THE SUBMARINE REVIEW

JANUARY 1991

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EDITOR'S COMMENTS

If we were to draw main themes for this issue, we would probably choose two that are at the heart of the Submarine League's reason for being: **Education of the Public** as to what submarines are all about and what they can do; and, the **Professionalism** of submariners.

The professionalism factor shows through first in our search for doing our business better and for making our equipment more effective. We know that we have to understand the big picture as well as the nuts and bolts. We think we do and we are trying to explain what that means from a submariner's view. Secondly, our community has always looked to our traditions and history for foundations of our current conduct and the lessons of the past have always been our instruction for the future. The third factor of professionalism is evident in the pride of a difficult job done well. The two pieces in the Reflections section of this issue are classic examples of that submarine pride.

Several of the articles are calls to get out the right word. That is, let's insure that the American people, the rest of the Navy (who realize how right they are), and, indirectly, those that make our National Security decisions, that USN submarines, of the proper type, designed and built by American experts, can be highly effective, and less costly in real terms, in any kind of conflict or crisis that the nation may face in the all too uncertain future.

There is a second, very important, part to getting the word out; and that is to make sure that what is published in the general press, or discussed on the air, is technically correct and the argumentation is fair and objective. Making up the IN THE NEWS notes indicates that those who cover submarine news over a long period generally can be counted on to be objective, fairly knowledgeable and open to learning more about the subject. The casual writer, however, coming upon the complex world of undersea warfare for the first time tends to jump at the easy answers to the wrong questions. All of us should take those such opportunities, when we see them, to offer the public better information on which to make their own judgements.

Jim Hay

FROM THE PRESIDENT

On 21 November, 1990, the leaders of NATO and the Warsaw Pact declared in the Charter of Paris, an end to the "Cold War", proclaiming an era of peace and democracy and an end to confrontation. As a result, perceptions of threat to our security are changing. The Soviet "containment" policy which served the free world so well for forty years is no longer considered necessary; neither are the forces created to support that policy. Planners are told to refocus on regional conflicts, contingency and limited objective warfare. Light, mobile, rapidly deployable forces, backed by a larger, more capable Reserve, represent the new order.

Despite, however, significant reductions in Soviet conventional arms, modernization of the Soviet submarine force continues apace. Construction of SSBNs is ongoing, each new ship armed with missiles able to reach any target in the U.S. from deep within the "bastions." In tactical submarines, the Soviets are improving the overall quality of the force by adding modern, very capable SSNs, SSGNs, and SSs, while discarding whole classes of old, noisy submarines. **This threat has not diminished.**

In the coming rush to "build-down" the U.S. defense forces, it is hoped that the decision makers will remember that the only platform capable of conducting an ASW campaign in the most forward areas is the SSN, which, by the way, can also deal very nicely, thank you, with the newly discovered Third World submarine threat, conduct covert land attack missile strikes, plant mine fields, insert and recover Special Warfare forces, sink surface ships (re BELGRANO), collect intelligence, provide early Indications and Warning, and provide combat search and rescue. In versatility, mobility, firepower, endurance and life-cycle cost effectiveness, the SSN wins!

Recently, we have been asked if certain submarine special operations might ever be declassified so that participants would be able to discuss details with the press, or even publish them as part of their memoirs. Without exception, those operations remain classified and are not releasable to the public. You must assume that the personal security safeguards enacted for each operation remain legally (and morally) binding. I trust that message is clear.

We are finalizing the agenda for the June Symposium. It looks like another winner. Please plan to join us.

Bud Kauderer

■

NSL SYMPOSIUM 1991

When: June 12 & 13
Where: Radisson Mark Plaza Hotel
Alexandria, VA
Theme: Continuing Evolution of Submarine Roles and Missions

Agenda: **12th (Starts at 1 p.m.)**

- Interesting and informative Navy and Civilian Speakers
- Business Meeting
- Happy Hour, Singalong, Piggy Back Reunions

13th (Starts at 8 a.m.)

- Introduction by OP-02
- Speakers representing Navy, Industry and Congress will develop the theme
- Fleet Award Ceremony
- Featured Luncheon Speaker
- Banquet, Guest of Honor Address

Details: Flyers will be mailed to all hands in February.

Mark your calendars and plan to attend!

POLITICAL REALITIES, ARMS REDUCTIONS, AND THE SHIPBUILDING INDUSTRY

by D. M. Johnston

For the past 45 years, the United States has had the advantage of a single, unifying threat around which to plan, equip, train, and, most importantly, justify its military forces. It made little difference whether or not the actual threat of direct Soviet attack against Europe or the United States was great or small, defense policy rested on our ability to deter a Soviet nuclear attack on the United States or its allies, and a capability to respond quickly to any Warsaw Pact attack on Western Europe with conventional forces. In this regard, it was felt that if United States forces could handle the European contingency, they could cope with lesser conflicts anywhere around the globe.

In carrying out our defense policy over the past 50 years, we have spent about $8 trillion in FY 1991 dollars. By the end of the 1980s, this had bought us 566 ships, 32 ground divisions (active and reserve), 36 tactical air wings, and a nuclear weapons inventory in excess of 13,000. Our annual defense budget was running at roughly $300 billion, and defense expenditures were consuming about 6% of GNP. Collectively, defense-related manpower, working either directly for the Department of Defense or indirectly in defense industry, numbered 6.5 million. As formidable as these numbers were, however, they represented a downward trend that is likely to continue as the Soviet threat continues to fade from the scene.

The beginning of the end for the Soviet empire came with Gorbachev's early recognition that until the lot of the Soviet consumer improved, worker productivity would remain marginal to nonexistent and the Soviet Union would become increasingly irrelevant to the 21st century. Key to his reform effort was the need to outflank the interests of an entrenched bureaucracy, a task which has only recently been completed.

At the same time, the Soviet military has also recognized the need for economic improvement in order to provide an adequate military industrial base for the future. Yet a pressing requirement remains to maintain strategic parity and avoid the possibility of accidental war arising out of instability at the conventional level. Unless Gorbachev can reduce the perceived threat to the Soviet Union through arms control agreements and confidence- and security-building measures, he will have difficulty holding his military to the new doctrinal line. Accordingly, he has been seeking political advantage out of economic necessity, putting pressure on the West through unilateral reductions and bilateral or multilateral proposals -- particularly in those areas where the Soviet Union is facing a situation of bloc obsolescence, whether it be in tanks or submarines.

In his five years in office, Gorbachev has removed Soviet troops from Afghanistan, concluded an agreement on intermediate-range nuclear forces, inaugurated the START talks, and just recently struck a deal on reducing conventional forces in Europe. More significantly, he has allowed the Eastern European satellites to break with Moscow and establish their own governments. Of all the steps taken to date, the dissolution of the Warsaw Pact has done the most to tip the military balance in the West's favor.

In Eastern Europe, the two most significant initiatives to date have been the reunification of Germany and Poland's sweeping approach to economic reform. It is interesting to note that some of the initial euphoria relating to reunification has already died down, especially within West Germany as it looks to the prospective need for enormous investments -- some say on the order of $750 billion -- to do an effective job. Assuming these formidable difficulties are overcome, it is probably only a matter of time before Germany will rebel at the notion of having foreign troops and nuclear weapons stationed on its soil.

In Poland, there is much at stake as the country works its way toward a market economy. If it succeeds, its northern-tier neighbors, Czechoslovakia and Hungary, will likely follow suit. If not, the process will be slowed considerably. At this point, the probability of their pulling it off successfully is about 50-50. Although the Polish government has the support of its people and inflation has dropped from 75% in January to 6% this summer, unemployment is rising and will probably exceed 10% by year's end. If one is used to a status quo of zero unemployment as the Poles have been, 10% will feel like a lot.

As if the situation of the Eastern Europeans was not challenging enough, the recent increases in oil prices represent an additional burden of immense proportions. With this being the first year in which the Soviets are requiring their former satellites to pay full-market prices for their oil purchases -- after having heavily subsidized such purchases in the past -- the run-up in prices triggered by the Gulf crisis could not have come at a worse time. It has thus become a one-two punch which all East European countries are being forced to absorb -- and at a time when the West will be sorely pressed with respect to its own oil imports. The southern-tier countries of Bulgaria and Rumania are even further behind economically and politically and will require significantly greater effort to reform.

Should these countries not succeed in their transformation, there is a strong likelihood that extreme nationalism will rise to the fore. There are any number of unresolved ethnic disputes that involve unbalanced distributions of wealth, political power, and cultural freedom. Czechoslovakia, for example, was created from two culturally separate provinces of the Austro-Hungarian empire. Despite far-sighted and largely successful attempts by the Czechs to improve the living standards of their Slovak brethren, the ties between the two have not improved during the past four decades of communist rule -- as differences have been kept at bay through suppression of political discourse and expression.

The United States, because of its own economic situation and because of the actions taken by the Soviet Union, has also been reducing its military expenditures. Between 1980 and 1985, defense spending in the United States grew by more than 50% in real terms. However, in 1986 it began to drop -- a trend that will continue, at least over the course of the next Six-Year Defense Plan. Whatever else the political changes in Eastern Europe may imply, they relieve the United States of the need to be able to wage war in Europe with little or no warning. Rather than having to transport ten army divisions, one hundred tactical air squadrons, and a Marine Corps expeditionary brigade to Europe within ten days, the United States will now have between six months and a year to respond to any Soviet military designs on Western Europe. This will permit the United States to maintain a much smaller active force at much lower levels of preparedness.

Pentagon planning presently calls for defense spending to fall 2% a year between now and 1995. The Congress could even take it deeper, perhaps on the order of 5% a year. If so, United States defense expenditures in real dollars could end up at half of their present level within a decade. In any event, by 1995 defense spending will be at its lowest level since before World War II, measured either as a share of GNP or as a portion of total federal spending.

The advocates for deeper reductions maintain that even at a level of $150 billion -- or 3% of GNP a year -- the United States would be able to buy 22 divisions (11 active and 11 reserve), 24 air wings (12 active and 12 reserve), and at least 400 ships backed by 3000 nuclear warheads. The Iraqs of the world notwithstanding, this would probably be adequate to maintain a global presence and ensure nuclear deterrence, while keeping sufficient forces in reserve as a hedge against any resurgence of the Soviet threat. However, even if the Soviets were to reverse their present policies, it is likely they would emerge as more of a regional factor than a global power in the future. Whether an active force posture of the above size would be enough to handle all conceivable contingencies on a unilateral basis remains open to question.

These, then, are the present trends. They are by no means inevitable, and it will be necessary for some additional pieces to fall in place for them to play out as predicted. First, the United States and the Soviet Union will need to conclude a strategic arms agreement, as they have just done with their conventional forces. It will also require providing political and possibly additional economic assistance to Eastern Europe and the Soviet Union to facilitate their respective transitions to market economies and democratic political systems. Not providing this assistance could ultimately mean a failure to achieve closure on the trillions of dollars we have invested over the past four decades to win the Cold War.

One thing that will not be required, however, is an agreement on naval arms control. It simply makes no sense for the United States to tie itself to a diminishing Soviet threat in the one area that is most likely to require future growth. In a time of great uncertainty, maritime forces provide a unique capability and flexibility for coping with the unknown. Any number of unforeseen developments could require us to rebuild our naval forces in the years ahead. Moreover, the assumption that continued improvements in U.S./Soviet relations will require the United States to agree to constraints or limitations on its naval activities (beyond those that already exist) as a quid pro quo for the disproportionate concessions the Soviets have been making in land forces is becoming increasingly suspect. Changes in the political and strategic environment are now overtaking and rendering moot the naval arms control debate. There can be no greater confidence-building measure for would-be adversaries than to start cooperating in areas of mutual concern, much as the United States and Soviet Union are presently doing with respect to Iraq.

Beyond the above, it is difficult to see how Gorbachev will be able to keep things together. Not only have the various Soviet republics declared their autonomy, but even some cities and individual districts within cities are doing so as well. When you couple these moves toward independence with a situation in which there are so many displaced nationalities -- a legacy from Stalin's time in which he purposely transplanted ethnic groups to remote regions in order to suppress them more effectively -- it is difficult to see how they will avoid anarchy, let alone preserve the empire.

Even if one assumes a benign Soviet Union, however, significant security challenges to the United States will remain. Saddam Hussein serves as a useful reminder of the untidy world in which we live. Unless the standoff in the Arabian peninsula leads to outright war, though, it is doubtful that the planned defense build-down will be reversed. While it is clearly mitigating the magnitude of the reductions, it will not reverse them. The crisis may ultimately influence our mix of forces as well. An attempt to decommission our last two battleships has already been reversed and other weapons systems such as the B-2 bomber, the C-17, and the V-22 OSPREY may also acquire a new lease on life.

Beyond any impact on future budgets, the confrontation is already costing the United States an additional $15 billion a year in operational terms, costs that we have been asking other countries to help us bear. At this time, it looks as though we will end up absorbing about half of the total.

