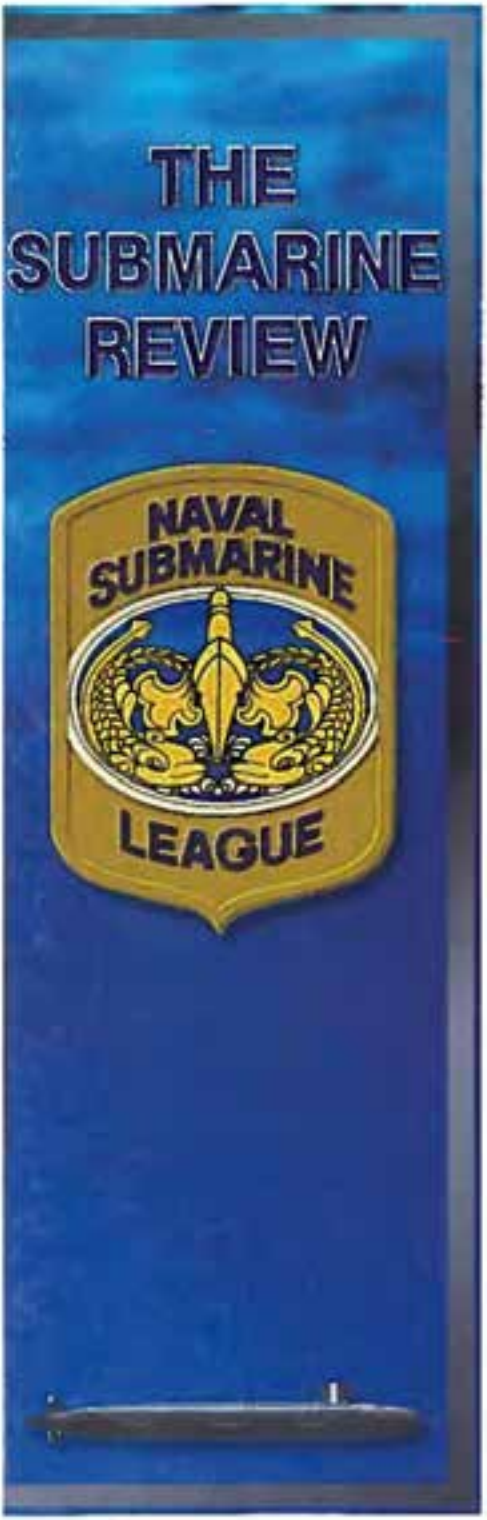

JULY 2002

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Undersea Warfare Systems

As a 50 year partner with the U.S. Navy, Lockheed Martin supports the continuous evolution of undersea warfare systems. Today, we are developing the Command, Control, Communications and Intelligence system for the new Virginia class attack submarines. By using commercially available technology and open systems architecture, we are helping the Navy achieve transformational operational effectiveness while driving down life cycle costs. The world is changing. Lockheed Martin is changing with it.

Undersea Dominance for the 21st Century

EDITOR'S COMMENTS

There are two headlines to this July '02 issue. The most immediate concerns the passing of Admiral R.L.J. Long and we recognize him with the two eulogies given at his funeral service at the Naval Academy on Thursday, July 11th. Admiral Bob Long holds a special place in the history of the U.S. Submarine Force during the Cold War and in the hearts of all who knew him. We all lament his untimely demise and we honor his memory.

The second headline was proclaimed at the 2002 Submarine Technology Symposium by Admiral Skip Bowman, the Navy's Director of Nuclear Propulsion. His presentation there is featured here because of the strong case he made for emphasis on the D for Development in the R and D of the submarine community. His lesson is for all concerned-policy makers, acquisition managers, military requirement generators, industrial leaders and even lawmakers-to get on with the business of fielding effective equipment in a timely manner. He says-once again-that *better* should not be used as an excuse to delay the *good enough*. This is a tough problem; it's not just our present day sociology, and the paperwork blizzard of never ending studies he cites is only a symptom of a deeply rooted institutional inertia which has to be corrected if we are to make the time lines dictated by this new form of super flexible warfare which has been thrust upon our nation. We in the submarine community should all understand very clearly that this problem affects us more than most since our ships and materiel have the longest natural gestation periods. Any delay of the production process, therefore, can render the final fielding outside the time constraints of our new security environment and come into use as less than optimum, or at worst, ineffective.

The articles in this issue of **THE SUBMARINE REVIEW** stretch across the spectrum of interest. First on the list are some further thoughts on submarine technology from the Johns Hopkins scientist who chaired the lead-off session at the Submarine Technology Symposium. He gives us both an overall look at the effect of new technology and a feel for what drives the development of innovative, impactive technology which can be highly leveraged.

The second article is also by an author-scientist named Thompson, but one affiliated with The University of Maryland rather than Johns Hopkins. The subject of this second piece is access to the battle area by the nation's strike force assents, and his conclusions point to greater use of U.S. submarines as our enemies become more dispersed. It is useful to note Dr. Thompson's citations for his facts and the logic he employs to arrive at his conclusions. Thoughtful readers may be able to extend that thinking to arrive at their own deductions about submarine force levels. Current force level targets, even though we are not close to meeting them, are based on peacetime usage of submarines. Dr. Thompson has given us some insight into the difficulties to be expected in national warfighting, perhaps those problems with employment of other forces should be considered in taking a look at the combat-strike needs for submarines.

A third scientist-author gives us another look at the use of cognitive engineering for improving the man-machine interface in submarines (see also The Role of the Human Operator by LT Shobe in **THE SUBMARINE REVIEW**, October 2001). Dr Kirschenbaum describes her career in looking at submarine cognition and, along with interesting observations and some surprising insights, concludes that greater emphasis has to be given to operator-centric design. That, of course, means that operators have to be more proactive in the design process, therefore, the technologists and developers have to go the extra mile to ensure the operators productive participation.

World War II comes in for a bit more than its usual share of attention with four articles in this issue.

Fred Milford winds up his two part treatment of Imperial Japanese Navy torpedoes and Chick Bowling aptly summarizes the Mk 14 torpedo problems in the U.S. Navy. The Japanese story is largely unknown to most of us while the USN tale of woe is one the older folks have at least heard of before. For all, however, there are lessons to be learned from both stories and the bottom line in all those lessons has to do with the necessity for everyone in the submarine community being interested and involved in submarine weapons—their design, care and use. The end game is always the payoff for all the work which precedes it.

There is a lot of heart in this issue also. There is another story of a family of a submarine skipper lost during war who have put together a plausible scenario of the action which sank the boat. There's a lesson there also. For those who remember the diesel boats, a SPINAX sailor has given us what might be called *an Audio Tour of the Boat*, which should bring back a lot memories. By all means do not miss the remarks which Vice Admiral John Grossenbacher gave at this year's Submarine Birthday Ball.

Jim Hay

FROM THE PRESIDENT

On 11 July 2002 the submarine family gathered at the United States Naval Academy to honor and bid farewell to an extraordinary man, a man who led our Navy, Submarine Force and Naval Submarine League, Admiral R. L. J. Long, USN.

Family, extended family, friends and admirers were there to give testimony to the life and accomplishments of Admiral Long. Like many in the Naval Academy Chapel that day, Jan and I appreciated the way Bob Long touched our life. While I was in uniform he provided guidance and mentoring. When it was time to put away my uniform and move on to another way of life, he was there with sage advice.

Admiral Long is one of those few individuals who had the capability to make a difference in the world, the United States and our wonderful Navy. He took the time to mentor individuals, including a wayward Commander, Captain and Flag Officer who needed all the help he could get. Thank you, Admiral Long. Your counsel and presence will be missed.

The eulogies delivered at the service were magnificent and are provided in this issue of the **REVIEW**.

Your Submarine League has accomplished much since the last **REVIEW** including a successful Submarine Technology Symposium and the annual June Symposium. I'll report on those activities in the October **REVIEW**.

J. Guy Reynolds

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THE "PULL" FOR SUBMARINE TECHNOLOG

GET REAL

Remarks by ADM F.L. Bowman, USN
Director, Naval Nuclear Propulsion
Submarine Technology Symposium 2002
14 May 2002

Today, I will argue for the title of this symposium, "Reaching Forward Through Technology and Innovation," but make the case that we must make some fundamental changes to the process in order to achieve the end result of delivering needed capability to the warfighters.

Recently, General Pete Pace, Vice-Chairman of the Joint Chiefs of Staff, talked about how the Joint Requirements Oversight Council should work to identify *capability gaps*. This is a healthy exercise, and I'm all for it. In fact, the Submarine Force is ahead of the game on that front. We've all spent a lot of time over the past few years talking about what the submarine community wants to get from technology. We haven't called them *capability gaps*, though—we called them our four *gets*. Remember:

- Get connected—so we can see and hear over the horizon, well beyond the shoreline. So we can net what we see and hear. And so we can then transfer that knowledge in real time to the battle group and joint warfighters.
- Get payload—not just payload that knocks down enemy defenses, but payload that goes over the horizon inland and loiters—or payload that escorts us through (or better yet, **around**) minefields and sitting diesels.
- Get modular—so we can custom-tailor these dwindling, precious assets called attack submarines precisely to the mission at hand.
- Get electric—so we can use the full reactor output to power all this. And avoid having to use premium internal volume for energy sources. And to get to the next level of acoustic superiority.

These four *gets* remain the right road. With acknowledgment to our younger members, I've got a new one to add today, and its what I want to talk about: we need to **get real**. Real hardware, that is. And separate the *doable* from the *PowerPoint*.

Spiral development may sound like the name of a bad '70s rock band, but it isn't.

- Under Secretary of Defense Pete Aldridge's concept is simply a development cycle that builds, tests, builds, tests, then deploys. It doesn't have to be the 100% solution with milestone pedigree, and we shouldn't be waiting for a whole new submarine to get new technology and capability out to the Fleet.
- Built into this philosophy is Pete Aldridge's recognition that deploying 70 percent of a capability is a lot better than deploying zero percent while we polish the cannon ball or change the font on the PowerPoint slides.

I fully agree ... and further, I believe it's the **only** way to make quick progress toward transformation—the only meaningful way to reach forward through the technology screen—is to build-test-build-test-deploy ...

That's not what we do today!

We must reduce our development cycle times, and increase the rate of technology deployment to the Fleet. And get needed capability (our four *gets*) to the Fleet faster.

I would propose that we've under emphasized the *D* in both government R&D and industry IRAD and that we **must** get this *little d* as large as what has been the *large R*, especially where the *large R* has come to equate to paper studies and PowerPoint discussions.

The submarine community has a long history of prototyping its way to improvement. We've certainly done it at the component level, and we've even done this at the *platform* level many times.

There have been plenty of submarines that provided front-line capability to the Fleet, successfully meeting warfighting requirements, while simultaneously prototyping *new* capabilities. Some were very successful, others were not:

- NAUTILUS and the first SEAWOLF were front-line,

underway, warfighting, nuclear-powered submarine prototypes. We learned a lot. The unsuccessful SEAWOLF put us way ahead of the American Heart Association in identifying problems with sodium.

- With ALBACORE, we tested the prototype hull form that led to our hydrodynamically efficient 637 class.
- We tested prototypes of an earlier generation of electric drive technology in TULLIBEE and LIPSCOMB. Although the technology they were protoyping was not terrifically successful, TULLIBEE and LIPSCOMB served ably on the front lines while teaching us a lot.
- We installed a prototype reactor plant in NARWHAL. NARWHAL not only had great Cold War mission success, that plant led to our huge advantage in Trident submarines.
- We started a transformation in the 1950s and 1960s (way before *transformation* was in vogue) when we cut a 594 class submarine in half and put in a missile compartment. That capability, of course, ultimately led through our *41 for Freedom* to Trident and sea-based nuclear deterrence, and without question was instrumental in winning the Cold War.
- Even LOS ANGELES was originally a one-of-a-kind high-speed submarine. This one turned out okay, I guess. We built quite a few of them: 62, to be exact.
- And then we prototyped the revolutionary drive train in the last four 688s for the new Seawolf and Virginia classes.

To the community's credit, we recognized some of these capabilities as diamonds and some as dogs. But remember: Rickover was right when he said that you learn more from failure than from success. We need to quit being afraid to fail occasionally, and keep our eye on the ultimate goal of high-frequency improvement in submarine capability.

This, currently out of vogue, tradition of demonstrating new capability in the Fleet has been somewhat renewed today as we drive toward payload demonstrations for SSGN. These demonstrations are a bridge—not just to the next SSGN, but to transformational payloads for the Virginia class.

But now, let's be honest: Current Pentagon organizational structures and the current budget process make prototyping transformational capability difficult. But SECNAV and CNO have told us to challenge all the old assumptions—so here goes:

- Look closer at what we're doing with SSGN payloads.
- The upcoming January Tomahawk demonstration is part of the acquisition program of record.
  - Driven by technical requirements and mission needs.
  - and is funded accordingly.
- However, the UUV demonstration is of equal technical importance because
  - It's one of the most important *gets*.
  - It will demonstrate an advanced payload concept.
  - But it is **not** part of the acquisition program.
  - And there's no money for it.
- We need to force people to think of more than Tomahawk and Special Forces when they think SSGN.

Why is there this disparity in funding between the Tomahawk demo inside the acquisition program and the UUV demo outside the acquisition program?

Why is it so difficult to build-test-build-deploy new concepts as part of developing and delivering SSGN? Where are all the great ideas from last year's payload and sensors studies?

- Simply put, the current ship acquisition structure doesn't permit significant development funding unless the development is tied to an acquisition program.
- Industry isn't interested in gambles outside the program of record and acquisition program managers don't want to commit to risky developments, because they're worried about cost and schedule.
- Couple this with the fact that ship R&D **in general** is the poor third cousin to airplane R&D, and here we are.

That standoff makes it pretty hard to demonstrate advanced capability outside the program of record. The system talks a good game of transformation but in reality is lined up against it.

As Admiral Denny Blair noted in a recent *Proceedings* article:

> "The big money in acquisition . . . goes to the long-term replacement programs that are detached at an early stage from the dynamic reality of operations and warfare. They emerge decades later with *new* generations of systems. Yes, these new systems are better than what they replace, but they are not as good as they could be in meeting the needs of the warrior ... " *Proceedings*, May 2002

- Money doesn't go to building, testing, and deploying new capability that's not part of the bureaucratic milestone acquisition system.
- This makes it almost impossible to deploy new technology while it is still *new*.

The shipbuilding industry and its subcontractors respond to the people with the money. Thus, Industry ends up being just as risk-averse as the acquisition programs. Look at the former DD 21 program. Even though we said we wanted all the technology under the sun, when it came time to ante up, both Navy and Industry balked at the risk of all that untested, **undemonstrated** technology. Should some of that testing have been done on the Arleigh Burke class or earlier? Well, it wasn't—and now we've had to restructure the program to do more building and testing.

Risk aversion in the submarine acquisition community means the only funding available for advanced technology development is the limited and constantly shrinking N77 R&D budget.

- Lots of people have things they want to do, so the competition per available R&D dollar is fierce.
- When competition goes up, the amount of marketing goes up.
- More marketing means more reams of paper or PowerPoint slide-shows and studies.
- The more paper there is, the harder it is to differentiate between one study and the next, so the funding gets spread out over lots more studies.
- The end result: piles of paper, little hardware.

I'm not saying that all studies are bad. A good study with a

proven methodology that is rooted in solid facts is an invaluable tool to guide technology development. Even the marketing slides and brochures can be useful.

[Editor's Note: At this point, Admiral Bowman held up a papier-mâché submarine.]

- This demonstration cost only $400,008. That's $400,000 for the presentations and studies my staff cut up, and 8 bucks to put it together.
- I'm not sure if papier maché will pass fire and toxicity, but what do you want for $400,008?

So where does this put us?

We say we want transformational technology, but often get cold feet before letting the final contract.

- The system doesn't support rapid prototyping and demonstrations if they aren't part of the acquisition program.
- The PEO shies away from making them part of the program because new stuff equals schedule and cost risk.
- And then, industry is afraid to propose high-risk concepts that risk losing contracts.

Let me be clear, it is not the daily decisions of the PEOs or the civilians in acquisition that are the problem.

- The drive for cost and schedule efficiency that exists in our acquisition programs is important if we are to be good stewards of the taxpayers' dollar.
- The heart of the problem is that the only place we have in the Navy that can afford the R&D required to bring transformation to the Fleet is necessarily organized to avoid the risks that such a transformation inevitably entails.

If we're to be revolutionary and transformational, we—Industry and the Pentagon—must change our ways of doing business.

So what should we do? There's no magic solution. It requires hard decisions from leadership, both in Industry and in the Navy.

For both industry and government, as I said earlier, getting the *D* to the same stature as the *R* is a good start.

For Industry then, the key is focusing efforts on more hardware, more demonstrations, more experimentation—and less on the iteration of studies.

- Building hardware is the best way for you to distinguish yourself from all the other organizations competing for that R&D dollar.
- Prototypes don't have to be expensive, and they invariably teach you something. Remember Admiral Rickover's admonition about **paper reactors**: they're always smaller, lighter, cheaper, and easier than the real ones. But we need to stop generating all these paper studies that often become paper programs and money pits.
- A piece of hardware markets itself. Parochially, hardware that fits the submarine vision shorthanded by the *four gets* garners a front row seat in our community.
- By delivering hardware, even at the 70 percent level, you naturally reduce the risk for the Navy, making it more likely a PEO will take a chance and that the submarine community would invest.
- In the end, this helps the Navy by overcoming the barriers to bringing new technology into acquisition. It cuts through the marketing and the studies, and gets to the heart of the technology: does it work, or not? Does it bring new capability?

However, Industry cannot solve this problem by itself. Ron O'Rourke's criticism that the Pentagon in general and the Navy in particular is behind the transformation curve is the worst kind of criticism. **It's constructive.** And it's true. And it's from inside the family (and not from that crazy aunt we keep in the basement). We **must** take a hard look at how we approach technology development in pursuit of transformational goals. We'd better start doing some looking ourselves, otherwise we're going to get *help* from somewhere else. In this context, I would also argue:

- We need to continue developing our EDOs into *warfighter engineers*. We need people who can distinguish needed capability from marketing and help separate the truly transformational capabilities from the papier maché. The ideas that come back from industry need to be evaluated by educated customers.

- Our R&D community needs to look for opportunities to build hardware. As I said, studies aren't all bad—but we don't have time to do a 4 year iterative study before we make something. From what I've seen, you're frequently around the 70 percent point after 6 months. That's good enough for proof of concept—and maybe for operational deployment.
- If we are serious about technology development, we need to start creating opportunities to deploy new capability quickly. The necessary link between the build-test-build-deploy philosophy and Pete Aldridge's spiral development philosophy is provided by real ships and submarines that are capable of testing unique systems, components, and payloads. We must make these platforms available more often.
- Today's successful example of all this is ARCI. But why have we stopped there?

We need to take advantage of VIRGINIA and now SSGN modular capacity to accept new capability as it becomes available—which was the plan all along, remember? Bundle 1... Bundle 2...

This approach requires adjustments to the acquisition process that encourage *accepting some risk* that a new technology won't work out as planned ... in exchange for the opportunity to take bigger strides faster. We must be willing and able to fail occasionally ... but quickly learn from the failure and get going again.

And let's not forget to look at how we evaluate new capability for the Fleet and demonstrate it to the national leadership. Who can blame Congress if their eyes glaze over when we show them **yet another** of our paper studies? We need to let hardware do the convincing.

Our national leaders can see the value of a new capability if it happens in 3-D right before their eyes. No explanation or marketing required. Industry needs to build, test, and deliver hardware so you can stop *telling* your customers about transformational capability, and start *showing* it to them.

Here's another example: Over the past several years, Naval Reactors has been building, testing, building some more, and testing some more new reactor technologies that could significantly

improve the life of the reactor core in future VIRGINIAs.

As a result of that prototyping work, we are now embarking on a program to develop a new reactor core for a future VIRGINIA that will fit in the same ship and same reactor compartment, yet increase the operating life of the ship **and/or** increase the baseline power usage of that ship for future payload requirements.

But I want to emphasize that we got to this point not by trading theories, not by waiting for next year's model, not by wishing and hoping, but by building specimens, testing them in real reactors, building prototype hardware, testing that, and finally, with lots of data in hand, determining how far the new technology could go.

And most of you know of our work—even more revolutionary—to remove the entire steam plant from the submarine. We're moving there, one piece of hardware at a time, and one efficiency point at a time.

Over the next few days I suspect you'll hear and see a lot of slides. I hope that many of them report on real hardware, and I am gratified to see the thought-provoking displays upstairs. But I would ask:

- How **can** we reduce capability cycle times?
- At the top of the hierarchy, why **does** it take 6 years to build the NSSN ... but given that it apparently does, must we wait those 6 years before we introduce the next increment of capability?
- I ask you to consider how we can do this whole technology development process better and turn those slides into something real, something practical.

Alternatively, I suppose we could work on our papier maché techniques.■

NEEDED: TECHNOLOGY TO SUPPORT THE PACIFIC OPLANS

by RADM John B. Padgett III, USN
Commander Submarine Force
U.S. Pacific Fleet
Submarine Technology Symposium
May 14, 2002

I appreciate this opportunity to join you today and to be allowed to share with you my thoughts and concerns about the investment in technology needed to address challenges we face in the Pacific and Indian Oceans.

Our submarines routinely operate in littoral waters where they must be prepared to deal with modern diesel submarines and mines, patrol craft, and they must be prepared to *stand and fight*.

As we look at the Pacific OPLANs, it becomes clear that our present capability to operate in littoral regions needs to be enhanced by technological improvements.

Assuring access in the littoral regions challenges our Navy throughout the region. Our attack submarines need the right tools to support operations in shallow water with a high contact density. We must be able to deal with the asymmetric threat represented by quiet diesel-electric submarines and mines, each of which provide a cost effective readily available solution for our potential adversaries as they consider how they might deny us access.

The littoral *Ground Truth* shown below represents the challenges met by our submarines during real world operations in the Pacific Command Area of Responsibility.

- Operations in 25-50 fathoms
- During 50 day timeframe:
  - 5000 sonar contacts
  - 3600 Trawlers with 500 DIW (Dead-in-the-Water)
  - 950 Merchants
- Drift net fishing & fishing float fields

Typical hazards include trawlers, some dead-in-the-water, merchant ships, drift net fishing, and fishing float fields. This is the type of environment our submarine Commanding Officers will

face as they execute Theater Commander OPLANs.

U.S. submarines must be prepared to combat threats such as high speed surface craft, low speed aircraft, and loitering diesel submarines. Quick reaction, *close in* weapons—point and shoot, both offensive and defensive—are needed for operations in littoral regions to allow the submarine Commanding Officer to *stand and fight* should the need arise. Improvements in the man-machine interface for targeting, weapon presets, and post launch control are essential if we are to maintain our edge in close encounters with these threats.

Submarine Force Roles

- Battlespace preparation
- Responsive strike
- Responsive Intelligence, Surveillance & Reconnaissance (ISR) operations
- Special Operations Forces (SOF) from submarines
- Maritime Interdiction Operations (MIO)
- Undersea Warfare (USW)

The submarine's inherent stealth, mobility, endurance, and firepower give us great confidence that the Submarine Force will retain its prominent role sustaining our Navy's capability for assured access.

Submarines provide a responsive platform fully ready to execute strike, ISR, SOF, MIO, and USW missions—all concurrently, some simultaneously.

Our Navy's recent operations in Operation Enduring Freedom reflect this capability. The first two U.S. warships in position to strike into Afghanistan were submarines, and both engaged in strike against the enemy. Thirty-seven percent of the Tomahawk missiles fired into Afghanistan were fired from submarines.

Throughout this operation, submarines provided situational awareness of land-based, surface, and diesel submarine threats. Rapid collection and dissemination of critical tactical information provided important intelligence to operational commanders as they

planned and executed their dynamic operational orders.

During pre-hostilities, commanders need a capability to collect intelligence in a non-provocative manner. During the advanced stages of hostilities, they need a survivable information collection capability that is reliable and sustainable. Areas where technology can contribute to this capability include:

- Improved mast mounted antennas that offer increased frequency coverage and improved performance against emerging RF technologies
- Off-board vehicles (UUV and UAV) with low probability of detection for intelligence collection
- Improved IMINT capability to include day/night and all weather coverage
- Improved IMINT/PHOTINT sensor accuracy as required to support target mensuration
- Periscope improvements to support collection operations and safety of ship
- Fixed sensor and re-taskable mobile systems.

Today strike planning and coordination procedures, tools and communications must be made less cumbersome to meet rapidly changing mission requirements, time critical targets or integrated operations with other naval forces and joint fires. Targeting and command and control capabilities must be able to meet short response times. The submarine needs to be able to communicate and integrate its strike assets with those of other Joint Forces. Critical elements include:

- Automated TLAM mission planning and knowledge management systems to support rapid re-targeting, joint fires, and attacks on time critical targets
- Improved data rate communications for faster mission download
- Improved battle damage assessment sensors and tools
- Improved tools for managing numerous contacts in a congested and dynamic environment.

Submarines operating in littoral regions acquire intelligence essential to achieving dominant knowledge. This includes indications and warning, signals, imagery and acoustic intelligence,

environmental data collection, installation of unattended ground sensors, spotter team insertion, and Weapons of Mass Destruction (WMD) detection. But this information is of limited use unless its shared with other operational commanders and forces. Areas where technology investment can improve this capability include:

- Improved surveillance sensors and processing to provide increased sensitivity and bandwidths, and improved discrimination against a wider range of threats, such as sensors for nuclear, chemical, and biological contamination detection
- Ability to use/control unmanned vehicles and unattended ground sensor as adjunct sensors for SOF operations.

Special Operations Forces Support by Submarines

We must be able to meet future challenges to providing support for special operations. Areas where technology can help us meet these demands include:

Delivery & Extraction

- Covert delivery and extraction of SOF to shore from all submarine classes (present and future), including improved Dry Deck Shelters and Swimmer Delivery Vehicles such as Advanced Swimmer Delivery System (ASDS) and follow-on improvements.

Communications

- Improved communications between SOF and the submarine including rapid and effective imagery transmission from SOF to the Joint Task Force or higher Command Authority, via the submarine when required
- Improved LPI communications between Special Operations Forces (SOF) and the submarine (coordination, tactical data, and imagery).

Defensive Weapon

- Submarine-based weapon for engaging hostile small watercraft or aircraft/helicopter in pursuit of SOF during an exfiltration event. Maritime ATACMs to support *Call-for-*

Fire.

Maritime Interdiction Operations

While Maritime Interdiction Operations may seem like a *new mission* related to the war on terrorism, SSNs have been conducting similar types of operations for several years, both Maritime Intercept Operations (MIO) in the Arabian Gulf, as well as counter drug operations in the Caribbean and eastern Pacific. Submarines provide VISINT, ELINT, and ACINT fingerprinting for finding and tracking hostile surface ships. Additionally, submarines can neutralize a threat through torpedo attack or support for SOF options.

As MIO contingencies become more and more complex, the Navy must increase surveillance and be prepared to interdict. Improved imagery (day/night/all weather) and improved communication data rates are needed to support the myriad joint assets involved in interdiction operations.

Integrated Operations

Undersea warfare is complex and a Navy core competency. The USW force needs to be fully integrated to provide the JTF Commander with battlespace understanding, to provide responsive prosecution and attack, and to provide seamless transition from CTF to JTF command and control.

To meet this operational challenge, USW technology investments are needed to improve critical elements such as:

Theater ASW

- Interactive collaborative planning over secure Internet Protocol (IP) based network between disbursed ASW forces and provide a seamless transition from CTF to JTF
- Interactive capability to share products developed on a myriad of Tactical Decision Aids and C2 Systems
- Sub-surface Common Undersea Picture (CUP) for Theater-Level Collaborative Planning and Prosecution (Shared USW

tactical picture with common data bases and data fusion engines)

- Cross platform system to integrate all levels of command into Net-centric Ops.

Cueing and Wide Area Search

- Improved acoustic and non-acoustic sensor
- Automatic detection of signals
- Hull mounted sensors for target localization and allow auto-ranging during short range trail for close encounters

The training and experimentation derived from Pacific Fleet USW Exercises are essential if we are to improve detection of diesel submarines and execute large area search and fleet protection operations. These exercises provide excellent opportunities to evaluation new tactics and technologies. COMSUBPAC would entertain the hosting of new USW technologies in future fleet exercises and for those of you who have technology that may help us as we deal with the Theater USW challenge I will provide operational platforms to test your technology. "If you buy it, I will fly it"!

Thank you for this opportunity to speak with you here today. Efficient technology transition and insertion are absolutely essential if we are to sustain our operational primacy in the Pacific and Indian Oceans. Technology, thoughtfully applied, can lead us into the future and is key to our success in the Twenty-first Cennury. I look forward to joining you in addressing the challenges and the adventures that lie ahead.■

ADMIRAL R.L.J. LONG, USN(RET.)

EULOGY

by VADM J. Williams, Jr., USN(Ret.)
U.S. Naval Academy, July 11, 2002

Admiral Robert Lyman John Long, U.S. Navy (Ret.), Bob to most, is honored, pleased, and probably marveling that so many of his beloved shipmates and friends have come to remember him with gratitude and to say farewell.

He doesn't want a day of grieving and sorrow. He wants us to take advantage of the fellowship the day offers.

Bob loved this chapel, this Academy, and his Navy—all of it—every aspect, including appropriate pomp and ceremony. He left this world very proud of his contributions to Navy, country, and the free world—rightly so! Today, with appropriate pomp and ceremony, we will provide the recognition he deserves, and he will enjoy it.

Never doubt his presence! Events given in his honor were his cup of tea and he certainly would not miss this one with all its trappings. Never an egoist, yet humble he is not, God bless him.

Every sailor has a particular branch of the Navy which is special to him. Bob was no exception. Submariners and their submarines were extra special to him.

