol orders to CREVALLE and SPADEFISH. In view of decreasing coastal shipping activity, pack will patrol in lanes 30 miles wide running 025° - 205°, the eastern lane being tangent to west shore of Sado Shima. Southern limit of lanes is a line running 305T from Sado. All ships were advised to stay to southward of a line running 305T from Homjo. Believe this plan will give good coverage of shipping between Niigata, Sakata, Akita, and Korean ports.

15 June 1945

0305 Dived eight miles southwest of Oga Hanto, closed that point.

Attack #6 - Sunk: One small AK, 2,500 tons, similar to Hozan Maru class, (page 151, ONI 208-J), (EC).

0510 Sighted smoke bearing 354T. Commenced approach. A small AK, standing south past the northern end of Oga Hanto. We were about 4,000 yards off the beach so he couldn't get past us, unless he should sight us in this calm sea. He continued on a steady course of 180T, so at

0544 Swung left for 70 port rack short from bow tubes. One next observation, however, he had changed course to 150T to follow the coast, so swung for a 90 starboard track from stern tube.

0552-42 Fired one torpedo, 1,000 yard run, 92 starboard track, gyro 5° left from #10 tube.

0553-21 Hit, just forward of amidships. Tried the movie camera but it jammed; changed magazine and it jammed again. Finally got some still pictures as he sank about four minutes later.

0610 Set course for patrol up the coast of Oga Hanto again; watched small craft from the beach come out and rescue survivors.

17 June 1945
Patrolling on surface. Converted #4 FBT during night and made dives to flush it out. Also had a very interesting SJ conversation with SKATE at a range of 150 miles. She reports one SS and four merchantmen sunk, all fish expended.
2145 Effected rendezvous with SPADEFISH and CREVALLE. Exchanged information on areas, now to be rotated, and issued data on slight modification in exit plans. SPADEFISH reported having sunk a total of six ships with torpedoes and four trawlers and sampans by gunfire. CREVALLE did not have any further sinkings to report.
2250 Rendezvous completed; opened to southwestward to transmit above modification in exit plans to remainder of Japan Sea Pack, then set course for new area (Japan Sea north of Lat 42-47N).

18 June 1945
1205 Commenced making full power in order to reach area north and northeast of Benkoi Misaki for patrol this afternoon and tonight.

19 June 1945
0248 Dived and closed coast about four miles south of Kamoi Misaki.
Attack #7 - Sunk: One medium AK, 4,000 tons, (UN).
0559 While about 4,000 yards off the beach, three AKs loomed up through the haze at a range of about 4,000 yards, angles on the bow 15°, standing up the coast from southward. Turned toward in order to bring the more numerous bow tubes to bear, and commenced firing about nine minutes after the first sighting. Fired two at the leading ship. Fired three at the second ship as she was turning away; the short torpedo run caused the first ship to be hit before the fish were away at the second. Needless to say, the third AK was showing her stern by this time. Turned back to the first target, now north of us, and saw her sinking, stern under, her crew getting into a lifeboat from the high deck amidships just abaft the bridge, which was then just at water level. Sighted a single engine plane approaching from about three miles away, beyond the sinking target. Being then headed toward the beach on 060T, quick range on the sinking ship (about 400 yards) showed there would probably be insufficient room to turn toward her, in consideration of the northerly current existing. Started a turn right, ordered QB rigged in, called for a sounding, and ordered 150 feet (based on last sounding of 45 fathoms obtained early in the approach, with allowance for having closed the beach

in the turn toward the targets). Before QB could be rigged in, or a sounding obtained, grounded lightly forward in 116 feet of water on heading 065T. Backed her off, and continued backing for about ten minutes, swinging her stern southward, as the diving officer handled the situation very nicely (the efficacy of exchanging the bow and stern planesman in this case was fairly well demonstrated). When well clear, heading north, there was ample room for turning left to clear the beach. Surprisingly, there was no attack by the plane; nevertheless, went deep for a while and opened out to gather our wits and survey the damage which fortunately consisted only of a smashed QB head and bent shaft. In retrospect, it is realized that the whole attack was misdirected by a greedy desire to empty all the bow tubes at three beautiful, unescorted AKs, and that this merely resulted in a hurried attack and firing at too short a range for effective multiple fire. By the time we were ready for action again, there were several patrol craft pinging up and down the coast, and a DE showed up in the late morning for a thorough search of the area, which lasted all day. No other shipping was sighted.
1200 Position Lat 43-08N, Long 140-06E.
2020 Surfaced.