The ultimate impact of all this on Navy shipbuilding is yet uncertain. If the President's FY 1991 budget request and subsequent modifications thereto hold up, the Navy's shipbuilding and conversion budget will approximate $9 billion. This includes funding for thirteen ships -- down from nineteen requested a year earlier. These would include: one TRIDENT

SSBN, one SSN-21, four DDG-51s, one amphibious assault ship, one landing ship dock, three coastal mine hunters, one fast combat support ship, and one oceanographic research vessel.

As the Navy's older classes of ships are retired -- the DDG-2 ADAMS class destroyer, the DDG-37 COONTZ class destroyer, and soon the FF-1052 KNOX class frigate -- in greater numbers than newer ships are added to the fleet, the Navy's inventory of battle-force ships will steadily decline. At the end of FY 1989 the number was 566, and that is projected to decline to 546 by the end of FY 1991.

Such reductions also shrink the opportunities for overhaul and repair work. These trends are already at work as demonstrated by the differences in the FY 1990 and FY 1991 budgets for Navy ship repair, dropping from $4.15 billion to $3.53 billion, a reduction of 15%. If one carries out the harsh arithmetic of whatever "budget compromise" ultimately emerges, one faces the prospect of even further reductions in ship procurement, overhauls, and repair work.

In spite of the negative trends in the defense budget that inevitably affect our maritime forces, there is strong support within the Administration for a robust Navy that can meet peacetime requirements and respond effectively to unanticipated crises. That perspective, to the degree it is shared by Congressional leaders, will hopefully mean that future reductions are managed wisely and in a manner that will minimize economic dislocation.

Yet another ingredient in this equation are the lessons that are flowing from our military buildup in the Gulf, especially with respect to our needs relating to sealift. While the buildup has been impressive by any standard, with more than six billion pounds of supplies shipped, in some cases 8,000 miles by sea and air, to Saudi Arabia during the first 30 days of the operation, there have been a number of problems in using our 96-ship Ready Reserve Force. Only 14 of the first 41 ready reserve ships reached their loading ports on time. A few didn't make it at all. Because of some breakdowns in these ships which are generally in a poor state of readiness due to congressional under-funding, more foreign vessels have been recruited into service than originally planned -- and at considerable cost. Of the 44 private cargo ships chartered to support Desert Shield, 35 are foreign-owned, underlining the dramatic decline in the U.S.-flagged merchant marine -- down from 893 vessels in 1970 to only 367 today.

A Presidential commission warned in February of last year that the United States was dangerously short of the transport ships it would need in a major war. Accordingly, the panel recommended a 10-year, $13 billion construction program to meet the shortfall. Although Navy planners expect renewed shipbuilding on the commercial side to revive in the late '90s, there is presently only one such vessel now being built in a U.S. shipyard.

With the removal of U.S. shipbuilding subsidies a decade ago, U.S. yards are no longer competitive with their Japanese, Korean, and European counterparts, despite lower U.S. wage rates in most instances. Consequently, a number of U.S. yards have gone out of business and the industry has shrunk considerably. With fewer Navy contracts, this situation will be further exacerbated. Because the present attempt to persuade foreign countries to eliminate their subsidies is unlikely to succeed, other more creative approaches will be required.

It is imperative that the United States reposition itself with respect to commercial shipbuilding, both to maintain a viable base for the future and in order to compete effectively in what will become an increasingly lucrative market as older ships are replaced and the requirements of worldwide shipborne commerce increase. Moreover, the need to accommodate environmental concerns relating to oil spills and the like will dictate the replacement of single-hull ships with newer double-hulled alternatives.

There is simply too much at stake in terms of our future economic competitiveness to permit this country's once-proud shipbuilding industry to collapse as it most certainly will if present trends are not reversed.

[Ed Note: Dr. Johnston is a qualified submariner who served in SKIPJACK, ULYSSES S. GRANT and JAMES K. POLK. He is currently Executive Vice President and Chief Operating Officer of the Center for Strategic & International Studies in Washington, DC.] ■

A PERSPECTIVE OF SOVIET STRATEGIC SUBMARINE BASTIONS

by H. Lee Dantzler, Jr.

bas-tion n. 1: a fortified area or position that is considered to be a stronghold.

Strategic nuclear weapons systems are under intense review. This review is motivated by the changing world political climate, domestic economic and budgetary demands, and increasingly difficult technical challenges in maintaining a credible land-based strategic deterrent in an era of highly accurate missiles. SSBN submarines comprise a potent and central element of both the U.S. and the Soviet Union's strategic ballistic missile arsenal. The likelihood of a preemptive, short-notice nuclear war appears genuinely to have decreased. **The prospects of protracted, low-level conventional military conflicts that raise the risks of inadvertent nuclear escalation cannot be discounted.** While not attempting to predict the outcome of the current strategic weapons systems debate, it is likely that SSBN's will continue to play a central role in future strategic political and military policy debates. Consequently, an examination of Soviet SSBN operational strategies is appropriate.

Increasingly quiet and capable, the Soviet Union's SSBN force structure and deployment strategy pose a unique challenge to U.S. warfighting capabilities. The 1989 Soviet Military Power summary published by the Department of Defense continues to indicate that a significant number of Soviet submarines are deployed in coastal bastions -- namely, the Barents Sea and the Sea of Okhotsk. The 1988 summary outlines this strategy, and provides estimates of the actual SSBN force levels deployed in each area; those estimates are provided in Table 1. A deployment strategy that holds SSBN's in areas that are in close proximity to land-based defensive forces of the Soviet Union may significantly reduce the risk to them of the U.S. surface and airborne ASW pressures. The inherent stealth and mobility of the attack submarine makes it the ASW platform of choice, and necessity. This article explores these bastions, and attempts to provide some perspective on some of the challenges U.S. submarines might face if called upon to contest this strategy.

ESTIMATED SSBN FORCE LEVELS	
BARENTS SEA:	*SEA OF OKHOTSK SEA OF JAPAN*
• 24 DELTAS	• 16 DELTAS
• 9 YANKEES	• 8 YANKEES
• 5 TYPHOONS	
Source:	Soviet Military Power (1988) U.S. Department of Defense

Table 1.

Bastions

Bastions have rarely fared well in land combat. Immobile and frequently by-passed or neutralized, land bastions often provided security to the occupants only in times of peace. Soviet strategic submarine bastions incorporate attributes similar to those historically sought on land; namely,

- Controlled access.
- Defensive cover in depth.
- Bolt holes (escape routes) for the SSBN's in case the first two defense strategies fail.

The inherent stealth and mobility of nuclear submarines, however, inject new dimensions to the bastion concept. Consider now, the attributes of Soviet submarine bastions from a U.S. submarine's ASW perspective.

Submarine Access into Soviet Bastions

The Barents Sea and the Sea of Okhotsk are contiguous to the Soviet land mass and sheltered from the open ocean by island formations along the seas' ocean-facing perimeters. The Soviet Union's three major deep-water, ocean-access ports (Murmansk, Vladivostok, and Petropavlovsk-Kamchatskiy) all are located in or near these marginal seas, making the Barents and the Sea of Okhotsk prominent in any naval warfare planning. The general geography of both seas establishes natural ASW barriers that can be exploited by the Soviet Union to channel access into the postulated SSBN deployment areas through a few, defensible routes.

The principal passages into the Barents Sea (from the Norwegian Sea to the west, and the Arctic Ocean from the north) are relatively shallow (less than 1300 feet deep), and easily accessible from either the Soviet mainland or nearby islands within easy reach from the Soviet Union.

Access into the Sea of Okhotsk is more restricted than into the Barents Sea. Entry from the west is hindered by Sakhalin and Hokkaido Islands, and from the south and east by the Kuril Islands and the Kamchatka peninsula. The principal western approaches are through the Tatary Strait between Sakhalin Island and the Soviet mainland, and through La Perouse Strait between Sakhalin and Hokkaido, Japan. Navigable passages are available between some of the Kurils. The Kuril Island passages are more narrow than those of the Barents, but are significantly deeper, with some passage depths approaching 900 fathoms.

Both the Barents and the Sea of Okhotsk have extensive shallow water areas where average depths are less than 100 fathoms (Figures 1 and 2). Ice cover is an important tactical consideration in both areas during winter when much of the surface area of both seas is ice-covered. The winter ice cover in the Sea of Okhotsk is widespread, frequently extending out into the Pacific off the Kurils and the Kamchatka peninsula. The Kola peninsula coast of the Barents Sea (off Murmansk) remains relatively ice-free during the winter, with the remainder of the sea ice covered. All of the Sea of Okhotsk and all but the northernmost area above Spitsbergen and Franz Joseph Land in the Barents are ice-free during the summer.

The Barents Sea's varied bathymetry reflects the effects of extensive glaciation during the last glacial period. Significant bottom relief features resulting from that glaciation include submerged troughs and ridges, and coast lines that are broken by numerous fjords. The potential operational implications are discussed in a later section.

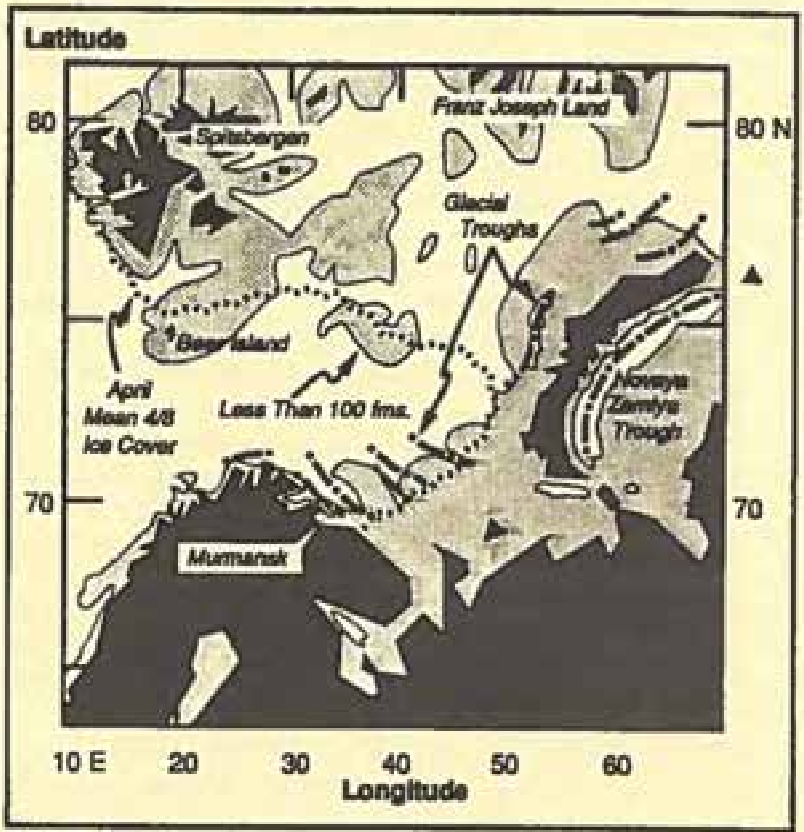


Figure 1.

[General Geography and bathymetry of the Barents Sea. The bottom topography reflects the effects of glaciation with scoured, deep-water basins and fjord-like coastlines. Extensive areas of the sea are covered with shallow water having depths less than 100 fathoms. These shallow water areas are punctuated with deeper-water troughs (indicated by the heavy, dot-dashed line segments) that are a result of previous glacial activity. The contemporary winter extent of four-eighths sea ice coverage is illustrated by the heavy, dashed line from near Spitsbergen to the Kola Peninsula east of Murmansk.]

Jane's Underwater Warfare Systems 1989-90, credits the Soviet Union with significant ASW mine capabilities. Inventories are estimated to include a deep-water 1000-fathom deployable vertically-rising acoustic influence mine as well as shallow

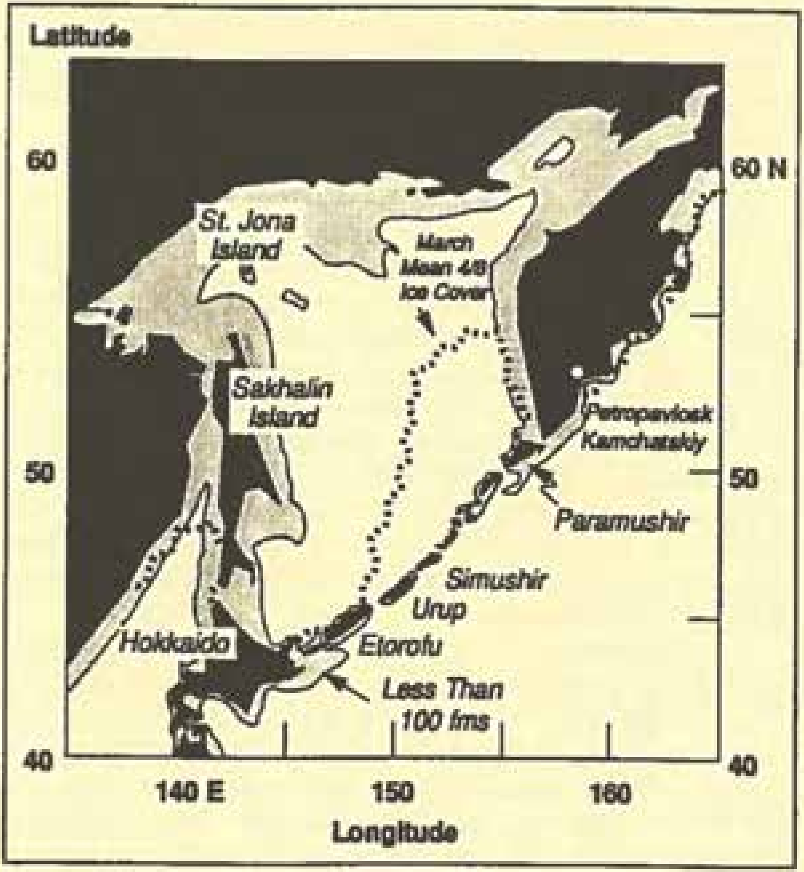


Figure 2.