When Admiral Jim Holloway selected Bob to be the Vice Chief, he reminded him he was to be Vice Chief of the **whole** Navy. Bob, agreeing laughingly, assured him he would be no more parochial toward submarines than he, Admiral Holloway, was toward his Naval Air.

Those two became a terrific team, deftly restoring tradition and balance to a Navy in turmoil.

Admiral Long, a practical visionary, became an extremely well rounded, complete Naval officer. He had just that bit of parochialism and advocacy for submarines that he maintained was needed from the leaders of each of the unique branches in order for each branch to become the best it could be for the common good of the whole Navy. But, Bob never lost sight of the nation's need for a

balanced Navy of high quality and allies to facilitate its worldwide use.

He had strong opinions about how the Navy should be structured and the missions it should undertake. He worked vigorously for acceptance of his concepts and in pursuit of acceptance, became, in time, astute in the art of compromise and persuasion. Always considering time to be of the essence—he was always in a hurry—he learned to occasionally accept half-loaf if not estopped from coming back for the other half. He was very pleased when he could walk around a barrier instead of having to crash it. He was happiest when he could succeed in getting an adversary to hoist himself on his own petard and he tailored his approach to the personality of the person with whom he was dealing. In his good ol' Southern Boy persona, he said to Senator Stennis, "Senator, I know better than to try to tell an old dog how to suck eggs, but I'm not afraid to tell him which eggs are rotten and which are good for sucking." A laughing Stennis gave him what he wanted.

He could be a hard line, table thumping ogre if need be, but he could also be an old smoothie. I'm sure some of the losers, on reflecting what had happened to them in negotiations, concluded they had been *had* by a slick operator. Never! They just couldn't discern the difference in ultra-smooth and slick.

Bob was adept at selecting the right time to strike. It took him only 15 minutes to get an Army Colonel, whom he found puzzling over how best to reduce maintenance costs of Army base, to sign over to the Navy a worthless, snake infested, never used, costly to maintain NATO ammunition facility in Georgia. It is now the location of our magnificent Kings Bay Submarine Base.

Bob was actively involved in World War II and the Korean and Vietnam conflicts. He was a major player during the long, tense forty-plus years of the Cold War, and in more worldwide crisis events than one can imagine. Regarding such, he had a knack for cutting to the core of a problem, making a decision as to the solution, and getting on with it. I estimate his batting average for success was over .800. If he realized he had taken a wrong turn, he would quickly and unabashedly about-fact and march off in

another direction, never blaming others for his mistake.

In the course of his career, he served as a battleship Division Officer, Department Head on various diesel submarines and a Commander of one. He oversaw construction and had operational command of two nuclear powered Polaris submarines, was Branch Head in the Special Projects organization, and was Executive Assistant to Under Secretary of the Navy Bob Baldwin. He told the Secretary he did not want the job because he had orders to the billet of Deputy Director Special Projects Office which was producing the Navy's Polaris Missile System. Mr. Baldwin said, "Would you not like to aim higher than that?" Bob did choose to "aim higher".

As a Rear Admiral, he commanded the Service Force in Sasebo, Japan in support of the forces engaged in Vietnam and then took over responsibility as Deputy NAVSEA for Navy-wide maintenance.

As a Vice Admiral, he commanded the Submarine Force Atlantic Fleet and NATO, before becoming Deputy CNO for submarines under Admiral Holloway. After promotion to Admiral, he moved up to be Vice Chief of the **whole** Navy and then to Commander in Chief Pacific, from which after a distinguished tour he retired to civilian life, keeping his thumb well stuck in every worthwhile pie he found being baked by the Navy or DoD.

In every assignment, he had worked very hard to become the best, most professional officer ever to serve in that billet. He expertly gave his all.

During his career, the technological advances were mind-boggling. He was not an inventor, designer or hard-core engineer, but he well understood the scientific and engineering aspects of each advance. More importantly, Bob knew how to make operational use of new technology and provide it the required logistic support.

A great leader, Admiral Long inspired fierce loyalty in subordinates and great respect from peers and seniors. He was a great teacher. Two of his more apt students, both former aides, are here today—Admiral Tom Fargo, now CINCPAC, and Vice Admiral John Grossenbacher, now COMNAVSUBFORCES.

He gained wide recognition as a wise counselor and statesman

in the halls of the Pentagon, Congress, White House, NATO, and the governments of countries in the Pacific area he commanded.

Bob believed and forcefully expressed his conviction that great leaders were first and foremost imbued with honesty, integrity, a sense of morality, an understanding of right and wrong, and a strong, strong work ethic.

He had great contempt for cheaters, slackers, and the immoral. He ruthlessly tossed away any rotten apples in barrels under his control.

He did not change when in retirement he joined the Board of Directors of such as GTE, Kaman, Morgan Stanley, and Northrop.

He was never a rubber stamp for any CEO. He left his mark on every corporation for which he served.

As for rotten apples, suspecting financial mismanagement at Northrop he led an investigation team of outside Directors with one of the end results being the departure of the CEO.

Would we had more like him out there today!

Bob was devoted to his first and only love, the very intelligent and cultured Sarah Helms, and the feeling was mutual. She is a great lady with a flair for home making and proper rearing of children. She possesses the savoir-faire which enabled her to gracefully and effectively team with Bob in the milieu in which they moved.

Together, they raised Charlie, Bill, and Rob to be fine young men—good responsible citizens all. Using a lot of guidance, and just the right blend of carrot and stick, they brought to fruition the intellectual growth and maturity presaged by the splendid genetic endowment they provided their children.

Like attributes can be seen in the ladies who chose their sons for husbands, and in their grandchildren.

It is not an exaggeration to say Sarah Long has always been revered by those in her immediate and extended family. Bob can rest assured such reverence will endure, and his beloved Sarah will receive continuing loving care and attention from their progeny.

We will miss him; however, we can all be grateful he came our way.■

EULOGY

by Admiral Thomas B. Fargo, USN
CINCPAC
11 July 2002

Good morning, and from all of Bob Long's friends in Hawaii and the Pacific, aloha. It is my great honor today to represent the legion of officers that Admiral Bob Long trained, nurtured, sometimes *fussed at*, but always ensured we were best prepared to serve our country.

And it is truly wonderful to see so many, who care so much for a man who not only led our Navy and our Nation in times of great importance, but who shaped our lives in countless, and different, ways.

The first time I met Admiral Long was the day I reported as his new aide in OP-02. It was 1976. I really didn't know what to expect—I had never interviewed for the job—in fact, I had never seen him before. In retrospect, I'm sure his strong network had taken care *of all that*.

He called me in, sat me down in one of those big, high-backed chairs and said, "Tom," (and you can almost hear him) "I want you to know I didn't hire you to carry my bags; I hired you for your brains—but you're gonna carry the bags too!" It was the start of my training, and a relationship only exceeded in importance by that of my parents.

He was a man of great warmth and compassion, and unquestionable strength. He once told me that a quality he looked for in each of those he evaluated was a "measure of steel." That philosophy was reflected by a Bernard Baruch quote he kept on the front of his desk for all to see; it said, "every man has the right to his own opinion, but no one has a right to be wrong with their facts."

I watched many officers over the years, both junior and senior, walk into his presence and realize they would be wise to have their act and their facts together, because that "measure of steel" was present in large quantities within Admiral Long.

But equally present, were his smile and the unmistakable qualities of charm and good humor.

I remember a particularly difficult trip we once made. It was a day that all aides live in fear of; those bags we just talked about, **failed** to get to their appointed place. Now, I was fortunate that Joe Williams had found enough uniform items to bail me out. But at the end of the journey, I'm sure my distress was still clearly evident.

Admiral Long simply put his arm around my shoulder and said, "Tom, if that is the biggest problem we have, you will probably survive this tour nicely. Why don't you join Sara and me for dinner."

He always made time. Time to teach, and time to make sure each of us was *on a fair course*.

Admiral Vern Clark made that clear at his change of command ceremony two years ago. When Vern remembered Admiral Long to the large audience, he said he could recall vividly "the days when Admiral Bob Long bounced the two of us on his knee" when we both worked for him in the Vice Chief's office.

And there are many here with us this morning who can make a similar claim. When you look at the three year period Admiral Long spent in the Vice Chief's chair alone, he *brought up* nine officers who would go on to make flag from his personal staff, and a host of officers and enlisted men and women who went on to serve their nation with great distinction. Each fiercely loyal to a man who had made a difference in their lives.

From SEA LEOPARD to CINCPAC, his influence on generations of officers in itself contributed immeasurably to the future direction of our armed forces.

And he brought us along with his certain style, a subtle manner that often had us comparing notes at the end of the day—finally figuring out the lesson we had just been taught. He invested in each of us to a huge degree and in a very personal way. And we each left understanding the importance of our contribution, our purpose, and our worth.

There are many ways to describe the enormous respect we have for this man. And one last story may help. It reflects a conversation I'm sure he had with many of us. My wife and I were having

lunch with the Longs at the Annapolis Yacht Club. We had just returned from Bahrain and duty in Command of the Fifth Fleet and In the course of the conversation that day, Mrs. Long interrupted and said, "Tom, you really need to call me Sara." And I responded, "Okay, I'll try." Admiral Long immediately chimed in with, "Tom, do you think you can call me Bob?" I paused and then said, "Admiral, I don't think we can get there..."

So Admiral, I apologize for taking some liberties here this morning.

Joe Williams has very properly and eloquently chronicled a career that highlighted Admiral Long's **courage**, his **extraordinary strength** during the *high stakes* days of the Cold War, and the **visionary leadership** that helped guide our Navy.

And of course, he led the vast array of U.S. Pacific military forces during the height of the Cold War. As CINCPAC, he was one of the first to articulate the importance of the Pacific region, and his **steady hand** in those days **was instrumental to the prosperity we enjoy in the region today**. And you have to love the symmetry of his service—Bob Long concluded his time in uniform in the same way it began—as a **guarantor of peace** in the Pacific.

It is easy to understand why Admiral Long was revered throughout the Pacific as CINCPAC. And when we travel the region to this day, so many people continue to ask that I pass along their respects to Admiral Long. "Boss, I do that once again."

Just as a ship returns to the safety of her port—and her sailors to the embraces of their loved ones—we trust that God will guide and welcome home the journey of this truly, good man.

We have read, "Death comes to all. But great achievements raise a monument which shall endure until the sun grows old." As long as that sun burns, as long as this Nation endures, and as long as the seas carry this nation's Sailors to the far corners of the earth—the memory, the legacy and the greatness of Admiral Bob Long will linger for us all. We all will miss him greatly.■

ARTICLES

TECHNOLOGY ADVANCES AND ENABLERS

by G. R. Thompson
Johns Hopkins Uuniversity
Applied Physics Laboratory
Session Chair
Submarine Technology Symposium 2002
May 15, 2002

This session, concerning technology advances and enablers, will address selected innovative technologies and how they can be effectively brought to the fleet. The Submarine Force, in my opinion, has always been a leader in innovation. Examples include stealth, advanced sensors and processing, expanding mission capability, and special if not very special operations—which we rarely get a chance to appreciate in open sessions. Perhaps innovation—or at least its focus—was easier in the Cold War era, where there was a clearer understanding and priority of needs, such as quieting, acoustic superiority, and ship performance. This urgency allowed for a concentrated and protracted plan for science and technology, and a sustained evolution in improved performance and payoff. Clearly things are different now, maybe even more so after September 11th, with broader mission requirements and associated technical challenges, and the need for rapid technology insertion and adaptation to changing military needs. Commensurate with this is a wealth of new and emerging technologies, including possible commercial technology that will ultimately help address these needs, some of course not as yet defined.

In my opinion, the Submarine Force and its tech base has responded well to the past and recent changing needs. I look at the changes even over the 11 years ago since last I was the Program Chair. There is a whole new class of SSN on the ways; a substantial payload reconfiguration has been made to the third unit of the Seawolf class; an SSGN class is emerging from converted Tridents; and already significant hull changes are being imagined for the

Virginia class—specifically an advanced sail and possibly a large reconfigurable payload bay. Of course, one could go all the way back to nuclear propulsion and submarine launched strategic missiles as seminal examples of submarine innovation. These examples reflect a submarine technical community willing and able to make dramatic changes to adapt to emerging national needs. Nevertheless, some feel the Submarine Force or the system is too slow in its willingness to accept new technology, and may not adapt sufficiently to the new world order...if that phrase still applies.

In discussing this session with Rear Admiral Brickell, he mentioned that he had recently read Clayton Christensen's book titled, The Innovator's Dilemma[1], which deals with how some companies—even very successful ones—have suffered in the presence of what he refers to as "disruptive technologies", that is technologies that do not emerge from a well-planned and forecasted understanding of the future, and displaces existing markets and companies. A broad range of examples is cited, from the computer disk industry, discount retailing, the automobile market, steel industry and the pharmaceutical industry. At his recommendation, I quickly read through this book, and pulled out some key points that might have analogies to the subject at hand. These include:

1. The process or emergence of disruptive technology is fundamentally different from the otherwise more evolutionary process involved in improving or sustaining current technology.

2. Current customers (read users) are not the best source for future requirements or markets; they have their current beliefs that tend to be tied to current practices.

3. One needs to be flexible and highly adaptive to changing markets and technology; e.g., make flexibility a part of the enterprise, and, furthermore, sufficiently invest in both time and money to allow for failures and 2nd and 3rd tries. One seldom gets new ideas fully right the first time.

4. Similarly, don't expect immediate payoff...the initial users of new technology may be an outlier set or new user, but as the

[1] "The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail", Clayton M. Christensen, Harperbusiness.

technology matures and is recognized, the crowd will follow.

5. Finally, timing is important. It is critical to get new ideas/capabilities into the market...to try them out...to allow them to be used, even in ways not originally intended.

Christensen cites, for example, that IBM almost went out of business for failing to move beyond the mainframe computer, when the personal computer was the disruptive technology. Its traditional large-business base did not see PC's as a requirement, so IBM did not make the move. Sears stuck with its traditional business plan and merchandise, while failing to recognize the trend towards discount merchandising and home improvement products—and as a result also almost went out of business. Other provocative examples are cited.

There are probably real differences between experiences in the commercial market place and the military; however, I suspect there are similarities as well. The most fundamental point is that the future is difficult to predict, disruptions will occur and in fact be essential for success, and that flexibility, risk, persistence, and adaptability are essential characteristics of the innovation process. It is important that there be both mechanisms for fostering disruptive technologies, to easily insert or accommodate them when they appear valuable, and get them in front of the operator, who may then use these technologies in ways not originally appreciated.

There are certainly examples of attempts to foster disruptive technologies for the Submarine Force. DARPA, for example, has had several programs over the past decade and a half, which I bring up mostly because of my direct familiarity with them. These include the Advanced Submarine Technology Program in the late '80s which looked into a broad range of new HM&E technologies including propulsion, materials, and automation; the ATSOL program of the mid '90s that examined advanced sail concepts and stealth technologies for expanded littoral operations; the Submarine Payloads and Sensors Program, which is now leading to some novel payload demonstrations, and the Multi-Element Buoyant Cable Antenna program, which in conjunction with ONR is examining an advanced concept for comms at speed and depth. Collectively,

these programs are consistent with many of Christensen's precepts, in that they are targeted to new concepts or paradigms, solicit ideas from in and outside the traditional market base, are prepared to accept *high risk* in order to achieve high potential payoff, and seek early prototypes or demonstrations to not to only test, but to expose the technology to potential users. The success of these programs must be measured in not only what they have produced, but also the opportunity for new ideas they have provided.

The Submarine Force is making significant steps to help accommodate new and potentially disruptive technologies. They are committing to more versatile, flexible systems and platforms, such as open system architectures, making accommodations of COTS, and seeking far more flexible payload volume. Each of these attributes is accommodating of an unpredictable future and sets the stage for new, if not disruptive technologies. The Advanced Rapid COTS Insertion, or ARCI, program is an example of an essentially new business model for rapidly developing and testing new ideas, in this case acoustic processing, and speed them to the operator. Navy leadership is exploring ways of extending this build-test-build or rapid prototyping approach to other areas where it makes sense. The Navy is exploring new ways of expanding and executing its missions via forums such as the N77-sponsored Future Studies Group, which is looking at ways to extend the payload capacity of the platform and the reach of submarine sensors. These clearly are innovative steps, and hopefully will allow for new, even disruptive, technologies to be identified and more readily incorporated.

But we have to be aware that the adversary is innovative, if not disruptive as well. They are perhaps even more likely to seek *unconventional* ways to disrupt, defeat, or just bypass our more conventional military means and methods—such as we have seen with the USS COLE and September 11th. We have to be highly imaginative and forceful to stay ahead of or at least quickly respond to, these *pop-up* threats. The submarine is clearly a unique platform—in fact a disruptive technology in its inception—and continues to be so today, by virtue of its stealth, endurance and survivability. But times are changing, and like IBM and others, the

submarine needs potentially to change as well—as it is. Platforms such as the SSGN and future Virginia class offer a fertile ground for attracting and fielding disruptive technologies, along with efforts to backfit these high-payoff technologies to the 688 class. In addition, we have to be sure that the overall process—from requirements, S&T, to acquisition—is vital, flexible and responsive enough to take full advantage of this disruptive potential. Maybe provisions for a *skunk works* like approach is sometimes needed, one that is focused and intense enough rapidly to respond to disruptive ideas when not adequately accommodated by the otherwise evolutionary mechanisms...we could call this *the disruptive* fund. I felt that the SSN Security Program of several years past was an example of such a program—at least on a limited scale.

So with this background, this session will present several examples of advanced and perhaps disruptive technologies and system concepts, and some of the issues associated with their transition and insertion. The first four papers address specific technologies, these being advanced digital control and automation, micro-electro-mechanical systems (MEMS), the use of smart materials for platform control and quieting, and advanced propulsion concepts. The second and third paper, I might point out have involved DARPA efforts. The final paper then addresses the need for more comprehensive and timely tactical and operational analyses, to pinpoint technology needs and maximize their operational employment, and in general support the overall technology life cycle.■

STRIKE WARFARE IN THE 21ST CENTURY: RELYING ON THE KINDNESS OF STRANGERS?

by Dr. Richard Thompson

Dr. Thompson is a professor at the University of Maryland, Baltimore Campus.

Strike warfare remains a core U.S. capability, certainly an essential part of our military portfolio. Not only is it a key part of military strategy, but a credible strike capability is a significant deterrent to aggression. Despite its importance, however, our strike capability is less credible than before (despite innovative new weapons and platforms), and some pending decisions threaten to degrade it further. Note that in this context we are discussing only conventional, not nuclear, strike warfare, and then only beyond artillery range.

Our strike capability can usefully be divided into land-based air, sea surface-based, carrier air-based, and submarine-based. Our land-based strike capability (consisting of cruise missiles and some theater ballistic missiles) mostly requires air cover to deploy, so many of the arguments dealing with land-based air apply to it as well. Similarly, the vulnerability issues regarding aircraft carriers apply to surface vessels capable of strike warfare, so they largely may be considered together as well.

Land-Based Airborne Strike Warfare

Our colleagues in the Air Force have recently made much of the *global reach* of their strike capability, and particularly its efficacy in the Balkans. Yet despite the introduction of outstanding new technology such as stealth and new smart munitions, I would argue that the reliance on fixed airbases makes this approach less and less viable. The decline in viability comes from the reduction in air bases accessible to the U.S. worldwide, and the vulnerability of those air bases to a variety of agencies. Certainly the vulnerability of air bases in Europe, Korea, and Japan was an important concern during the Cold War (see P.T. Bingham, "Fighting from the Air

Base," *Airpower Journal*, Summer 1987, <www.airpower.maxwell.af.mil/airchronicles/apj87/bingham.html>; and P.C. Baham and K.W. Polasek, "Tactical Aircraft and Airfield Recovery," *Airpower Journal*, Summer 1991 <www.airpower.maxwell.af.mil/airchronicles/api/4sum91.html>, and events since then have only exacerbated this trend. The vulnerability of airbases arises because they are large, fixed, difficult to camouflage, and have vulnerable logistics. They are also vulnerable to many different forms of attack, including by missiles using a variety of warheads, aerial bombing, and special forces. Furthermore, they are soft targets for intelligence collection. Finally, the availability of third country air fields or even air space is definitely unreliable, as recent events have shown.

The threat to airfields from ballistic missiles carrying conventional or nuclear warheads was (and remains) difficult to counter. While sophisticated anti-missile defense systems such as Patriot and Aegis/Standard are proposed for defense against ballistic missiles, their efficacy is the subject of debate, and clearly they must be in place to fend off an attack. The threat of using chemical warheads is also viable, and was of particular concern during the Gulf War. During the Cold War NATO personnel were exercised in rapid runway repair wearing chemical protective suits. However, even at moderate temperatures under simulated chemical attack (during exercise Salty Demo at Spangdahlem AB in Germany in 1985) personnel were unable to complete repairs (J.A. Centrone, "Triple R in a Chemical Environment," *Engineering and Services Quarterly*, Spring 1982, pp. 20-21). The reader may consider the difficulty of working in protective gear in Saudi Arabia in July. The reader may also consider the difficulty in decontaminating vehicles, aircraft, and personnel at airfields lacking abundant water. Certainly many nations are seeking or developing theater ballistic missiles, and chemical warheads are overtly more accessible to these nations than other weapons of mass destruction. While the Scud missiles used in the Gulf War were ultimately ineffective (except perhaps politically), they also represent very old technology that made them vulnerable to counterforce tactics. In particular,

they must be erected to be fueled, which takes some time, during which they can be hunted. A more modern missile which can be transported fueled (like the U.S. MGM-52 Lance using UDMH and IRFNA deployed in 1962, or any solid propellant missile) can be erected and fired within minutes. Such a missile is much harder to target. The comments of the then-commander of U.S. Air Forces in Europe, General Jumper, ("Operating Abroad,") *Air Force Magazine*, Volume 81, December 1998, <http://www.afa.org/magazine/1298operating/html>) suggesting that their operational limitations have made Scuds straightforward to find (and thus not a threat to Allied airbases) presumes one is still hunting '50s-era missiles.

Certainly bombing is a time-tested approach for neutralizing air bases, and specialized munitions have been developed for the purpose. These munitions include bomblet dispensers (such as the JP 233) designed to crater runways, and bunker-busting smart bombs designed to penetrate hardened aircraft shelters. One can anticipate that these munitions (or former Soviet equivalents) will be readily available to any who can pay. Airbases will of course have anti-aircraft weapons, and in the Gulf War even guns and shoulder-fired weapons were effective against Coalition Tornadoes attacking Iraqi airfields with cratering munitions (C.M. Centner, "Ignorance is Risk: The Big Lesson from Desert Storm Air Base Attacks," *Airpower Journal*, Winter 92 <http://www/airpower/-maxwell.af.mil/airchronicles/apj/centner/html>). Indeed, the Coalition air campaign against the Iraqi air bases was less successful than is widely believed, despite 3000 sorties. The Iraqi use of superhardened bunkers and airbase layouts with redundant taxiways and runways made the Coalition efforts less successful; this was attributable to an Iraqi construction program begun during the Iran-Iraq War. The lesson to be learned here is that airbase operation in the face of determined air attack is feasible if one is prepared, but takes substantial money and time; we were fortunate that the Saudis had plenty of both in constructing the bases used by Coalition forces in the Gulf War.

The corollary is that using improvised airbases or commercial airports in neighboring countries is likely to be risky by comparison

with more survivable military fields. General Jumper is quite right that a nation under attack would be eager to have our aircraft use its airfields. The problem is that unless those airfields are constructed with hardened aircraft shelters, redundant taxiways and robust fuel supplies they will be vulnerable to even unsophisticated attacks. Lieutenant Colonel Bingham pointed out that "Even Third World countries are likely to possess significant airbase attack capabilities," and development of specialized munitions is within the means of many. Certainly laser-guided bombs (first deployed almost 30 years ago by the U.S. in Vietnam) and cratering munitions are within the reach of many nations either to purchase or develop. Moreover, an opponent contemplating aggression at leisure can be relied upon to devote special attention to airfields (even those in third world countries). A non-allied nation which is not at risk (like Uzbekistan providing the use of its airfield(s) during the current conflict) is likely to drive a hard bargain for their use.

An additional threat to any airbase is its logistical tail: in particular, the need to supply huge quantities of fuel and munitions for an active air campaign. While modern jet aircraft have longer ranges, they nevertheless are very thirsty as well. For instance, a medium-large commercial airport such as Baltimore-Washington International (400 outgoing flights daily prior to September 22, mainly regional jets) consumes 600,000 gallons of jet fuel daily. Lacking a pipeline, that amount of fuel requires 80 to 100 tank trucks to transport daily. While tactical aircraft are smaller than commercial airliners, they still require lots of fuel: the fuel for one sortie by each of the aircraft in the 366th Air Expeditionary Wing on full internal fuel (e.g., 18 F-15C, 18 F-15E, 6 KC-135R, 3 E-C, 6 B-1B, and 18 F-16) comprises over 350,000 gallons. Whether fuel comes by pipeline or surface transport, the countryside surrounding the airbase must be secured to prevent interdicting the fuel flow. Similarly, munitions are heavy and bulky and are shipped by surface transport; full bomb loads for a single sortie by the 366th comprises nearly 700 tons of bombs and missiles, or 35 truckloads. Obviously an exposed pipeline, a bridge, or a convoy

of trucks represent targets well suited to attack by special operations forces or guerillas.

Not only are bases overseas vulnerable, but they are fewer and farther between. If a crisis erupts on Taiwan, the nearest base Americans can expect to operate from is on Okinawa; if the American bases there are closed, the next closest is in Korea, a 1200 nautical mile round trip. Twelve years ago it was Clark AB in the Phillippines. While the range of tactical aircraft can be extended using aerial refueling, longer distances reduce the sortie rate in any case. Since World War II a great many bases have been closed to American operation; outside NATO countries the places we can operate from without securing prior permission can be counted on the fingers of one hand. The loss of Clark AB and Howard AB in the Canal Zone are particularly telling. Thin basing and stretched resources make diplomacy and subversion more effective in denying airbases. Either could close Okinawa to U.S. forces, and likewise closing the Panama Canal or Suez Canal to U.S. warships cuts our (shrinking) fleet in half for weeks. Most recently, the lack of bases in theater has limited the Air Force to employing only aircraft (B-1Bs and B-52s) with intercontinental range to strike targets in Afghanistan from the British base on Diego Garcia, roughly a 5000 mile round trip.

The Air Force has made much of the worldwide reach of the B-2 Stealth bomber from its base in Missouri, and this was demonstrated in Kosovo. Yet how sustainable are 24+ hour combat sorties? Air Force sources speak of the ability to catnap for twenty minutes at a time as a restorative, but how many crews could pull an *all nighter* every few days for weeks on end? The tension of a combat sortie under fire is greater than on a training flight, even in a stealth aircraft, and correspondingly more tiring. The experience of bomber crews in World War II and the postwar Strategic Air Command taught that long missions (8 hours) could seldom be scheduled more frequently than 2-3 times per week, even if the aircraft can be maintained. Perhaps multiple crews could be trained, but the short answer is that bombers outside the theater are pretty much out of the fight.

Airbases, being large and fixed, are also comparatively easy to

keep under surveillance. Certainly the number and types of aircraft arriving and departing are often observed by agents, and observations of departing strike aircraft was used to cue defenses by the British during the Falklands War. With the advent of commercial reconnaissance satellites with 1 meter resolution (in addition to military systems), frequent observation of airfields should be straightforward.

Carrier-Based Strike Warfare

The fundamental difference between land-based strike aircraft and carrier-based aircraft is the carrier can move. The carrier, being mobile, is a much tougher target than the airbase. Norman Friedman in his recent *Seapower and Space* (Naval Institute Press) recounts in great detail the efforts by the Soviets to develop systems which would credibly threaten aircraft carriers. Suffice it to say that, except in confined waters, it is very difficult to get close enough to an operating carrier to target it (using one's own sensors) well enough to get a fire control solution. Even a supersonic missile launched from beyond the reach of the carrier's air umbrella would take more than ten minutes to arrive, ample time for decoying, interception, jamming and evasion. Similarly, it is very difficult for a submarine to get close enough to track the carrier with its own sensors, and not be detected; this is doubly true if the carrier is operating aircraft because it requires the submarine to sustain speeds of 20+ knots, (e.g., be nuclear propelled) which increases the chances of detection and degrades its sensor performance. Supersonic cruise missiles similar to the SS-N-19 (NATO designation is Shipwreck) are too large to launch from torpedo tubes and require correspondingly large, purpose-built submarines (in this case, the Oscar II class exemplified by the lost KURSK). While the credibility of the Soviet threat to our carriers might have been debatable and the object of much concern, the threat from a small diesel-electric submarine force operating subsonic missiles relying on their own sensors is clearly modest.

As some have pointed out, aircraft carriers in the Gulf War

ultimately were supplied from seaports, which of course are large, fixed targets. However, there are some important differences compared with airbases. First, a seaport is by and large a tougher target to put out of action. If you crater an airbase runway anywhere along its length, it is inoperable until it is repaired and swept clean of debris. By comparison, a pier can be heavily damaged and still be useable immediately, as long as traffic can move to and from ships tied up to it. Although drydocks, repair facilities, cranes, and other specialized equipment in a port can be destroyed by bombardment, with consequent loss of efficiency, much of the capability of the port can be restored by tenders and floating drydocks. Airplanes (except VSTOLs) must have runways; for a carrier, a pier nearby is only a convenience. Perhaps the best examples of the ruggedness of seaports were the Nazi submarine bases in Occupied France in World War II, which withstood prolonged bombardment; certainly a seaport is not harder to defend from air attack than an airbase. Furthermore, interdicting operations of a seaport itself (as opposed to sinking a single ship) is much harder for guerillas or special forces, since supplies of fuel and munitions can be brought in by ship, rather than overland. Finally, the vulnerability of a seaport to chemical weapons is modest due to the abundant supply of water for decontamination and the ability of naval ships at least to seal and wash themselves down.