20 June 1945
0255 Dived and closed coast off Ofuya Misaki. No contacts during the day except sampans and two small ships similar to tugs. Two planes sighted during the day, patrolling the beach.
1200 Position Lat 43-45N, Long 141-14E.
2030 Surfaced. Answered SPADEFISH's dispatch of yesterday. She is all out of fish. Told her we would work in the northern part of her area tomorrow, and headed for Motsuta Saki. Received a plea from TUNNY for use of the northern area off Otaru. She still has 15 fish.
Granted this; warned her of planes and radar equipped escorts.

21 June 1945
0253 SJ contact bearing 221T, 8,000 yards.
0300 Sight contact on DE (probably) bearing 033T, range about 11,000 yards. Much signalling, at long range, between the two, as they attempted to close in from both sides and we slipped away to seaward at flank speed. Momentary visual contact was also made on another ship, bearing 200T, range 10,000 yards. This incident killed our chances of getting into the coast.
0436 Dived, set course for rendezvous with CREVALLE and SPADEFISH.

0610 Sighted friendly submarine, probably SPADEFISH, heading toward rendezvous.
1200 Position Lat 43-05N, Long 138-49.5E.
1255 Heard one distant explosion, sounding much like a torpedo but followed by two more (as of two more hitting the beach, or exploding at end of run).
1258-1310 Twelve distant explosions (depth charges?).
1950 Surfaced.
2247 Changed course for a short time to transmit orders to all ships in Japan Sea regarding the exit.

22 June 1945
0300 Dived. Sighted a large AK and an even larger tanker—both Russian—during the morning. Surfaced twice during the day for sun sights. Tested FM gear; fairly good results.
1200 Position Lat 45-09.5N, Long 139-07.5E.
2040 Surfaced.

23 June 1945
0300 Dived. Surfaced twice during the day for sun sights luckily obtained through breaks in the clouds.
1200 Position Lat 45-31.5N, Long 140-02.5E.
1955 Surfaced at rendezvous.
2045 Contacted SPADEFISH and CREVALLE; sent the former to join the FLYING FISH group, the Southern Group of the exit plan.
2200 TUNNY and SKATE joined up, coming from their rendezvous to northward. Northern Group of exit plan now complete except BONEFISH. TUNNY states BONEFISH did not make the scheduled rendezvous with her at sunset. In accordance with previous arrangements, did not await BONEFISH, not having heard from her. Formed the four ships present into position for dawn dives. The SCR/610 communication was fairly satisfactory during these rendezvous, though it was often necessary to relay messages through a third ship which sometimes resulted in confusion and lost circuit time.

24 June 1945
0300 Dived. All ships were ordered to dive at this time and steer course 140T at two knots, surfacing at 2000.
1200 Position Lat 46-14.5N, Long 140-36E.
2000 Surfaced.
2030 Completed forming column: SEA DOG, CREVALLE, TUNNY and SKATE, in that order, distance 6000 yards. Set

course toward La Pereuse at speed to arrive at agreed initial point at specified time, to coincide with exit of Southern Group some distance from us. Obtained radar fix on Kaiba To enroute.
2125 SJ radar failed. Told CREVALLE to lead us through.
2200 Fell in astern of SKATE, keeping station visually with some difficulty. Manned battle stations, gun action, and commenced transit. One of the most beautiful fogs ever seen, settled over the Strait; visibility after 2230 was about 300 yards. SKATE kept SEA DOG coached into position, by brief SCR transmissions, throughout the passage, and CREVALLE did an excellent job of leading us through, including avoiding the single SJ contact made. The radar-blind SEA DOG watched the dim white light of this ship move aft on the starboard side just before the fog set in solidly.

25 June 1945
About 0200, with the transit almost completed, the radar officer and his technicians coaxed life into the SJ again. FLYING FISH shortly reported, in a faintly heard SCR transmission, that her group was coasting down hill. At 0500, still in a heavy fog and with the Strait well astern, the Northern Group scattered to proceed independently to base. It was an amazing passage, with no opposition—not even an APR contact to any kind.
0740 CREVALLE stated (in a voice message which did not come in well) "Starboard propeller guard cable snapped, fouled screw."
0810 Contacted CREVALLE. Fog still heavy. Simultaneously received information from her that she was putting divers over, that only one screw was fouled and did not desire us to stay with her.
1200 Position Lat 45-46N, Long 145-51E. Transited Eterafu Kaikyo during the night and set course for Midway in company with CREVALLE, SKATE, and BOWFIN. CREVALLE reported she had repaired her starboard screw.