[General geography and bathymetry of the Sea of Okhotsk. The sea has extensive areas of shallow water (depths less than 100 fathoms), and much of the area is covered with ice during thewinter. The shallow water areas are indicated by the shaded regions, and the mean maximum of four-eights ice cover (which occurs in March) is indicated by the heavy, dashed line.]

water magnetic, electric influence, and contact mines. Soviet Military Power postulates that ASW mines may be an integral part of the defensive strategy for their coastal bastions. The combination of naturally-restricted access into the Barents Sea and the Sea of Okhotsk, the close proximity of these areas to the Soviet mainland, and the ready availability of ASW mine resources makes an aggressive defensive ASW mining strategy a credible military option. Such a strategy would significantly challenge safe, unrestricted U.S. submarine access into these areas were mine barriers actually deployed and activated.

Defensive Cover in Depth

The Barents Sea and the Sea of Okhotsk are home to major organizational components of the Soviet Union's naval surface, air, and submarine ASW assets. The Defense Department's annual review of Soviet military power identifies several major military ground combatant, naval, and air facilities near Murmansk in the Barents, and Petropavlosk-Kamchatskiy, Sovetskaya Gavan, and Vladivostok in the Sea of Okhotsk areas. Geographic atlases show that both seas are also ringed by commercial and secondary airfields capable of handling up to commercial-sized aircraft. Helicopters could readily be deployed from any of these aviation facilities. Some of these secondary fields might also be capable of handling intermediate-range ASW aircraft such as the MAY as well.

The combination of favorably positioned in-place organic surface and submarine ASW forces together with an ASW aircraft surge deployment option provides a defense-in-depth for both submarine bastion areas. Defensive minefields could provide both an initial early warning and possible attrition of non-Soviet submarines entering either sea. Defensive minefields could have the additional impact of shepherding entering submarines into pre-defined ASW prosecution areas. Submarine contact datums in these ASW free fire zones could rapidly be prosecuted. Such a coordinated, multiple ASW platform defensive strategy, if successful, could reasonably be expected to help insulate bastion-deployed Soviet submarines from U.S. or Allied ASW pressures during a future conflict.

Bolt Holes for Soviet SSBNs

Medieval fortresses are renowned for secret passageways – bolt holes for the owners to use to escape or hide should the fortress defenses fail. The Barents Sea and the Sea of Okhotsk offer a strong natural analogue to this concept.

As presented earlier, the bathymetry of the Barents Sea reflects the effects of heavy glacial activity during the last ice age. Numerous deep-water fjords are found along the Kola, Novaya Zemlya, and Franz Joseph Land coasts. The deep water axes of many of these fjords extend out into Barents Sea, the results of glacial scouring. As the ancient ice sheets moved offshore, sediments from the coastal shelves were deposited at many locations in the Barents basin. The periodic advance then retreat of ice left an almost corrugated landscape of depositional ridges and meltwater erosional valleys. Many of these now-submerged features have a relative relief of 50 fathoms or more. Examples include the Novaya Zemlya Trough east of Novaya Zemlya, the Kanin Trough northeast of Murmansk, and the Dyprent depression extending seaward from the Parsanger fjord at North Cape, Norway. The submerged channels are often flanked by shallow banks, potentially affording an evading submarine opportunities to exploit topographic shielding from search sensors.

The Sea of Okhotsk reflects a different geologic history. The sea itself was closed off from the Pacific by volcanic islands (the Kuril Islands) landward of the Kuril-Kamchatka ocean trench. There the bottom of the Sea of Okhotsk rises from 1500 fathom depths along the Kuril Islands in the south to broad, shallow shelves to the north. Several large gulfs and bays indent the coastline, sometimes leading to protected, deeper water small basins such as the Shelikhova Gulf in the northeast. Several shallow water banks north of Sakhalin Island also create isolated pockets of navigable deepwater off Iony Island southwest of Okhotsk and Magadan. All of these areas offer naturally-sheltered havens for deployed submarines. Should the Soviet Union elect to deploy defensive minefields in the Sea of Okhotsk, these naturally-occurring evasion opportunities could be significantly enhanced.

A Question of Mines

The defensive ASW mining option figures prominently in both the Barents Sea and the Sea of Okhotsk. The geographic configuration of the Barents Sea and the Sea of Okhotsk encourage the use of mines as front-line defensive systems. The benefits could be many. Mine fields placed within the primary entry passages could provide some initial attrition of ingressing hostile (U.S. or Allied) submarines, and could also help improve ASW cueing by concentrating inbound submarines through the few deep entry passages. Mine fields within the seas themselves could also be used as they were during the Second World War as defensive barriers to protect SSBN deployment areas or escape routes. According to R. C. Duncan, in America's Use of Sea Mines, the U.S. and Great Britain laid over 300,000 offensive and defensive mines during World War II. By early 1942, the U.S. Army had completed the laying of defensive mine fields off the major ports in the northeast U.S., San Francisco, and the Panama Canal. These mine fields were remotely controlled from shore to allow transit to known, friendly vessels. Similar remotely controlled mine fields in either the Barents or the Sea of Okhotsk would pose a serious mobility problem to U.S. submarines attempting to operate in Soviet submarine bastions. Soviet submarines, on the other hand, could be allowed to operate at will over the entire areas.

Mines can serve as either defensive or offensive weapons. Consider the U.S. Command's offensive mine campaign in the Pacific Theater against Japan's sea lines of communication with southeast Asia. It is interesting to note that the tonnage lost to offensive mines with minimal U.S. platform losses is almost half the total lost to direct submarine combat in the Pacific.

The effectiveness of submarine-deployed, offensive mine fields during World War II with relatively unsophisticated mines raises the prospect that offensive submarine mine operations might offer a possible counter to bastion-sequestered targets. Unfortunately, mines are indiscriminate weapons whose effectiveness is strongly dependent upon the number of mines used, whether the mines' presence is known, and the number density of targets. Target selection and priorities cannot be ensured, and large numbers of mines might be required if used over broad areas of the Barents or Sea of Okhotsk. Therefore, the value of offensive submarine mining relative to the use of that weapon space for torpedoes is an open question.

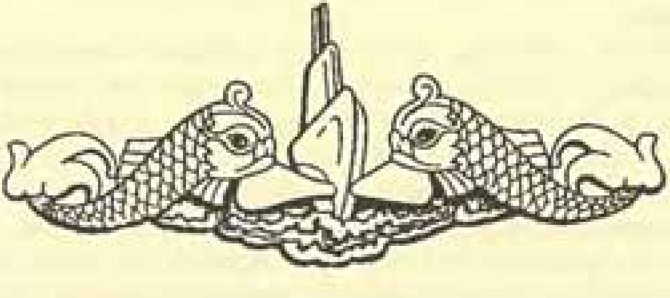
The Submarine's Perspective of Soviet Bastions

History has not been kind to fixed, military defensive systems. The Maginot Line was rendered ineffective by highly mobile German armor. The guns of Singapore were outflanked by a landward attack by the Japanese. Japan's Pacific island fortresses were by-passed by a U.S. "island-hopping" strategy. Numbers, technology, and tactics all work to the benefit of the offensive combatant.

Yet, a Soviet SSBN bastion deployment strategy will present formidable challenges to a viable, forward-oriented maritime policy in a major conflict. The combination of large, naturally-protected geographies, the ready availability of combined-arms ASW defensive cover, and the inherent mobility of the real target -- the Soviet SSBNs -- all will work against a U.S. strategic ASW campaign. The implications of permitting Soviet strategic submarine bastions to go unchallenged are, however, severe:

- U.S. surface and air ASW forces would effectively be eliminated as viable options in the heavily defended bastion areas, leaving U.S. SSNs to bear the brunt of a bastion ASW campaign.
- U.S. SSNs would be left to press the anti-SSBN campaign while operating in a severe, combined-arms defensive ASW cover, a cover that in all probability could see an extensive use of ASW mines.
- By using air and surface defensive ASW forces in the bastion area to help protect their SSBNs, the Soviet Union creates the option to release front-line SSNs otherwise employed in pro-SSBN operations for out-of-area offensive missions -- compounding the demand for U.S. SSNs already pressed to the forward areas.

Whatever the outcome of contemporary events in the Soviet Union and its allies, we must not lose sight that the U.S. attack submarine force must remain capable of exerting military pressure on Soviet SSBNs, whatever their deployment strategy may be. A critical examination of technological, tactical, and offensive options must be made to develop a viable submarine-bastion counter. The strategic military and political implications of acquiescing the bastion areas are simply unacceptable. ■



THE FIRST SOVIET NUCLEAR SUBMARINES

by Norman Polmar

Atomic research was underway in several countries before World War II, including in the Soviet Union where scientists are known to have been conducting research in this field as early as 1932. In 1939 or 1940, the USSR Academy of Sciences established a senior research committee to address the "uranium problem," which included the potential results of nuclear fission. The German invasion of the Soviet Union in June 1941 curtailed nuclear research efforts if not interest, because the major laboratories conducting research into nuclear physics were in Leningrad and Kharkov and were evacuated eastward from the war zone.

Early in the war, academicians Igor Vasilyevich Kurchatov and Anatoliy Petrovich Aleksandrov, the leading Soviet nuclear scientists of the 1940s, worked primarily on the protection of ships against magnetic mines at the Leningrad Physico-Technical Institute; subsequently, Kurchatov went to Sevastopol and Aleksandrov to the Northern Fleet to work in the mine counter-measures area. Late in 1942, however, they were reassigned to the development of nuclear weapons. There is ample evidence that the Soviets were by then aware of nuclear developments in the United States as well as in Germany. The Soviets correctly concluded that the United States was making an atomic bomb when American physics journals ceased publishing material about uranium fission and chain reactions; similar indications from Germany were confirmed by a notebook containing calculations related to nuclear weapons taken from the body of a dead German officer. The Soviets were also aided by an atomic espionage ring in the United States and Canada.

By late 1942 the Soviet State Defense Committee had established a military nuclear program, only a few months after the U.S. Manhattan Project to develop the atomic bomb had been initiated in the United states. In early 1943 research was resumed in Moscow under the leadership of Kurchatov, with scientists and engineers being recalled from the front, other research institutes, and industry to develop the atomic bomb. This wartime effort was under the overall direction of Lavrenty Beria, the head of state security and one of Stalin's principal lieutenants. Immediately after the U.S. atomic bombings of Japan in August 1945, the Central Committee of the Communist Party "outlined the primary state task -- to eliminate in the shortest period of time the monopoly of the United States in nuclear weapons ...."

The secret Laboratory No. 2 of the Academy of Sciences in Moscow was the focus for basic scientific research into nuclear weapons. (Nuclear Laboratory No. 1 was in Kharkov.) The scale of the Soviet laboratory effort was, however, much smaller than the analogous U.S. activity at Los Alamos, New Mexico. The first Soviet atomic reactor, the F-1 (Physics-1) was started up on 25 December 1946, and the first Soviet atomic bomb was detonated in August 1949 -- several years before U.S. scientists had predicted that such an event would occur.

Soviet sources indicate that the initial work on nuclear propulsion began shortly after World War II. Apparently even during the war there was some discussion of the use of nuclear energy for ship propulsion but, according to Soviet scientist Aleksandrov, "...in 1945 it was Beria who imposed a ban on the idea of atomic ships: First the bomb, all else later. You see, back then we at the Institute ... had begun designing an atomic plant for ships."