A key advantage of a carrier battle group is its ability to keep the sea and continue operations for months independent of any shore base, while being resupplied at sea. Nimitz class carriers can stow nearly 2,000,000 gallons of aviation fuel and approximately 2,000 tons of aviation ordnance, enough for a few days sustained operations at a high tempo. The underway replenishment (UNREP) procedures and the specialized supply vessels needed to carry them out have been refined over decades, and consequently the process is relatively fast and efficient. Thus hundreds of tons of munitions and hundreds of thousands of gallons of fuel can rapidly be transferred to an aircraft carrier. While the carrier almost cannot carry out flight operations during this time, it is *off line* less than 1/3 of the time. Also, the base which supplies the auxiliary vessels

which supply the carrier and her escorts need not be within tactical air range at all; the fast speeds (26 kt) of current auxiliaries permit the base to be a thousand miles away and still be convenient for resupply. While with midair refueling, airbases also need not be within range of the opposition's tactical air force, the tankers themselves may well be. The carrier has full maintenance capabilities onboard, with nearly 2,000 personnel to maintain aircraft in a Nimitz class carrier, dedicated spaces, and substantial spares.

While the advantage of carrier aviation for strike warfare (and other missions) remain strong, currently there are several issues confronting the Navy. The modest capabilities of the Hornet as an attack aircraft are being addressed by the advent of the Super Hornet, and the introduction of the Joint Strike Fighter will finally bring a stealthy attack aircraft to the carrier deck. While it remains a superb fighter, the Tomcat is thirty years old, along with its Phoenix missiles. Although the threat from long range aircraft with supersonic missiles is less now than in the Cold War, the ability to establish at least local air superiority is essential for many of the carrier's missions, and no replacement for the F-14 is in prospect. The only contemplated replacement for the overstretched EA-6B Prowler fleet is a modified Hornet; the degree of automation required with a two-man crew would appear to require extensive development of what promises to be a very expensive aircraft.

Submarine-Based Strike Warfare

In many ways the ideal platform for strike warfare is the nuclear submarine. Once in theater, it practically cannot be threatened by any potential adversary, due to its stealth. It has no logistical tail, being able to operate for months independently without refueling, and indefinitely if a tender is present in theater. Armed with cruise missiles, it can hold a score of targets at risk, with no countermeasure able to stop it. Given its stealthy nature, its presence is non-provocative, but there may be one, five, or a dozen submarines present. The submarine can shoot quickly following receipt of the order to fire, in (almost) any weather, and without coordinating

with other units; no air tasking order need be generated, tankers needn't be deployed, and it doesn't take hours to reach a firing position. It can loiter for months if need be, instead of hours. The nuclear deterrent patrol record compiled over the last forty years makes the submarine a very credible threat. The only current aircraft armed with cruise missiles is the B-52H, with the B-1B slated to receive this capability in the future; neither aircraft is viewed as survivable in a modern air defense environment as deployed by the Iraqis. By comparison, a Trident carrying a number of missiles comparable to a squadron of B-52s is essentially invulnerable, and no conceivable degree of modification or upgrade, at any price, can make either of these bombers as secure as the submarine is today. Of course, both bombers can still drop large loads of iron bombs and nuclear weapons, but both capabilities would appear to be less important nowadays, particularly in a tactical context. The complete inability of an enemy to hit back at a missile-firing submarine is likely to be very demoralizing. The low risk to the submarine crew compared to aircrew is of particular importance in the current news media environment. Moreover, under conditions where the only intelligence capability the enemy possess is all-news commercial television, the invisibility of the submarine and the discretion of its operations is particularly valuable. The advantages of the submarine (particularly the Trident submarine) as a strike platform argue that its weapons suite should be expanded to include tactical ballistic missiles for bunker penetration and sophisticated new warheads for the cruise missile. If the most recent nuclear arms reduction proposals are implemented, several more Trident submarines will become available for this purpose. Having built the ships and refueled them, the operating costs for the balance of their service lives are comparatively modest, particularly compared with an aircraft carrier battle group.

The principal drawbacks to submarines as strike platforms are the fairly high cost per round fired, the limited volume of fire possible, and the inability to engage moving targets on land. However, recent experience suggests that *smart* weapons are so much more cost effective than *dumb* iron bombs, that the former will be preferred for almost any fixed target worth destroying.

Once Tomahawk-armed Tridents go to sea, volume will be less of an issue, since a single pair will carry a number of weapons nearly equal to the 297 Tomahawks fired during the Gulf War (N. Friedman, *Desert Victory*, Naval Institute Press, 1991).

In conclusion then, it is evident that the advantages of sea-based strike platforms are many and growing, particularly for the submarine. While the missile-armed submarine cannot replace either land-based air forces or carrier aircraft, its unique advantages and cost-effectiveness argue that it is a capability which should be expanded in the first half of the 21st century.■

REUNIONS

USS GROWLER (SSG 577) San Diego, CA September 27-29, 2002. Contact: David Bishop, 1937 Silverwoold Lane, Los Angeles, CA 90041-3127; (323) 254-6045; e-mail: sbishop@lausd.k12.ca.us.

USS NAUTILUS (SS 178/SSN 571) New London, CT October 3-6, 2002. Contact: Walt Lincoln, One Butter Brook Hill, New Milford, CT 06776; (860) 355-1822; e-mail: cilincoln@snet.net.

USS ROBERT E. LEE (SSBN 601) New Orleans, LA September 26-27, 2003. Contact: Tim VeArd,P.O. Box 33666, Indialantic, FL 32903; (321) 722-0220; fax (321) 722-1080; e-mail: tveard@ssbn601.com; website: www.ssbn601.com.

USS SABLEFISH (SS 303) Groton, CT November 16-17, 2002. Contact: John Longo (908) 781-1518; e-mail: ljohn908@aol.com.

USS SENNETT (SS 408) Mt. Pleasant, SC May 18-21, 2003. Contact: Ralph R. Luther, P.O. Box 864, Summerville, SC 29484-0864; (803) 492-4023; e-mail: rsdluther@prodigy.net

SUBMARINE OFFICERS' CLASS 1950 San Antonio, TX November 5-7, 2002. Any shipmates of that vintage are welcome to attend. Contact: CAPT R.E. Thomas, USN(Ret.), 3712 Southernwood Way, San Diego, CA 92106-2965; (619) 222-2036; e-mail: rethomas@earthlink.net.

USS TRITON (SSRN/SSBN 586) Norfolk, VA October 25-27, 2002. Contact: Harry W. Hampson, 3404 Montgomery Place, Virginia Beach, VA 23452; (757) 462-7875; e-mail: harry1523@cox.net.

LESSONS LEARNED AND MIS-CONCEPTIONS: EIGHTEEN YEARS OF SUBMARINE DECISION RESEARCH

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The application of Human Factors research to submarining is not new. The Combat Systems Department at NUWC (Naval Undersea Warfare Center Division Newport) has been investigating the best way to present information to submariners for more than two decades. In fact, the first use of the term "Human Factors" was in a WWII report from the National Research Council on "The Human Factors in Submarines" (Panel on Psychology and Physiology, 1949). We know that today there are many more choices for how, what, and why to display information—and therefore many more human factors! This paper is intended to show how the science of Human Factors and Cognitive Engineering can provide answers that are both broader and more useful than just guidance on font size and style.

One of the first things that I did when I joined the group at NUWC was to take one of the excellent courses at the U.S. Submarine School, Naval Submarine Base, New London. That was only an introduction. I have spent the last 18 years interviewing submariners, observing in attack centers, running the analysis of Concept Of Operations EXperiments (COOPEXs), and collecting and analyzing experimental data in a large number of research projects. The objective of this research is to provide guidance for the development and implementation of technology to support human decision making. The prerequisite for improving support tools is understanding the relationship between information (content and structure) and human performance so that is where I have focused my efforts. Below I give examples of research and results from my own work and those of colleagues at NUWC and elsewhere. However, my main goal in writing this paper is not to

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describe specific research results. It is to demonstrate that there are decades of research and experience that can be brought to bear on the problems of supporting submariners (and others) at every level, from the most junior operator to the most senior decision maker.

Expertise

Expertise is an important research area because NUWC designs decision support systems for experts—and novices. Therefore, the research asks how expertise develops, and how we can better support the expert (and pre-expert) at work. This research has implications for training and for the design of systems to be used by the full range of users, from novices to experts.

One of the hallmarks of expertise is the ability to respond appropriately to difficult situations. One of the most difficult kinds of situation is the one where a particular signal can arise from a number of causes. For a rather obvious example, a low contact bearing rate can be due to range (distant) or geometry (bow null or parallel relative motion geometry). Navy training and doctrine teach the potential Officer of the Deck (OOD) to think about the dangerous situation of a contact close aboard on own ship's track. However, non-experts often assume that if the contact is not on own ship's bow, it is distant. Failure to test for other, lower probability alternatives (e.g., parallel geometry), is called a conformational bias and is common in all but the best experts.

One of the ways that experts accommodate the dynamic submarine problem is by continually sampling the full range of available information. They move from plots to Fire Control consoles to sonar to weapons. They look at the target of interest and at other contacts. In this way they avoid the hazard of tunnel vision and are often the first to recognize a change in the situation. This argues for flexibility in distributing and displaying information. It also argues for including contacts other than the contact of interest on displays, whenever possible.

Another consistent finding is that experts often look at raw data as a way of confirming information that has been analyzed either by automation or by more junior individuals. Forcing the expert to depend solely on analyses conducted by automation or by those

with less experience places a limit on his ability to apply his experience to the problem.

Perhaps surprisingly, experts are more variable than non-experts. This may be, in part, because they know more different ways to accomplish the same goals. Experts are also more variable because they are sensitive to local variation. For example, the experienced Approach Officer (AO) or OOD knows that he can trust what Joe tells him but that the Fire Control Tech (FT) has been up for 22 hours, there is a problem with some piece of equipment, and the Contact Evaluation Plot (CEP) plotter is standing his first watch at that station. Thus, the expert can respond appropriately, even to previously un-foreseen events. To accommodate this variability (flexibility) experts need the possibility of viewing things in a variety of ways. This translates into a flexible variety of displays to support many ways of accomplishing the goal. Actually, flexibility supports more than just experts, it supports human variability, in general.

The findings above do not imply that the AO/OOD should be doing all of the jobs nor that his displays should be the same as those who are. It only argues that he should not be limited to a couple of displays, a few fixed views, or only highly processed information. It argues for access. Likewise, the AO is not the only expert in the crew. Nor is his the only perspective. The experienced FT or Sonar Tech (ST) is also an expert at his job. The jobs are different, but the description of expertise cuts across specialties and even domains.

User-Centered Design

The concept of User-Centered Design is strongly supported by the Human Factors literature. It provides a set of methods that facilitate designing systems that advance the goals of the user and support the tasks people are actually doing, or need to do, to accomplish those goals. What is the difference between User-Centered design and other design processes? User-Centered design begins with the needs of the user. At this point in our technological history there are far more choices of how to proceed and what to build than we can afford (in time or money) to produce. User-Centered design supplements and supports the military idea of

requirements-driven acquisition by assuring that the acquired technology actually meets the requirements—when the entire human-machine system is considered.

One Example. For example, in many domains, databases have made the transition from books of paper look-up tables to electronic format. The user has a specific task to accomplish (it could be creating an air tasking order, a mine clearance plan, or a transit plan for one platform or an entire battlegroup).

One possible implementation is for the interface to mimic the earlier table look-up process. Thus, it would require the user must inspect potential solutions, data-cell by data-cell. Many tools have been built in just this way! Alternatively, the interface could have the user input the inflexible data (platform data, dates, constraints, etc.) and would output graphical (geo-referenced, if appropriate) color-coded, information. If, for example, the task were route planning, the tool could output all routes that satisfy the constraints, color coding segments for risk (safety, time delay, etc.), recommended speed, or other factors. When no route satisfies all requirements, the output could show the best compromises and potential alternatives, again, color coded for additional information. Such an interface would not require any additional information, just an understanding of the user's goals and common query ability.

Design for Reduced Training. Another use of User-Centered Design is to provide a tool that is as self-explanatory and easy to learn as possible. In this way the new tool does not add a new training requirement. Training is important but we must not confuse **task** training with **equipment** training. Most Navy tasks are complex and difficult. Task training should not be complicated by tools that are difficult to work, hide or scatter the essential information that needs to be integrated, or actually hinder the user (operator or senior decision maker). Yet, for years we have been told that any design problem, can be fixed by "training the operator."

Training is expensive. It takes time, space, and uses equipment and people that could be put to better use actually working the problem. How do we design for reduced training? One way is to design equipment to support the user by taking advantage of his strengths. A good example of a new tool idea that is built upon the

way the human system works is the set of sonar displays being designed by Ray Rowland at Naval Undersea Warfare Center Division Newport. These displays capitalize on animation and the fact that the human eye is optimized as an edge detector to facilitate target detection across different frequencies. They do not require much user training because they capitalize on his natural strengths. They even reduce content training because they facilitate the perception of key features.

Bottom Line. It is time to stop trying to fix mistakes with training. It is far cheaper to design a system right—and test it to be sure it is designed for operability—than it is to train every user for the life of the system or pay for the consequences of a single catastrophic accident!

Uncertainty

Uncertainty is a well recognized problem among submariners. It exists in other domains, but in submarines, it is the major source of difficulty. The problem is that we don't know how to communicate (or analyze), the degree, source, or even the possibility of uncertainty. Even if we could mathematically describe the numerous uncertainties, that does not mean that the decision maker can use that information appropriately. The most common human response to uncertainty is to delay taking action, but often, in the military, that is not an option. In fact, delay can increase uncertainty in a dynamic problem. The solution that is good at time(t) can quickly fall apart by time($t+1$).

Lessons learned from research are sparse, but provide some guidance. For example, if no information is given on uncertainty, people will search for it. Verbal and numeric information are about equally informative. However, spatial and dynamic representations of uncertainty are often better than verbal/numeric ones. Again, the intuitive solution is not usually the right one. Representing uncertainty is truly an area where the hard work is just beginning. It will build on efforts to model the physical and statistical phenomena.

Opinion and Data

I am trained as a researcher and have many years experience working for the Submarine Force. I have worked on many projects including COOPEXs for combat control and ship control. I have always been impressed with the effort and enthusiasm of the submariners who have participated in these COOPEXs and in all of my experiments. On the whole they have been knowledgeable and innovative. However, no matter how knowledgeable a practitioner is, there is no substitute for data. For example, in one experiment I tested the effects of a new kind of information on performance. At the end of the data collection session, I asked each OOD if he thought the new information would be useful and how he thought it might help. Interestingly, the data showed that the new information improved solution accuracy but had no effect on time-of-fire. However, the OODs thought that this new information would improve time-of-fire but not solution accuracy. Their experienced and professional, but subjective, judgment was exactly the opposite of the data on their experienced and professional performance! That is the reason why testing involves more than just asking, even when the *answer* comes from an experienced professional.

Every component of the submarine system is thoroughly tested to see if it performs as expected. Engineers know that even when something should work in theory and in the model, it might fail for any number of reasons when placed in the real environment or with other systems. That is the reason why systems are tested and certified. The only component that is not tested is the user interface, but that is the piece that communicates the state of the world (or system) to the decision maker and returns his intentioned actions to the system and hence to the environment. It is the most critical part of the entire system, yet it is the only one that is not tested. Data, not opinion and stress testing, not just theory are required to certify reliable user interfaces, just as it is with software and hardware!

Lessons Learned

None of the above means **don't** listen to the operator. He has

generations of experience in his insights. Rather, it means use the voice of experience as guidance for where to look, but do not fail to test that guidance as well. On the other hand, there is an entire field that specialized in Human Factors, applied cognitive engineering, and user-centered design. Not everyone is a psychologist because they are human or an expert at human cognition because they think or an Human-Computer-Interaction (HCI) specialist because they use a computer. The HCI/applied cognitive psychologist has at her or his disposal test, analysis, and application methods to support the design and evaluation of systems that will better support and even significantly improve the performance of our Submarine Force.

Perhaps the most important of the lessons learned, and the most difficult to implement, is that systems need to be designed to meet the needs of the users (regardless of level). Although often accepted, in principle, this requirement is not usually followed. Years ago, systems were designed to do the possible. However, with today's fast computers and virtually unlimited memory, there are few limits on the possible, except for those imposed by development time and money. Hence, there is a greater than ever need for guidance in selecting where to focus our efforts. I suggest turning the design strategy upside down and driving design choices from the perspective of users' needs, not developers' possibilities! To make this radical change in design strategy requires that we know what the user needs. This brings us full circle, to the methods and results of the science of Human Factors and Cognitive Engineering. Let's use this science to build a better submarine!■

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IMPERIAL JAPANESE NAVY TORPEDOES
Part II
Heavyweight Torpedoes 1918-1945[1]

by Frederick J. Milford

Mr. Milford is the author of an eight part series on USN torpedoes in ***THE SUBMARINE REVIEW*** *in 1996 through 1998. He followed with an article on Soviet and Russian post-WWII torpedoes in October 1998. Part I of this Japanese subject appeared in January 2000.*

As we have noted, by the end of the First World War the Imperial Japanese Navy (IJN) had developed 45 cm torpedoes for submarines and 21 inch torpedoes for surface vessels. These torpedoes were competitive with those of other navies. Other navies had, primarily as a result of WWI, accumulated more current experience in the combat use of torpedoes both as submarine and surface launched weapons. IJN participation in WWI did not involve torpedo warfare. Most of the other navies also had made more progress in switching to larger 21 inch torpedoes. Further, Japan lagged in the development of a submarine force. Only sixteen submarines had been completed for the IJN by the end of 1918. Major navies, in contrast, had each completed 80 to 100 submarines by that date. Japanese submarine torpedo armament consisted of 45 cm torpedoes and only three (of the sixteen) submarines carried more than two torpedoes. Surface vessels also carried 45 cm torpedoes. The first ship in the IJN fitted with 21 inch torpedo tubes was the destroyer URIKAZE, which was completed at Yarrow in 1915, but not delivered to Japan until 1919. The cruisers TENYU and TATSUTA, which completed in 1919, also carried 21 inch torpedoes. Some 21 torpedoes were

[1]The principal sources for this article are Kaigun Suiraishi Kankokai, *Kaigun Suiraishi*, Tokyo: Shinkosha, 1979 (abbreviated KS) and various reports of the U.S. Navy Technical Mission to Japan (USNTMJ). David Evans and Mark Peatie, *Kaigun*, Annapolis: Naval Institute Press, 1997 provided important background and details concerning the interwar period.

acquired from Whitehead-Fiume and Jure produced some before WWI. Major production of 21 inch torpedoes began, however, with a four year run, 1918-1921, during which the Mitsubishi Nagasaki torpedo plant produced over 500 21 inch Type 44 torpedoes. In 1922 this plant began production of 21 inch Six Year Type torpedoes with a run of 250. By the time production of this type ended over 3500 had been manufactured.

Thus in the years immediately following WWI the IJN torpedo establishment found itself technically competitive with the other major navies, but somewhat behind in torpedo deployment. The subsequent deployment of 21 inch torpedoes on surface vessels was relatively rapid and included both new construction and rearmament of existing vessels. Twenty-seven more submarines fitted with 45 cm torpedo tubes were, however, laid down between 1919 and 1923. The transition to 21 inch tubes began with submarines laid down in 1920-21, somewhat later than in the USN or the RN. The only new Japanese submarines completed after 1923 that carried 45 cm tubes were one experimental submarine (no. 71) and midgets, smaller that 100 t submerged. The universal technical objectives for improved torpedoes included more effective (destructive) warheads, higher speed, greater range and improved accuracy together with good reliability, availability, maintainability, and durability. There are two principal approaches to these objectives, increased size and new technology. The Japanese torpedo establishment pursued both, following rather different lines than those followed by other navies.

The Development of Conventional Heavy (21 inch and 24 inch) Torpedoes

The starting point for the post WWI development of IJN heavy torpedoes was the 21 inch Sixth Year Type. As previously described this was a conventional steam torpedo with a four cylinder radial engine that was competitive with torpedoes in service in other navies at the time. There were three key events in the subsequent development of Japanese heavyweight torpedoes: the introduction of 24 inch torpedoes for surface vessels; the use of

horizontal double acting engines following a Whitehead design; and the development of oxygen torpedoes. In this section we will consider the first two events, which involve conventional steam torpedoes, saving the fantastic story of the development of oxygen torpedoes for the next section. The specifications of the torpedoes we will be discussing are given in the table.

In torpedo design there is a trade-off among speed, range, and warhead weight. For example, for a given size and propulsion system, warhead weight can be increased at the expense of reduced fuel and oxidant and concomitant reduced range. Providing a larger engine can increase speed, though this may require a modified or new engine design, but range and/or warhead weight must be reduced if the more powerful engine is larger or heavier. One way to mitigating these restrictions is to increase the size of the torpedo. The IJN followed this course by developing the 24 inch Eighth Year Type, a scaled up version of the 21 inch Sixth Year Type, which boasted no innovations other than size. These huge weapons were mounted on cruisers beginning with the Nagara class, laid down in 1920-21, and on destroyers beginning with the Mutsuki class, laid down in 1923-26.

Both the 24 inch Eighth Year Type and the 21 inch Sixth Year Type were conventional designs for their time. Propulsion was provided by an external combustion system burning kerosene with air as oxidant and a four-cylinder radial engine of the Whitehead/Schwartzkopf type. Fresh water was carried and injected into the combustion chamber for cooling and the thermodynamic advantage of the steam cycle. Performance of the 21 inch torpedo was competitive, but not spectacular. The engine of the 22 inch version had about 50 percent more swept volume and so about 50 percent more horsepower. About 60 percent more internal volume was available for the larger engine, a larger warhead and more fuel and compressed air. Drag, which for a torpedo is roughly proportional to the wetted surface area times the square of the speed, increased by about 40 percent. Thus the maximum speed of the torpedo was slightly increased. The additional volume was used to increase the range by a third and the warhead weight by almost 75

percent to 345 kg (750 lbs). The Eighth Year Type 24 inch torpedo was a formidable weapon. Except for the very limited production of 24.5 inch torpedoes designed for HMS RODNEY and NELSON torpedoes this large were not seen until the Soviet Navy introduced 65 cm torpedoes in the 1970s.

IJN 21" TORPEDOES

Type	Year	Dsgn-/Mfg	Quan	Lgth	Wt	War-head (a)	Prop	Rng/ Spd
06	1917	Kure/-Mit.	3537	6.84m	1500 kg	200 kg	4cyl steam	15000m @26kt 10000m @32kt 7000m @36kt
89	1929	Kure/ Mit.	1147	7.15m	1625 kg	295 kg	2cyl hor. steam	11000m @35kt 6200m @43kt 5500m @45kt
92	1932		650	7.15m	1720 kg	300 kg	elec-tric	7000m @30kt
95-1	1935	Naga-saki	2699 (b)	7.15m	1665 kg	400 kg	2cyl hor. oxy	12000m @46kt 9000m @50kt
95-2	1936	Naga-saki		7.15m	1730 kg	550 kg	2cyl hor. eneric hed air 38% oxy	7500m @46kt 5500m @50kt
96	1936	Naga-saki	~ 300	7.15m	1665 kg	400 kg		4500m @49kt

Note: (a) Picric acid, Type 94 or Type 97; all roughly equivalent to TNT; (b) Total for both models.

IJN 24" (61 cm) TORPEDOES

Type	Year	Dsg n-/Mfg	Quan	Lgth	Wt	War-head (a)	Prop	Rng/ Spd
08	1919			8.41-5m	2400 kg	345 kg	4cyl steam	20000m @27kt 15000m @32kt 10000m @38kt
90	1930			8.55-0m	2450 kg	400 kg	2cyl hor. steam	15000m @35kt 10000m @42kt 7000m @46kt
93-1-1	1935	Kure	2600 all model	9.0m	2700 kg	490 kg	2cyl hor. oxy	40000m @37kt 32000m @41kt 20000m @49kt
93-1-2	1936	Kure		9.0m	2700 kg		2cyl hor. oxy	do
93-1-3	1944	Kure	(a)	9.0m		490 kg	2cyl hor. oxy	30000m @37kt 25000m @41kt 20000m @49kt
93-2	1935	Kure	2 (a)	9.0m			2cyl hor. oxy	5000m @56kt
93-3	1943	Kure		9.0m	2800 kg	780 kg	2cyl hor. oxy	30000m @37kt 25000m @41kt 20000m @49kt

Note: (a) not used in service.

The small increase in speed obtained by going from 21 inch to 24 inch diameter reflected a fundamental limitation on the displacement (swept volume) of single row radial engines of constrained diameter. With this constraint, significantly higher power required higher mean effective pressure and/or higher rotational speeds. Both of these possibilities posed serious practical problems so torpedo designers examined alternative engine designs. Several possibilities emerged—the Royal Navy burner cycle engine, two row radial engines in Italy and turbines in the U.S. are examples. A fourth possibility was a two-cylinder, horizontal, double acting engine designed by Whitehead-Fiume around 1909. Before WWI torpedoes using this horizontal engine were sold to several navies and examples were consigned to other Whitehead sites. Among the navies that purchased torpedoes with horizontal engines was the IJN, which purchased ten 45 cm torpedoes of this type in 1914. This development was shelved during WWI, but clearly knowledge of it and details of the design were widely disseminated among the numerous Whitehead companies and to at least five navies.[2] The major advantage of this engine was that because of its configuration, particularly its horizontal orientation, it could accommodate both larger diameter cylinders and longer stroke. Since it was a double acting engine, it was equivalent to a four cylinder single acting engine. The resulting larger displacement made it possible to fit torpedoes of a given diameter with engines that were more powerful than the four cylinder radials and so increased the maximum speed to about 45 knots. Torpedoes using this engine design were developed for several navies after WWI and in the early 1920s Whitehead-Weymouth was offering to build torpedoes using this new engine configuration for export.

In 1926 the IJN ordered the smallest acceptable quantity,

[2]Dr. Eng. Benito Petrucci Director of the Whitehead-Alenia Museum in Livorno Italy kindly supplied the Whitehead records on which this statement is based. It is interesting, but unnoted in U.S. literature that one of the five navies was the USN.

twenty, of these new torpedoes from Whitehead-Weymouth.[3] The price was 30,000 Yen (about $14,000) per torpedo including exercise heads. In addition Vickers-Armstrong, by then the parent company of Whitehead-Weymouth, was paid a lump sum of 150,000 Yen (about $70,000) for full instruction in all aspects of torpedo design and manufacture. This presumably included a license to manufacture torpedoes of this design in Japan. Whitehead-Weymouth began work on the torpedoes in 1927. During the construction a team of eight Japanese naval officers was in residence in Weymouth and had essentially unlimited access to the Whitehead plant. The report produced by this team reportedly ran to sixty bound volumes and must have been a veritable bible of late 1920s torpedo technology.

The Weymouth torpedoes were completed in the fall of 1929 and shipped to Japan. The first service torpedoes with horizontal engines were designated 21 inch Type 89.[4] It is not clear whether or not these torpedoes were 1) simply Weymouth torpedoes fitted with warheads, 2) the result of a production program based on the 1914 acquisition from Fiume, or 3) developed in a program parallel to and based on the Weymouth torpedoes. Type 89 torpedoes were issued to the fleet beginning in 1931. The 21 inch Type 89 torpedo was 125 kg heavier than the Sixth Year Type, but most of that weight, 95 kg, went into a larger warhead. Engine power was

[3]Considering the earlier, 1914, purchase of torpedoes with this engine design, the 1926 purchase is a little surprising. The motivation may have been more intelligence, learning about contemporary western torpedo technology, than strictly acquiring the specific design. Proximity and ability to observe activities at the RN Portland naval base would have enhanced the intelligence value of having officers in residence at Weymouth. Another primary motivation may have been acquiring a manufacturing license, which might not have been part of the 1914 acquisition.

[4]Type numbers were generally assigned according to the year the design was completed or the year test firing *Eighty-nine* represents the year of the Empire 2589 and corresponds to 1929. It seems unlikely that there was a Japanese produced prototype available in 1929, but KS claims that Type numbers were not assigned to the Weymouth torpedoes. The torpedoes issued in 1931 were almost certainly Japanese production.

approximately doubled yielding a maximum speed was 45 knots, an increase of 25 percent. The range was 5500 meters, somewhat less than that of its predecessor. The two cylinder engine became very popular with the Japanese torpedo establishment and engines of this design powered all subsequent heavy surface and submarine launched torpedoes of the IJN except the Type 92 electric.

The two cylinder engine design was quickly enlarged to serve 24 inch torpedoes and the 24 inch Type 90 emerged to replace the Eighth Year Type. This torpedo with its 400 kg warhead and range of 7000 meters at 46 kt was the final development of conventional, heavy, IJN steam torpedoes. In addition to steam torpedoes a relatively unspectacular 21 inch Type 92 electric torpedo was designed, but the design was shelved. Ten years later, in 1942, the Type 92 electric torpedo was put into production and about 650 were produced to supplement the Types 95 and 96 submarine launched oxygen torpedoes. At the beginning of the 1930s, Japanese torpedo performance was as good as that of any in the world and the IJN enjoyed the substantial, but relatively unknown, advantage of 24 inch torpedoes for surface vessels. This advantage was increased in the next generation of torpedoes, which consisted of oxygen and enriched air torpedoes as discussed in the next section.