30 June 1945
Arrived Midway. Fueled and had divers inspect bottom, QB head and starboard propeller guard cable both entirely missing. ■

SEA TRIALS STORIES, CONT'D.

Reading the reprint of Tom Maloney's remarks at the BATON ROUGE inactivation in the January 1995 **SUBMARINE REVIEW** brought back vivid memories of the *Great Sea Trial Rig for Red Before Sunrise Flap of 1977.*

As Tom relates, two stubborn old men were needling each other by taking carom shots off of new construction skippers who were facing probably their most stressful ordeal up to that time: making their first personal underway in command in a new construction SSN. It was nuts!

It began, I think, when Rickover wanted to start the PHILADELPHIA trials well before sunrise. Curt Shellman, the SUBLANT N4 who was riding, got in a fight with him over it and Joe Williams weighed in. Bud Kauderer, who was Chief of Staff may have also gotten a piece of the action earlier as the SUBLANT representative on the LOS ANGELES trials.

All I know for sure is that I got a call in my cabin at Squadron Six from Bud and Curt one afternoon saying that the two of them had just had a meeting between them to decide who would ride as CSL rep on the BATON ROUGE trial. They told me I had been selected and that the second place finisher wasn't even close.

Tom told you we finessed the old men but he didn't tell you how. Now it can be told.

When Tom went to get Admiral Rickover we rigged Control for white with the navigation party and appropriate others red-goggled. HGR came through and up the ladder. As soon as his buns went through the upper hatch, we did a *silent* rig for red. By the time he came down the sun had risen.

I rode a lot of trials in those days. I know a lot of sea trial sea stories. Watch for my memoirs.

Warm regards,

RADM Austin B. Scott, Jr., USN(Ret.)
230 Magnolia Lake Road
Aiken, SC 29803

USS 0-9 (SS 70)/ USS SQUALUS (SS 192) MONUMENTS

Squalus Memorial Chapter, U.S. SubVets WWII and Thresher Base, U.S. SubVets are conducting a drive to raise funds to purchase a pair of monuments in memory of the lost crew members of the 0-9 and SQUALUS.

These monuments will be similar in nature to the WWII and Thresher Memorial Monuments and will be placed in the proximity of these monuments at Albacore Park, Portsmouth, New Hampshire.

If anyone has knowledge of family members of 0-9 or family members and crew of SQUALUS, please contact us. Any donations may be sent to:

0-9/Squalus Monuments
P.O. Box 315
Chocorua, NH 03817-0315
(603) 323-8782

A LETTER TO A CONGRESSMAN

January 13, 1995

The Honorable Sam Brownback
United States House of Representatives
Washington, DC 20515

Dear Sam:

This evening I read GAO's report entitled "Attack Submarines, Alternatives for a More Affordable SSN Force Structure" (GAO/NSIAD 95-16).

At some point this year, your commitment to a strong national defense is going to be put to the test. It is very possible that when decisions are made about the size and composition of the Submarine Force, those who look to the military as a source of all spending cuts will wave the GAO report at you and quote extensively from its findings.

Accountants believe that they can analyze anything involving numbers and arrive at meaningful recommendations. GAO, in its report, has taken many numbers and arrived at what it considers

to be a rational result. In actuality, all they have built is a skeleton, devoid of flesh and lacking a brain.

The size and composition of the Submarine Force cannot be fixed without taking into consideration the threat, operational and industrial factors, national policy, and the ability to produce submarines in the future. Many of the elements that must be considered cannot be reduced to numbers and are beyond the ken of accountants.

If Congress relies only on cold numbers, it may well reduce Submarine Force levels below the point from which there can be no recovery, in effect deciding that this nation no longer will have submarines in its arsenal. Given international conditions and technology, that would be a grave mistake.

Should you find yourself needing detailed information regarding the Submarine Force, present and future, I suggest that you contact the Navy's Office of Legislative Affairs. They will be able to get you what you need, and, if you have the time, will be able to arrange familiarization embarkations. A day at sea is worth weeks of reading and committee hearings.

If I can be of assistance, please ask.