In 1947, B. M. Malinin, the dean of Soviet submarine designers wrote:

> *A submarine must become an underwater boat in the full meaning of the word. This means that it must spend the greater and overwhelming part of its life underwater, appearing on the surface of the sea only in exceptional circumstances .... The submarine will remain the most formidable weapon in naval warfare .... If... it is considered that the appearance of superpowerful engines, powered by intranuclear (atomic) energy is probable in the near future -- then the correct selection of the direction in which the evolution must go is ... the basic condition for the success of submarines.*

Malinin, however, did not live to see the realization of an atomic submarine. One of his assistants, Engineer-Captain 1st Rank Vladimir Nikolayevich Peregudov, became the chief designer of the first Soviet nuclear submarines. Peregudov was a graduate of the (Dzerzhinsky) naval engineering school in Leningrad, had worked on various submarine designs in the

1930s, and had been imprisoned during the Stalinist purges of the late 1930s (which thoroughly ruined his health). At the end of the war Peregudov was engaged in designing the new generation of Soviet diesel-electric submarines.

In 1952, probably at Malinin's behest, Peregudov was named chief designer of the first soviet nuclear-propelled submarines. Work on a submarine nuclear plant had been underway for several years when construction of the first nuclear submarine was initiated in 1953. Peregudov's efforts were under the aegis of design bureau TsKB No. 143, one of the central design bureaus for submarines.

With Stalin's death in 1953 the ban on open discussion of nuclear issues was lifted and in 1954 the newspaper Krasnya Zvezda, the official publication of the Soviet armed forces, broke the seven-year press silence on the subject of atomic energy and atomic power. During 1954-1955 approximately 50 articles on the military aspects of atomic energy appeared in that publication alone, some of which dealt with nuclear propulsion for ships. Most articles were guarded in their discussion of nuclear propulsion, with some favorable and some openly hostile. Discussions were being held at the highest level of Soviet government on the role of nuclear weapons. These discussions involved Marshal of the Soviet Union Georgi Zhukov, the Minister of Defense from 1955 to 1957. His indifference -- and possible opposition -- to naval programs, including nuclear submarines, was later cited as one of the reasons for his dismissal from the ruling presidium (politburo). Other factors, however, were more significant in Zhukov's dismissal by the presidium under Nikita Khrushchev's leadership.

The presidium approved nuclear propulsion and several submarine projects were begun in the mid-1950s. The first Soviet nuclear-propelled submarine was Project 627, being given the U.S./NATO code name NOVEMBER. The first NOVEMBER SSN was completed in 1958. The completion of the first Soviet nuclear submarine thus lagged about four years behind her U.S. counterpart. The senior assistant (executive officer) of that first nuclear submarine, Captain 2nd Rank L. M. Zhiltsov, recalled:

> *When in the tests the reactor drove the submarine to standard speed, everyone on the bridge was shaken ... by*

the quietness. For the first time in all my duty on submarines, I heard the sound of the waves near the bow end. On conventional submarines, the sound of the exhaust from the diesel engines covers everything else. But here there was no rattling and no vibration.

The first commanding officer of that first Soviet nuclear submarine, later named LENINSKY KOMSOMOL, was Captain 1st Rank L. G. Osipenko.

In 1960 Khrushchev asserted that the Soviet Navy had nuclear-propelled submarines and that they were capable of firing rockets with nuclear warheads. Khrushchev's announcement of 20 October 1960, was the first official Soviet claim that such submarines existed. A year later, on 14 October 1961, the newspaper Izvestia published what was purported to be a photo of a Soviet nuclear submarine and cited Khrushchev for his decision to proceed with nuclear submarine construction, as "the father of the nuclear fleet which today guards our Soviet state."

In July 1962 the Chief of the Main Naval Staff, Admiral F. V. Zozula, was quoted in the military newspaper Krasnaya Zvezda as declaring that nuclear-propelled submarines armed with missiles were "the main shock force" of the Soviet Navy. This statement -- soon followed by similar declarations from other Navy officials -- indicated still another dimension of the Soviet undersea threat to the West. (That same month, in conjunction with Soviet Navy Day, Nikita Khrushchev reportedly observed an underwater firing of a ballistic missile from a submarine in the Baltic.)

The United States had begun its nuclear propulsion program with two prototypes for torpedo-attack submarines (SSN), to be followed by series production of the torpedo-attack type. The Soviet program simultaneously initiated three production designs: the NOVEMBER SSN, HOTEL SSBN, and ECHO SSGN. All three classes shared certain design features and all had the same two-reactor propulsion plant, which was referred to by Western intelligence as both the Type 1 and the HEN (for the three submarine classes in which it was employed). The NOVEMBER plant, using pressurized-water as the heat exchange medium, is believed to have produced approximately 35,000 horsepower compared to 15,000 horsepower for the NAUTILUS and only 7,500 horsepower for the subsequent SKATE (SSN 578), the first U.S. series-produced nuclear submarine and a near-contemporary of the NOVEMBER.

Early Western intelligence analysis had underestimated the NOVEMBER's propulsion plant. When the NOVEMBER first went to sea the submarine was thought in the West to have a submerged speed of under 25 knots (the NAUTILUS was rated at 23.3 knots). Then, on 5 January 1968 a NOVEMBER was trailing the U.S. nuclear-propelled carrier ENTERPRISE (CVAN 65) off the coast of California. The carrier accelerated, expecting the submarine to drop away in her wake, but the NOVEMBER kept pace with the ENTERPRISE. Finally, the carrier reached 31 knots, about her maximum speed. The NOVEMBER reached a speed of about 28 knots. The Western intelligence community was surprised and concerned. (The follow-on VICTOR SSN, which was about to go to sea, was a still faster attack submarine.)

The NOVEMBER had an unusual hull configuration, somewhere between an advanced conventional (Type XXI) submarine design and the tear-drop or ALBACORE (AGSS 569) design. Incorporating the large two-reactor propulsion plant with a full armament, the NOVEMBER displaced approximately 4,500 tons surfaced and 5,300 tons submerged (i.e., it was 20 percent larger than the NAUTILUS). The Soviet submarine had an armament of eight standard 21-inch (533-mm) torpedo tubes forward and carried 24 torpedoes. No stern tubes were fitted (although most Western references list them).

The early nuclear-propelled submarines suffered engineering problems. There were continuous leaks in the propulsion plants, especially the steam generators, with the crew having to periodically don respirators while they searched for the leaks. The early generators were found to have an extremely short service life; those initially installed in Soviet nuclear submarines began to leak after some 800 hours of operation. "We felt like heroes," recalled one commanding officer of a NOVEMBER SSN when his engineers were able to extend the failure time to 1,200 hours. (Tests ashore had demonstrated that the operating time before failure should have been 18,000 to 20,000 hours. The long-term solution was to change the material in the generators, the design itself having been found sound and providing benefits over the similar U.S. system, such as higher operating temperatures and hence greater power.)

Reliability problems continued to plague Soviet nuclear-propelled submarines, and would cause several major casualties.

The first few NOVEMBER SSNs may have encountered engineering difficulties. According to German reports, after the first five submarines went to sea the successive units were modified during construction (or possibly just after completion). The hull was extended by a section -- possibly as much as 36 feet (11-m) long -- being added aft of the sail structure, to enlarge the submarine's engineering spaces. The modifications to the propulsion plant provided in this space resulted in the later submarines being slightly faster (and possibly quieter).

While the NOVEMBER was faster than contemporary U.S. submarines, her 35,000-horsepower plant still could not propel her as fast as the later-design U.S. SKIPJACK (SSN 585), which had an S5W reactor plant generating only 15,000 shaft horsepower. Several factors caused this situation, among them (1) the length-to-beam ratios of the submarines with the NOVEMBER having more wetted surface, (2) drag caused by the NOVEMBER having two propellers and the SKIPJACK one, (3) the revolutions per minute of the turbine, approximately 500 for the NOVEMBER and 150 in the more efficient SKIPJACK, which had improved gearing, (4) the NOVEMBER having fixed horizontal stabilizers ahead of the stern diving planes, and (5) the much greater reserve buoyancy of the NOVEMBER (in excess of 30 percent).

Not only was the NOVEMBER faster than contemporary U.S. nuclear submarines, but she could dive deeper. The NAUTILUS and the SKATE-class boats had an operating depth of 700 feet (213 m). While little definitive information on Soviet submarine operating depths is available in the West, the NOVEMBER and the other HEN-series Soviet nuclear submarines are believed to have been able to reach at least 1,000 feet (305 m). The NOVEMBER and her contemporaries in the Soviet undersea fleet, however, were noisier than their U.S. counterparts. Submarine noise is produced by three primary sources: internal machinery, propellers, and the flow of water over the submarine (hydrodynamic noise). In all three categories the early Soviet nuclear submarines appear to have produced higher noise levels.

The Severodvinsk Shipyard No. 402 built all 13 of the NOVEMBER-class SSNs. Construction of the first unit began in 1954, and that submarine was commissioned into the fleet in August 1958; the last NOVEMBER went to sea in 1964. The NOVEMBER marked the beginning of a nuclear submarine program that has overtaken the West in quantity and, some will argue with considerable evidence, in quality as well.

[This description of Soviet nuclear submarine development is adapted from *<u>Submarines of the Russian and Soviet Navies, 1718 to 1990</u>* *by Norman Polmar and Lt.Comdr. Jurrien Noot, Royal Netherlands Navy, published by the U.S. Naval Institute.]*

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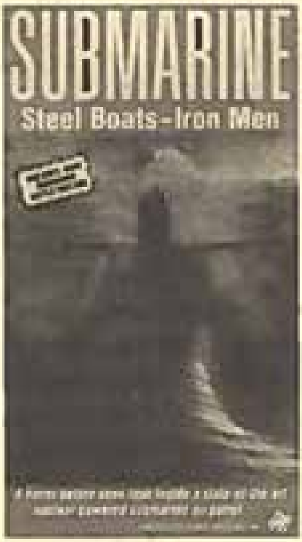
SUBMARINE: STEEL BOATS, IRON MEN



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DUTCH TRIPLE-HULL DESIGN REVISITED

by Pieter L. van Ewijk

There was an ingenious development in submarine construction by the Royal Dutch Navy. The importance of this one unique class of submarines may warrant another look at that development.

Throughout history there have been numerous interesting designs for submarines; there is no doubt of this. The very first designs were intriguing both in terms of navigation capabilities and weapon platforms. Some designs were a success, and were starting points for new and more innovative designs. Others were not, and sometimes this proved fatal to both crew and craft.

The First World War showed that submarines could, under the right circumstances, be very capable of performing dangerous missions, and be dangerous weapons. Great Britain came close to being totally isolated by the Germans. This served as a lesson to all major seafaring powers, and pressure was put on the various building and design departments in these countries to increase their submarine fleets both in size and capabilities. In the years between the two world wars, a great variety of craft entered service in the various countries. There were submarines with turrets housing "battleship guns." Some submarines were capable of carrying one or two airplanes in deck hangars or a platoon of marines; others had cargo holds to carry on trade by travelling beneath a force blockading a country's ports. There were submarines varying in size from one man craft to the very large, long range boats of the United States and Japan.

As the Second World War progressed, the superiority of the German submarine became evident. By the end of the war they had a large number of submarines which ranged from some pre-war, small coastal craft, to their most successful TYPE-7 U-Boats and newest designs of true submarines of the TYPE-21.

At the end of the Second World War the Netherlands had a submarine fleet comprised of three types of boats. There were the 'O' boats built and designed for service in the North Sea and the Atlantic. The 'K' boats, larger in size and longer range, were primarily used on the Dutch overseas stations of Indonesia, Suriname and the Netherlands Antilles. Both groups were designed and built by Dutch yards. Finally, to cover war-time losses and keep their forces at a required strength, the Dutch leased a number of surplus British craft.

All the previous developments were the result of only one consideration: staying ahead of what one's potential opponents are doing. The race for underseas superiority was started by the very first submarine builders, raged during the wars, and continues today with the advent of ultra silent submarines, nuclear power and missiles, closed cycle propulsion systems and state of the art sonar/sensor/detection systems.

During the late 'forties, however, it was quite clear that the Dutch Navy required replacements for outdated submarines. During the design stages, Mr. M. F. Gunning, a retired Dutch naval designer, came up with a new design that, although not continued in any other class of boats, is interesting to review.

The new design called for an outer hull in the general shape of a triangle, with three individual pressure hulls inside the triangle: the top hull housed the control room, all sensors, weapon systems and crew's quarters, while the lower two contained the port and starboard engine room, auxiliary engines, motors and generators, as well as battery storage and pumps.

These lower pressure hulls were connected to the upper hull in two places only, which also greatly increased the survivability of the submarine as a whole. The design allowed for a fairly large-sized sub to be fitted into a medium-sized hull, therefore not compromising the weapon load she carried, and allowed for an operational diving depth of 1000 feet, which was a remarkable achievement in the late 'fifties and early 'sixties.