Oxygen Torpedoes

Almost as soon as steam torpedoes were developed, it was widely recognized that the energy stored in the compressed air was small compared to that stored in the hydrocarbon or alcohol fuel. The primary function of the compressed air in a steam torpedo was to provide the oxidant for the combustion of the fuel. In particular, the nitrogen in the compressed air contributed very little to the performance of the torpedo, but added considerably to the weight, occupied valuable volume and was largely responsible for the distinctive wake left by steam torpedoes. It occurred to many individuals in the torpedo development community that replacing the compressed air with pure compressed oxygen or finding an alternative source of oxygen, for example, hydrogen peroxide,

would be very advantageous. Among others, the Royal Navy and the Japanese Navy began experiments using *enriched air*, a mixture of air and pure oxygen, in place of air in steam torpedoes. The Japanese experiments began in 1916, but they were abandoned after a few years apparently because of explosions, which occurred at high enrichments, and other hazards. The Royal Navy began experimenting with *enriched air* torpedoes in the early 1920s. Two working torpedoes of this type, the 24.5 Mk. I and the 21 Mk. VII were developed and issued.

The team of Japanese officers at the Whitehead-Weymouth plant from 1927 to 1929 correctly concluded, on the basis of *unofficial information and observation*, that large diameter enriched air or oxygen torpedoes were fitted in RODNEY and NELSON. This conclusion was reported back to Japan in the summer of 1928. By the end of the year work on oxygen torpedoes had been resumed at the Torpedo Testing Department of the Kure Naval Arsenal. The first experiments involved modified 24 inch Eighth Year Type torpedoes, converted to use a mixture of 50 percent oxygen and 50 percent air. These torpedoes, which were designated Special Torpedo B, were successfully test fired in 1932. In parallel with these experiments a 24 inch pure oxygen torpedo, Special Torpedo A, was being designed. One of the biggest problems in oxygen torpedoes is that they tend to suffer oil-oxygen explosions in the vicinity of the starting valve when the engine is started. Starting the propulsion system using air and then switching to pure oxygen circumvented this problem in Model One and Two torpedoes. In the Model 3 carbon tetrachloride, a well-known fire suppressant was injected during start up. The amount injected was enough to prevent explosions, but not enough to prevent combustion. The first design was completed toward the end of 1932 and the construction of two trial production torpedoes was initiated. After successful test firing in 1933, Special Torpedo A was temporarily

designated 24 inch Torpedo Type 93[5] (1933 was Year of the Empire 2593) and this designation eventually became permanent. This enormous torpedo came to be known in post WWII years as the Long Lance.[6] The Type 93 torpedo was officially adopted for service in 1935 and beginning in 1938 the slightly modified Type 93-1-2 (Type 93 Model 1 Modification 2) was issued to four cruisers, the Myoko/Nachi class. These vessels were fitted with new Type 92 torpedo tubes to fire these 24 inch oxygen torpedoes. Type 93-1-2 torpedoes carried 299 kg (658 lb) of pure oxygen, the equivalent of 1495 kg (3289 lb) of air. Eliminating **over a ton** of nitrogen made possible a 490 kg warhead and a range of 20,000 meters at 49 knots. Several other versions of the Type 93 torpedo were developed including the experimental high speed, 56 knot, Type 93-2 and the Type 93-3 with a larger, 780 kg warhead and shorter range. Significant production was, however, limited to the Type 93-1-2 and the Type 93-3. The latter arrived rather late in WWII. Only a few were fired in combat and some were diverted to Kaiten or human torpedoes. The Kaiten Type 1 was based on the Type 93 torpedo. Over 300 were produced using some of the production of Type 93 Model 3 torpedoes. The number of these weapons actually used during WWII was quite small. Successes were claimed for about 50 Kaiten attacks, but Allied records indicate that they sank only two ships, MISSISSINEWA, (AO 59) and UNDERHILL (DE 682).

The other heavy oxygen torpedoes of the IJN were the 21 inch Types 94, 95, and 96. The 21 inch Type 94 was really a light air-launched oxygen torpedo and is better discussed in that context.

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[5]The full designation of this first Type 93 torpedo was Type 93 Model 1. Minor improvements were designated modifications. It appears that there was not Modification 1. The version issued to the fleet in 1938 was the Type 93 Model 1 Modification 2 which were abbreviate Type 93-1-2.

[6]The most credible explanation of the origin of the name *Long Lance* is that Samuel Elliot Morison coined it, cf. Evans and Peattie p.577, n.56. This is consistent with the first use of the name that I have been able to find which is in Vol. VI of *History of U.S. Naval Operations in WW II*, originally published in 1950.

Types 9 and 96 were submarine launched torpedoes that replaced the Type 89. Their general specifications are given in the Table. The Type 95 torpedo was a smaller version of the Type 93. The Type 96 torpedo was essentially the Type 95-1 with less fuel and air enriched to 38 percent oxygen instead of pure oxygen. The range was halved to 4500 meters but this was entirely adequate and further accepted because it alleviated operators' concerns over the safety of pure oxygen torpedoes in submarines. About 300 Type 96 torpedoes were produced. Compared to the submarine launched torpedoes of other navies, the IJN torpedoes were slightly faster, significantly longer ranged and carried a greater weight of high explosive. The higher speed represented a small, but real, advantage in that it increased the hit probability for a given accuracy of fire control inputs and solutions. Hit probability against a single ship target at 4000 yards is, however, so low, even with relatively good fire control, that the principal utility of long range capability is in browning shots.[7] In most cases better high explosives, Torpex, for example, in U.S. and British torpedoes, more than compensated for the increased warhead weight of Japanese torpedoes.[8]

Japanese torpedoes were not failure free. At the Battle of the Java Sea, 27 February 1942, ten of forty-three Type 93 torpedoes

[7]This may be controversial. Some U.S. submarine commanders thought that the low speed 9000 yd range of the Mk 14 was useful and objected to the Mk 23 because the low speed capability had been omitted. It would be interesting to know how many Mk 14 hits were scored at ranges greater than 4500 yards, but I have not yet had an opportunity to access the data.

[8]OP 1507 "Japanese Underwater Ordnance", 20 April 1945 p.27 says "Type 97...is slightly less powerful than TNT." Torpex is usually evaluated as about 50 percent more powerful than TNT. Simply quoting the weight of high explosive in a warhead is not enough. The 300 kg of Torpex in a heavy Mk 14 warhead was equivalent to at least 450 kg of Japanese Type 97 high explosive. The only Japanese submarine launched torpedo with a more powerful warhead was the Type 95-2, which entered production in 1944.

detonated prematurely and none hit their targets.[9] A rather large number of submarine launched torpedoes suffered detonator failures as a result of depth instabilities at shallow depths. The accelerations caused by these instabilities were large enough to trigger the ball type detonator and cause prematures. Other problems occurred, but except for the propulsion system, Japanese torpedoes were generally simple, rugged and reliable.

Torpedo supply may, however, have been a problem a full load-out of surface vessels with 24 inch torpedo tubes would have required about 2250 torpedoes including onboard reloads. This plus 360 allocated to Kaitens would account for all of the largest number, 2600, I have seen quoted for Type 93 production. It appears that in some surface engagements older, 24 inch steam torpedoes were fired. In any case, it is clear that Type 93 torpedoes were not in long supply. Japanese submarines were probably short of torpedoes. In 1944, for example, the average number of submarines in commission was 60. The production reported for that year, which, according to the USNTMJ was 960 21 inch torpedoes (16 per boat), was the largest for any year of the war. This was worse than the appalling U.S. situation for 1942 when about 20 torpedoes were produced per boat in commission, but the smaller Japanese submarine force on 1 January 1944 made one patrol per boat and either fired all of its torpedoes or was lost, and the number consumed significantly exceeded the number produced. This rather meager supply of torpedoes was adequate for the way IJN surface and submarine forces operated in the later years of the war, but it is difficult to be sure what was cause and what was effect.

Deployment and Combat Use of Torpedoes by the IJN

We have already commented on the transition from 45 cm torpedoes to 21 inch torpedoes in submarines and surface vessels. Except for MUSASHI and YAMATO, which had no torpedo armament, Japanese battleships were armed with torpedo tubes until

[9] KS page 30.

the 1930s. Torpedo tubes were removed from the battleships during the 1930s in the course of various reconstructions. All of th eighteen heavy, or A-class, cruisers were built with 24 inch torpedo tubes. Those that were not originally equipped with tubes capable of firing Type 93 oxygen torpedoes were converted before Pearl Harbor. During WWII the torpedo armament was twelve or sixteen 24 inch tubes and usually twenty-four Type 93 torpedoes including reloads.

Fifteen of the light cruisers that were commissioned in the Japanese Navy after WWI were built with 24 inch tubes. Several others were converted to 24 inch tubes. All of these cruisers probably were capable of firing Type 93 torpedoes, but some may not have been issued oxygen torpedoes until some time after Pearl Harbor if at all. The two oldest light cruisers, three vessels built as training cruisers and two ex-Chinese cruisers, were not rearmed with 24 inch tubes. OYODO had no torpedo tubes. KITAKAMI and OI were remarkable in that they were converted to torpedo cruisers with forty 24 inch tubes in ten quadruple mounts and forty Type 93, oxygen torpedoes. This configuration, however, was not extremely useful and the two ships were further modified. KITAKAMI evennually landed all of her tubes.

Japanese destroyers from the Mutsuki class (1925-27) on carried from four to fifteen 24 inch torpedo tubes. Of the 111 destroyers with which the IJN entered WWII, 81 were armed with 24 inch torpedo tubes. The 32 fleet destroyers and 32 smaller destroyers (DE equivalents) that were added during WWII all carried 24 inch torpedo tubes. Twenty-four inch torpedoes were the dominant torpedo armament of Japanese destroyer type vessels. The total 24 inch torpedo load-out, including onboard reloads, of IJN destroyer type vessels that served in WWII was an astonishing 1640!

The IJN developed two major types of torpedo tactics for surface forces, "long range concealed attack" and "close-in strike home" attacks. In long range attacks, which seem to have been abandoned by 1943, large numbers (plans called for as many as 100) of torpedoes were fired from ranges in excess of 20,000 yd. in "close-in" attacks torpedoes were fired at about 4000 yd before

opening gunfire.[10] Both of these tactics depended on stealth and that was lost when radar became standard equipment and its proper use was understood. Japanese training, especially for close-in attacks, was ruthless. Significant casualties and damage to materiel were accepted as costs of proficiency. This proficiency was amply demonstrated in the year years of WWII in the Pacific.

The effectiveness of Japanese surface launched torpedoes and tactics is not easy to evaluate. The U.S. Navy lost about 75 DE and larger surface combatants as a result of enemy action in the Pacific. Japanese surface launched torpedoes, in some cases in combination with gunfire, sank sixteen of these: seven and nine destroyers. Six other Allied ships, five cruisers and one destroyer, were sunk by Japanese surface launched torpedoes or torpedoes and gunfire. Eleven cruisers and six of the destroyers were sunk in 1942, one cruiser and three destroyers were sunk in 1943 and one destroyer in 1944. Through the end of 1942 the IJN maintained a favorable or at least balanced exchange ratio, i.e., they lost the same number or fewer ships than the U.S. for every class of surface combatants DE and larger except light fleet carriers (CVLs).[11] Japanese surface launched torpedoes played a large role in the successes through the end of 1942, but from then on the U.S. lost only four destroyers and one cruiser to these weapons. One of the 1943 destroyer losses, STRONG, was caused by a Type 93 torpedo fired from 22,000 yards, a counterexample illustrating occasional startling success at very long range. U.S. destroyer-launched torpedoes[12] sank or contributed to the sinking of two battleships, one cruiser and twelve destroyers. All but one of these sinkings occurred after July 1943.

While, as we have noted, a significant number of Japanese

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[10]Both of these modes of attack are discussed more fully in David C. Evans and Mark R. Peattie "Kaigun", Annapolis: U.S. Naval Institute, 1997 and in KS p.500 ff.

[11]This specifically includes CVs where each side lost four.

[12]I have found no indication of damage inflicted by U.S. cruiser launched torpedoes during WWII.

submarines were completed after WWI with 45 cm torpedo tubes, all medium and large submarines, except one, completed after 1923 mounted 21 inch tubes. Most of the large I-series submarines had six or eight torpedo tubes and carried twelve to twenty torpedoes. The medium RO-series usually had four tubes and carried eight or ten torpedoes. The 21 inch torpedoes were Sixth Year Type, Type 89, Type 94 and Type 96 as discussed earlier. Altogether about 180 I- and RO- series Japanese submarines were involved in WWII. Rohwer [13] lists about 400 Japanese submarine attacks in which the targets were believed to have been sunk or damaged. Actual sinkings were 171 merchant vessels, 17 naval vessels (DE and Larger and submarines), three small naval vessels and five naval auxiliaries. Of these, five merchantmen were sunk by gunfire alone. This record, about one sinking per submarine, does not compare favorably with U.S., British or German results, which ranged from 2-1/2 to 4 sinkings per boat. These are admittedly crude comparisons, but they are so striking that it seems unlikely that any refinement would lead to a grossly different evaluation. The problem, however, was not torpedo performance or the submarines or the officers and crews. It was, as Morison observed many years ago, doctrine and possible constraints arising from torpedo supply. IJN submarines were diverted to supply, reconnaissance and other missions at the expense of anti-shipping work. There were other problems, including command and control, but we say again, torpedo failures, though there were some, were not an important contributor to the comparatively poor record.

Conclusions

Battles and wars are won by a combination of weapons, doctrine, manpower, training and tactics. All of these components are essential. Weapons are unique in that in modern warfare they are complex and their development requires a substantial infrastruc-

[13] Jurgen Rohwer "Axis Submarine Successes of WW II" Revised Edition, Annapolis: USNIP, 1999.

ture, R&D, manufacturing, and test and evaluation facilities in particular. The young Imperial Japanese Navy was faced with the problem of acquiring weapons when it had no infrastructure. The solution was to import weapons, manufacture them under license, modify the foreign designs and manufacture modified weapons, and finally design and manufacture indigenous designs. This efficient and effective strategy was followed in the acquisition of torpedoes for the Imperial Japanese Navy with outstanding success culminating in the development of very large, 24 inch, torpedoes and oxygen propulsion systems. Production, however, was not adequate to sustain WWII operations. The production shortfall was exacerbated by shortages of strategic materials, particularly high performance metals and alloys. Torpedoes are only the weapons. The other ingredients, doctrine, manpower, training and tactics, received appropriate attention leading, by 1941, to an outstanding Japanese capability in surface torpedo warfare. Japanese victories in surface actions in the first fifteen months of WWII in the Pacific were in no small measure due to this capability. The initial advantage was lost because of the rapid growth and acquisition of new technology and operational experience by the U.S. fleet. Japanese submarine doctrine, both strategic and tactical, was defective and torpedoes were in relatively short supply. These factors were in large measure the causes of the poor performance of the Japanese Navy's submarine force.■

THE MARK 14 TORPEDO TRIBULATIONS

by CAPT R.A. Bowling, USN (Ret.), PhD.

Initially in World War II, major defects in the Mk. 14 torpedo—the ultimate arbiter of the effectiveness or failure of any weapon — delayed the effectiveness of our submarine campaign for well over a year.[1] When war broke out, the Mk. 14 torpedo was the most recent model in quantity production. Ostensibly it had been certified for combat use by both submarines and destroyers by the Naval Torpedo Station, Newport, Rhode Island, which had the responsibility for checking its running depth and the testing of the exploder and warhead. But, from the outset, major defects in its performance and that of other torpedoes became clearly evident. Those defects may be classified into three broad categories: (1) either they ran deeper than set depth, (2) had a tendency to explode prematurely, or (3) frequently failed to explode even on impact. All three defects were interrelated — directly or indirectly — with the performance of the Mk. 6 exploder.[2]

The major features of the Mk.6 exploder were that it was designed to be triggered either by the magnetic signature of a target when the torpedo passed under its keel or by direct impact against its hull. In either case, the same firing pin mechanism was used to initiate an explosion of the main charge. Although there was no direct relationship between running depth and the Mk. 6 exploder, the failure of its magnetic feature masked both the deep running and dud defects, which in turn prolonged the search for solutions.[3]

Previous firings of the Mk. 10 torpedo, which did not have a Mk. 6 exploder, provided ample evidence that it was running deeper than set. On 5 January 1942, BuOrd acknowledged that the Mk. 10 ran four feet deeper than set.[4] But it was not until August of 1942 that tests conducted by Admiral C.A. Lockwood, Jr, ComSubSoPac, confirmed that the Mk 14 was running 10-11 feet deeper than set. A significant point here is that Admiral Lockwood took the unusual and career risking action of testing a piece of ordnance without specific approval from BuOrd. The test was simple. At Albany, Australia, a fish net was rigged in Frenchman's

Bay, and on 20 June 1942, a series of Mk. 14 torpedoes were fired into it from a range of 850 yards. Holes in the net indicated that the torpedoes had run at between 11 and 15 feet below set depths. Admiral Lockwood reported his findings to BuOrd. BuOrd disagreed on technical grounds. Admiral Lockwood repeated the tests and reported that the Mk. 14's were running 11 feet deeper than set and requested that BuOrd conduct equivalent tests. Finally, on 1 August 1942, BuOrd confirmed that tests conducted at Newport corroborated reports that Mk 14 torpedoes were running 10 feet deeper than set. Thus, after almost eight months of war, BuOrd confirmed that the Mk. 14 torpedo had a major defect.[5]

Determining the causes for prematures and duds were more complex because of the closer interrelationship between the two. Repeated reports of torpedoes exploding shortly after arming or before reaching the target led to a blizzard of correspondence between the submarine forces and BuOrd. Summarizing the results: on 27 April 1943, BuOrd stated that the Mk. 6 was susceptible to prematuring if set for 12 feet or less and recommended disconnecting the magnetic feature in favor of contact shots; on 3 and 7 May BuOrd informed Admiral King, CNO, that the effectiveness of the Mk. 6 would be increased by 10 to 30 percent if the arming distance were increased from 450 to 700 yards and fired under a list of additional limitations; Admiral King replied that the increased arming distance was unacceptable and concurred with Admiral Lockwood (by then ComSubPac) that the MK. 6 exploder should be replaced; on 24 June, Admiral Nimitz, CincPacFlt, ordered ComSubPac and ComDesPac to inactivate magnetic exploders on all torpedoes; next day BuOrd asked why; Admiral Nimitz diplomatically but firmly replied that his decision was made because the Mk. 6 was "ineffective" and because of "the impracticability of selecting the proper conditions [recommended by BuOrd] under which to fire". Thus, Admiral Nimitz' order stood and Admiral Lockwood's submarines were rid of the beast.[6]

Not so for the boats in ComSubSoWestPac—Lockwood's former command but not under Nimitz's theater command—where Admiral Ralph Christie ordered that the magnetic feature be retained. Nevertheless, CDR H.P. Hottle, CO GROUPER, in his patrol

report of September 1943 to Admiral Christie recommended inactivation of the Mk. 6 exploder and had the testicular fortitude [balls] to opine:

> "It would appear far better to sink the enemy vessels encountered . . . than to continue spoiling good chances just to prove that *a really useless mechanism* [emphasis added] can be made to function a fair proportion of the time."[7]

Still, it was not until March 1944 that it was inactivated in SoWestPac submarines. Two down and one to go.

With the running depth and premature problems solved, the interaction of which masked the dud problem, it was now possible to solve the latter more readily. The problem manifested itself dramatically when Lieutenant Commander L.R. *Dan* Daspit in TINOSA fired eight Mk. 14's at a dead-in-the-water 19,262 ton whale factory, converted to an oil tanker, from a point blank range of 850 yards with a optimum 90 degree track—torpedo strikes perpendicular to the target's hull. Admiral Lockwood, mindful of the prolonged effort with BuOrd to even admit to the premature problem, tackled the dud problem himself. Two Mk. 14's with warheads attached were fired at submerged cliffs at Kahoolawe; one was a dud, recovered and disassembled. Examination of the firing pin—an integral part of the Mk. 6 exploder—revealed that it had been released but had not traveled far enough along its guide rails to strike the primer cap with sufficient force to initiate an explosion. To confirm this diagnosis, 10 dummy warheads, fitted with Mk. 6 exploders, were dropped from a height of 90 feet onto a steel plate. Seven of the 10 were duds. Disassembly revealed once again that the firing pins in the duds had not traveled the entire distance required along their guide rails to set off the primer cap. Further investigation concluded that the design of the firing mechanism was not rugged enough to withstand the distorting force of deceleration equivalent to 500 times the force of gravity with a frictional component of 190 pounds on the firing pin guide rails when the torpedo struck square-on.[8]

Armed with this information, Admiral Lockwood approved the production of modified Mk. 6 exploder firing pin mechanisms on the tender HOLLAND. On 30 September 1943, BARB departed Pearl on patrol with 20 torpedoes, all equipped with the modified firing pins. And by mid-October, HOLLAND had produced enough of the modified firing pins for all the torpedoes issued to submarines departing Pearl on patrol.

In summary, at the beginning of the war, the Mk. 14 torpedo ran 10-11 feet deeper than set, had a tendency to premature, and frequently failed to explode even after striking the target. Almost two years later, all of these defects had been detected and corrected in the fleet by modifying the procedure for calibrating the depth setting mechanism, disconnecting the magnetic feature of the Mk. 6 exploder, and modifying the design of the Mk. 6 firing pin mechanism. Thus, submarines and destroyers finally had a reliable torpedo which could have been realized from the beginning if the pre-production testing and post-production proofing by the test firing of torpedoes with warheads attached had been more comprehensive.

The effect of these defects is summarized by a consensus of those submariners who fought the war:

> *The war would have been foreshortened and many American lives saved had a reliable torpedo been available from the beginning*. . . . The cost to the United States war effort in lives, dollars and time remain incalculable.[9] ■

ENDNOTES

[1]Theodore Roscoe, *United States Submarine Operations in World War II* [*SS Ops WW II*] (USNI: Annapolis, MD, 1949, Seventh Printing), p. 255; Friedrich Ruge, *Der Seekriege: The German Navy's Story, 1939-1945* (Annapolis, MD: U.S. Naval Institute, 1957), p. 294. The German U-Boats also had torpedo problems early on during the Norwegian campaign, but corrected the defects by June 1940. In the process, two flag officers responsible for torpedo development and production were court-martialed.They

considered themselves fortunate for not having faced firing squads. See Friedrich Ruge, *Der Seekriege: The German Navy's Story, 1939-1945* (Annapolis, MD: U.S. Naval Institute, 1957), pp. 61, 92-93; Captain S.W. Roskill, RN, *White Ensign: The British Navy At War 1939-1945* (Annapolis, MD: U.S. Naval Institute, 1960), p. 41; Jean Noli, *The Admiral's Wolf Pack*, trans. J.F. Barnard (Garden City, NY: Doubleday, 1974), pp. 46-47; David Mason, *U-BOAT: the secret menace* (New York: Ballantine Books, 1968), p. 36; E.B. Gasaway, *Grey Wolf, Grey Sea: Aboard The German Submarine U-124 in World War II* (New York: Ballantine Books, 1970), p.18. Conversely, Japanese torpedoes appeared to perform very effectively (Roskill, p. 255).

[2]*SS Ops WW II*, pp. 251-52.

[3]*SS Ops WW II*, pp. 253-54, 257.

[4]*SS Ops WW II*, p. 253.

[5]*SS Ops WW II*, pp. 145-47.

[6]*SS Ops WW II, pp. 257-258.*

[7]*SS Ops WW II*, p. 258.

[8]*SS Ops WW II*, pp. 260-61.

[9]*SS Ops WW II*, p. 263.

THE NEW IUSS TEAM

by CAPT Neil E. Rondorf, USN(Ret.)

The **SUBMARINE REVIEW** is dedicated to submarine subjects as is should be. In recent years the Integrated Undersea Surveillance System (IUSS) has become an integral part of the Submarine Force. As a result, this publication is the ideal medium to continue to educate the Navy on IUSS. The organizational changes that have taken place in the Navy have embraced the IUSS community. The incorporation of Integrated Undersea Surveillance into the OPNAV Submarine Directorate was the beginning of an organizational change that has had far reaching impact. In 1997 the Theater ASW Commander (CTF-84) was shifted from Commander Patrol Wings Atlantic (COMPATWINGSLANT) to Commander Submarine Force, U.S. Atlantic Fleet (COMSUBLANT). In 1999 Commander Undersea Surveillance (CUS) went from an echelon 3 command administratively subordinate to CINCLANTFLT to an echelon 4 command administratively subordinate to COMSUBLANT. In addition, the same shift took place in the Pacific as COMSUBPAC assumed the role as CTF-12 from COMPACWINGSPAC with Naval Ocean Processing Facility (NOPF) Whidbey Island, Washington subordinate to CTF-12.

Even as this is being written the evolution and revolution of IUSS continues under the able leadership of a new Commodore, Captain Greg Vaughn. His submarine ASW background combined with extensive experience with the intelligence community and international relationships has prepared him for the task ahead. The post 9-11 events are changing the world and some perspectives in it and this will cause IUSS to again reevaluate priorities and how it's capabilities match the needs of the nation. As always, IUSS will have to determine how to contribute to national defense in the new order of national issues.

Several years ago the question was asked: "Doesn't IUSS compete with the Submarine Force in the ASW mission role?" That question prompted then N87 Director, Rear Admiral Giambastiani, to direct the IUSS Branch (N874) to begin an

education process for the OPNAV staffs and the fleets. That education effort continues today and in all likelihood should be continuous for the future. The fact of the matter is that the IUSS requirements do compete with submarine programs for dollars because the Submarine Directorate (N77) supports IUSS cueing available to all fleet tactical and intelligence entities from within the N77 budget.

As for the mission, the Submarine Force and the IUSS team are inextricably linked in the pursuit of mastery of the Undersea Warfare mission. The concept of separate teams or competing entities from within the U.S. Navy must be eliminated. The ASW/USW mission is a team concept, always has been and always will be. The problem is difficult, the assets limited and thus by necessity the only reasonable solution is to use everything in the inventory to solve the problem. Even then, as it has been proven in recent operations, it is a close-run race.

In past decades, the SOSUS message was the tipper for the SSN to intercept...; the SSBN to *disappear*...; the P-3 to launch; and the ASW Task Force to alter course. In many ways, that concept is still working today. The assets are fewer and the targets more difficult. On the other hand, today's ASW team is truly integrated and huge benefits are being realized.

Some background will be provided here, but Dr. Gary Weir, an official naval historian, is penning the detailed history of IUSS. The Commander Undersea Surveillance (CUS) staff is the combination of the old CUSL (Lant Flt) and CUSP (Pac Flt) IUSS elements. When the staffs were combined, the headquarters was relocated from NH-95 in the CINCLANTFLT compound to Dam Neck, Virginia. The staff assumed responsibility for IUSS maintenance, training, and operation of IUSS facilities and SURTASS ships worldwide. The make up of the staff was primarily IUSS trained and qualified officers. There was a sprinkling of P-3 and submarine qualified officer and enlisted, but they were rare indeed. Quite frankly they were sometimes viewed as *intruders* into the domain of the OT Ocean System Technician rating.

In the 'mid 90s due to the downsizing of the IUSS community, it was decided to merge the OTs into the Sonar Technicians (Surface) STG rates. At the outset there were those who stubbornly resisted to the point of opting not to go to sea knowing that without *at-sea warfare qualification* their career advancement was in jeopardy. This further exacerbated the situation because the IUSS facilities continued to be manned by those wanting to stay in *the business*. The assignment priorities for IUSS were high enough that the detailers were willing to retour the *volunteers* to IUSS sites overseas. They were then eligible for stateside shore duty and would return to Naval Ocean Processing Facilities (NOPF) Dam Neck or Whidbey Island to continue their resistance to change. This is certainly not to criticize the leadership and decision makers of the time. They did a magnificent job of maintaining morale while reorganizing a community, which was being reshaped by number driven reductions with little regard for retention of capability.

Fortunately, by the late 90s the CUS staff / CTF-84 / CTF-12 relationships were becoming effective and the mood in IUSS was shifting from survival to visionary. The E-5/6 who had opted for sea tours on fleet assets was returning ESWS qualified to IUSS facilities for shore duty and it was clear from the advancements results their efforts were recognized. The new at sea experienced (ESWS) qualified STGs were making a leadership impact.

In addition, there were some innovative leadership changes occurring. Captain Randy Wagner, a submariner, was relieved as Commander, Undersea Surveillance by Captain Jerry Faber who was an ASW Helo pilot. Randy had done a magnificent job in leading the IUSS community during some of the most difficult days of its 45-year history. The new CSO at CUS was Commander J.J. Jeffery; one of the few IUSS/P-3 qualified officers in the Navy who although a commander, was specifically recruited to fill the O-6 job from an overseas billet. The XO of Naval Ocean Processing Facility (NOPF) Whidbey Island was a submariner. The fresh air of change was blowing briskly across the IUSS landscape.

By 1999 the CUS operations officer was actually dual hatted (TAD) from the CTF-84 staff and had served an XO tour as a

surface warfare officer gaining valuable fleet ASW experience. The N-1 was a non-IUSS officer who had extensive personnel management experience. The Staff/System Command Master Chief was a submariner who further incorporated IUSS sailors into the Submarine Force programs. The Commanding Officer of the premier overseas ASW facility, Joint Maritime Facility, St. Mawgans in Cornwall, England, was Captain Paul *Pops* Hallowell. His extensive P-3 experience was the needed ingredient to reshape IUSS support to ASW in the North Atlantic.

These men and women began a revolution in manning, training and qualification of the staffs and watch stations of IUSS. The first major step was taken at JMF St. Mawgan. This facility is co-manned by the U.S. Navy, Royal Air Force (RAF) and Royal Navy (RN) officer and enlisted rates. The personnel shortage at JMF St. Mawgan required drastic action. BUPERS decided to send 40 A-school graduates to Cornwall, England.