Sincerely,
John D'Aloia, Jr.
311 West Alma Street
St. Marys, KS 66536

SUBMARINES OF THE 21ST CENTURY

by Lev U. Khudiakov
SPMBM Malachite
St. Petersburg, Russia 1994
61 pages (in Russian)[1]—with appendices;
not including photographs

SUBMARINE DESIGN FOR THE 21ST CENTURY

by Stan Zimmerman
Pasha Publications, Arlington, VA 1993
182 pages

Reviewed by K.J. Moore

These two similar books with similar titles provide an interesting set of contrasts and similarities. The differences, in part, reflect the differences in the backgrounds of the authors. Professor Khudiakov is a recently retired Russian Naval Officer who directed much of the Soviet naval research and development efforts in his position at the First Central Research Institute. He is now the Chief Scientist (Navy) at the same institute. As demonstrated in the book, Khudiakov is an expert in naval technology as well as in naval doctrine and tactics. Mr. Zimmerman is an award-winning journalist who spent many years on the *international submarine beat.*

Professor Khudiakov has presented an overview of his proposals for submarine development in the first 15 to 20 years of the 21st century. The text is relatively short, but each paragraph requires careful reading to ensure that the full implication of the insightful but terse statements are recognized. The text is supported by five appendices, four of which present analytical models upon which some of the propositions for tactics, technology focus, and force levels are based. Perspectives that range from the success of acoustic silencing and the current need to suppress turbulence-related signatures to the arguments of the relative value

[1] The book has been translated into English and is expected to become available in the United States.

of double hull submarine architectures are presented in a declarative format. Several key perceptions, such as force level requirements for ballistic missile submarines and the need for submarines operating in the littoral to control magnetic signatures, are supported by analytical arguments.

Mr. Zimmerman has maintained the style of a journalist. He states at the outset that the focus of the book is on "the grand design, which begins not at the drawing table, but in the drawing room, in the minds of the policy makers—who decide how to conduct their nation's defense, and what role the submarine may play". Except for his obvious support for submarines and his repeated argument that *silence* by submarine proponents is not in the best interest of the nation, since discussion is necessary to build political and public support, the text is documentary in nature. After a short summary of the current status and significance of submarines, he provides a primer on submarine propulsion, weapons, and sensors, followed by a discussion of submarine roles and design considerations. To the well-informed, these first four chapters are a bit basic, and not always accurate in terminology or values. This appears to be the result of using such a diverse set of sources, including most European and some Asian submarine designers and builders. While the U.S. expert will be distracted by the inconsistencies in international terminology and values, the journalistic style and generous use of side articles throughout the text make this both an interesting read as well as a useful compendium of contemporary submarine references.

The next two chapters relate to some of the factors that have stimulated development of the international submarine market and the competition between the former Soviet Union and the United States. Each is followed by a case study, first of the SSN 21 SEAWOLF and second, the Centurion. With the ongoing discussion and pending Congressional action on both the SSN 23 and the new attack submarine (NAS), the historical review of these two topics is interesting in terms of the accuracy of the prognoses offered two or more years ago.

The parallelisms between Zimmerman's chapter on the impact of new technology and much of Khudiakov's book are notable. They both believe that electric drive is a high priority and the direction of the future for reasons of stealth and displacement. Both believe there is little future for the diesel electric submarine. Both believe that the successes of acoustic quieting will drive

toward the development of non-acoustic sensors for both airborne and in-situ ASW platforms. Khudiakov describes this as the exploitation of *footprint wake fields*. Both describe the developments in *cybernetics* that support rapid information processing, artificial intelligence, and automation as key to improving performance while reducing submarine displacement (size) and cost. While Khudiakov is more explicit with regard to the operational requirement, both predict the development of active torpedo countermeasures, specifically, self defense methods to intercept incoming weapons. Khudiakov quantitatively defines the value of releasing the *first volley*, but continues that it should be secret; otherwise, at the expected short detection ranges, rapid counterfire could result in mutual destruction. Khudiakov extends the rationale to exclude the use of active sonar by the attackers, but allows its use for an immediate counterattack. He further intimates that the development of covert active sonar ranging is continuing. Both predict the use of non-metallic hull materials for weight and signature reduction, and Khudiakov asserts that at least several submarines built in the next century will have titanium hulls. In reference to the apparent Russian debate between single and double hull architecture, he suggests that the ability to install active visco-elastic coatings that simultaneously decrease radiated noise, lower resistance, and act, in part, as an acoustic antenna could change opinions on the value of a *light hull*.

Khudiakov concludes that the further development of Russian technical achievements will be introduced into submarines built in the 21st century. These include: titanium hull construction, which has led to the practical realization of 1000 meter diving depths on KOMSOMOLETS (MIKE); complex automation, which allowed the reduction of the crew to several dozen on ALFA; and control of the boundary layer in the interests of reducing power requirements and the intensity of the turbulent wake ("and accordingly, the possibility of detection through non-acoustic methods") on the experimental submarine BELUGA.