These boats had a surface displacement of 1494 tons, while submerged they displaced 1826 tons. The maximum speed of the boats in this class was 14 knots surfaced, and up to 17 knots submerged. It is interesting to note, however, that the surface speed was attained by 3100 HP diesels, while contemporary subs like the British PORPOISE class, which were only a few hundred tons larger in size, required 6000 HP Admiralty Standard diesels to achieve the same surface speed. There were a total of eight torpedo tubes: four in the bow and four in the stern of the boat. A total of twenty-two reloads were carried on board.

Four boats of this new type were approved by the Dutch government in 1949, and ordered from Dutch shipbuilding companies the following year. As construction started, however, two boats were delayed in order to evaluate the new design and to be able to incorporate changes due to lessons learned from the first two boats. In addition to this, the Dutch were also able to install new technology in the fields of sensors and communications in the last two boats of the class.

Any other boat at that time (and up to the present for that matter) was constructed with a single cylindrical shaped pressure hull. Large boats usually had two decks, but this was achieved simply by inserting a horizontal deck within the one pressure hull. As boats got to be bigger in size, the need arose to use heavier gauge steel for the pressure hull; the only drawback to this principle is that more of the submarine's weight is used for hull structure and integrity, rather than equipment or machinery. As size increases, weight will increase, which will require more power, which in turn will increase weight ..., a vicious cycle.

All four boats in the class (HMNLS DOLFIJN, ZEEHOND, POTVIS and TONIJN) were completed between 1961 and 1967, and entered service about a year after completion. The designs were indeed superior at the time, making this class one of the quietest of all; a reputation shared with the British PORPOISE/OBERON boats. These boats fulfilled all requirements placed on their design, and operated for many years without any major problems or incidents. In the late 1970s, they were due for life extension refits, and were all upgraded to the same standards, thereby eliminating any previous differences between the lead boats, and the two followers. As the time came, however, in the seventies, to look for a replacement of some of the older boats still in service, it became increasingly obvious that this design, however successful, was not practical to incorporate in the new class of boats on the drawing board.

During the mid-life refits, the Dutch yard that overhauled the boats found it very difficult to service the diesels. All the engineering spaces were extremely cramped, making normal maintenance a strenuous exercise, and making any speedy overhauls impossible. Added to this, there were some other major concerns and problems that could not be ignored. These had either been overlooked when the DOLFIJN class boats were designed, or simply were not an issue at that time.

One of the main changes to be reckoned with was creature comforts. On the tri-hull boats a hot-bunking system was in place: there were only 50 bunks for 70 crew members. Only two shower stalls were to be found on the whole boat; one in officers country, and one for use by the enlisted men. The one galley that was used for serving the whole crew was only about five square meters in size, while the mess hall could only seat about fifteen to twenty men at a time.

To be incorporated in the next design were larger crew quarters and spaces, better sensors and nuclear propulsion. Although these boats were completed, they were not nuclear powered. All these changes in requirements, habitability, range and load, meant that the triple hull design was a one time only trial. While a successful design, it was not to be continued in further Dutch classes for the reasons stated.

When I had the opportunity to go on a tour of HMNLS DOLFIJN in the early 1980s, it became evident to me how cramped indeed these subs were. A visit to a USS BARBEL class sub in 1986 showed that, even though this was an old and cramped sub by the standard of nuclear submarines, it was spacious when compared to the Dutch tri-hull design. This could well be the end of the story, for the Dutch never did pursue the ideas, principles and lessons learned from this type of boat.

There is, however, a different ending here. Several sources, including the book Combat Arms/Modern Submarines by David Miller, report that the Soviet TYPHOON class ballistic missile submarines also are designed using multiple hulls. It is assumed that there are two hulls, side by side, on the bottom. Each of those cylinders would contain one row of missiles, forward torpedo tubes, one reactor, and engineering compartment containing the propulsion to the propeller. A third pressure hull is located on top of the other two, but it extends only over part of the length of the sub: it is situated under the sail, and contains crew quarters, all weapons and sensor controls. This is similar to the Dutch design, although these subs must certainly be roomier than the original Dutch version. As the total displacement is around 25,000 tons, this means that each hull would be quite sizable by itself, and it would be impractical to construct this behemoth using one gigantic pressure hull. Again, here the design surely has survivability, habitability, and time to be spent on station as the grounds for the design and layout of this class of submarines.

So it appears that the triple, or multiple, pressure hull designs in submarines are again in the news. What further developments are in progress, or being studied at this time, is not known. Whether the Soviets will pursue this design into the next generation of submarines will depend on how effective the design is, (as far as serviceability and routine maintenance is concerned) and what economic, political and strategic constraints are encountered in this decade.

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–Submarine Technology Symposium 1991–

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STS 91

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Members interested in applying for participation as a speaker should contact Mr. G. Richard Thompson, STS 91 Program Chairman, at (301) 953 5396.

■

REMEMBERING THE USS THRESHER (SSN 593)

by Daniel A. Curran

Commissioned on August 30, 1961 at Portsmouth Naval Shipyard, the USS THRESHER (SSN 593) was the lead ship of a new class of deep diving nuclear submarines that incorporated several new features. In addition to nuclear power, these included the optimum hydrodynamic hull form based on the USS ALBACORE tear drop design and an advanced, state-of-the-art integrated sensor suite -- the AN/BQQ-2, designed and produced by the Submarine Signal Operation of Raytheon Company.

The new ship, which was named for the thresher shark, was the second U.S. submarine to carry the name. The first THRESHER (SS 200) had achieved a distinguished war record in World War II. The nuclear powered THRESHER chose "Silent Strength" as her motto; when she was commissioned in 1961, she was designed to operate deeper and quieter than any of her predecessors, including the NAUTILUS, the SKATE class, and the SKIPJACK class.

After commissioning, the THRESHER's principal operational duties were to test and evaluate all of the new advances incorporated in her design so that modifications and corrections could be made to the THRESHER and her subsequent sister ships, starting with the USS PERMIT (SSN 594). Besides the crew, many people were deeply involved with these tests and sea trials, including officers and civilian technicians from the Portsmouth Naval Shipyard, and engineering and test people from Raytheon Company, Sperry Gyroscope Company, and the Naval Ordnance Laboratory.

On April 10, 1963, while conducting deep dive tests about 220 miles off Boston, Massachusetts, the THRESHER was lost with all hands. The complement of the ship that day was comprised of 129 men: 16 officers, 96 crew, and 17 civilian technicians. The nation and the naval community were stunned.

At the time of the THRESHER loss, President John F. Kennedy said, "*The future of our country will always be sure where there are men such as these to give their lives to preserve it.*"

On April 8, 1990, 27 years after that tragic event, a monument was dedicated to the memory of the THRESHER and her men at Albacore park in Portsmouth, New Hampshire. For those involved in the submarine business, the dedication ceremony brought back vivid memories of the loss of the ship, friends, and co-workers.

The writer, now the Marketing Manager for Raytheon's Submarine Signal Division, was then a young naval officer about to start submarine school at Groton, Connecticut.

"The completion of the nuclear reactor training in April was just the first step towards joining the submarine force. The start of submarine school meant signing up for base housing; so on the morning of April 11, 1963, I had driven from the SIC nuclear reactor prototype at Windsor Locks, Connecticut, to the submarine base. As I approached the main gate, the Marine guard waved me to the side of the road and a group of official Navy cars sped through the gate. I asked the Marine guard what was going on. He said that something had happened to one of the submarines and officials from Washington and Norfolk were meeting at the base. Later, on the evening news, the Navy announced that the THRESHER was missing after conducting diving trials off the New England coast. One of my friends from the Naval Academy, LT(jg) John J. Wiley, had been assigned to THRESHER as his first submarine. Although John was a year ahead of me at the academy, he and I had taken the first nuclear engineering course offered there in preparation for entering the nuclear submarine force."

Others remember that fateful day. Mark Chramiec, Raytheon Principal Engineer, was then the systems engineer responsible for the overall tests to validate the Retrofit 2 of the AN/BQQ-2. He remembers the events preceding the THRESHER's final sailing and his co-worker, Maurice Jaquay, who was aboard for the fateful trip.

"Sometime during the week preceding the scheduled trials, CDR Wes Harvey, the CO of the THRESHER, stopped by to notify us that no time could be spared on the first trial to conduct the scheduled formal sonar tests. Several of us knew CDR Harvey quite well, because he had been the Engineering Officer on the TULLIBEE, the submarine on which we had spent a lot of time installing and testing the second of the initial two lot BQQ-2 sonar suites. He did, however, add that one of us was welcome to check out the sonar fixes to get an idea of how things stood. Mo Jaquay, who was in the area, said that he would go. Mo then went home for the weekend, planning to return to the HoJo's at which we were staying Monday night so as to embark Tuesday morning. The rest of us stayed to make sure that everything was working.

"On Tuesday morning the wake-up call service in HoJo's called everybody late. As Mo left in a hurry for the THRESHER, he said, 'You guys think anybody will mind if I miss this trip?' The following Wednesday (I think), Jim Kyle and I were returning from an evening class when we heard on the car radio that the THRESHER had not been heard from after a test dive and was assumed to be in trouble. Jim said, 'It's probably only a communication problem,' and I remember saying, 'Sure,', but thinking that emergency communication to a nearby escort was relatively easy. Yet I was hoping he was right, because the other alternative was unthinkable."

Captain Art Gilmore, USN(Ret.), was then the operations officer for Submarine Development Group 2 (CSDG 2), and had responsibility for the sonars on the boats assigned to the Development Group. Later he made two dives on the TRIESTE, looking for any signs of the THRESHER.

"I rode the THRESHER several times between her commissioning and Post Shakedown Availability (PSA), and one was the roughest submarine ride into New London I ever made. That trip is worth a full page! LT Bob Ulman, the CSDG-2 engineer, and I both decided not to ride the Post PSA sea trials due to the crowd. The trial would not address the sonar and the ship was coming to New London within a month. A reluctant but good decision!

"We were notified as soon as the rescue ship realized she had a problem, and the atmosphere in the CSDG-2 headquarters at the day was subdued, tense, and hectic. I was not involved in the early activity, but I knew something was up. Lt Ulman left with a set of plans (salvage plans) by a chartered airplane for Portsmouth, NH. CDR Sam Francis was on leave in New Hampshire and he was being located. I got involved later in the day when CDR Jim Bellah told me to call my wife and tell her I would not be home until late that night without giving her any specific reason.

"About 4:00 p.m., CDR Bellah briefed me on the situation, essentially that communications had been lost with THRESHER and that if nothing changed, we were going to call the next-of-kin later in the evening. I don't remember when we started; the list was split between New London and Portsmouth. Between the two groups we called everyone we could locate, and most we called twice. The calls were simply to alert the dependents to the problem, assure them the U.S. Navy was doing everything we could to locate the ship and give them a personal point of contact. If they asked me what I thought, I told them that in my professional opinion the ship was lost. If they asked me what they could do, I told them they should pray; that was what I was doing. I'll remember some of those calls the rest of my life. We finished about 4:00 or 5:00 a.m.

"The next phase was the long search to find the THRESHER. I was involved in that from shortly after the accident until Labor Day. The atmosphere was different; while it was a tragic event, it was a challenge to find the ship with what little technology existed then. There was a lot of work involved and a lot of time at sea. Things that stand out include:

- The early search effort with lots of U.S. Navy ships with no real capability to search anything but the sea surface;
- The arrival of the U.S. Oceanographic Community ships, early side scan sonars, bottom photography, deep magnetometers, and precision bottom profilers. A false alarm based on a bottom photograph sent me to sea as the on-scene USN officer. After a good magnetometer strike and bottom photographs of some large submarine components, I returned to Boston aboard USNS GILLIS with no hat, five cents, and instructions to be in Washington, DC with the picture in the morning.
- The plan to bring the bathyscaphe TRIESTE from San Diego to Boston was written on the back of an envelope in a bar in Woods Hole, Massachusetts, late on a Friday night. The next day we were asked by Captain Bishop, the CNO THRESHER Search Coordinator, for just such a plan; we read the back of the envelope to him over the telephone. He said to add 'CNO concurs' and send it as a naval message. We did. It was hard to change that

plan, but somehow TRIESTE made it to Boston.

- Of the two dives I made in TRIESTE in the search area, the second one, by luck, was the one when we saw what we came for -- major parts of the ship. We photographed the sonar dome with the draft marks clearly visible and brought back a piece of battered pipe from the ship. It was an emotional experience. I trust the Almighty can receive prayers through 8500 feet of water better than we can communicate underwater.

"TRIESTE dives in themselves were interesting. They were 14 to 16 hours long with three people (and no head) and five racks of electronics in a six-foot diameter sphere. You controlled the oxygen and carbon dioxide levels by the headache tolerance factor. Both the TRIESTE and the piece of pipe are in the Navy Museum in Washington, DC.