The resulting training and qualification burden was staggering. It forced a re-molding of the thinking from wholesale (end to end) qualification without intermediate steps into a qualification philosophy of stages to more rapidly utilize new manpower. The sea returnee experience and Captain Hallowell's operational confidence were starting to show. These bright young sailors quickly proved themselves capable and the qualification process began to reshape itself to look much like a shipboard qualification program done in steps to get the new personnel on the watch bill as soon as possible. Initial qualification allowed utilization of manpower and the process ultimately resulted in a qualified supervisor.

By now submarine sonar technicians (STS), P-3 Air crewmen (AWs) and surface warfare sonar technicians (STGs) without prior IUSS experience began to be assigned to IUSS facilities. The staff of Whidbey Island under the able leadership of Commander Teresa Barrett, had worked hard to develop a team relationship with the P-3 Air Wing at NAS Whidbey Island. Several successful joint prosecutions and exchange programs had provided insight into IUSS for the AWs. Shore duty at the NOPF would also be a way

to stay in Whidbey if so desired. Several AWs were subsequently assigned to the NOPF. There was a learning curve to be experienced in that the first few AWs were on twilight tours and planned to retire after completing their tours in IUSS. This was not the goal of IUSS. NOPF Whidbey Island wanted those AWs back in the P-3 airframes with an appreciation of the capabilities of IUSS.

The CUS and WI staffs descended on Memphis like non-skid on a well-prepped topside. The education of the detailers on the benefits to the community in having well trained AWs returning from shore duty with enhanced acoustic analysis skills was only the beginning. With the help of Captain Steve Burich (CSO at CTF-12 with P-3 background) and Captains Larry Cotton and Hugh Dawson (both COS at CTF-84 with P-3 backgrounds) the cooperation between the Air ASW community and IUSS was beginning to build. Their perspective of cooperation required for successful execution of theater ASW gave great credibility to arguments for incorporating AW's into the IUSS manning. The support of CTF-12/CTF-84 was vital to convincing personnel management that cross-pollinating AWs and returning them to the air wing with a great appreciation of Theater ASW, cueuing, IUSS, and acoustic analysis was what the operating fleet wanted.

At NOPF Dam Neck the infusion of submarine (STS) and surface (STG) began to reflect broader thinking and new qualification concepts. Under the visionary leadership of Commander Jim Donovan a parallel revolution was taking place. The sea returnee's knowledge, leadership and experience were somewhat frustrated by a slow burdensome qualification system. The qualification system was based on IUSS experience because that is what had usually been assigned to the NOPFs. The overhaul of the administration of qualification for sea returnee (non-IUSS qualified) personnel resulted in a more rapid infusion of their experience onto the watch floor and brought the qualification of Reserves from an unrealistic 15-year plan to 6-9 months. The newly qualified Reserves were tested during an Operational Readiness Examination (ORE) with successful results. The training revolution took hold and continues today.

The IUSS team perspective was truly beginning to mature. The

operational briefs covering the entire theater at sea picture given to COMSUBLANT (Vice Admiral Giambastiani and Vice Admiral Grossenbacher) were given by AW/STG/STS teams standing shoulder to shoulder. The watch teams were being lead by surface warfare qualified Limited Duty Officers or in some cases by initial assignment 1635 (Intelligence officers) to the NOPFs.

The true value of the synergism became apparent from the at-sea perspective of the team. The *cue* of the tactical platform is still the essential element of IUSS. The watch team based on the at-sea experience of the members more readily understands the needs of the at-sea tactical platform. The AW knows exactly what the airborne crew is doing, experiencing and more importantly what is required to be successful. That insight is invaluable.

The surface STG (ESWS) has a great perspective of the ASW mission in the combined arms arena of the surface combatant. The presence of Officer of the Deck (OOD) qualified LDOs on the watch floor gives an at-sea commander's perspective to the watch teams and staff. The LDOs who come from communications (N-6) and Combat Information Center (CIC) jobs provide insight into information management and other challenges that are facing the fleet units during multi-mission tasking.

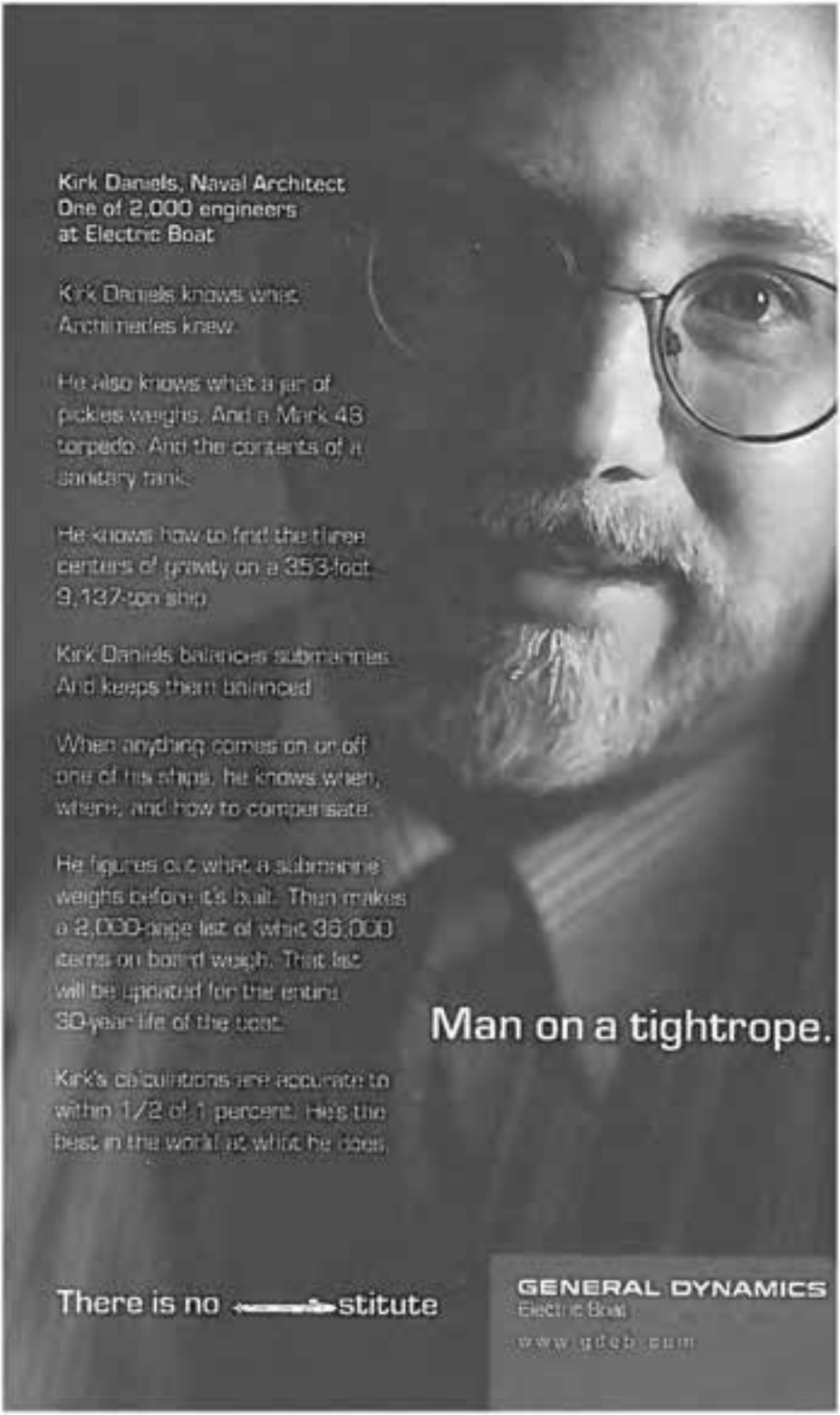
The STS knows how the submarine watch team is preparing or executing the search or any other assigned mission. This allows the watch team to communicate with the Task Force, Command Staff, or individual units in the most effective manner possible. This is when the IUSS watch team really is able to make an impact like never before. There is no longer educated guessing—they *really know* what is needed for the tactical user. This was never more apparent than when CTF-12 established a chat room on the SIPRNET WeCAN system to allow operator to operator data exchange in a near real time to support a real world operation. The watch floor to on board operator exchange became so close that one could almost believe they were co-located when reading the dialogue.

The combined effort of the watch team is only an immediate result. The long-term benefit will come when these individuals begin to return to sea. The staff and tactical units they are assigned

to will have on board the best trained Theater ASW experts the Navy has to offer. Their knowledge of the capabilities of all applicable ASW units is being merged with the tactical thinking and operator's perspectives as they work side by side. It could easily be said that the IUSS facilities may well be the best Theater ASW/-USW training grounds in the U.S. Navy.

The final aspect of the new IUSS team is the addition of Limited Duty Officers in key CUS staff and NOPF positions. The value of the LDO assigned as watch officer has already been alluded to. In addition, their presence as training officers, communications/C4I officers, Current Operations Officers, and Operations Officers has served to modernize these organizations compatible with fleet needs. Since the fleet is the customer and the customer is always right they must be on the right track. An added benefit is the leadership opportunities provided by assignment to SURTASS ship Military Detachments as Officer In Charge (OIC). The infusion of the larger *Fleet* perspective has had a great positive impact on the concept that IUSS does not exist to serve it's own end but primarily to *cue* the tactical units at sea, which will always be limited in numbers.

This infusion of new talent and aggressive, innovative thinking will have great impact on the future. The IUSS system works well now because there still exists a level of knowledge and experience in IUSS operators. As that dwindles with transfers and retirements the Navy, Submarine Force, and IUSS will have to look ahead at how to preserve this capability for the future. The analytical and operational skill in IUSS is a national asset and must be preserved for that conflict at sea all hands hope will not come. Hoping does not make facts or prepare for the future. The capability in IUSS will ensure that potentially hostile forces do not come to believe that they can freely roam the seas and conduct operations of which the world will have no knowledge. The United States Navy must continue to monitor, observe, and gain knowledge of activity at sea. That knowledge will be the beginning of wisdom and understanding. That wisdom and understanding will be key to shaping our future naval needs and priorities.■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One of 2,000 engineers
at Electric Boat
Kirk Daniels knows what Archimedes knew.
He also knows what a jar of pickles weighs. And a Mark 48 torpedo. And the contents of a sanitary tank.
He knows how to find the three centers of gravity on a 353-foot 9,137-ton ship.
Kirk Daniels balances submarines. And keeps them balanced.
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He figures out what a submarine weighs before it's built. Then makes a 2,000-page list of what 30,000 items on board weigh. That list will be updated for the entire 30-year life of the boat.
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UNDERSEA *FUTURE SHOCK*

by Nader Elhefnawy

Nader Elhefnawy nas a B.A. in International Relations from Florida International University, where he is currently pursuing graduate studies and teaching.

The rate of technological advance and of political change tends to outrun the speed at which major new weapons systems can be acquired and absorbed, a problem likely to grow more severe as the rate of change accelerates. At the least, advances in munitions and sensors, which are inherently more mutable than ship hulls, are likely to outstrip the rate at which improvements can be packed into submarines, suggesting that submarine forces may face a *future shock* at some point in the foreseeable future, to use Alvin Toffler's term: a point at which the rate of change becomes so overwhelming that one can no longer cope with it.

Such a shock is not likely to come about as a result of dramatically expanded or improved submarine fleets. Weapons like jet fighters, tanks, planes and even missile systems, incorrectly characterized as *state-of-the-art* by an adjective-happy press, tend to end up as showpieces in Third World arsenals. Owned by states without the resources to operate them properly, let alone in a manner that will enable them to get the most out of their dearly bought systems, matters are even worse in the case of countries like Iraq where civil-military relations are such that the ability of officers to do their jobs is crippled by politics. Naval warfare, which involves the largest, most expensive, most complex weapons systems, is also the sphere of conflict where such inadequacies are both most obvious and can least be afforded. Of course, there are exceptions to this rule, and the inherent stealth of the submarine makes it difficult to rule out in any case, so that it would be unwarranted to dismiss these forces out of hand. Nonetheless, navies of the poorer countries are unlikely to drastically increase their anti-submarine capability in the foreseeable future.

The principal danger lies in the rogue nation equivalent of what

we have termed the *Revolution in Military Affairs*: the bringing together of precision-guided munitions with unprecedented ability to surveil the battlespace and coordinate strikes, which it has been argued, are making major aircraft, armored vehicles and warships senile. Submarines, however, have been immune to such threats, because of the relatively short range of submarine sensors and weapons, the slower pace of underwater warfare (sonar travels at the speed of sound, where radar and lasers travel at the speed of light), and because it involves small numbers of inherently stealthy units. Nevertheless, it is unlikely that submarines will permanently escape such fundamental changes in warfare.

This article will emphasize technologies which need not be the purview of large, wealthy or technologically advanced states, and which could be used by states without submarine fleets of their own, though it goes without saying that they could make those submarine fleets that do exist more effective. Dramatic improvements in torpedoes, sensors and communications could drastically increase the anti-submarine capability of even small powers, and the vulnerability of submarines in the littorals where most future naval conflicts are likely to be fought.

Supercavitating Weapons

Supercavitating weapons have the potential to revolutionize undersea warfare by greatly accelerating its speed. The Russian Shkval, a rocket-powered torpedo, can achieve a speed of two hundred knots, three times as high as any other torpedo currently in service.

The existing torpedoes do not by themselves change the face of undersea warfare. The Shkval has no homing or maneuvering capability, which limits its usefulness.[1] Nonetheless, the problems of control and intelligence are not insurmountable, with control surfaces like fins and thrust-vectoring systems already being studied.[2] Moreover, much higher speeds are possible. In experiments, supercavitating rounds have reached speeds of over three thousand miles per hour, markedly higher than that of a bullet from a rifle like the M-16. An intelligent, supercavitating torpedo could

prove to be as deadly to today's submarines as smart bombs and missiles have become to tanks and surface ships, especially if they are designed to be launched from a wide variety of platforms, not only submarines but also surface ships, aircraft and even land-based ASROC-type launchers for long-range missiles.

It has been suggested already that supercavitating torpedoes may make concrete submarines a serious threat to surface fleets.[3] Unlike the typical submarine, the concrete sub plants itself on the bottom and waits for ships to come to it instead of itself going on the prowl, essentially an aggrandized, manned mine. The concept has been around for decades without attracting much interest, but it is thought by some experts that the rocket-powered Shkval torpedo in even its current form has the potential to make it a system very much capable of being used by little navies to check big fleets. (Supercavitating weapons can also be followed up by supercavitating vehicles—*sub-fighters*, for instance—but these pose far greater technical challenges than mere torpedoes, and so are likely to be outside the scope of this article.)

Improved Sensors

Even though the speed of supercavitatng weapons makes them something to watch, even the fastest torpedo can not hit what it can not see, and submarine warfare remains a cat-and-mouse game. Consequently, for supercavitating weapons to truly revolutionize undersea warfare, there would have to be corresponding progress in the development of anti-submarine sensors.

While unlikely to make the oceans transparent anytime soon, improvements in sonar or non-acoustic sensors (like laser, radar, infra-red or magnetic sensors) could still offer a measure of capability, especially in the shallow waters of the littorals where the effects of submarines are most pronounced. (The closer a submarine is to the surface, the stronger its wake, for instance.) Systems of sensors which bring together data from various types of acoustic and non-acoustic sensors into a single composite picture could also dramatically increase the effectiveness of sensors vis-à-vis subma-

rines. That would especially be the case if these could be built into cheap, little units with which a small navy could inundate a particular patch of water (whether they are placed by vessels or aircraft, or the sensors themselves are drones). The trend toward miniaturization, and the ever-plunging price of computer processing power, could make this more likely than may initially seem to be the case. Compact, improved sensors would also translate into smarter and deadlier mines and torpedoes, as well as a greater threat from cheaper and more widely available submarine-hunting units like patrol aircraft or coastal vessels.[4]

Communications

Improvements in underwater communications, in the ability to combine data from multiple, widely dispersed sensors would be key to bringing together improved sensors and smart, supercavitating weapons in a *Revolution in Undersea Military Affairs*. The integration of data from widely distributed sensors may extend the range at which submarine engagements occur, especially with munitions capable of traveling longer distances at higher speeds.

A low-budget navy which saturates the battlespace with a large number and wide variety of anti-submarine sensors and mates those sensors to supercavitating weapon launchers in the air, on the surface, on land and even underwater would possess a barrier against attack from the sea. (The underwater launchers need not be limited to submarines, but could also include remotely-controlled mines, or torpedo-firing drones or mini-subs, all of which would become increasingly capable as fields like artificial intelligence and robotics develop.)

These undersea fortresses could be seen as a component of, or a complement to, the naval firebases some writers have envisioned, the nets and mines surrounding which would offer further protection. The creative deployment of these systems also offers a cheap way of establishing or extending a picket line, making it possible to conduct patrols or blockades with fewer assets, or to establish a defense-in-depth, with a reserve of other assets ready and waiting behind a screen of fortifications. While patrol submarines would

be best, small, short-range submarines based at nearby coastal facilities or floating facilities like the Mobile Offshore Bases, or even surface assets, could also make up such a reserve.

Such fortification of the seas could become more commonplace as the seas themselves are territorialized, with not only the sea lanes but the use of patches of sea, like fishing grounds, and waters over oil deposits becoming objects of contention.[5] Indeed, such underwater fortresses could be the model for fundamentally different future submarines—skeletal *reconnaissance-strike complexes* built around command and control cores for numerous and widely dispersed sensors and weapons launchers. It also goes without saying that these fortifications can also threaten surface craft and that, if situated inside narrow waterways, like the Strait of Hormuz or the Strait of Malacca, may be able to block them, allowing them to substitute for some of the submarine's offensive functions.

The redundancy allowed by a multiplicity of sensors and launchers make it difficult to destroy, though it has the disadvantage of being static and defensive, despite the fact that its small, mobile components should make it relatively easy to dismantle and set up. Its physical dispersion of its elements may also make it more vulnerable to electronic attacks. Those elements, moreover, are no substitute for the greater mobility and offensive power of a submarine fleet. Still, given limited resources, they are a wiser investment than an obsolescent submarine force that will rust at the pier for lack of funds.

Conclusions

That all of this will happen is by no means a foregone conclusion, and even if such a situation does come about, it will more likely be decades than years before it develops. Moreover, the threat posed by these technologies is not necessarily the sounding of a death knell for the submarine. Despite having faced such threats earlier on, tanks, aircraft and surface warships are still around. However, they survive only through adaptation, the

increased investment to achieve which has led to arguments that they are providing ever-diminishing returns.

Adaptability also has limits. While American air power may appear able to go anywhere and strike anything that can be seen, the precision of air power is due to its exploitation of these technologies, and the survivability of manned aircraft is the result of a vast investment in stealth technology, Herculean efforts to suppress enemy air defenses, and the relative unsophistication of the opponents that the United States has faced in recent years.[6] Satellites, missiles and drones, Martin Van Creveld has observed, are likely to replace manned fighters and bombers entirely in the coming decades.[7] Tanks have already reached the point where any real further advance will require fundamental changes in armament, protection and power source, running the gamut from particle beams to electromagnetic cannon and armor. (At the same time, the infantry of the future, wearing armored exoskeletons and carrying elaborate sensors, communications equipment and greatly increased firepower, including missiles, will increasingly resemble one-man tanks.)

Compared with battle tanks and aircraft, submarines in their present form have not yet had to begin adapting to these new realities, and so are likely to have much longer lives ahead of them, but the attention being given to all-electric, platform-modular submarines with sophisticated anti-torpedo armament and large storage capacity for unmanned underwater vehicles represents the direction in which thought on the subject is moving.

Nonetheless, irrespective of how today's large submarines adapt, it is not too early to start fundamentally rethinking basic submarine concepts, especially given the evolving mission of the American military, and the rapidly rising cost of submarines. More thought should be given to how the development and proliferation of better anti-submarine sensors, underwater communications and supercavitating munitions apart from submarines will impact undersea warfare. For all of the attention accorded submarine purchases in the Middle East and southeast Asia in recent years, this could be the true driver of change in the maritime security picture in the years to come.■

ENDNOTES

1. This is one reason why the first use to which the United States Navy is putting supercavitating weapons is not as a torpedo like the Shkval, but rather the Rapid Airborne Mine Clearing System (RAMICS), which uses a twenty millimeter round to destroy mines near the surfce. Duncan Graham-Rowe, "Faster than a speeding bullet" *The New Scientist* 22 Jul. 2000.
2. Steven Ashley, "Warp Drive Underwater" *Scientific American* Apr. 2001.
3. Jim Wilson, Concrete Submarines" *Popular Mechanics* Dec. 1998.
4. The inundation of a patch of ocean with sensors will not make the oceans transparent, at most make clearer narrow patches of it—albeit the patches where the fighting is most likely to occur. The high seas, by contrast, will remain a place where submarines will more fully benefit from their stealth.
5. One estimate is that the United Nations Law of the Sea Convention includes more than a third of the high seas inside Exclusive Economic Zones, and could eventually lead to the "nationalization" of seventy percent of the world's oceans. Charles E. Pirtle, "military Uses of Ocean Space and the Law of the Sea" *Ocean Development and International Law* 2000.
6. In the aerial campaign against Yugoslavia in 1999, over a third of the attack sorties flown were dedicated to suppressing Yugoslav air defenses.
7. In Afghanistan, RQ-1 Predator drones have already fired missiles in anger. More strikingly, serious consideration has been given to the development of an unmanned variant of the Joint Strike Fighter down the line.

FIRST FUEL-CELL SUBMARINE IS CHRISTENED AT HDW

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Howaldtswerke-Deutsche Werft AG (HDW) in Kiel has christened the first of four 212A class submarines as U31. The submarine is destined for the German Navy. HDW in Kiel and Thyssen Nordseewerke in Emden are currently constructing the four boats. After comprehensive tests and trials, U31 is scheduled for commissioning on 30 March 2004.

The new class 212 submarine developed by HDW has an air-independent propulsion system using a hydrogen fuel cell. HDW is the first shipyard in the world to offer a fuel cell propulsion system ready for series production. The fuel cell plant, which produces electrical energy from oxygen and hydrogen, allows the new class of submarines to cruise under water for weeks without surfacing. Conventional diesel-electric submarines have used up their battery power after about two days cruising under water. In addition, the fuel cell makes no noise and produces no give-away exhaust heat. These factors help to make the submarine virtually undetectable.

Advances in detection capabilities and the increasing ability of anti-submarine warfare means as well as the extended scope of operations prompted the development of this new submarine class 212A. The extremely favourable signatures, the fuel cell propulsion plant and the boat's detection and weapon systems ensure that these new submarines will be suited for successful employment in every conceivable area of operations. At the same time, the design allows for high availability and low maintenance cost.

In his speech at the name-giving ceremony, Mr. Hanfried Haun, Vice Chairman of the Board of Directors of HDW, remarked that the decision in favour of incorporating the fuel cell in the submarine building programme had laid the foundations of continued long-term employment for the HDW shipyard. He said that a large number of sub-contractors and suppliers in the whole

of Germany also profited from submarine construction by HDW.

The development of the fuel cell propulsion system also furnished HDW with a number of follow-on building contracts. Orders are on hand for export version submarines of class 214, with three on order each for the Greek and Korean navies. The Italian navy has followed the lead of the German Navy and is building two class 212A boats at the Fincantieri shipyard in Italy.

Technical Data of U31 at a glance:

- General characteristics: Length overall—about 56.0m; Height to top of bridge fin—about 11.5m; Maximum diameter—about 7.0; Displacement—about 1450 tons; Crew—27; Pressure hull—non-magnetic steel; Fully integrated control system; Command and weapon control system; X rudder.
- Propulsion plant: Diesel generator; Propulsion motor—Siemens Permasyn motor; Fuel cell plant; Low-noise skew back propeller.
- Weapons: Heavyweight torpedoes; Torpedo tubes with water-pressure expulsion system.■

WW II SUBMARINE ACTIVITY IN AUSTRALIA

by CDR David Nicholls, RAN(Ret.)

World War II submarine bases were established in both Brisbane and Fremantle in 1942. The U.S. submarines, which fell back on Australia in early 1942, were the remnants of the Asiatic Fleet Submarine Force. They were literally on the front line of the Pacific War with the Japanese occupying the Dutch East Indies (now Indonesia).

Brisbane

The Brisbane Division was formed by the re-location of five S class boats from Fremantle in late March 1942 which were joined by six more S boats, and the tender GRIFFIN which had been transferred from Panama via Bora Bora. The division came under the command of Captain Ralph Christie in April 1942. He remained in command until February 1943 when he was promoted to Rear Admiral and transferred to Fremantle to relieve Rear Admiral Charles Lockwood in command of the West Australian Submarine Force. Submarines based in Brisbane came under the command of Fremantle in 1944.

Although Allied submarines took no part in the Battle of the Coral Sea (which started on May 3rd 1942), the Japanese submarine I 28 was sunk by USS TAUTOG on or about May 11th south of Truk. In August, September and October 1942, 11 Fleet submarines were transferred to Brisbane from Fremantle, joined by a twelfth (SPEARFISH) after her September patrol. For a short time towards the end of 1942 the major Submarine Force was based in Brisbane. Over the period 1942-45 both Royal Navy and U.S. Navy were active from Brisbane into the Pacific Ocean and beyond. U.S. submarines undertook 60 war patrols in 1942, another 60 in 1943, 39 in 1944, reducing to 2 in 1945. The most successful year was 1944 with over 17,600 tons of enemy tankers being sunk. Eight Japanese warships were sunk by Brisbane based boats and seven submarines were lost between 1942 and 1944.

A personal recollection was that of Kimball Young, a WWII

submarine veteran living in Hawaii. He served on (amongst others) USS GUARDFISH which, while undergoing repairs in Brisbane in December 1943, had a kangaroo motif welded onto the ship's fin by a dockyard welder. The U.S. submarine completed three war patrols with that Australian emblem in place.

Fremantle and Albany

Submarine operations from Fremantle began on March 3rd 1942 with the arrival of the submarine depot ship USS HOLLAND shortly followed by the USS OTUS.

Fear of attack by Japanese forces led to HOLLAND and five submarines being relocated to Albany where they arrived on March 17th 1942 (some consternation was caused when these vessels entered harbour unannounced to the Australian Army gunners manning the Albany forts—however, relief prevailed once the *Stars and Stripes* was identified). On July 23rd 1942 the tender USS PELIAS arrived at Albany and HOLLAND departed for return to Fremantle the same day. OTUS, which had only been partially converted for use as a submarine tender, departed Fremantle on 27th July 1942 for return to the U.S. for completion of her conversion, after HOLLAND returned to Fremantle to take over the depot ship duties. By the first weeks in July 1942, 20 fleet submarines were operating from Western Australia; 15 from Fremantle and 5 from Albany. PELIAS remained in Albany until the end of October 1942 during which time 31 submarines were maintained and refitted. These submarines came alongside at either the Albany jetty or the jetty at the Quarantine station (the station was used as a barracks and for rest and recreation facilities). A number of buildings in the town were occupied by US forces. Westfarmers Building, at the bottom of York Street, housed the periscope workshop, which were brought there by rail from the main jetty. Trains from Perth and Fremantle brought torpedoes and other supplies and provided transport to/from Perth for personnel on leave. Many local friendships were made and a number of local girls married U.S. servicemen. The two submarine tenders,

PELIAS and OTUS (which had returned to Fremantle after completing her conversion) were sent to Albany again in March 1944 when a Japanese attack on Fremantle was feared. This proved to be a false alarm and they returned after only a week.

The first commander of the Fremantle submarine division was Captain John Wilkes who had moved his command from Manila to Surabaya and then to Fremantle. He was relieved in command in May of that year by the newly promoted and dynamic Rear Admiral Charles Lockwood. Evidence from submarine engagements at sea convinced Lockwood that the Mark XIV torpedo was running too deep and passing underneath targets. To gather some data on his suspicions, he commissioned some trials at Frenchman's Bay, Albany on June 20th 1942. A fishing net, borrowed from a local fisherman, was lowered into the water and three torpedoes were fired by USS SKIPJACK: these torpedoes were found to have holed the net at an average of about 10.5 feet lower than the depth at which they had been set to run. A further subsequent test by USS SAURY followed by some strongly worded correspondence between Lockwood (supported by the then CNO Admiral King and the Bureau of Ordnance, finally resulted in confirmatory tests being conducted by the bureau and the problem being rectified.

The Royal Australian Naval Officer in Charge (NOIC) in Western Australia at this time was Commodore (later Admiral Sir..) John Collins, for whom the new RAN Collins class submarines are named. He and Rear Admiral Lockwood had a high opinion of each other: Collins described Lockwood as *that grand man* while Collins was to Lockwood *a tower of strength and possessed of a fine sense of humour*.

From August to November 1942 the number of submarines in Western Australia was drastically reduced to replace the Brisbane Division's old S boats with Fleet class boats. By the end of November only 6 of the original 20 submarines remained at Western Australia bases. The tender PELIAS returned to Fremantle from Albany at he end of October 1942 and HOLLAND sailed for the U.S. The numbers of US submarines increased to 8 in December 1942. In February 1943 Lockwood was promoted to be the youngest Vice Admiral in the U.S. Navy and transferred to

replace Rear Admiral English (who had been killed in an air accident) as Commander Pacific Fleet Submarines. Rear Admiral Christie from Brisbane replaced Lockwood. The number of Allied submarines based in Fremantle increased significantly from 1943 through 1944. British submarines began arriving in September including the depot ship HMS MAIDSTONE and her 10 boat flotilla (with 3 older training boats). HMS ADAMANT arrived with her flotilla in April 1944, followed in September by the 8th Flotilla and the 4th Flotilla in April 1945. At one stage 32 Royal Navy submarines were based in Fremantle. A number of Dutch submarines (in varying states of repair—some escaped from the Battle of the Java Sea) were also based in Fremantle under the command of Rear Admiral Christie.