Both books are valuable additions to one's submarine library: Zimmerman's because of the unique range and breadth of contemporary submarine issues gathered from all over the globe; and Khudiakov's because of the opportunity to share the insights of one of the world's greatest contemporary experts on submarine warfare.

CONCEPTS IN SUBMARINE DESIGN

by Roy Burcher and Louis Rydall
Cambridge University Press, 1994

Reviewed by CAPT Mike Gouge, USNR

This book is a welcome addition to the limited open literature publications on the design of modern (post ALBACORE) submarines. As stated in the book, there is very little unclassified information on integrated submarine design since the seminal work by Arentzen and Mandel[1] in 1960. This book is well written and organized and can provide someone with a general engineering background a good introduction to the submarine design process including multiple constraints and trade-offs. Chapter 1 discusses the design progression from definition of submarine class mission and overall design requirements to final production drawings. Chapter 2 provides a concise history of submarines with emphasis on design evolution. Next, Chapter 3 provides an overview of submarine hydrostatics including arrangement of external and internal tankage. Chapter 4 covers the important concept of weight/volume constraints in submarine conceptual design including allocation of margin. The next chapter covers submarine structural aspects with emphasis on the pressure hull. Chapter 6 covers submarine powering including resistance coefficients, propulsor design and a brief treatment of available propulsion plant options. Chapter 7 treats the important topic of internal arrangements including space allocation. Chapter 8 deals with submerged dynamics and control and is more analytical than material presented in other chapters. Chapter 9 covers the range of submarine auxiliary systems including electrical, hydraulic, water, high pressure air, escape systems, etc. Production techniques/sequencing and costing are covered in Chapter 10. The final chapter integrates the previous chapters in describing the generation of a concept design. Finally, several technical appendixes cover hydrostatics, trimming, variable ballast calculations, pressure hull strength and resistance/propulsion.

There are some terms that require modest interpretation for readers on the west side of the Atlantic: for example bridge fin (sail), fore end (bow plus forward midships), eletrolyser (oxygen generator), D/Q tanks, etc. but the intent is usually quite transparent in the context of the discussion.

In regard to depth of treatment, this book goes deeper than general semi-technical works[2] and approaches the depth of Captain Harry Jackson's summer short course at MIT[3] with somewhat less detail but more basic concepts as is appropriate for a stand-alone technical text. I would highly recommend this book to those in the naval engineering field who want a good introduction to submarine design concepts. I also recommend it to submariners who can benefit from seeing familiar operational concepts presented from a conceptual design perspective. It can certainly serve a part of a technical foundation for more detailed methods which invariably require computer-based analysis which is more powerful but often less intuitive.

REFERENCES

1. Naval Architecture Aspects of Submarine Design, E.S. Arentzen and P. Mandel, SNAME Transactions 68, pp. 622-692, 1961.

2. Submarine Design and Development, N. Polmar, Conway Maritime Press, 1984.

3. Notes from MIT Summer Course on Submarine Design, H.A. Jackson, 1984.

THE SCORPIUS CONNECTION

by Craig L. Etka
American Literary Press
Baltimore, Maryland 1994

Reviewed by John Pritzlaff

Craig Etka—ex-U.S. Navy sub skipper—has written a classic techno-thriller in the image of Tom Clancy and Clive Cussler.

The action is fast paced and technically correct while making use of futuristic developments in today's real world. The Time/Date message and subsection headings lead the reader through well orchestrated and detailed plot lines.

One of the main plot lines revolves around the transfer/purchase/theft(?) of two Russian Kilo submarines into a Columbian drug cartel's operations. U.S. submarines and specialized covert submersibles are used along with U.S./USSR space station interactions to uncover and combat the evil deed doers.

This book, along with a sequel due this year, should be of particular interest to the submarine, deep submergence and covert operations communities as it draws on the author's direct experience to portray fictional events in a realistic, believable and exciting fashion.

The only problem that I found in reading The Scorpius Connection was that the sequel The Kilo Affair has not yet been published.

[Editor's Note: Mr. Pritzlaff is well known in the development of unmanned undersea vehicles and as an expert in submersible safety. He was associated with the Westinghouse Oceanic Division in Annapolis from 1965 to 1994. He has also authored numerous technical papers on manned and unmanned vehicles, offshore operations, logistics and safety.]

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