"Other memories come to mind:

- CDR Wes Harvey, the Commanding Officer in the THRESHER graduated from the U.S. Naval Academy in 1950. My sister and a friend of hers (who is now my wife) attended the graduation ceremony. After the THRESHER was lost, my sister discovered that the midshipman's cap that she retrieved that day had Wes Harvey's card in it. We refurbished it with a new cap cover and new gold and gave it to his widow.
- The Dolphin Scholarship fund was established for the THRESHER dependents and the Rhode Island Chapter of the Navy League presented the first major contribution at a Yankee-Red Sox baseball game in Boston. We were invited to the game with our wives as guests of the Red Sox. My wife, Nell, sat in a box seat with the Red Sox Manager's wife, waving her Yankee Pennant. The Red Sox won 21-14; there were 42 hits in the game, and I think Yogi Berra got thrown out of the game for something he said that the umpire understood.
- Mike Dinola's widow and family stand out. They stayed in Rye Beach, NH, where his wife raised a super family on her own. Most of his submarine friends and classmates in the Washington, DC area joined them in Arlington a few years ago when a headstone was placed for Mike. I guess that sort of laid a lot to rest for all of us."

The TRIESTE located the wreckage of the THRESHER during the summer of 1963 in 8,400 feet of water, 220 miles off Boston. The subsequent board of inquiry headed by Vice Admiral Bernard L. Austin concluded that a flooding casualty in the engine room was the most probable cause of the sinking of the THRESHER. As a result of the THRESHER loss, significant improvements related to ship safety were made in the design, testing, certification and operation of submarines. These improvements were called the SUBSAFE program and were implemented on every nuclear submarine.

The years go by too quickly and there were special memories for each of the people at Albacore park on April 8, 1990, for the dedication ceremony. Mr. Robert Silberman, Deputy Assistant Secretary of the Navy, delivered some remarks and read letters from the President and from Congressional and Naval officials. Reprinted below is the President's letter:

THE WHITE HOUSE
Washington
April 6, 1990

I am delighted to send my warmest greetings to all those gathered for the dedication of the USS THRESHER Memorial. It is most fitting that the memory of those who gave their lives aboard USS THRESHER (SSN 593) be preserved in Portsmouth, where so many of our silent sentinels of the deep have been built.

Almost three decades ago, 129 men were lost aboard the most advanced attack submarine of its day. These men knew the risks they would encounter in testing a new, untried vessel, but they pursued their duty with courage and unselfish dedication. Their sacrifice was great, but it was not in vain. This tragedy resulted in significant advances in the design, testing, and operation of critical submarine systems that today go to sea in our STURGEON and LOS ANGELES class submarines.

The contribution that these brave men made to the defense of their country can best be understood by recalling the reason they were aboard THRESHER that fateful day in 1963. They were working to perfect a vital component of our deterrent forces -- and, thus, safeguarding the great blessings of freedom and democracy that we and our Allies enjoy.

I salute the spirit of the men -- both Navy and civilian -- of

THRESHER, and I commend the United States Submarine Veterans, the citizens of Portsmouth, and all others whose dedication and hard work have made this memorial a reality.

Barbara joins me in offering our best wishes on this special day of remembrance for the crew and families of THRESHER. God bless you.

George Bush

Rear Admiral William P. Houley, Commander Submarine Group 2, made the closing remarks, and the granite and bronze monument was unveiled. The monument contains on the front side the names of all of the men lost on the THRESHER, including the civilian technicians. The ship's plaques and the U.S. Submarine Veterans insignia containing the submarine dolphins are on the top of the stone.

Many organizations and individuals donated to the memorial fund, which was managed by the United States Submarine Veterans. Mrs. Curran and I represented Raytheon, one of the three corporate donors, at the ceremony. Also attending were Fred Korth, then the Secretary of the Navy and many families, friends, and former shipmates of those who were lost.

Because the funds collected exceeded the amount needed for the monument and the dedication ceremony, excess funds are being used to establish a memorial fund for the USS SCORPION (SSN 589) lost in the Atlantic on May 21, 1968. Donations for SCORPION may be made to:

The U.S. Submarine Veterans/SCORPION Memorial
P.O. Box 370, Tamworth, NH 03886.

[Ed. Note: The stipend for this article is being sent to the SCORPION Memorial Fund in the name of Dan Curran, Art Gilmore and Mark Chramiec.]

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THE CONTROL OF HIGH SPEED SUBMARINES

by William P. Gruner

The Submarine Stability Problem

As the numbers, types and capabilities of modern weapons and weapon systems have proliferated, the pace and tempo of modern warfare has increased. As this has occurred, the ability of human beings to manually control their weapon systems has decreased. A major problem exists in controlling the underwater trajectory, or "flight path", of submarines during high speed maneuvers. This first became known in 1954 shortly after the experimental research submarine ALBACORE (AGSS 569) began operations. Officially described as a hydrodynamic test vehicle, ALBACORE had the hull design of a low drag "body of revolution", and a high capacity battery. Her submerged speed was somewhat in excess of thirty knots. With considerable foresight, the designers provided ALBACORE with a one-man control system with modes varying from manual to fully automatic. In concept, she was to be "flown" by the "pilot" like a high speed aircraft.

When operations began, ALBACORE performed splendidly while submerged on a steady course. However, it was discovered that her design permitted a roll/yaw force-coupling to take over when she was put into a high speed turn. In the **SUBMARINE REVIEW** of January 1988, Henry E. Payne III discussed submarine instability during high-speed maneuvers. He drew the dramatic picture of a modern high-speed sub pilot in a melee situation. He "tries to turn too sharply at too high a speed" and finds himself "in a snap roll, hanging from his seat belt and with a loss of several hundred feet in depth at a markedly slowed speed." In support of his article, Mr. Payne discussed the characteristics of water flow about the hull, sail and planes, and the generation of vortices of turbulent water. He stated that vortices result from ship motion through the water, and are the root cause for the inability of modern submarines to maneuver under water with the same sort of stability as airplanes in the atmosphere." The article included pictures of smoke-flow patterns made during wind tunnel tests of a 1/75th scale model of SKIPJACK (SSN 585), another submarine with a "body of revolution" hull design. The purpose of the tests was to examine flow patterns about the hull during high speed maneuvers. It is evident from the pictures that significant pressure differentials existed in various locations on the hull. Such pressures cause varying forces to be exerted on the hull at different roll and yaw angles. Applying the basic law of physics that Force = Mass x Acceleration, it is clear that these forces would cause gyrations of the hull about all three axes, and also affect the submarine's depth and speed. Mr. Payne states, "With a sail height over 60% of the hull diameter, the sail rolling-moment alone at 20 knots can be several MILLION foot pounds." Forces of that magnitude cannot be neglected if stability is to be maintained.

In a later article (**SUBMARINE REVIEW**, January 1989), Mr. Payne confirmed the existence of ALBACORE's instability problem. He stated that rumors had begun to surface about the "submariner's J. C. maneuver" where "the crew nearly found itself hanging upside down from its seat belts after attempting a high-speed 30° rudder turn." Not too much was understood at the time as to why the submarine could not be controlled during such turns. In any case, ALBACORE's control system had difficulty in satisfactorily handling the instability problem as the ship was originally designed.

A number of alterations were made to ALBACORE over the next eighteen years. These included moving the sail mounted hydroplanes to the sides of the hull, substituting stern planes of a "X" configuration, substituting counter-rotating propellers, and adding dive brakes and a dorsal fin rudder. These changes did not completely solve the instability problem before ALBACORE was decommissioned in 1972. In addition, doubts were raised in some quarters as to the advisability of relying on submarine automated control systems.

When nuclear power was introduced for submarine propulsion, the Navy placed great emphasis on submerged speed. Therefore, the low drag "body of revolution" hull form was applied to the design of attack submarines despite the instability and control problems encountered in ALBACORE. SKIPJACK (SSN 585) with that configuration was laid down in May 1956 and was followed by THRESHER (SSN 593) and STURGEON (SSN 637). In 1972, LOS ANGELES (SSN 688), the lead submarine of its class, was also laid down with a "body of revolution" hull form.

Investigations of stability and control problems continued. For example, Ken Hart (**SUBMARINE REVIEW** July 1988) reported on automatic control system experiments conducted with LOS ANGELES in early 1977. His comments were amplified by Alfred J. Giddings (**SUBMARINE REVIEW** January 1989). As operational experience with these submarines accumulated, a number of steps were taken to learn even more about the causes of the instability problem, as well as means for correcting it. These included studies, analyses and tests with various hull and control surface configurations. Recommended corrective actions included the addition of a fin keel to balance forces acting on the sail, better fairing of the sail into the hull, attachment of tab controls to the after end of the sail, placing "spoilers" and holes in/on outer hull surfaces to affect water flow, varying the stern plane configuration, and others. Alterations were made in some cases. For example, diving planes have been relocated from the sail to the sides of the hull, and a cruciform tail plane configuration has been used.

It appears that U.S. high speed submarines are not the only ones that have instability problems. In the April 1988 issue of the **SUBMARINE REVIEW**, W. J. Ruhe described what appear to be steps taken in the design of TYPHOON to minimize the formation of vortices at rudder, planes, sail and main deck areas. He also commented that in the design of VICTOR III, the "coke bottle" shape was used to improve laminar flow and that polymer stain was applied for changing boundary layer flow conditions.

Based on these and other articles on submarine design, control aberrations and steps taken to find solutions, it is clear that the problem of controlling submarines during high speed maneuvers has not been solved.

<u>The Basic Diving Control Problem</u>

Depth control of the World War II vintage, Fleet type, diesel-electric submarines was purely a manual operation. The diving officer received information required for depth control by viewing the depth gauge, dive/rise angle (bubble) indicators, plane and rudder angle indicators, pitometer log speed, and course changes shown on a gyro compass repeater. Based on this information he issued orders to the bow and stern planesmen, and to the trim and high pressure air manifold operators. At submerged speeds of less than nine knots, (almost all operations were performed at speeds of less than five knots), forces exerted by bow and stern planes and minor adjustments in water ballast were normally adequate for diving, and depth and trim control. Diving officers became fairly competent in maintaining depth control in calm seas after a few months of training. However, diving to two hundred feet or more to avoid air attacks, and depth control at radar and periscope depths in rough seas to track targets and launch torpedoes was another story. As a result, it was not unusual for the diving team to "lose the bubble." A major cause was sluggish ship response to bow and stern plane forces at low submerged speeds. Control was worsened by the fact that the diving officer had no knowledge of the location and magnitude of forces acting on the outer hull. He knew only that dive angle and depth responded very slowly to orders given the diving team. To aggravate this situation, opportunities to train diving officers were limited during wartime because patrols were conducted largely on the surface. Since it was normal practice for the OOD to take the dive when necessary to submerge, and because none of the diving procedures were automated, each officer tended to conduct a dive differently. As a result, few became truly skilled diving officers, and few became familiar with the degree to which external water forces could cause loss of depth control. For example, when PIKE (SS 173) exceeded a dive angle of greater than 8^o, pressure on the forecastle deck caused the angle to increase further. The only recourse was to back full and blow bow buoyancy tank.

Depth control became an even more serious problem when ALBACORE and nuclear submarines became operational. High speeds coupled with the "body of revolution" hull design and a large sail area caused extremely great and variable water forces to act suddenly on the hull when large rudder angles were applied. Without knowledge of the magnitude and moments of these forces, diving officers could not know the actions to take to maintain dynamic stability, and the very serious problem described earlier resulted. In order to cope with such forces, a means must be provided for assessing all the force-moments working on the hull.

<u>Control Limitations Imposed By The Human Brain</u>

Without that knowledge, the diving officer of a high speed submarine is worse off than the diving officer of a Fleet type submarine. Even if these forces were to be continually assessed by a suitable sensor system, the human brain lacks the rapid computational capability to continuously compute the resultant 3-dimensional moments of external and internal forces, integrate them into overall moments, select appropriate control devices, direct the application of those devices to counteract the destabilizing forces, and at the same time mentally program course, roll and depth changes. Simply put, the human brain does not operate with the speed of light. Consequently, it cannot do all of these jobs in time to maintain a stable attitude during a high speed maneuver.

The Approach To Full Maneuverability

Dynamic instability of vehicles in motion is caused by unbalanced forces. If a submarine is to be "flown by a pilot like a high speed aircraft," two things must be done. The inherent design features of the ship which produce upsetting moments must be altered so that their moments are decreased, and a control system must be developed which is able to automatically exert adequate and timely counter moments.

Reduction of upsetting moments is a job for hydrodynamicists and submarine design engineers. Their task is twofold; i.e. modify the hull design to reduce the upsetting moments, and design improved control devices capable of creating greater counter moments. Primary contributors to upsetting moments are the sail and various vortices formed in water flow patterns. Reduction of these moments can best be achieved by reducing the size of the sail, improving the fairing of the sail into the hull, and adopting other vortex minimizing features and devices. A compromise must be reached between sail size and requirements for access trunk, antennas, periscopes and piping. Great engineering ingenuity will be required to make a significant reduction of upsetting forces in this area. Development of control devices capable of exerting greater counter moments is a fairly straight-forward engineering task.