From 1943 to 1945 Fremantle based boats sank over 273,000 tons of enemy tankers as well as 19 destroyers, 16 frigates, 4 minesweepers, 9 submarine chasers and 6 patrol craft. From 1942-45 354 patrols were undertaken and 11 boats were lost. Western Australia based submarines completed only 22 percent of the total Pacific submarine war patrols but they accounted for 38 percent of the Japanese oil tanker tonnage sunk. That the Fremantle boats could maintain such an offensive against Japanese oil supplies attests not only to the strategic situation of Fremantle but also to the technical efficiency of the base. The high morale of the crews who lived and relaxed among the people of Albany, Fremantle and Perth between patrols was a significant factor, borne out by the many enduring friendships and marriages which ensued.■

THE LOSS OF USS GRUNION

by Bradford L. Abele

Editor's Note: Mr. Abele is the son of Lieutenant Commander Mannert L. Abele, USN, Commanding Officer of GRUNION at the time of its loss.

In March of 2002 we found a listing on the web from Commander Submarine Force, U.S. Pacific Fleet in which there was a new entry for the loss of GRUNION. It cited a message from a Japanese man, Yutaka Iwasaki who had translated some Japanese writings in which was described this incident. The article he had translated had appeared in a special July 2001 issue of the Japanese trade magazine *Maru* as a reprint of an article which had first been published (in Japanese) in March 1963 also in a special issue of *Maru*. The article by Navy ex-Captain Seiichi Aiura who had been the Superintendent on KANO MARU at the time of the attack, was headlined, "We Have Sunk US Submarine" and the title was "Transport KANO MARU 8cm Gun Got the Target".

In the article, Mr. Aiura states, "Now the transport mission is the most important work in the Western Aleutian front. But for our transport ship, this work is so dislikeable because the North Sea has the worst weather in the world; dense fog and heavy weather harass the ships through the year. Also the ships must suffer a submarine threat throughout this 'Devil Sea', and in the vicinity of the islands there exists the additional threat from aircraft. Furthermore, once a ship sinks and one is thrown into this North Sea even in summer one cannot survive more than a few minutes."

Further along in the article he speaks of the encounter with the submarine (almost certainly GRUNION). "The KANO MARU arrived at a point North of Kiska in a heavy fog on the 30th of July 1942. Since it had lost contact with its escort and was lost, it was forced to stop and drift for most of the night. Later she found where she was by an astronomical fix, which put it then at a position east of Kiska some 12 sea miles NW of Segura Island (which in turn lay some 25 miles east of Kiska Island). The ship started up and changed course so that it was traveling WSW on a

course of 255 degrees at 15 knots approximately towards the mountaintop at the North tip of Kiska Island. Meanwhile, GRUNION, having been recalled the previous evening (on 30 July), was presumably in the same area as KANO MARU at the time of attack. At 05:47 on the morning of July 31st, two torpedoes were spotted coming at the cargo ship from the starboard quarter. The ship tried in vain to turn into the torpedoes but while the first torpedo passed astern, the second exploded aft at the machinery room on the starboard side. At this time, KANO MARU spotted the periscope of a submarine quite close by on the forward starboard side. The cargo ship hadn't sunk but its main engine, generator and its radio were out of commission. The now terrified Japanese seamen, recognizing their helplessness and probable fate had to put all their faith in the one remaining operable 8cm gun on the forecastle—the one on the stern having been made inoperable by the torpedo hit. This forward-located 8cm gun was immediately put into action, as were the 13mm machine guns mounted on its bridge. The periscope that had been on the forward starboard side gradually moved aft on the starboard side. Then, at 05:57, ten minutes after the first shot, another torpedo came from about 300 meters distance but passed harmlessly below the ship without detonating. The periscope was then observed moving from the starboard stern around the stern to the portside. Ten minutes later at 06:07, three more torpedoes in a salvo came, two of which hit the forecastle and amidships with thuds but both of these torpedoes were duds. One of these duds struck the forward bridge at the #2 cargo hold. After it hit, it apparently lost its head while the rest of its body floated on the water, tail down with about two feet of it protruding above the surface. Then, having already fired six torpedoes at the cargo ship (which was three more than Admiral English, then COMSUBPAC and Lieutenant Commander Abele's ultimate superior, would have been content with) GRUNION apparently elected to surface behind the cargo ship and finish it off with its deck gun. Shortly thereafter, a submarine was spotted surfacing about 400 meters away and aft of KANO MARU. GRUNION had now reversed its course 180 degrees, turning away

from the cargo ship and heading once more aft of the ship where it might be shielded from the 8cm gunfire by the superstructure of KANO MARU. At this point the submarine was bearing 135 degrees on the port quarter.

Suddenly disaster struck for GRUNION! Before the sub had fully surfaced and moments before it had passed safely astern, a direct hit (probably a lucky shot) was scored on the conning tower by the fourth shot from the 8cm gun, after it had resumed firing, and the submarine disappeared from the scene. (This was presumably the 84th shot overall which had been fired from the 8cm gun.) As the shell hit the washing wave, a column of water was observed and a dull water explosion sound was heard. Also much spouting oil, a piece of a lifeguard buoy and pieces of wood chips which appeared to be material from the submarine deck were observed. In addition to the 8cm gunfire, numerous 13mm shells from the machine guns were also fired, which while ineffective on the submarine structure, served to mark the location of the periscope for the 8cm gun crew to follow. Word of this action was reported to the Japanese Fifth Fleet and the Chief of the Grand Fleet via the fifth guard troop Commander (Kiska Island) but apparently was lost in transit somewhere for there was no record of the attack in the official Japanese records after the war.

Later, rescue came from Kiska in the form of three seaplanes, a cable laying ship and sub chaser No. 26 (which ironically had been damaged by GRUNION two weeks prior). The damaged cargo ship was towed back to Kiska harbor and tied up at a pier there. On August 8th the harbor was bombed by U.S. planes. The cargo ship was one of the targets hit and its sinking was claimed by the attacking aircraft. After the war KANO MARU was patched up and recommissioned.

What happened on GRUNION after the 8cm shell (about 3.15 inches in diameter) hit the conning tower can only be speculated on. While the hit alone might have been insufficient to sink the boat, it is possible that the hatch between the conning tower space and the control room below might have been open at the moment to allow sub personnel to ascend to the submarine bridge. If that were so, the explosion could have jammed the hatch so it couldn't

be closed and when the sub instinctively submerged (they may not have known for sure who or what was firing at it). The water would then not only fill the conning tower but the control room below as well. Also it may have been possible that 3 inch ordinance for the deck gun was present inside the conning tower in preparation for its upcoming use. In any event, GRUNION never made it back to Dutch Harbor, which was an easy 1.5 to 2 days run on the surface from where they were hit. Upon learning the details of this account, it is now apparent that the loss of GRUNION can be directly traced in addition to the hit by the 8cm shell to the known malfunctions of the torpedoes of that day. This may have been the first recorded instance of this in WWII.

We first heard of this account in March of 2002. After hearing the initial description of the action, my brother John and I both contacted Mr. Y. Iwasaki who had translated the version which had appeared in the July 2001 issue of *Maru* magazine and posed some additional questions to him. He kindly translated the complete article and e-mailed it to each of us along with answers to our queries. For the prior 59 plus years we had been of the understanding that the fate of GRUNION was unknown and that her crew therefore was officially *missing in action*.■

HOLLYWOOD AND SUBMARINES

by Jonas Sanchez

Jonas Sanchez earned his degree at the University of Connecticut. Mr. Sanchez currently works at Sonalysts, Inc., in Waterford, Connecticut. He has line-produced many television, video and film projects, including the feature film, Mystic Nights and Pirate Fights.

The fascination the public has with submarines is a strange but understandable phenomenon. With its covert missions in one of the most potentially hazardous working environments, submarine operations, while instilling great pride in submariners, confers a sense of bewilderment to the uninitiated. It is no wonder that the majority of submarine movies have been, to an extent, successful. They provide the public at large a glimpse into a world that they are not regularly privy to—a world of cloak and dagger secrecy and stealth hidden by a classified veil. It is this inherent allure that has prompted moviemakers to produce submarine films for over 90 years. From archaic diesel submarines to modern nuclear powered wonders to futuristic, high tech submersibles, submarines have continued to entertain and captivate.

The following lists of movies offer a sampling of the many submarine films produced over the years for the entertainment and education of the public.

Classic Submarine Feature Films

A Submarine Pirate (Keystone Film Company, 1915)

America's first undersea move features Sydney Chaplin as a bungling waiter who thwarts the hijacking of a gold-laden liner.

Hell Below (MGM, 1933)

This story of a love triangle is set in the turbulent events of World War I.

Submarine D-1 (Warner Bros., 1937)

An action adventure, this movie showcases a sunken submarine crew's rescue using the McCann Rescue Chamber and the Momsen Lung.

Submarine Raider (Columbia Pictures, 1942)

This World War II tale tells of a U.S. submarine's failed attempt to warn Pearl Harbor of the impending Japanese attack and its redemption by sinking the carrier that launched the attack.

Crash Dive (20th Century Fox, 1943)

USS CORSAIR engages German submarines in the Atlantic in this World War II story.

Destination Tokyo (Warner Bros., 1944)

This World War II adventure reveals a U.S. submarine's secret mission to enter Tokyo Bay to gather intelligence for the Doolittle air raid against Japan.

Ocean Pacific (Warner Bros., 1944)

This World War II story engages the U.S. submarine THUNDERFISH's fight against the Japanese. It is loosely based on the actual exploits of USS ANGLER and USS GROWLER.

The Flying Missile (Columbia Pictures, 1950)

A naval commander develops the means to launch missiles from a submarine platform.

Submarine Command (Paramount Pictures, 1951)

A Korean War submarine commander is haunted by memories of the last days of World War II, when, as the second in command, he saved his boat at the cost of his captain's life.

20,000 Leagues Under the Sea (Buena Vista, 1954)

A ship is sent to investigate mysterious sinkings, encounters the advanced submarine NAUTILUS, commanded by Captain Nemo.

This movie was based on the novel by Jules Verne.

The Enemy Below (20th Century Fox, 1957)

A U.S. destroyer plays cat and mouse with an elusive German U-boat during World War II.

Hellcats of the Navy (Columbia Pictures, 1957)

Based on the book, Hellcats of the Sea by Vice Admiral Charles Lockwood, WWII ComSubPac, the film is a fictionalized account of a U.S. submarine group's attempt to destroy Japanese shipping in the Sea of Japan in 1945.

Run Silent, Run Deep (United Artists, 1958)

With grim determination, an American skipper pursues the Japanese destroyer responsible for sinking his previous boat. This movie was adapted from the best selling novel by Ned Beach.

Torpedo Run (MGM, 1958)

A U.S. submarine commander is forced to sink a Japanese transport carrying American prisoners and his own family when it acts as a shield for a Japanese carrier.

The Atomic Submarine (Allied Artists, 1959)

An advanced submarine is sent to investigate another submarine that disappeared crossing the Arctic Ocean.

On the Beach (United Artists, 1959)

Set in 1964, a U.S. submarine crew finds itself stranded in Australia after the rest of the world has been destroyed by a nuclear holocaust.

Operation Petticoat (Universal, 1959)

This World War II comedy tells of a damaged submarine seeking a yard for repairs. Along the way, it picks up five stranded Army nurses.

Up Periscope (Warner Bros., 1959)

This movie is a World War II story about a U.S. submarine's mission to photograph a Japanese codebook.

Around the World Under the Sea (MGM, 1966)

Attempting to help warn scientists of impending earthquakes, a mini-submarine crew plants sensors on the ocean floor.

The Bedford Incident (Columbia Pictures, 1966)

Richard Widmark stars as the captain of the U.S. destroyer BEDFORD. Sidney Poitier is the reporter given the task to interview him. Things go awry when BEDFORD detects a Soviet submarine and gives chase.

Ice Station Zebra (MGM, 1968)

A Cold War story of U.S. nuclear submarine TIGERFISH's attempt to rescue the crew of Drift Ice Station Zebra at the North Pole.

Contemporary Submarine Feature Films

Gray Lady Down (Universal, 1978)

The Navy attempts to rescue the crew of USS NEPTUNE, which sank after a collision off the Connecticut coast.

The Hunt for Red October (Paramount Pictures, 1990)

This Cold War drama describes a Russian captain's attempt to defect with his country's most advanced nuclear submarine.

Crimson Tide (Buena Vista, 1995)

This post-Cold War story involves the U.S. ballistic submarine ALABAMA that receives a partial transmission, leaving the crew to dispute if it ordered a launch or not. The indecision causes the crew to mutiny.

Hostile Waters (HBO, 1997)

This account relates what could have occurred when a Russian Typhoon class submarine collided with a U.S. submarine off the coast of Bermuda. The tension mounts with the realized potential of a reactor meltdown, as well as the ramifications that the situation may have on delicate peace negotiations between the United States and the Soviet Union.

Sub Down: Take the Dive (Columbus Films, 1997)

Research scientists and Navy men clash aboard USS PORTLAND after a mishap perilously pins the submarine beneath the waters of the Bering Strait with no escape. Only by working together can the military and civilian crew survive.

U571 (Universal, 2000)

A U.S. captain attempts to retrieve an Enigma decoding machine from a stranded German U-boat in this World War II based-on-fact story.

Submarine Specials/Series

Silent Service (NBC, 1957)

This half hour episodic series chronicles the adventures of World War II U.S. submarine operations based partly on actual events.

The Hunley, (TV, 1999)

This is the story of the Confederate submarine HUNLEY, which became the first submarine to sink a ship when it destroyed USS HOUSATONIC in Charleston Harbor in 1863.

Submarine Documentaries

Submarine Warfare: The Navy's Most Deadly Weapon (1942)

This chronicles the U.S. Navy Submarine Force's role during World War II, including the Pacific Fleet operations that would destroy Japan's merchant fleet and cripple their Navy.

No Deck to Strut Upon (Navy, 1971)

This film shows the development of the modern submarine with a background on John P. Holland, inventor of the U.S. Navy's first viable submarine.

Nova: Submarines, Secrets & Spies (1974)

Nova brings to light several confidential and controversial submarine related incidents that occurred throughout the forty years of the Cold War.

Submarine: Steel Boats - Iron Men (1989)

Shot aboard a Los Angeles class submarine, this video depicts the real 24 hour workday on board a nuclear fast attack submarine.

Submarines: Sharks of Steel (Discovery, 1993)

This informative, multi-tape series features the U.S. Submarine Force and includes comparisons to the submarine of other navies of the world, as well as interviews with crewmembers and their families.

Super Structures of the World: SEAWOLF (1998)

This is a documentary of what has been called "the most complex military machine of the 20th century", USS SEAWOLF. A visit to the facilities of General Dynamics' Electric Boat Division reveals the construction of the most lethal force in the Navy's arsenal.

Blind Man's Bluff (History)

A 2 hour special, based on the bestseller by Christopher Drew and Sherry Sontag, documents the stories of the brave men who dedicated their lives to stalking the world's oceans during the Cold War. Submarines were the super-secret front line of the Cold War and played an undersea game of hide and seek with the fate of the world as stakes. For the first time on television, U.S. and Russian submariners share their stories and harrowing experiences.■

NAVINT NEWS

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From the 15th March 2002 issue

Canadian SSKs Hit Problems

The Canadian Navy has encountered technical problems with its four Victoria class diesel electric submarines (SSKs). As a result none will be fully operational until spring next year at the earliest.

The problems have arisen during the installation and setting-to-work of Canadian-specified equipment such as fire control and communications. Three Loral Librascope SFCS fire control systems have been transferred from the paid-off Ojibwa class SSKs, replacing the UK Royal Navy's DCC systems. Presumably a fourth SFCS set has had to be bought from the manufacturers. Another change is the replacement of the 2046 towed sonar array for a Canadian product; the SFCS is already capable of handling the U.S. Navy-pattern Mk 48 Mod 4 torpedo. The submarines will not be armed with UGM-84C Sub-Harpoon anti-ship missiles.

Inevitably these changes have generated problems; it is never easy to install equipment in a warship designed around other systems, and submarines are even more complex because of the restricted space. Some earlier problems had arisen when the four Upholder class were being refurbished at BAE Systems' Barrow in Furness shipyard after being laid up for some time, High-pressure welds in three boats, a leaky fuel tank in another, and a leak in the hull of a third boat were dealt with at Barrow in Furness during their refurbishment.

To reduce delays in the training programme the Canadian Navy has decided to get the second of class, HMCS WINDSOR, to sea for crew-training, even though she is still equippped with the DCC fire control system and her original communications system. The

remaining pair will become operational in 2004 and 2004 respectively.

The Navy has long-term plans to upgrade the four Victoria class with an air-independent propulsion (AIP) system. A fuel cell system is the likeliest choice, and Can$250 million has been earmarked. Recently Rolls-Royce Marine recently described a suitable plant for the Victoria class, based on its high energy-density Zebra battery and an unspecified fuel cell AIP system. The Zebra sodium/nickel chloride battery weights 55 percent less than a standard lead-acid battery with the same energy-storage, or 35 percent more energy-storage and a weight-reduction of 40 percent. Zebra has a typical operating temperature of 270° C, but uses safe-to-touch vacuum-insulated modules. In a submarine the only impact would be the provision of appropriate mountings and temperature-management.

Updates

- According to the Portuguese Defence Minister, Rui Peña, the decision to order new diesel electric submarines will be taken by the Government after the General Election on 17 March. The original intention was to order three, but budget problems forced a reduction to two, with a third leased. The eventual contract, payable over 25 years, is expected to be about €1.7 billion (US$1.48 bn) including interest. Although the partnership of DCN and IZAR has widely expected to be the winner with the Scorpène, *Military Procurement International (MPI)* suggests that the German Submarine Consortium may offer its IKL Type 214 design as an alternative.
- An Indian Defence Ministry announcement on 12 February said that the US$600 million deal to acquire Scorpène type submarines is close to completion. Project 75 calls for two submarines to be built at DCN Cherbourg and another six to be built with French technical support at Mazagon Dock Ltd in Mumbai. The prime contractor will be Thales, in partnership with DCN International, the commercial arm of Direction

Constructions Navales (DCN). The Indians are also talking with the Russians about the possible of two Project 677 Amur type, possibly with an air-independent propulsion (AIP) plant. The Indian Navy plans to acquire 26 new submarines over the next 25 years, using two building facilities to reduce its dependence on foreign suppliers.

- The Australian Government's National Audit Office has published some disturbing figures on the *Fast Track* upgrade of the Collins class submarines HMAS DECHAINEUX and HMAS SHEEAN.
  The cost of this interim upgrade is quoted as US$139 million, but it has produced only a limited increase in capability. A major improvement programme taking in all six boats is estimated to cost US$444m, and another US$434m is to be spent on weapons upgrades.

From the 1st April 2002 issue

Surprise U.S. Takeover of HDW

On 11 March the U.S. investor One Equity Partners unexpectedly took control of German shipbuilders Howaldtswerke-Deutsche Werft (HDW). The private equity firm has negotiated a complex deal with HDW's parent companies Babcock Borsig (50 percent plus one share) and Preussag AG (50 percent minus one share); 20 percent of the Preussag shareholding is held by a German financial investor. The deal provides for a purchase by One Equity Partners of 75 percent (minus one share). The U.S. company is a subsidiary of U.S. Bank One.

The takeover of the country's largest shipbuilder opens the door to closer cooperation among all German shipyards, and is likely to reshape the relationships already forged between HDW and other European builders such as Kockums in Sweden. Cross-shareholding has been likely for some time, but negotiations between ThyssenKrupp and Babcock Borsig had broken down. Preussag will give up its stake completely, and in return One Equity Partners has offered 15 percent each to Ferrostaal and ThyssenKrupp, owner

of Thyssen Nordseewerke (TNSW) and Blohm+Voss. If accepted, this would leave One Equity Partners as the single largest shareholder in HDW, with 45 percent. Last December, SAAB received DM355 million (US$159.2m) for its 25 percent stake in HDW.

Only two months ago HDW and Babcock Borsign's chief executive Prof Klaus Lederer announced that HDW would in the future concentrate on shipbuilding. In addition to general shipbuilding HDW is noted for its lucrative partnership with submarine design bureau Ingenieurkontor Lübeck (IKL), giving it a dominant position in the submarine export market. It is also active in the construction of surface warships. At present only 10 percent of HDW's Euro5 billion (US$4.38 bn) order book is mercantile. As the German Submarine Consortium is now one of only three Western exporters of diesel electric submarines (SSKs), the U.S. Department of Defense now has an extra option if it wishes to support Taiwan's bid to acquire SSKs.

Two days after the announcement of the takeover, HDW confirmed that it will remain active in shipbuilding. Prof Lederer said that the agreement was "enshrined in the contract". He will remain in control at HDW, but will give up his post as Chief Executive of Babcock Borsig, probably in June.

News in Brief

- The UK Royal Navy's nuclear powered strategic missile submarine (SSBN) HMS Vanguard arrived at Devonport Naval Base on 3 February to begin a two-and-a-half year long overhaul period (refueling), at an estimated cost of £217 million. The overhaul period includes trials and training. The plutonium hydrodynamic experiment conducted in Nevada on 14 February is officially to "ensure that UK nuclear weapons [i.e. Trident] remain safe and reliable". The SSBN was first commissioned in 1993.
- Further details of the air-independent propulsion (AIP) conversion of Japan's Maritime Self Defence Force (MSDF) submarine ASASHIO (TSS-3501) have emerged. The V-4-275R Mk

2 Stirling system fitted has a diameter of 60cm and a height of 140cm. At 2000 rpm it generates 65kW (88 hp). It is designed to operate at 4-5kn or to float the load on the batteries when the submarine is motionless. The system includes four Stirling engines on the upper deck level, two liquid oxygen (LOX) tanks and other items are sited a deck down. Kerosene is stored in a pressure-tight tank between the pressure hull and the external hull. Unlike diesel fuel, the consumed kerosene cannot be replaced by seawater because of contamination. The AIP compartment is unmanned, and handling is done from a console in the control room.

The hull was separated between the machinery compartments and the accommodation, to allow a 9m *plug* containing the AIP system to be inserted. This increased the length to 87m and increased displacement by 400t. The Stirling engines were produced under licence by Kawasaki, and 90 percent of the components were produced in Japan.

- On 5 March the UK Armed Forces Minister announced a revised timetable for the paying-off of Swiftsure and Trafalgar class nuclear attack submarines (SSNs):

  HMS SPLENDID (2003)
  HMS SOVEREIGN (2005)
  HMS SUPERB and HMS SPARTAN (2006)
  HMS TRAFALGAR (2007)
  HMS TURBULENT (2008)
  HMS SCEPTRE (2010)
  HMS TIRELESS (2011)
  HMS TALENT (2017); serving two years longer
  HMS TRIUMPH (2019); serving two years longer
  HMS TORBAY (2021); serving a year longer
  HMS TRENCHANT (2023); serving a year longer

The 1998 Strategic Defence Review (SDR) ordered the reduction of the SSN force to ten boats, but the latest figures show that number will fall to nine in 2006, and then to eight or nine until 2015.

From the 1st May 2002 issue

Refurbishment of Third Canadian SSK Goes Well

The major programme of work required to bring the Canadian navy's third diesel-electric submarine (SSK), HMCS CORNERBROOK (ex-HMS URSULA), into service has been completed four weeks ahead of schedule. The submarine has been refurbished after a long lay-up at BAE Systems Marine's Barrow in Furness shipyard.

CORNERBROOK was rolled into the Devonshire Dock Hall (DDH) on 24 October 2000 for what was seen as an eight month overhaul, but it became clear that the amount of work had been seriously underestimated. Tests revealed excessive corrosion in two hull valves, which had to be cut off the hull for repair. A review of the boat's maintenance history while in Royal Navy service revealed the need for a large amount of work, caused by the fact that she had paid off before her Extended Docking for Essential Defects period fell due. Corrosion was also found in the upper rudder, necessitating the removal of the skin on the starboard side for repair. Post-shotblast inspection of No. 3 and No. 4 main ballast tanks revealed large areas of pitting in the plating which brought the thickness below minimum tolerance. The plating was removed and a new section was manufactured and installed.

Because of the extent of the extra work the contractor agreed with both the Canadian Ministry of National Defence and the UK Ministry of Defence to the submarine's undocking should be put back from December 2000 to March this year. She was rolled out of the DDH onto the shiplift on 25 February, and was then prepared for basin dives, and trim and incline dives at the end of March. The Canadians will then assume operational control and sea trials will start in June.

Malaysia to Buy French SSKs

Kuala Lumpur. According to a Reuters report on 9 April, the

Royal Malaysian Navy (RMN) has agreed to order three French submarines. This will make the RMN the third ASEAN member to own submarines, and is part of a concerted effort to modernize its armed forces, according to local defence sources.

The sources told Reuters that the Ministry of Defence (MinDef) issued a letter to agreement (LOA) to a Malaysian company which is representing French warship builder DCN International (DCNI). The LOA was issued last month and DCNI has been given three months to work out terms of the contract, according to the same source.

DCN and its commercial arm DCNI had been considered front-runners to land the Malaysian deal, wich analysts value at US$1.08 billion.

Apart from DCN/DCNI, Germany's Howarldtswerke-Deutsch Werft (HDW), leader of the German Submarine Consortium (GSC), the Netherlands' RDM and a Russian company (possibly the Rubin Bureau) were also believed to be bidding for the contract. Didier Arnaud, regional director for DCN, said that the company was in talks with the Malaysian agent and the government over the submarine deal. Malaysian Defence Minister Najib Razak, speaking to reporters the week before, declined to say which company had won the submarine order. "We will announce it at an appropriate time", he said. But Najib has said the French Navy was willing to train Malaysian Navy personnel in submarine warfare if Malaysia agreed to buy French submarines.

The French nuclear powered aircraft carrier, CHARLES DE GAULLE, will visit Malaysia next month and will play host to key RMN personnel. DCN, in collaboration with Spanish shipbuilding IZAR, has offered to supply the new generation medium-sized Scorpène type diesel electric submarines (SSKs) to the RMN. The deal under negotiation involves two new build Scorpènes and a refurbished Agosta class boat. In return, the French Government has decided to consider a request from the Malaysian flag carrier Malaysian Airlines for more flights to Paris, sources said.

Malaysia is building a naval base to house its submarine fleet at Teluk Sepanggar in the east Malaysian state of Sabah in Borneo. The RMN has been considering the purchase of SSKs at lest since

1988, but changing priorities have moved the decision to the right more than once. Malaysia is seen as trying to match Singapore's submarine capability, and is expected to send personnel overseas to gain experience.

UK MoD Accepts Recommendations on Redundant Submarines

The UK Ministry of Defence (MoD) has accepted 57 out of 65 recommendations in an independent report from Lancaster University into issues the public wants to be considered in finding the best option for future land storage of redundant nuclear submarines. Five more recommendations will be considered further as the project develops, and before the next stage of consultation.

Defence Minister Dr Lewis Moonie said, "We have been open and consultative from the start on this important project, and will expect our industry partners to be prepared to take the same bold approach that has been the mark of the work so far. The majority of the recommendations made by Lancaster University have been embraced by the Ministry of Defence and will be taken forward. Key among these are the need to continue our policy of openness and trust with the public, and to consider nuclear and environmental safety over cost. We will consider further another five recommendations, which concern how future consultation will be carried out."

The report indicated public support for storing of submarines on land rather than afloat. The public accepted that the consultation was a positive step but emphasized the need to continue with this open and honest approach, and that more needs to be done to engender trust and understanding. Concerns that the involvement of private industry will mean the decision will be driven by profit have also been addressed, with the MoD making it clear that industry has the necessary expertise for storage of rector compartments. There will therefore need to be some form of partnership with industry, but it will not be at the expense of factors such as safety.

From the 15th May 2002 issue

Updates

Trials of the UK Royal Navy's new Core H long-life reactor core for nuclear submarine reactors have begun at the Vulcan Naval Reactor Test Establishment at Dounreay in Scotland. The shore test facility comprises a PWR pressurized water rector and the associated turbo-generators, mimicking the plan in a Vanguard class strategic submarine (SSBN). The 13 year programme began late last year, when Rolls-Royce Naval Marine was awarded a £360 million contract for the Vulcan Test Operation and Maintenance (VTOM) programme. Under a separate £190m contract, awarded in 1997, the PWR 2 reactor at Dounreay was prepared for Refuelling, Updating, and Revalidation (RUR).

The recipient of the first operational Core H, the SSBN HMS VANGUARD, has already been docked in No. 9 Dock in the D154 complex at Devonport Naval Base. The new core will be retrofitted to the remaining three Vanguards, and will be fitted in the Astute class during construction.

Dounreay was originally known as the Admiralty Reactor Test Establishment (ARTE), and the Dounreay Submarine Prototype (DSMP 1) was assembled in 1957-65. Core A went critical in January 1965; it was burned up by October 1967, and was followed by Cores B and Z. Core B achieved initial criticality in June 1968; it was installed in the Swiftsure class attack submarines (SSNs) and was retrofitted to the Valiant class SSNs and the Resolution class SSBNs. Core Z started testing in 1974 and was installed in the Trafalgar class SSNs.

From the 1st June 2002 issue

Germans and Italians Hope to Move in on Small Submarine Markets

Howaldtswereke Deutsche Werft (HDW) and Italy's stated owned shipbuilding group Fincantieri Navali SpA recently an-

nounced a joint venture to design and build small submarines displacing 700t or less. The two companies have had a loose collaborative agreement since 2000, although ten years ago HDW supplied details of its German Navy Type 212 submarines to allow Fincantieri to build virtually identical boats for the Italian Navy. The headquarters of the new joint venture will be at Muggiano, outside La Spezia, site of a long established submarine building shipyard.