Development of a means for continuously measuring the pressure field acting on the external hull is a necessity. It is a task for hydrodynamicists and instrumentation engineers. The concept for sensing external pressures can be illustrated by imagining the external hull divided into approximately six to eight lateral sections. Each of these sections is divided into four subsections to represent top, bottom, port and starboard hull areas. Each subsection is instrumented with pressure sensors except that the sail is instrumented separately. Sensed pressures are continuously transmitted to the submarine automatic control system.

Finally, computer hardware and software, control system and human engineers must develop a computer system for automatic control. Based on maneuver instructions from the diving officer and data from the external pressure measuring system, the control system must actuate control devices to execute a stabilized maneuver in three dimensional space.

In concept, the control system receives maneuver instructions from the diving officer and computes a program of "safe" roll, pitch and yaw angles necessary for making the maneuver. In a continuous process, the system senses external forces acting on the hull, computes their moments and combines them with the internal force moments working on the submarine. The system then computes the counter-forces required to stabilize the submarine as it maneuvers, and selects and actuates control devices to generate those counter-forces.

An automatic control system must perform the following functions simultaneously and continuously to provide this capability:

- Provide an interface with the diving officer to: (1) receive his maneuver instruction inputs, and (2) present him with status information on internal and external forces and moments, the ship's attitude, and progress of the maneuver in terms of heading, heel and dive angles, depth and speed.
- Compute a program of roll, pitch and yaw angles for carrying out the desired turn, plus depth and speed changes,
- Sense water pressures acting on the hull in a manner to allow external forces and their moments to be calculated,
- Calculate and resolve all internal and external force-moments working on the ship into three orthogonal moments about the c.g., referenced to the true vertical, true north and the sea surface, and
- Actuate control devices to provide dynamic stability while carrying out the ordered maneuver.

One design concept for an automatic closed-loop control system is composed of three major subsystems; an Automatic Attitude Control Subsystem, a Sensor Subsystem, and an Automatic Maneuver Subsystem.

The Automatic Maneuver Subsystem

This subsystem contains a Man/Machine Interface Element to provide the diving officer with a means for defining the desired maneuver. The diving officer enters maneuver instructions, for example, a 500 yard tactical diameter turn at 25 knots at constant depth, or a turn with 25° right rudder and increase in depth to 450 feet. The interface also provides the diving officer with data on submarine attitude and maneuver status.

A Maneuver Programmer Element for generating a maneuver program of time related roll, pitch and yaw angles is also a part of the Automatic Maneuver Subsystem. It transmits this program to the Automatic Attitude Control Subsystem.

The Sensor Subsystem

As previously described, this subsystem senses the sea pressures acting on the external hull and transmits that information to the Automatic Attitude Control Subsystem.

The Automatic Attitude Control Subsystem

The primary function of this subsystem is to automatically operate attitude control devices to maintain dynamic stability while carrying out the desired maneuver. It contains three elements; an Inertial Reference Element, a Computer Element and a Control Actuation Element. The Inertial Reference Element provides an independent orthogonal reference system for measuring roll, pitch and yaw angles and their rates of change. The Computer Element performs all required calculation, data handling, storage, retrieval and display functions for the entire system. It provides inputs to the Control Actuation Element to actuate all attitude control devices including rudder(s) planes, fins, tabs, and spoilers.

Force moments experienced during maneuvers are monitored by the Attitude Control Subsystem to ensure that they do not exceed upsetting force limits previously established during system development testing. Corrective attitude control device actions are automatically applied by this closed-loop control system.

Conclusions

- Future development of attack and ASW submarines will require safety of maneuvers at high speeds. A major effort to solve the dynamic control problem would permit a shift of emphasis from pure high speed to controllability at speed,

- Pressures generated by water flow along the hull cause sudden and variable high magnitude forces to develop as the flow patterns change during maneuvers. Knowledge of the locations and magnitudes of these forces is essential for the development of a control system that will allow quick turn maneuvers at high speeds.
- Submarine design must evolve further toward the true submersible. The fixed height and area of the sail must be reduced to lessen destabilizing moments. In addition, the distortion of flow patterns experienced during maneuvers must be minimized. Modification of the "body of revolution" hull form may be made if it eases the control problem by increasing stability.
- The brain does not permit human control of submarines during high speed maneuvers due to the number of complex thought processes involved. Therefore, a fully automatic, highly reliable, attitude and maneuver control system must be developed to program maneuvers ordered by a human operator. It must be able to generate force moments capable of counteracting the upsetting moments created during high speed maneuvers.
- To accomplish this, a Sensor Subsystem must be developed to provide external pressure inputs for calculating external force moments,
- The diving officer must be provided with a control system interface for entering maneuver instructions. The interface must also provide the diving officer with output data on submarine attitude and maneuver status, including visible and audible warnings of the build up of dangerous upsetting forces,
- Stability during high speed maneuvers must be such that the crew has freedom of movement, and that loose materials and equipment are not dislodged from their normal resting and stowage spaces. A fin keel, if added, should not eliminate appropriate banking during high speed turns,
- An automatic control system will permit the standardization of submerged maneuver tactics, thereby reducing the time required to train skilled diving officers,
- There is no alternative to an automatic control system despite a reluctance to rely upon one. A very high degree of reliability can be built into automatic systems by such means

as use of high reliability components, functional redundancy, incorporation of computer error detection, extensive development testing and thorough quality control processing during system development and production.

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THE SUBMARINE REVIEW

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

Articles for this publication will be accepted on any subject closely related to submarine matters. Their length should be a maximum of about 2500 words. The content of articles is of first importance in their selection for the REVIEW. Editing of articles for clarity may be necessary, since important ideas should be readily understood by the readers of the REVIEW.

A stipend of up to $200.00 will be paid for each major article published. Annually, three articles are selected for special recognition and an honorarium of up to $400.00 will be awarded to the authors. **Articles accepted for publication in the REVIEW become the property of the Naval Submarine League.**

The views expressed by the authors are their own and are not to be construed to be those of the Naval Submarine League. In those instances where the NSL has taken and published an official position or view, specific reference to that fact will accompany the article.

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

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THE CASE FOR A SUBMARINE-BASED ANTI-SATELLITE SYSTEM

by D. Nahrstedt

Introduction

The primary objective of America's Maritime Strategy is to demonstrate sea control as a deterrent to wartime escalation. A critical element of the strategy is the carrier battle group providing containment of forward area air and naval forces, and strikes against their bases and support facilities. Unfortunately, transiting battle groups are subject to detection, tracking, and identification by enemy radar and electronic ocean reconnaissance, and infrared-sensing satellites. U.S. fleet operations therefore require an anti-satellite (ASAT) system to control Soviet access to space, and to defeat their spaceborne sensors and command, control, and communications networks. Of the near-term ASAT basing options using kinetic energy weapons, submarines provide the greatest coverage, survivability, and intercept opportunity.

Intercept Opportunities

Regardless of the state of hostilities, satellite deployment allows three intercept opportunities: resident, boost phase, and antipode. Satellites in **resident** orbit can be precisely intercepted based on track data. Sea-based ASAT platforms provide greater mobility and resident satellite coverage than land-based facilities, which may have to wait days for intercept opportunity. Among the sea-based alternatives, only the submarine provides the necessary covertness for extended, autonomous operations, allowing intercept in areas inaccessible or too threatening to surface ships.

Boost phase intercept at about the 1/4-orbit point during ascent may be necessary as a countermeasure to sub-orbital "quick look" capability in the future. For the three major Soviet launch facilities at Pletsetsk, Kapustin Yar, and Tyuratam, intercept occurs in the Western Pacific (west-to-east launch). These regions coincide with proposed forward operating areas for U.S. naval forces and supporting long range communications; therefore, covert deployment of ASAT-capable submarines into these areas, prior to arrival of U.S. battle groups, requires no change in the Maritime Strategy. Unescorted surface ships carrying ASATs would be vulnerable, requiring air cover and ASW support for protection due to the proximity of coordinated Soviet naval and air forces.

Intercept at the **antipode** takes advantage of the principle that during launch, a satellite must pass over a point (antipode) on the earth's surface diametrically opposite to the launch point, minus the earth's rotation during ascent. Intercept from the area in the South Pacific enclosing the antipodes of the three Soviet launch facilities represents a means of blocking access to space.

Oceanographic data for the South Pacific antipodes shows wide variations in the sound velocity profile, bottom contours, and ambient noise. For example, broadband noise levels range from high near the marginal ice zone in the southern latitudes, to low levels, due to the absence of shipping, in the warmer northern area. The diverse acoustic conditions favor the U.S. due to advanced sensor and processing capabilities, and lower radiated platform noise. Sensor and weapon development for under-ice operations should complement existing open ocean ASW tactics and technology. Operational requirements for ASAT basing at the antipode are discussed below.

<u>The Anti-Satellite Weapon</u>

Kinetic energy weapons (KEWs) represent the most mature, reliable, near-term ASAT technology. The kill mechanism is simple: impact the satellite with a few kilogram mass traveling at speeds of several kilometers per second. The primary issues are booster missile size and weight for launcher commonality and reduced cost, versus missile range and KEW impact velocity.

The ASAT interceptor envisioned consists of an autonomous, high-velocity (10 - 12 km/sec), lightweight kinetic kill vehicle (KKV) with visible seeker, mounted on a Standard SM-2 missile with a kick stage. Technical risks are reduced because the boosters and SM-2 Extended Range stage exist, and the KKV and seeker are in the prototype stage. The booster technology, modified for additional mission flexibility, could be used to provide rapid deployment of smaller, low earth orbit and depressed trajectory, single-mission satellites, e.g., for time-urgent intelligence-gathering missions in Third World conflicts.

The advantage of the TOMAHAWK-size envelope is so the missile can be launched from the Mk45 Vertical Launch System, or standard 21- and 30-inch torpedo tubes. Minimal changes would be required in the ship's fire control, navigation, and communications systems to accommodate the missile's "fire-and-forget" command and control sequence. The missile is enclosed in a transportable canister including a gas generator for ejection and "zeroth-stage" for propulsion to the surface. It would be a relatively safe "wooden round" requiring periodic recertification, but minimal service, access, and environmental control. No additional manpower would be needed to maintain or launch the missile. Finally, full warfighting capability of the host submarine would be retained.

ASAT Submarine Force Level for Antipode Basing

Because the resident and boost phase intercept missions are in accordance with existing operations, no changes in submarine force levels for these missions are anticipated. Force levels for the remaining antipode mission can be made based on the following assumptions and a 688-class model: (1) 5-day transit one-way (2400 nmi to any of several Pacific islands) at a tactical speed of 20 knots, (2) 2 days in-port replenishment, (3) 37 weapon loadout (ASATs and torpedoes), and (4) 3 satellite engagements per day (1 per site per day). The high engagement rate reflects the Soviet's proven ability to "surge" launch for reconstituting satellite networks. Figure 1 shows operating areas at the antipodes for three ASAT ranges based on their projected terminal velocities. The figure illustrates the advantage of larger operating area and lower probability of detection for increased missile range and KKV velocity.

Figure 2 shows the required submarine force level as a function of ASAT load and number of submarines on-station. The figure indicates that ASATs should comprise at least half the weapon mix to reduce the force number and base loss factor to reasonable levels. The high loss factor is due to the assumed long transit, and relatively high engagement rate and short on-station time. This shows the need for at-sea rearming, particularly in a protracted conflict.