The two partners are not sanguine about the shrinking European submarine market, and see an urgent need to export, but they also face competition from other suppliers. Fincantieri has been hit badly, having received no submarine orders since 1988, apart from the two HDW Type 212A boats in hand at Muggiano. Although HDW has a full order book, it has also had setbacks; some export prospects have gone sour, either through financial difficulties or coming second in competitions. In these circumstances HDW is very much in favour of pan-European cooperation. According to an HDW spokesman quoted by *Defense News*, teamwork cuts costs and continuous technological development helps to keep abreast of challenges from other shipyards. A Fincantieri spokesman added that markets will soon develop for submarine under 700t, but did not identify potential customers.

Cold water was thrown on the idea by Arthur D. Baker III, the Editor of *Combat Fleets of the Word*, who says that he has seen no significant interest in small submarines. He is quoted as saying, "I'd say that the deal is probably more to show that there is life in both companies than in expectation of any immediate sales of small submarines". Baker points out that HDW has tried for a decade to see a 300t submarine. VSEL (now part of BAE Systems Marine had its 500t Piranha, while Fincantieri continues to produce catalogues full of small designs. As Baker points out, the steeply rising prices of existing small submarines, are not driven by size, but by the cost of combat systems.

There is also the frequently neglected aspect of habitability. Many Third World navies' submarines spend little time at sea, so in theory a 300t boat is just as effective as a 1000t boat. But navies

buy submarines because they want flexibility, and crew fatigue rises sharply in a small, cramped hull sent out on a long patrol. The Second World War exploits of midget submarine were performed by highly motivated personnel, prepared to accept the harsh conditions. In comparison, today's personnel have higher expectations, and are unlikely to take kindly to lengthy peacetime patrols.

In practice the new partners will concentrate on the Italian Navy's planned submarine replacement programme by working on the next two Type 212A boats. These will replace the Nazario Sauro class, and will eventually be followed by four more to replace the Improved Sauro class. Neither the German nor the Italian governments are prepared to countenance sales to Taiwan, so the likelihood of the new venture providing a *back door* to Taiwan is remote. In any case, the recent partnership agreement between General Dynamics Electric Boat and ASC in Australia offers a much more direct route for the Pentagon to meet its commitment to Taiwan.

From the 1st July 2002 issue

Norway Withdraws From Viking Submarine Project

The Norwegian Parliament has voted to end the Royal Norwegian Navy's participation in the *Viking* collaborative project to build a common design of submarine with the navies of Sweden and Denmark.

The cost of the programme is the most obvious cause of the Norwegians' loss of interest, but there are other reasons. A recent survey of the six Ula class diesel electric submarines (SSKs) shows that their hulls will last until 2020, so a replacement programme is not urgent. The Royal Norwegian Navy's commitment to NATO operations in the North Norwegian Sea would also require major departures from the *Baltic standards* envisaged by the Royal Danish Navy and the Royal Swedish Navy. The withdrawal simplifies the problems of the design authority, HDW's subsidiary Kockums, although the loss of a partner will increase the unit cost.■

THE SUBMARINE COMMUNITY

REMARKS AT THE 2002 SUBMARINE BIRTHDAY BALL

by VADM John J. Grossenbacher, USN
COMSUBLANT
Washington DC, 6 April 2002

This month marks the one hundred and second birthday of the United States Submarine Force. Our annual gatherings like tonight where we celebrate our submarine history and heritage, see old friends, reflect on the challenges and opportunities of the future and really enjoy ourselves, are important. They are local family reunions of a sort. They are also one of those traditions that remind us that we are different—and submariners are different.

Our gatherings this year are unique in my experience. I came to the Submarine Force during the Cold and Vietnam Wars. I have not experienced an annual gathering of the submarine family where it was first necessary to reflect on the fact that three of our brothers, Lieutenant Commander Patrick Murphy, Lieutenant Commander Ron Vauk, and Petty Officer Brian Moss were killed by people who attacked our country. These were three good men whose average age was 36. They were three submariners whose deaths leave our family with three widows and five children without their father. Reflecting on that loss is serious and sorrowful, but necessary. It comes with being part of a family. It makes the War on Terrorism intensely personal, as if the attacks on the Pentagon, World Trade Center and murder of Americans on four civilian airliners were not personal enough.

So we submariners, families and friends gather tonight while we are at war. I know that phrase *at war* is not one anyone in this room ever takes lightly, regardless of how often we see it in the press. As united and determined as we Americans are today by the events of 11 September, this war, as does any war, will surely test and try us. It will likely be a long and difficult effort and our enemy appears to be illusive, insidious and vicious. This war will, probably as never before, blur boundaries between military action

and law enforcement because of the nature of our enemy. This war will have us disturb, revise and debate the balance between our civil liberties and the need to protect our citizens to an extent that's unprecedented, because the terrorists seek to attack us from within. And although our submarines will probably not be directly threatened at sea, they and their crews will be a target for attack at home and in foreign ports.

To the war-experienced veterans among family and friends here tonight, I suspect there are more similarities than differences between the War on Terrorism and the wars they knew. Yet there are striking contrasts, like how we view our enemy compared with how our heroic World War II veterans did theirs. World War II was a different time, place and circumstance, some would even say this is a different United States. The contrast, however, is striking in any context. I have read some of the World War II correspondence of the Pacific Submarine Force Commander. For Vice Admiral Charles Lockwood, thinking and talking about his enemy was not an intellectual exercise, it was visceral. My read is that he hated them and expressed that hatred in words that today make us uncomfortable. His words seem racist and more. The factor of religion that looms large in the current conflict further complicates how we see our enemy, both individually and collectively. They are our enemies, and our personal and family losses steel our resolve to deal with them.

The lessons others have learned about warring on terrorism, the British with the Irish Republican Army and the Israelis with the Palestinians are many and sobering. Their experience tells us that terrorists succeed by doing the unexpected or by executing attacks from within that in the final analysis are extraordinarily difficult to stop in a free society. Terrorists can be very patient and only need an occasional success among frequent failures or aborted attacks to sustain their energy and motivation. It will be a difficult war indeed.

The complexities of our nation's current situation are many, but remember, these people entered our country, used our liberties and freedoms to conceal themselves and attacked our citizens. How dare they! Our response, the duty of your submariners is clear. We must do all we can to find, incarcerate or destroy our terrorist enemies. The British and Israeli experiences tell us we will not, in

any short order, either eliminate them or prevent all forms of attack. They will probably kill again. We can, however, create a constant, crushing force that seriously hinders their level of activity and makes it very difficult if not impossible for them to mount major attacks. That is what we submariners are off to do. We want to make fear and discouragement a part of the terrorists' daily lives. If they gather in anything larger than groups of twos and threes, if they communicate electronically anywhere in the world, if they even try to conduct anything like military training, we want them to be fearful. We want them fearful that we will find them. We want them fearful every second they pursue the activities of terror that the next sound they will hear is the local police or gendarmerie at the door, Special Forces crashing through the window or whatever an incoming Tomahawk cruise missile sounds like in its last seconds of flight.

To instill fear in the terrorists, we must be relentless in our pursuit, tenacious when we have a lead on their whereabouts, and flawless and bold in executing our attacks. Relentlessness, tenacity and boldness are part of our submarine heritage. Ladies and gentlemen, we have submarine crews that have delivered fear to the terrorists already and who are doing it right now. Our access to any coastline and our stealth are attributes that will continue to make us an important factor in this war.

Besides the war, I think our gathering tonight is also different than many in the past because of the changes that swirl around and through our Submarine Force today. Everyone in a position of responsibility fancies themselves present at some critical point in history, but it is difficult to know without the perspective that only time can bring. Nevertheless, there are three factors at work today that are generating change in our force, perhaps unprecedented change.

First. The end of the Cold War marked a turning point in nuclear submarine history. That change continues today and is not the change that some predicted. Instead of a reduction in the relevance of our submarines because of the demise of the Soviet Union, the Cold War's end unleashed us from our necessary but confining laser-like focus on Anti-Submarine Warfare. For the first time in their history, nuclear submarines are being allowed to

achieve their full potential as multi-mission stealthy warships. The decade-plus since the fall of the Berlin Wall has seen an expansion of missions and demand for our attack submarines, and that continues.

Second. The conversion of four Trident ballistic missile submarines to submarines that carry things other than intercontinental ballistic missiles is an enormous issue for us and the rest of our Navy. When we talk about these converted Tridents today the focus is on how many Tomahawk cruise missiles or Special Forces troops they can carry. These capabilities are exciting and important, but thinking of our converted Tridents in that way is a short-term view that misses the long-term point. The point is PAYLOAD. We have certainly had big submarines before—like TRITON and the conversions of POLK and KAMEHAMEHA for Special Forces operations. What we have today, however, is different. The confluence of the availability of these wonderful ships and the products of technology is, I think, unique. Technology has delivered the capability to sense, find, strike with great precision, out-know and out-think an enemy. These great submarines will allow us to employ these technologies in the oceans, on the sea beds, in the air and on the land. We will put unmanned air, sea, undersea and land vehicles to work, implant and exploit remote sensors and communications tools and networks. All these coupled with unprecedented submarine striking power, the stealth, agility and endurance of our nuclear powered Tridents provides enormous potential. They can make the undersea battlespace look substantially more like the domain of airplanes and missiles. They can also change the way our Navy fights, and alter the way it looks.

Third. Today the leadership of our country is making sweeping changes in defense strategy that will have potentially profound effects on us. For example, instead of sizing our Navy, instead of composing our Navy of ships, submarines and airplanes to deal with countries we have classified as threatening, we are being told to develop capabilities that exploit our country's competitive advantages. We are being told to develop capabilities that allow us to be and remain superior in ways that totally frustrate and incapacitate adversaries. Given our preeminence under the sea this is a change in defense planning and policy that we submariners embrace with enthusiasm.

As another example, the recently completed Nuclear Posture Review changes course with the past in a major way. It takes the Cold War equation of mutual nuclear deterrence and replaces it almost wholesale with a broader, more complex, more comprehensive and, in my view, more relevant approach. It will better arm us to deal effectively with those who may threaten to or use chemical, biological or nuclear weapons against us or our allies. It will prepare us to deal with those against whom Cold War style deterrence alone is not enough. This can have a significant impact on how and where we operate the current Trident force and what the force looks like. It will also affect the operations of not only our attack submarines but all the elements of our Navy that we used to call *conventional forces* and previously excluded from discussions of *strategic deterrence*.

There are other major winds of change like technology, and our defense leadership's view of the need for the military to transform ourselves for the future. Submariners welcome these as well. The foundations for the future of your Submarine Force are well established, continually renewed and adapted. Wonderfully talented people, disciplined demanding training, high standards of performance and reliability in our boats and crews, exceptionally competent technical discipline in the designing, building and maintaining our submarines, these foundations remain strong and secure. With those foundations and the example and legacy of our 102 years of exceptional submarine leaders, with women like Mary Lou Moss, Masako Murphy and Jennifer Vauk, with the memory of their husbands and the presence of their children in our family, we have every reason for determination in our present tasks, pride, optimism, the comfort and confidence that only family can bring. We also have every good reason to celebrate tonight, have a great time and look forward to tomorrow.

I could not be prouder of this family, the submarine family and each of you. I am fortunate enough to be in a position where I am inspired every day by the work, ethics, energy and unlimited capabilities of the submarine brotherhood. God bless each and every one of you, our boats and their crews. Thank you.■

WHAT THE NAVY MEANS TO ME
A Short Speech on the Retirement of A Sailor

Anonymous

I was a boy and I became a man.

I marched and drilled and cleaned and cried. I scrubbed clothes by hand and hung them to dry in subzero temperatures—tying each article of clothing onto a wire with a military spec length of string, called a *clothes stop*, in a uniform seaman's knot.

I met other men, from the bowels of large cities, who had lived their young lives at great risk using their fists or guns or knives to make their point and I knew I had as much to learn from them as they did from the Navy.

I was a janitor and I took pride in making floors shine and mirrors spotless.

I was a typist when I could not type, I spent my first day on a submarine painting the control room when I had never touched a spray gun in my life.

I was a mess-cook, a cook and a steward, sometimes by choice and others by necessity; my last assignment as a cook was a tribute and a Christmas present from a thankful Commanding Officer to a great crew on a great ship deep in the middle of Indian Country.

I was a compartment cleaner and a garbage hauler and, at the same time, a lookout and a planes-man—showing great pride in being selected as the battle stations helmsman. I could carry five steaming cups of coffee from the mess decks to the bridge on a pitching and rolling Guppy class submarine and I never spilled a drop.

I have scrubbed decks, bulkheads and heads and cleaned up the mistakes of others after they opened the flapper valve with 100 pounds of air in the tank.

I was a welder, a mechanic, an oiler and an engineman—I breathed, bathed and ate hydraulic oil and diesel fuel; I stood watches on the sonar and the radar during a long picket patrol in the North Pacific snorkeling for 40 days in state 6 seas.

I learned that being deathly seasick and doing your job were not mutually exclusive; cleaning fuel oil filters while on your back in

the bilge with a bucket by your side was a way o. handicap.

I learned how to take on shore power, not from a maneuvering, but by hauling heavy and oily black cables a ..s a rickety brow.

I found out that a leading seaman cannot spray paint the new service dress khaki uniform devron black while the uniform is resting on the hulk of a very large Chief of the Boat and get away with it—even if it was an accident!

I discovered that *Hotel Street* was an ugly place and not lined with hotels and that celebrating New Years Eve in a bar brawl was not my cup of tea.

I took the Buddha off USS REMORA twice in a month and I shared the rush of fear when two submarine crews seriously battled for possession of that Buddha at 0200. I learned that submariners worked very hard and dedicated their lives to their shipmates and they played just as hard in competition.

I have loaded, cleaned and fired torpedoes, thankfully never in anger.

I was machinist mate by heart, an electrician by necessity and an electronics technician by training; I was also a friend and father to my fellow crew members;

I discovered that with only average measured intelligence an application of very hard work, total self-discipline and dedication I could produce significant academic achievements.

I was the benefactor of the greatest of sacrifices, from a growing family led by a strong wife and mother, every time I went to sea.

Ever naive I always believed that my ID card was green and that the detailer never lied—even after my fourth shipyard overhaul.

I learned to never buy your dream house while on active duty.

I flunked moving 101 and always relied upon superwoman to get it done.

I found command at sea to be an awesome, but never overwhelming responsibility. I was always supported by the best sailors

in the world.

The words **integrity**, **trust**, **respect** and **honor** always provided the basis for self- measurement. I believed through experience that these traits and others like **quality** and **professionalism** or the lack of those necessities were not tied to race, religion or gender, but to individual human capabilities and frailties.

Teaming became my middle name. Getting others to believe became my greatest challenge. I learned that *Rice Bowls* were not utensils for food and that *not invented here* was not a Government Patent Office logo.

When things were bad I relied on the old saw "it's not how bad you fall, but how well you get up that matters".

I served with great people and great leaders and unfortunately with insensitive and incompetent shipmates. I learned from both and that lesson is the most important of all.

Lastly, I found a great friend and lifetime companion—my partner. As we depart we do so with many more warm thoughts than sacrifice and certainly no regrets.■

The following member was inadvertently omitted from the 2002 **DIRECTORY**:

CAPT James T. High, Jr., USN(Ret.)
P.O. Box 221
Burke, VA 22015

THE FIRST SKIPPER

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

To begin with a premise, a naval officer's first Skipper cannot assure that an individual will stay in the Navy, but surely can guarantee that he won't.

Submariners are a breed apart, as everyone reading this already knows. Until the early '60s however, every officer on a nuclear submarine had first served at least a year on surface ships (to obtain the requisite OOD ticket), then spent a half year at Sub School fighting for class standing to be able to pick the best boat (CO?) on the waterfront to spend a year *getting his Dolphins*. Only then could he try to *face down* Admiral Rickover to get (always reluctantly) selected to spend another stressful year or more of six months of an academically concentrated Nuclear Power School, followed by an equally intense six months at a shore-based nuclear prototype.

In 1960 there was an abrupt schism in the scheme of things. We intended to build a hundred or so SSNs/SSBNs in the next decade, and to bypass the unacceptable three or more year *pipeline* for new members of nuclear submarine wardrooms, an experiment was conducted where a small number of graduates of the Naval Academy and other engineering-oriented NROTC colleges were selected and directed directly into an abbreviated Nuclear Power School/Prototype/shortened Sub School to arrive at their first ship as Ensigns on a nuclear submarine—where the rest of the wardroom (already with Dolphins) were a half decade or more senior.

Even more stressful than being tossed into a covey of competent and already proven peers, what this new route meant was that your first Skipper was one who was not accustomed to having been tasked to convert such raw meat into a nuclear submariner.

I was fortunate. My first Skipper was Commander Norman B. (Buzz) Bessac. Before being tasked with building SCORPION, he had been CO of GUDGEON, a SUBPAC diesel boat with an extraordinary record and reputation, and had no pretentions or concerns about "...what kind of CO did he want to be when he

grew up".

My first encounter with him was when I had just reported in, right from an abbreviated SubSchool, early in the morning on the day that SCORPION would leave PSA at EB and transit to Norfolk to become the first SSN there. I had previously met some of the other members of the Wardroom (*lightweights* such as XO Ken Carr, and JOs such as Jerry Holland and Bob Fountain).

It was 10 minutes before 0800 (underway time) and I arrived in the Wardroom, in blues, with my B4 bag. Lieutenant Commander Ken Carr (XO) asked if I had met the CO. "No", I said. "Cap'n, your new officer's here" he called through the CO's stateroom door which was right off the Wardroom on that class. Then a totally naked, what I remember as at least an eight foot tall person came out and asked, "What's your name!" "Ensign Patton", I managed to squeak out. "I know that, what's your first name?" was the response. "Jim" I said.

"Well Jim, we're getting underway in a few minutes, and you've got the Bridge—somebody show him where it is". He disappeared back into his stateroom, and someone else pointed me towards the bridge where a skilled phonetalker already had things well in hand, and kept advising such as "...recommend you test the shaft on the EPM"—answer, "Yes, do it, good idea".

At a few minutes to eight, SCORPION was *singled up*, and we (phone talker and I) had heaved around on line one (that would really kick the stern out on that class—totally ogival hull), and Mr. Phone talker (wish I could remember his name so I could finally thank him after almost a half century) recommended that I inform the Skipper and XO that we were ready to get underway. "Make it so", I responded, very proud of myself that I had managed to get a handle on this submarining business in only 10-15 minutes.

Buzz showed up on the bridge in a minute or so, lit a cigarette, and said, "Let's go"—only me, him and the best phone talker in the world on the bridge. He didn't like tugs to touch his ship, so all I had to do was to back out of that EB finger pier, turn around in the Thames River, and head out to Block Island Sound.

With what I now recognize was an extraordinary amount of help from the Navigator Dick Lumsden, most of the transit up the

river happened without Captain Bessac saying anything (except I now remember that he was by then on his second pack of cigarettes).

In any case, Ensign Patton was now riding high. *All by himself* he had gotten out of port and into the channel, and with SCORPION now *on the step* (an almost class-unique phenomena—later tried to do it with both a 593 and a 616—didn't work) where, once at a Full bell or more, some rise was put on the stern planes, and when the ship got to about a 5 degree up angle, it picked up some 5 knots or so, and you could take the stern planes off (keeping in mind that you were now drawing more than 40 feet aft). Kind of a *bat out of hell feeling* on the surface. When you later slowed, it was like an aircraft stalling—ship would shudder and shake, then literally drop down to a more traditional stance.

As we approached Point Alfa (New London Ledge light SW of Fisher's Island—entry to the infamous Race where all of Long Island Sound dumps in or out of the Atlantic twice a day through a gap only a mile wide), the Navigator, now beginning to bore me with unsolicited and unnecessary advice, said "...when Point Alfa is 45 degrees off your port bow, recommend come left 10 degrees to new course xxx". "Bridge Aye", I responded casually, then showing my professionalism, manned the pelorus on the bridge gyro repeater so I could hit that turn bearing right on the mark.

"Left full rudder" was my order when Point Alfa was precisely 45 degrees off the port bow. "Wait!" came from somewhere on the bridge—oh yes, the Captain, perhaps by now on his third pack of cigarettes—I had forgotten he was there. "Put your rudder amidships, then try about 2 degrees left rudder".

After getting through the Race rather than endlessly circling just in front of it, Buzz went below and the real OOD, Lieutenant Jerry Holland, who had been in the *doghouse* a level below the bridge in the sail came up and, as he has always since, graciously taught me a few things I needed to know. Then we did the easy part out to Montauk Point, where a turn to the right would open up all of the adventures and risks of the Atlantic (and the then burgeoning Soviet Navy)—an experience with which I was subse-

quently to fall in love, along with such as the officers and crew who were in *the belly of the whale* that day with no other purpose than to professionally make happen whatever the person having the conn dictated, be he Ensign or Commander.

It was an interesting first few hours on my first submarine with my first CO. That evening at dinner (submerged) he would further advise me that I was to be an OOD within a month, and that he didn't ever want me to "go aft of frame 53 (forward Reactor Compartment bulkhead)—I had been doing *nuke stuff* for more than a year now, and it was time I learned to be a submariner".

It was a marvelous six months with a marvelous skipper. He strapped that ship on like a gunslinger would strap on a pair of Colt .45s. He had my later arrived classmate Mark Golden or I make every underway and landing without tugs. We saw and did things that even in this enlightened *out of the closet* times we don't feel comfortable talking about, but only enhanced our *gee whiz!* feelings about what the Submarine Force was, is and will be.

Buzz was a geographic bachelor in Norfolk, knowing he was to return to New London to build ALEXANDER HAMILTON and a few times I remember him stalking around a largely deserted in-port wardroom until he asked such as:

"What are you doing?"

"Sir, sketching the hydraulic system for my qual notebook."

"Isn't there a diagram of that in the Ship's Information Book?"

"Yes Sir."

" Do you know how the system works?"

"Yes Sir."

" Then tear the damned diagram out of the SIB, put it in your notebook, and come to the O-Club with me."

Yogi Kaufman relieved him some 5-6 months later. Yogi was also a talented submariner, but very different than Buzz. Whereas Captain Bessac loved to be argued with (I think often purposely stating something questionable just to stir up discussion), Captain Kaufman didn't really seek out conflicting views on his stated opinions. In fact, I can now realize he must have gotten a little tired of Ensign Patton's unsolicited views that "...Cap'n, with all due respect, that's the dumbest thing I ever heard". But all that's

yet another story.

Somehow Mark Golden and I forgot to tell Yogi that Buzz "had directed" that we split doing the qual notebook chapters in two, and that when typed, a carbon copy be made. There was a brief *hell to pay* episode when, returning from our third deployment in a year (finally qualifing as EOOWs just the night before), Mark and I found that we both had orders to New Construction JAMES MONROE via Bettis (the class there starting in 3 days). Yogi protested, but was told that Mark and I, as the promised two sea-experienced JOs' each new construction SSBN was promised, would have Dolphins on our chest and be detached by noon the next day. When he saw our literally identical notebooks (other than the fact that every other chapter in each was a carbon copy vice original) he became somewhat *stressed*. We were both on the road to Pittsburgh the next day sporting Dolphins (but never having stood an EOOW watch on our first submarine).

As it turned out, I was lucky enough to have had two extraordinary COs on my first ship. It is hard for me to decide who was the better. I am fortunate, however, that the sequence was as it was. Buzz knocked down any artificial barriers to the training of young officers and, with a great deal of elan, faith and support, pushed me into the deep end of the *submarining* pool while having a good deal of *understanding* for my mistakes. Yogi was tough to work for, had little patience for anything but his conception of excellence, but managed to *harden* the soft edges left from my having been somewhat coddled as a *cute* little aspirant to the profession. He taught me the value of being a little tough at times in the future. I really consider him a good friend now, but in 1962 it was a different matter. Neither of those first COs lacked for confidence, but each expressed it differently, and both passed on a bit of that internal philosophy to me and many others, to meld and blend with many other experiences before being trusted to shape others on a large scale.

Other than being *just another sea story*, I guess the audience for this piece is that group of officers who have just (or are about to) assume command. Forty years from now there will be a small

number of ex-naval officers who will also speak of what kind of *first CO* you were. Be careful, understanding and considerate. The entry level people you are working with are the best in the world, and it is within your power to either *turn them on* or *turn them off*. Be a Buzz Bessac—inspire and train them—keep them aboard. Some subsequent Yogi Kaufman will harden their edges. They need you both.

In retrospect, one of the finest compliments I ever received, though it was not meant as such at the time, was from a very disappointing 2nd XO while I was CO PARGO. The NESEP program was marvelous, and brought us some marvelous submariners, but just a few of them made the mistake of considering themselves *Mustangs* after the Navy sent them to college as 3rd Class Petty Officers. His comment was "Captain, your problem is that you are too easy on the junior officers and crew, and too hard on the more senior". I was accused of being Buzz Bessac to the Seamen and Ensigns, but Yogi Kaufman to the Chiefs and Lieutenant Commanders. Guilty as charged.

May it ever be so. What parent doesn't shower more affection and attention on the infant rather than (though not neglecting) the adolescent, who's already had his turn.■

SYMPOSIA INFORMATION

The Submarine Technology Symposium (SUBTECH) will be held at Johns Hopkins Applied Physics Laboratory May 13-15 2003.

The annual NSL Symposium will be held June 11-12, 2003. Registration packets will be mailed to NSL members in April.

DOLPHIN SCHOLARSHIP FOUNDATION
THEN AND NOW
A Continuing Series

by Kathy Grossenbacher
DSF President

Like any well administered organization with dedicated employees and volunteers, the DSF requires time, team effort, professionalism, strong support, sound investment policies, continual advice from our legal counsel, sound recommendations from our financial advisors and up-to-date guidelines from our Board of Directors, and other distinguished members.

For over 40 years DSF has been the fortunate beneficiary of the generosity and tireless efforts of the many clubs and their members around the world. We have also received many personal, business and corporate donations, for which we at DSF are most grateful. All of us here at DSF, including the Board of Directors, are committed to protecting this priceless foundation long into the future.

When I arrived in July 2000, the staff and I developed a list of objectives and goals to help improve efficiency, investments and corporate and foundation fund raising. We all wanted to better define our goals both short and long term. During the past two years we have been working very closely with the DSF Board of Directors and Distinguished Advisors to this end. Currently we provide 131 scholars with on going tuition grants of $3,000 per year for up to four years of undergraduate work. Our biggest challenge is to support 200 scholars by 2009. This seems like a daunting goal, but we can reach it if we follow our plan and find more corporations and foundations to support our mission.

I would like to explain very briefly who we are here at DSF. Currently we have nine members on our Board of Directors including myself. We meet every three months. We also meet at other times during the year for special meetings called by either the President or other Board members. This year we have been extremely busy working through a number of issues related to our

objectives and goals and have made great progress. The Board consists of retired Navy submarine admirals, other retired officers, a former Mayor of Norfolk, and a retired Master Chief. Also, the Honorable Anita O. Poston is our legal counsel. Our Distinguished Advisory Board is made up of 15 leaders in business and the military. We rely on these members for advice and recommendations from time-to-time and last met with them here in Norfolk May 10, 2001. Finally, the nuts and bolts of DSF, our office staff: we now have five part time employees at DSF and myself. These women are jewels with special talents and backgrounds. They are in the DSF office nearly every day and are the *walking encyclopedias* of the history, structure and workings of the Foundation. In the next issue, I will highlight each of them individually so you will have an idea of how very fortunate the DSF is to have them here.

In closing, I would like to again thank all of you for your continued support for the auctions, cookbook sales, calendar drives, Dolphin Stores, etc.

The Dolphin Scholarship Foundation is the **model** for all other scholarships within the military today. YOU ALL and EVERYONE in the past 41 years should be most proud of this wonderful Foundation because you have made it the success it is. I will close with our mission statement which you will see on our updated stationery very soon.

The Dolphin Scholarship Foundation—Supporting the Children of the Submarine Force. Providing undergraduate scholarships for children and stepchildren of qualified active, retired and former members of the U.S. Navy Submarine Force. ■

Dolphin Scholarship Foundation
5040 Virginia Beach Boulevard
Suite 104A
Virginia Beach, VA 23462
(757) 671-3200

2002 DOLPHIN SCHOLARS

This year the Dolphin Scholar Foundation will fund 132 Scholarships, including 30 new recipients. Each grant will be $3000, totaling $396,000 in scholarship monies.

Scholar	Sponsor	Home State
Pamela Adell	CAPT Allan Adell	VA
Patrick Daquilante	ETCM(SS) Vincent Daquilante	WA
Daniel Eyler	CAPT David Eyler	NY
Michael Eyler	CAPT David Eyler	NY
Elisabeth Freeland	LT Jeffrey Freeland	WA
Mark Gonzalez II	MM1(SS) William Parsons	GA
Eric Habermeyer	CDR Alan Habermeyer	WI
Stephanie Hood	SK1(SS) Phillip Hood	AL
Nathan Kelley	MT1 Michael Kelley	WA
Destony Koontz	ETC(SS) Tony Koontz	VA
Brett Legendre	MT1(SS) Vernon Legendre	TX
Kristen Leonard	MMC(SS/SW) Thomas Leonard	AL
Lisa Long ICC(SS) Robert Long		Japan
Andrea Maloy	FT1(SS) Robert Maloy	TX
Krystal McCombs	MTC(SS) Robert Georges	GA
Audra Mendelsohn	STG1 Jeffrey Mendelsohn	WA
Christopher Meshanko	MTCS(SS) William Meshanko	GA
Adrienne Morris	STSCS(SS) David Morris	SC
Jennifer Mosher	MS1(SS) Edward Neleski	GA
Tiffany Murray	FT1(SS) Christopher Murray	VA
Nicholette Neff	LCDR Randy Neff	WA
Alicia Rezendes	LCDR Robert Rezendes	CT
Lyndsey Scott	CNOCM(SS/AW) Terry Scott	Bahrain
Jennifer Sigg	CAPT Daniel Sigg	VA
Shannon Sprague	FT1(SS) Timothy Sprague	CA
Iolanda Stott	STS1(SS) William Stott	WA
Marcus Wallace	EMC(SS) Daryl Wallace	WA
Choi Williams*	LCDR Vernon Williams	TX
Paige Williams	STSCM(SS) Kenneth Williams	CT
April Yount	MMCS(SS) Joseph Yount	VA

*Declined the scholarship due to appointment to U.S. Air Force Academy.

NSL ANNUAL AWARD WINNERS 2002

JACK N. DARBY AWARD
CDR Paul W. Siegrist, USN
USS WEST VIRGINIA (SSBN 736)(GOLD)

FRANK A. LISTER AWARD
COB Mark C. Shearer
USS CHICAGO (SSN 721)

CHARLES A. LOCKWOOD AWARD
LCDR Michael Robert Toepper, USN
USS ALASKA (SSBN 732)(BLUE)
ETCS(SS) Sean Allen Connelly
USS ALBANY (SSN 753)
MM1(SS) Edward T. Rathgeber, USN
USS MEMPHIS (SSN 691)

LEVERING SMITH AWARD
LCDR Sean O. Harding, USN
USS FRANK CABLE (AS 40)

FREDERICK B. WARDER AWARD
LT Michael William Francis Yawn, USN
Commander, Submarine Development Squadron Five

GOLD DOLPHIN AWARD
CDR Norman Moore, USN
USS COLUMBUS (SSN 762)

SILVER DOLPHIN AWARD
ETCM(SS) Larry W. Keene, USN
USS MARYLAND (SSBN 738)(GOLD)


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REFLECTIONS

MORE SEA STORIES

by CAPT Robert T. Styer, USN(Ret.)

Fond Encounters with Rear Admiral Eugene B. Fluckey

In January of 1966, I took command of USS PLUNGER (SSN 595), my first command, and at that time one of the most advanced attack submarines in terms of advanced sonar equipment and built from the keel up to be the most quiet submarine operating at sea. The change of command took place in Bremerton, Washington. Our next port of call was Pearl Harbor where we became homeported. Admiral Eugene Fluckey of WWII submarine fame was ComSubPac, the Pacific Submarine Force Commander at the time. We were pleasantly surprised when we learned on arrival that Admiral Fluckey had designated us as his Flag Ship. In the next few years our interaction with him was highly interesting, from which a few stories now emerge.

The first is about the *Admiral's steward* who wanted to get back to sea and requested some sea duty, specifically in PLUNGER. I had only two young stewards who were doing a great job, but who turns down a seasoned Chief Petty Officer who wants to take over your relatively small wardroom? The Fluckey angle: this top steward knew Admiral Fluckey, and the day the Admiral came to the boat for a personal tour, my Chief took charge to ensure a smooth visit. The Admiral and I were leaning into the Ship's Office chatting with my First Class Yeoman, when all of a sudden I heard a gruff voice whispering in my ear: "Hold still, Captain!" Next, I realized that my slightly dirty white web belt had been whisked off my pants and replaced by a clean belt. Nobody in the vicinity noticed the fast maneuver, and I will never forget how meticulous this Chief could be. No one of his officers would ever be observed wearing dirty clothing as long he was in charge of the wardroom.

The next story demonstrates his quiet post war smoldering following the war with Japan and how tactfully he handled it. I had

been advised that the Admiral wanted to take a very important foreign dignitary for a demonstration cruise in PLUNGER. What I didn't know at first was that this dignitary was a top ranking civilian in the postwar peace time Japanese government. The Admiral and his VIP guest were on the bridge to observe getting underway, when the Admiral directed me to go the long way to the channel, i.e. around Ford Island. Normally any boat leaving the Submarine Base would depart directly south to the exit channel. What the Japanese gentleman didn't understand is that when a U.S. Navy ship passes the battleship ARIZONA sunk along side Ford Island, the ritual is to render honors—"Attention to port!", and all hands topside drop what they are doing and salute the sailors perished in the attack on Pearl Harbor, December 7, 1941. Our visitor on the bridge was obliged to place his civilian hand over his heart and follow suit during the brief passing ceremony.

The next story indicates how well Admiral Fluckey handled difficult submarine family situations. During my tour of command of PLUNGER a great deal of time was spent on *special operations*. The wives and sweethearts of the crew never knew when we would sail, where we would sail or when we would return. The deployments were usually months, not weeks. A few days before each return they would be notified and one of the customs was for the wives to get together and create a huge Hawaiian lei about forty feet in diameter to be draped around the sail from the bridge to the forward deck on docking—an aloha custom used greeting people arriving in the islands. My wife at the time came up with a creative idea on one of our arrivals.

Instead of the usual flowers decorating the lei, her gang of girls got together and created a huge lei which was loaded with family odds and ends such as bowling pins, diapers, canned dog and cat food, bras, panties, baby shoes, pots and pans, dish towels; you-name-it. However when we arrived, we were presented with a large lei made up of paper napkins from the Officer's Club and put together by a some guys who operated the club. This was done on Admiral Fluckey's orders. It turns out that one or two of the more prudish ladies who disapproved of the homegrown lei and complained to my Division Commander who saw nothing wrong with

the homegrown variety. Somehow the controversy ended up in the Admiral's office. Admiral Fluckey called my wife and invited her up for a cup of coffee to explain his awkward position which he decided to solve on the safe side. He told her and told me later when I viewed the controversial lei stretched out on his large office floor that he felt the lei was a work of art, innovative and humorous. He regretted that he had to make a decision to ward off the complaints of a few ladies with their noses in the air who could make trouble in general over the silly issue.

This final story evolves from a trip with Admiral Fluckey on board to observe a SUBROC test missile firing in the broad Pacific ocean area. PLUNGER was the first to be fitted with this (then) new weapon and was designated to conduct many test and evaluation firings of which this was only one. At the end of the exercise, we surfaced and rendezvoused with a helicopter to fly the Admiral and several staff officers to Wake Island for return flights home. When all were assembled on the bridge for the transfer wearing life jackets, one of the young staff officers stepped out on the sail plane to receive the helo harness. Past experience had shown me that this would be a hazardous operation since the helo pilot has nothing to maintain station on with most of the hull underwater and the sail directly beneath out of sight. After securing the harness the helo lifted the officer, but he precariously swung back and forth, almost striking the sail. Admiral Fluckey immediately changed the *recover* plans, directing those to be transferred to dive into the water, a good twenty foot dive into choppy seas, and thence be picked up by helo where any mishap would only result in the high jump into the waves—a great idea and very successful. An interesting twist to this true story is that Admiral Fluckey later testified before Congress supporting submarine pay for submarine staff personnel who routinely go to sea in support roles when the submarine is home based. He cited this incident, among many others as evidence of hazards experienced by submarine staff personnel from time to time. Obviously the testimony was successful since shortly there after seagoing staff personnel started receiving their well deserved submarine pay.■

SOUNDS OF THE SILENT SERVICE

by Bob (Pecos) Larsen (former TM2 (SS))

Maybe it's part of the human physiology or maybe it's just me, but there were sounds that I heard so often aboard SPINAX that burrowed their way deep into my soul. Sounds that while I was aboard became so commonplace that they were just part of everyday life, and now spring out at me in unguarded moments.

One of the most profound, of course, was the roar of the old Fairbanks Morse diesels coming to life. I can remember being topside handling lines when the old gal would cough forth her billowing clouds of smoke and the low rumble of 1600 horsepower diesels would vibrate through every plate and bolt of the old gal. What a rush! Here we go! We're leaving now! Off to see the world, coming back who knows when? Rumble, rumble...

Of course this sound meant different things to me, an old hairy-knuckled Torpedoman, than it did to an Engineman. I'm sure the snipes were busily checking gauges, opening valves, and squirting oil in a weird sort of mating ritual dance with their pistoned slaves, their ears being tuned more to the subtle nuances of clattering valves and worn bearings than to the overall feelings of power from the mighty four. But for me it was "Feel the power! We are headed your way with 6400 horsepower of screaming diesels bulldozing us through towering waves at 16 knots, all ahead full and damn the torpedoes!"

Of course this was before the *stick your nose in the air and smirk* nuclear boats came along that could run circles around us without even breaking an atomic sweat. But I bet the nukes never experienced the thrill of waking up to the mighty roar of diesels in the morning. They just wound up the key and quietly snuck out of the harbor to run in underwater circles 'til it was time to come home for a rewind. Nothing personal against the nukers, they are, after all, submariners, and are carrying on the tradition...only in a quieter, more gentle way.

Riding and living in the Forward Room, I naturally relate more to the sounds from that area especially as heard from my bunk. Submarine sailors spent a lot of time in their bunks simply because

if everyone were up at once, there would be a lot of uncomfortable body squeezing as the crew fought for standing room. One sound that will stick with me to my dying day and beyond is the *clump* of somebody's right foot coming through the forward room hatch and hitting the deck plate. Now there is an art to going through sub compartment hatches that becomes second nature in no time at all. You approach the hatch varying your steps so that when you are at the hatch your right foot (or left for those with south feet) comes up at the same time as your head ducks down and your hand grabs for support. You then follow through with your right foot and clump it down with some force in the designated next compartment and follow through with your body, then your quieter left foot. This sound was usually followed by mumbled greetings, or loud hoots and wisecracking, depending on exactly who had invaded the room.

Each room had its own particular sound. The Forward room was usually fairly quiet underway, especially submerged. The only sounds normally being heard were the snoring of the off duty personnel, and the *murrr-murrr* sounds of the hydraulic pump pushing the bow planes up and down.

Of course at *Battle Stations Torpedo* it was a different story. The room was now packed with sweaty Torpedomen and others that were hijacked for the reload party. The hiss of air, the flush of water, the whirr of outer doors opening, all mixed in with pulleys being rigged and the grunts and cursing of the reload party trying to push a 2100 pound torpedo into a 21 inch hole (nothing Freudian here). This all was combined with the typical *grab-assing* that goes along with such serious events.

The Forward Battery was also fairly quiet. This was where our officers made their nests, so the crew usually moved through on tippy toe. But it also got rambunctious at chow time, or at movie call, and the Acey Ducey tournaments could be heard all the way back in the Control Room. The loudest snores to be heard came from the Goat Locker where the senior chiefs slept. The Goat Locker was also where you could locate COB MacFarland piecing together his old Kodak after breaking it yet again on liberty.

The Control room was the heart of SPINAX (the Captain was the soul). Here was where all the excitement took place. This is where you would hear the words you had come to love from the

movies. "Clear the Bridge! ...Dive! Dive! Aooooooogah, Aooooogah!" The Thwump! Thwump! of the lookouts hitting the deck, "Green board sir!" "Green board aye! 5 degree down bubble, full dive on the bow planes." "Pressure in the boat." "Pressure in the boat, aye, blow negative to the mark!" Whooooooooosh! "Negative blown to the mark, sir." "Very well!" ...and on until the boat was settled comfortably at 100 feet or whatever the depth of the hour was. The frantic but controlled excitement over, hands would reach for their mugs of coffee, bodies would settle back into the curves of the boat, the flicking sounds of lighters snapping shut as the control room air settled back into its normal state of opaque smokiness, and the sea stories would continue, seemingly uninterrupted by such nonsense as diving the boat.

Up the ladder from the Control Room was the little 8'x12' space known as the Conning Tower. This was where the brains of the boat (depending on who was up there) stood watch. This was also the Captain's favorite haunt. The old man was in charge here and everyone knew it. This was where the Captain wore his crown and his subjects bowed. I didn't spend a whole lot of time there, but here in my later years I can still hear the Captain's voice snapping "Up scope" or "Come right to 155" or "Black and bitter to the conn." The conn went from moments of extreme calm, with the hydraulic creak of the helm punctuating the whispered murmurs of the Navigator and Quartermaster trying to figure out where the heck we were, to the tense but clear ... "Bearing ...Mark!, range...Mark!" "Open doors on tubes one and two!" "Outer doors open!" "Fire one" "One fired electrically sir!" "Fire two!" "Down scope!" "Make your depth 200 feet! All ahead flank, and hold on to your cajones!" Ah yes, the good life.

Leaving the Captain to his castle we sneak back to the After Battery. Stomping through the hatch, avoiding the bustling mess cooks, we step into the mess hall. Here we find the big-bellied cooks squeezed into the tiny galley, sweating bullets and trying to ignore the raucous crew insulting the cooking and harassing the mess cooks. The mess hall was the social center for the crew. Here is where you learned to cuss and brag about your latest conquest. You could hear about the little blonde gal over and over, marveling how she changed from a tattooed bar lady to the prettiest of movie stars in just a few tellings. The sounds here were of the

clinking of silverware, the pouring of coffee and milk, the continuous outflow of put-downs and laughter, and the cursing as the boat took a huge starboard roll and everyone had to grab their plates. It was also the place of movies. The roar of John Wayne shooting down Jap Zeros, the gaudy trumpets of the parade of Cleopatra, and the laughter as the latest comedic genius joked his way across the screen. The best and the worst of movies—we had 'em all. It was amazing how every member of the audience could, at the same time, spot and cheer an errant naked breast in a teeming crowd of thousands!

Right below the mess hall was the Sonar room. You accessed it from a hatch right in the middle of the passageway. To leave the Sonar room you had to sound a buzzer, and whoever was in the mess hall would yell "Come up!" if it was clear. Oft times the Sonarmen would jump the gun and get a foot in their face as they opened the hatch.

The Sonar Room was the compartment of sounds. Here is where the professionals sat listening to all the sounds of the vast sea. I was only down there a few times, but I will remember to my dying day the mournful sounds of whales singing off somewhere in the lonesome depths. There were all kinds of sounds, from the snapping of shrimp to the whistling of dolphins, and even the sound of a ship's propellers swish-swishing off in the distance. The Sonarmen could always tell what was going on. That's what they were trained for, but to me they were just lonesome sounds in the deep.

Continuing aft we go through the door to the main crew's quarters. Usually fairly quiet here, snores and quiet conversation from the bunks were the general rule. Of course in port you had to learn to tune out the returning drunks, and you never gave anyone a real bad time, because you might be the next returning drunk.

The next compartment we'll skip through fairly fast, because the sounds here we've learned not to discuss in the presence of wives and kids. This was the main head area. This is where the crew lined up to shower and shave (in port), and they waited their turns at the two shiny metal doors. These doors led to the main *Freckle Makers* on board. And the sounds emanating from within, we

don't need to discuss. Hell, we were all there, we know what they were.

The Forward Engine room was next. Here was the Kingdom of the Snipes. The Bubba Smiths and Goat Lydells reigned supreme in their oily castle. If they weren't checking gauges, they were sitting on a dirty stool puffing a greasy cigarette and drinking oily coffee. I'm not poking fun at the snipes, it's just the way it was when you spent your time in the engine rooms with the monstrous diesels puffing forth smoke and dripping oil on your shoes. I cannot describe the sounds here. It's called overkill. When you are in the same room with the engines it's like sitting in the middle of an active volcano or having someone exploding dynamite all around you. I can't relate to it, it was just noise and a whole lot of it. The Enginemen wore large ear mufflers to help block the sound and, I guess, were in tune with it to a large extent. All I know is that it didn't seem to bother them and that they had a genuine love for their big engines. This was also a dangerous area for some Torpedomen, but that's another story.

The After Engine room was pretty much a carbon copy of the Forward. The only changes were the faces and the number of dirty coffee cups lying around.

Maneuvering room was a strange little room that I never really understood. Oh, I know that it was where you controlled the main motors, pushing them to all ahead full or starboard back one third. This was done with a blurring dance of levers and valves that I never could figure out completely, qualified or not. Two Electricians sat here with their shiny levers, one port and one starboard (Electricians not levers). I remember that I could still hear the engines in maneuvering room, but I cannot for the life of me remember the sound of the motors. I'm sure some Electricians from long ago will help me trip my memory on this.

Last, and probably least, was the Stern room. This room on normal boats would be the After Torpedo room, but when SPINAX converted to a Radar Picket sub, all the tubes were replaced with shiny new radar equipment. When she was no longer useful as a Radar Picket, all the fancy equipment was removed and it became just the Stern room. It was mainly a sleeping and storage compartment, and had a neat little horseshoe type bench and table in the after section. This was the SPINAX Casino. Gambling was, of

course, illegal on boats, but nobody seemed to mind the friendly games of poker, Acey Deucy and Backgammon, and under the watchful eye of the COB, no one was ever hurt. I always think of Reno when I think of the Stern room. The clink of chips, the puffing of smokes and the poker talk that goes with any game...- "Hell, you're bluffin', Chief!" "Cost you a sawbuck to find out, Toadface, didn't anyone tell you that Chiefs don't bluff?" "Ante! Who the %$$ didn't ante?" "Gimme a smoke, Pigpen!"

The Stern room, in it's quieter moments always seemed to vibrate and kind of hop crazily around. It was right by the screws, so it picked up a lot of wayward motion. At least it seemed that way to me. I preferred the *bounce your stomach on the overhead then bounce it off the deck* movement of the Forward room.

There were the loud noises...the *Aooooooogah, Aooooooogah* of the diving klaxon; the musical chimes of *man battle stations*, the wonderful sound of *first call to chow* popping over the 1mc, and the sound I was to become more than familiar with—the *vooooom, phoooosh* sounds of torpedoes being shown their way out of the forward room, or the horrible clatter of flying objects as the boat took a 60 degree typhoon roll or a stuck stern planes 50 degree down angle...or the clankety-clank of someone coming down the forward escape trunk after liberty...

And the quiet noises...The sounds of the movie playing in the wardroom, the gentle sound of swells hitting the boat and lulling me gently to sleep, ...or the muttering of non-quals as they climbed over torpedoes and under deckplates looking for the mysterious and elusive *Golden Rivet*.

Finally, the sound that I feared the most, the sound that woke me out of a deep sleep sweating with terror. The sound of number one sanitary tank being blown while submerged... because I knew what was coming next... "Venting inboard!" ...The horror!!

Sounds are something we live with all our lives and take for granted. It feels good to let the memories of my ears open, and recall sounds almost lost in times past, those Sounds of the Silent Service.■

THE SUBMARINE REVIEW

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

Articles for this publication will be accepted on any subject closely related to submarine matters. Their length should be a maximum of about 2500 words. The League prepares **REVIEW** copy for publication using Word Perfect. If possible to do so, accompaning a submission with a 3.5" diskette is of significant assistance in that process. 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.

NAVAL SUBMARINE LEAGUE
STATEMENT OF FINANCIAL POSITION
MARCH 31, 2002

ASSETS

CURRENT ASSETS	
Cash	$ 9,191
Cash Equivalents	9,576
Restricted Cash	5,489
Investments at Market	300,579
Prepaid Expenses	13,605
Accounts Receivable	568
Total Current Assets	$ 339,008
FIXED ASSETS	
Furniture and Computer Equipment	$ 27,879
Office Condominium	251,021
	278,900
Less Accumulated Depreciation	(106,587)
Total Fixed Assets	$ 172,313
Total Assets	$ 511,321

LIABILITIES

CURRENT LIABILITIES	
Accounts Payable	$ 1,025
Deferred Income	75,390
Deferred Membership Dues	40,622
Rental Deposit	675
Total Current Liabilities	$ 117,712
LONG TERM LIABILITIES	
Deferred Membership Dues	$ 130,795
Total Liabilities	$ 248,507

NET ASSETS

UNRESTRICTED	
Undesignated	$ 85,294
Board Designated for Equipment	21,150
RESTRICTED	
Centennial Endowment Fund	$ 156,370
Total Net Assets	$ 262,814
Total Liabilities and Net Assets	$ 511,321

NAVAL SUBMARINE LEAGUE
STATEMENT OF ACTIVITIES
FOR THE YEAR ENDING MARCH 31, 2002

REVENUES	PERMANENTLY RESTRICTED	UNRESTRICTED	TOTAL
Contributions		$106,935	$106,935
Dues		87,939	87,939
Annual Symp.		101,707	101,707
SUBTECH Symp.		188,935	188,935
Sub Centennial	$340,147		340,147
Bank Interest		255	255
Dividends	3,371	8,363	11,734
Advertisements		24,700	24,700
Rent		8,100	8,100
Realized Gain (Loss on Investments	(7,519)	(20,830)	(28,349)
Unrealized Gain (Loss) on Investments	(16,020)	48,741	32,721
Other		4,267	4,267
Total Revenues	$319,979	$559,112	$879,091
EXPENDITURES			
Awards and Grants		$ 15,920	$ 15,920
Publishing		81,713	81,713
Promotion		44,089	44,089
Annual Symp.		101,539	101,539
SUBTECH Symp.		149,355	149,355
Sub Centennial	$266,248		266,248
Chapter Support		17,281	17,281
Special Events		1,814	1,814
Total	$266,248	$411,711	$677,959
SUPPORTING SERVICES		$188,347	$188,347
Total Expenditures	$266,248	$699,058	$866,306
Increase (Decrease) in Net Assets	$ 53,731	$(40,946)	$250,029
Net Assets, Beginning of Year	$102,639	$147,390	$262,814
Net Assets End of Year	$156,370	$106,444	$262,814

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BOOK REVIEWS

UNITED STATES SUBMARINES

by

David Randall Hinkle, Editor-in-Chief

Arne C. Johnson and Harry H. Caldwell, Editors

350 pp., $75.00

Distributed by Publishers Group West

Reviewed by CAPT Joseph C. Dobes, USN (Ret.)

This coffee-table style book was produced by Sonalysts, Inc. and The Naval Submarine League in celebration of the U.S. Naval Submarine Force by presenting the story of the history of the first hundred years of submarining. The editors, in the foreword, advise the reader that, "We view the book as analogous to a small museum. Flipping through and looking at the pictures should be enjoyable. If your interest is piqued, read the captions and become better informed. If you're hooked, read the text and you will become much better informed." The editors were more than successful in their endeavors.

This book consists of a series of articles, vignettes, and anecdotes describing the Submarine Force from the acceptance of USS HOLLAND on 11 April 1900 to the celebration of the 100th anniversary in the year 2000. It also contains a superb collection of photographs, documents, and diagrams that explain this history in ways that words are frequently incapable of doing. Although much of the text appears written to inform the non-submariner of the uniqueness of these ships and the men who man them, it is sufficiently enthralling as well for a person who has served in or is familiar with submarines.

Divided into seven major sections, this book addresses a chronology of the key Submarine Force events, the early years of submarining, World War II operations, Cold War operations, the submarine family, proud traditions, and explorations and the future.

The section on the early years describes the initial operations of

USS HOLLAND including an informative article by the son of the first Commanding Officer, Lieutenant Harry H. Caldwell, USN. This article gives the reader an insight of the difficulties experienced and traditions established during that first submarine command. An anecdote describes the crew dealing with its first flooding casualty and attempting, thereafter, to determine how to escape from a stricken submarine (using a dog, no less). This section also contains the publication of Admiral Crowe's 2000 banquet address to the Naval Submarine League on the early days of submarining and an interesting discussion of submarine sinkings, rescues, and salvage during the first 100 years.

The section on World War II starts with an excellent summary of submarine operations from the war's beginning to its end. This was followed by an article describing the various classes of submarines and their variants that fought during the war and the process that led to the development of the Gato, Balao, and Tench fleet boat classes. This article also discusses the selection of the yards that built these submarines and covers the many improvements in technology that helped the Submarine Force win the war in the Pacific. An article addresses the 52 submarines lost during the war and the means (or suspected means) of their loss. Finally, an article identifies the seven submariners who were awarded the Congressional Medal of Honor during the war and presents the reasons for these awards. This review of these medal winners' bravery brought back memories of the types of people of which the Submarine Force consists.

By far the largest section of the book, and appropriately so, is the one dealing with submarine operations during the Cold War. This section commences with a description of the evolution of submarines and technology from the end of World War II to the present. Following are two views of Admiral Rickover and his impact on submarines. A Cold War retrospective summary provides an excellent background for further discussions of submarine operations during this period. An article on the different submarine strategies employed by the United States and Soviet Union during the period gives the reader a better understanding of Cold War submarine operations. Lastly, the book provides two

articles that discuss fleet ballistic missile and attack submarine operations during the Cold War period, describing why each was instrumental to the U.S. victory of this non-shooting war.

Of interest to readers, both submariners and non-submariners, are vignettes describing two recently declassified Cold War, submarine versus submarine operations. The Commanding Officers of the U.S. submarines involved convey the stories of these operations and give an excellent perspective of the types of encounters that submariners experienced in the Atlantic and Pacific areas of operation during that period.

A section on the submarine family characterizes the life of the men who serve on submarines and the families that support them. It also provides a brief history of the U.S. Naval Submarine School and discusses the role of the Chief of the Boat in the day-to-day operation of a submarine. In addition, this section discusses the Dolphin Scholarship Foundation and Red Cross Volunteers (Gray Ladies). These two descriptions provide a human touch to the book which is otherwise about men and their ships.

Proud traditions addresses the types of insignia, medals, awards, and citations given to submariners. It also explains the submarine battle flags flown by ships during World War II and the patches designed by submarine crews throughout the century. Finally, this section provides a brief description of all the submarine memorials and museums throughout the country. This is a handy tool for those wanting to go to visit a submarine to get an appreciation of their size and the accommodations they provided or learn more of the history of these ships.

The final section of the book covers submarine involvement in scientific exploration. It primarily examines the ice and deep submergence operations in which submarines have been involved. This section also attempts to give the reader a look at the submarine and submarining of the future. Looking back through this book and seeing how much submarining has changed over the past 100 years, demonstrates the difficulty of this latter task. Unfortunately, we are only looking forward in time through a periscope with the narrowest field of view in predicting submarine operations in the

future.

This book is an entertaining and educational look at the first 100 years of submarine operations. It documents well in words and pictures the life that submariners, past and present, experienced in their love of country and love of the sea. It is a **must have** for submariners and those with interests in the field of submarining.■

RAISING THE HUNLEY
The Remarkable History and Recovery of the Lost Confederate Submarine

by Brian Hicks and Schuyler Kropf
New York: Ballantine Books, 2002
ISBN 0-345-4471-9

Reviewed by CDR John D. Alden, USN(Ret.)

Submariners have long known the general outlines of the story of the Confederate submarine H.L. HUNLEY, the first submarine to have sunk an enemy warship in combat. Two of our tenders, now unfortunately decommissioned, were named after members of the boat's ill-fated crews: HUNLEY (AS 31) honored Horace L. Hunley, who promoted and financed the submarine's construction and died at its helm on a trial dive, while DIXON (AS 37) was named after George E. Dixon, who commanded the boat and made the successful attack on USS HOUSATONIC. Ironically, the Navy has never given comparable recognition to the submarine's actual designer, James R. McClintock.

Concerning HUNLEY's major particulars there was always general agreement: built in secrecy during the Civil War, the diminutive submersible, its single screw cranked by the muscles of a volunteer crew, had rammed a spar torpedo into the side of the Union warship HOUSATONIC and sunk it to the bottom just outside of Charleston, South Carolina harbor, then disappeared without trace. The submarine thus achieved fame for an exploit not to be repeated for another fifty years. In other respects the history of H.L. HUNLEY was shrouded in mystery, confusion, and

misinformation. Although the story was revived every few years in books, magazine articles, and newspaper features, the few definite facts were usually obscured amid erroneous conjecture, sensational speculation, and unsupported claims by searchers that the wreck had been found. Even the most sober accounts, including the U.S. Navy's official ship's history, relied for many details on eyewitness statements written from memory.[1]

The news in 1995 that the long-sought wreck of HUNLEY had finally been found and positively identified, immediately stimulated hopes and demands that the hull be raised, its secrets revealed, and the bones of its lost crew be laid to rest ashore. In spite of some squabbling over the assignment of credit for locating the sub and competition for its possession and ultimate display, the team that found it, sponsored by novelist Clive Cussler, made sure that it would be painstakingly excavated by marine archeologists and professional salvagers from the sand and silt in which it was buried, then turned over to qualified conservators for study and preservation. Raised in August 2000, HUNLEY now lies in a well-equipped laboratory on the former naval base at Charleston, where it has already disproved several long-accepted *facts* about its construction. Its hull, long believed to have been crudely improvised from an old boiler sliced in two, was actually carefully fabricated with frames and plates and smoothly streamlined. Instead of having a propeller shaft with eight hand-cranks directly driving the screw, there are cranks for only seven men and the shaft is connected to the propeller through a reduction gear. Other features of the boat are considerably more sophisticated than was originally believed. What has not been, and may never be, determined, is the cause of the boat's sinking and the crew's demise. Some evidence seems to indicate that the hull remained unflooded for a considerable period of time and that the crew died of asphyxiation rather than drowning.

Despite some excessive journalistic *hype*, the authors have stuck quite close to the facts concerning their main subject. Only in their comments on broader naval matters do they reveal some background weaknesses. HOUSATONIC, a 1,240 ton screw sloop,

does not merit being described as "mighty", "formidable", or "a huge Union Warship". At one point it is even called a "battleship". Likewise, HUNLEY, ingenious as it has proven to be, was hardly a "marvel of nineteenth century engineering". Referring to a sketch of the boat sitting on a pier, they describe it as being in "dry dock". With regard to later submarine developments, the authors characterize Simon Lake as "the father of the modern submarine" and state that he "ultimately set the standard for underwater boats". Most students of the subject would give greater credit to John Holland. Most egregiously, the writers repeatedly refer to the ironclad CSS VIRGINIA (ex-USS MERRIMACK) as MERRIMACK. The book is also weak in technical details, many of which remain to be revealed or clarified after further study of the relic. Such minor lapses aside, this book presents a readable and reasonably complete account of what is currently known about HUNLEY and the people who designed, built, and operated it. I strongly recommend it to submariners who are interested in knowing more about the origin of the boats in which they serve or have served, and the men who devoted their lives to making them what they are today.■

ENDNOTE

1. *Dictionary of American Naval Fighting Ships*, Volume II. Navy Department, Naval History Division: Washington, 1963.