The total force level may be reduced by limiting defensive weapon mix -- not a viable wartime option -- and reducing the number of submarines on-station. More than two requires significant cost and base support. A single submarine must use the higher performance 14 km/sec terminal velocity KKV to cover the antipodes corresponding to the three Soviet launch

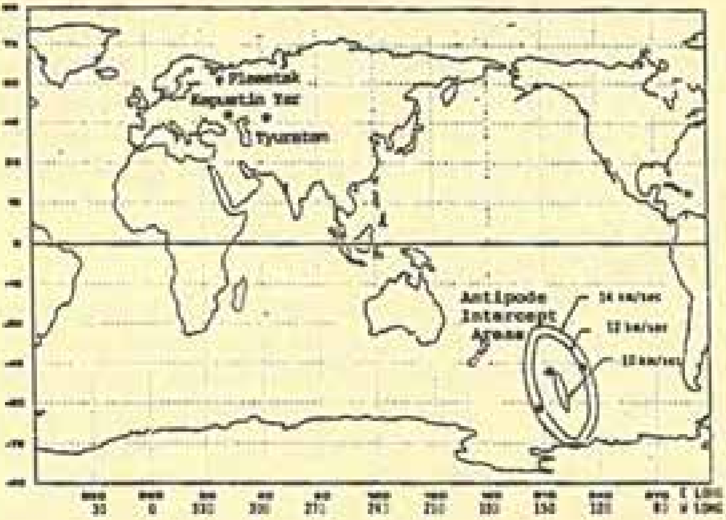


Figure 1: Soviet Launch Sites and Antipode Intercept Operating Areas

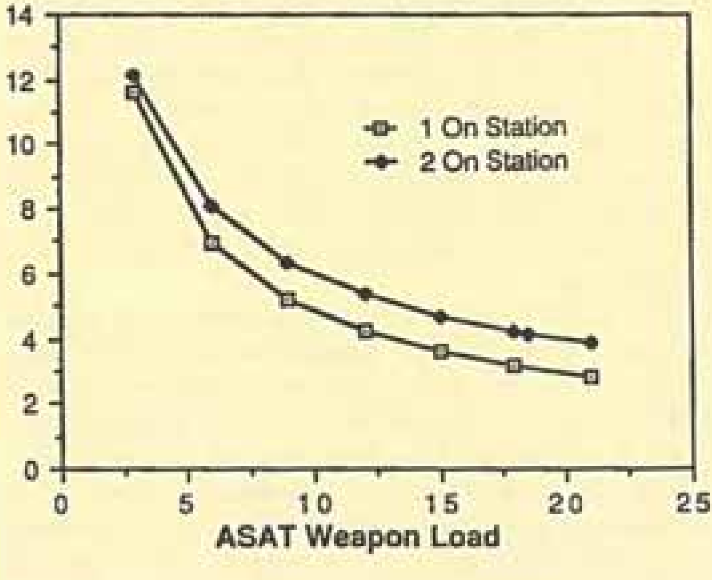


Figure 2: ASAT Submarine Force Level

sites, and allows no redundancy in case of loss. Thus, two submarines on-station are about optimum based on the assumptions and a 50:50 weapon mix. This calls for a total force level of about four 688-class submarines. Should the SSN-21 be available with its larger 50 weapon loadout, it would reduce the level by about 40%. In the future, other ASAT systems, including those using direct-energy for greater range, should be available to complement the sea-based systems in helping to reduce the engagement rate and required force level.

Soviet Response to Antipode Intercept

There are several possible Soviet responses to a submarine-based ASAT at the antipode. The first is to provide separate, mobile land- and air-launch facilities. The Soviets are currently studying the use of the giant An-225 transport aircraft as an airborne launcher for unmanned space craft. Mobile ICBM boosters are another option. Although these countermeasures defeat the effectiveness of antipode-basing, they provide little defense against boost phase and open ocean intercept. Soviet-imposed treaty limits placed on the testing and deployment of sea-based ASATs must also be considered in an era where intentions, but not capabilities, are changing.

The most likely Soviet wartime response to antipode basing would be containment of the ASAT submarines. However, the Soviets are restricted by type and number of ASW assets. Aircraft do not have the necessary size and endurance for transit and loitering, and capacity to deploy sonar in large numbers for wide area search. The location of the antipodes further reduces the effectiveness of airborne communications for off-board processing of aircraft and air-dropped sensor data. For carrier-based aircraft, high value units would require AAW and ASW defenses.

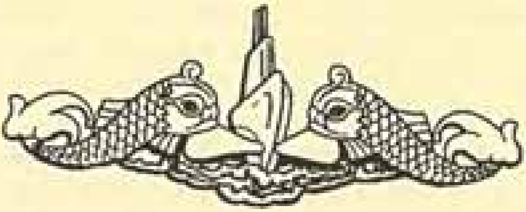
Unassisted Soviet submarine force requirements to provide ASW coverage are based on the assumptions that each submarine is assigned a 250 nmi square area, and a base loss factor of 60% (40% on-station). The loss factor is for a 15-knot transit (tactical) speed to and from Cam Rahn Bay, 60 days on-station, and a 15-day replenishment period. Submarine coverage is scaled from open literature U.S. submarine force levels in the GIUK gap: a 1000 nmi barrier with two screens and a total of eight submarines for about 250 nmi per submarine.

The requirements, shown in Table 1 for defending against a single ASAT submarine, indicate excessive Soviet forces necessary to defend their access to space from their three largest launch facilities. Increasing the number of ASAT submarines increases the area and number of ASW forces. Ironically, this is an example of Soviet Admiral Gorshkov's contention that it has been, and will continue to be, more expensive to mount ASW defenses that to build and man submarines, particularly in out-of-area operations.

INTERCEPTOR VELOCITY (KM/SEC)	OPERATING AREA (NM-SQ)	NO OF CONVERGENCE ZONES	REQD NO OF SOVIET SUBS FOR COVERAGE
10	2.7×10^5	92	11
12	2.6×10^6	897	104
14	6.5×10^6	2255	262

TABLE 1: SOVIET SUBMARINE REQUIREMENTS FOR ASW AT THE SOUTH PACIFIC ANTIPODES

There is an additional issue related to Soviet training and force deployment. Operating submarines in a remote area where long range communications may not be reliable or secure, places greater command and control responsibility on the submarine CO. This is contrary to Soviet training which relies on command from a central authority. As a result, changes in Soviet doctrine would be necessary or effectiveness of command could suffer. ■



THE USE OF SUBMARINES IN SMALL-SCALE CONFLICTS

by Midn 2/c Sean Osterhaus
University of Virginia
NROTC Battalion

The nuclear-powered attack submarine (SSN) of the United States Navy is designed primarily for naval combat with the fleet of another superpower. During the 1980s the U.S. Navy carried out a number of naval air strikes, amphibious landings, and supporting actions. In these cases the U.S. Navy fought not the forces of another superpower, but rather the forces of Soviet client states and Third World nations. Although designed for confrontations with high-technology forces, the SSN has many capabilities which make it a flexible and valuable platform in these lower intensity operations.

The SSN's usefulness does not start with the outbreak of hostilities, however. It is best to deploy the submarine to the area in question while the situation is still at a level of diplomatic crisis. This action gives the U.S. two assets if the situation deteriorates: a potent naval platform unknown to the enemy, and the ability to gather first-hand intelligence. The British made use of this tactic by deploying SSNs to the South Atlantic before war broke out in the Falklands.

The SSN is well-suited for early deployments to crisis areas for several reasons. First, the anti-submarine warfare (ASW) assets of most smaller nations are usually low in quantity and quality. Therefore, SSNs deployed near such nations have little chance of being detected. When coupled with the secrecy which surrounds submarine movements, this allows the U.S. to avoid increased diplomatic tension which would result if a surface ship were deployed. In addition, remote destinations pose no problems for the SSN, and actually give it an edge over conventional vessels. Although an extreme example, the British diesel submarine (SS) ONYX arrived in the Falklands three weeks after her simultaneously deployed nuclear-powered counterparts. The SSN's nuclear propulsion allows it to travel anywhere in the world submerged and at top speed. Once the SSN arrives on station, it can remain there indefinitely. Also important is the SSN's operational independence, which is useful in "come as you are" conflicts. Such early deployments could be made by surface platforms, but with greater complexity and diplomatic tensions.

Intelligence is key to the success of any naval operation. The submarine's stealth allows it to operate in close proximity to the enemy. This capability, combined with the wide array of sensors possessed by the SSN, makes the submarine a good platform for intelligence gathering. The SSN also presents little target for the enemy, which is a boon in times of high tension or combat. The British Navy used such tactics to compensate for its lack of airborne early warning (AEW) aircraft during the Falklands War. The Soviets also use their submarines for intelligence gathering, as exposed by the grounding of the Soviet submarine U-137 near Karlskrona Harbor, Sweden.

Should the decision to take military action be made, the SSN can pursue a broad spectrum of operations which can be carried out with little or no support from other platforms. Continued intelligence-gathering close to shore allows the surface task force to remain distanced and make use of the over-the-horizon capabilities of its air-cushion landing-craft, helicopters, and carrier aviation assets.

A second mission is the insertion of special operations forces. Special forces are capable of conducting missions relevant to various naval operations, but notably to amphibious assaults. The Sea, Air, and Land Teams (SEALS) performed such tasks in the Grenada invasions, and the British Special Air Service (SAS) and Special Boats Service (SBS) troops performed similar missions in both the South Georgia and the Falklands operations.

Special operations forces, because of their small unit size, rely on the element of surprise to achieve success, making the method of insertion critical. The submarine is a good means of transporting such units to their target, when stealth is required. There are limiting factors involved, but when conditions are favorable, the submarine has proven itself a viable platform. HMS CONQUEROR inserted special forces during the campaign for South Georgia, and North Korean submarines inserted scores of troops into South Korea between 1967 and 1968.

The submarine's ability to approach the enemy undetected coupled with the limited ASW capability of most Third World nations enhances the SSN's potential for anti-surface warfare

(ASuW) operations. Destroying enemy ships is the classic mission of the submarine, and British SSNs performed this mission by enforcing the Maritime Exclusion Zone during the Falkland Islands War. The material and psychological damage which can be inflicted by submarines has not diminished over time. After the sinking of the GENERAL BELGRANO by the British SSN CONQUEROR, the Argentine Fleet stayed within its territorial waters for the duration of the conflict.

Against the smaller navies with which the U.S. has most often clashed, the ASuW mission may not necessitate roaming the high seas for the enemy. It seems that smaller enemy warships, with poor sea-keeping ability, will often remain in port or close to shore until the time of attack. This was the case with the Libyan warships encountered by the 6th Fleet in March 1986. The proliferation of land-based surface-to-surface missiles (SSMs) and surface-to-air missiles (SAMs) lends further credence to such tactics, making it difficult for U.S. warships or aircraft to close with these forces before they sortie. The submarine, however, incurs little increased risk when operating close to the home ports of these vessels, and can be employed as a first line of defense (or offense) against such forces.

The weapons load of the submarine now includes not only torpedoes but also submarine-launched HARPOON (and in some cases TOMAHAWK) anti-ship missiles. HARPOONs have proven effective against the corvettes and guided-missile patrol boats which constitute the bulk of most small navies. If the submarine has already been detailed close to shore for other missions, ASuW can be performed by the same platform.

The ability of some SSNs to launch TOMAHAWK land-attack missiles (TLAMs) allows them to strike static targets inland. Such a mission can be performed either in conjunction with or in lieu of air strikes. The submarine may not always be the optimal platform for this purpose, but the TLAM equipped SSN gives the Task Force Commander one more platform with which to strike inland targets.

A final offensive mission which the submarine can carry out is that of mining. The United States has not made use of this option frequently, and public opinion on such tactics is frequently negative. However, SSNs have this capability, and mines are an effective and cost efficient weapon for damaging or bottling up an enemy's fleet. While the use of mines may have declined, it should not be forgotten that the option exists.

The SSN can also perform a vital role defensively. Many nations now possess diesel submarines. Syria and Cuba each possess three, Libya owns six, and approximately 19 are operated by North Korea. These boats have proven themselves to be potentially lethal to even the best navies, as the Argentine submarine demonstrated when she launched several torpedo attacks against British warships during the Falklands War. American carrier and amphibious task forces provide enticing targets for these submarines. While U.S. surface forces possess a wide array of ASW tools, the best sub-hunter is often another submarine. The presence of an SSN gives the Task Force Commander a precious ASW asset if a diesel submarine threat exists.

The American SSN is capable of taking the battle to Soviet strategic and conventional naval forces. Yet, our submarines can also perform tasks valuable to the types of combat operations that the U.S. Navy undertook during the 1980s. While keeping the SSN ready for war with another superpower, its potential for participating in the more frequent conflicts America fights with smaller nations should be utilized.

■

BOAT ASSOCIATIONS

NSL is trying to develop a mailing list of Associations (formal or otherwise) representing past and present crewmembers of our various submarines (e.g. USS JOHN C. CALHOUN (SSBN-630) Veterans Association, NAUTILUS Alumni Association, etc.). Any members belonging to such associations are encouraged to provide us with name(s) and address(es). Having this information will allow us to develop a dialogue to explore areas of cooperation and mutual interest.

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LESSONS OF THE PAST FOR TODAY'S SUBMARINERS

by W. J. Ruhe

It has been the editorial policy of the SUBMARINE REVIEW to print submarine experiences of the past which hold lessons that are seemingly applicable to today's modern submarines and their submariners.

The sprinkling of World War II submarine stories in past issues in effect were not mere "sea stories" to entertain the old hands, but were always ones chosen for some guiding principle which the present reader of the REVIEW could lash onto and say "I hope that today's crop of submarine sailors will take this to heart."

Seemingly, the conventional boats with their low mobility and limited submerged endurance did things in war which nuclear submarines would now do far better and in most cases do in a different way. Hence, it might appear that for a nuclear-submarine-oriented audience, the occasional submarine account of past submarine matters makes for a waste of time. Yet Arleigh Burke emphasizes "God help any nation (or submarine force) which neglects to study its past."

A perusal of SUBMARINE REVIEWs of the past eight years reveals a great number of insights, some of which are recorded here. These observations, it is felt, can be related profitably to today's submarine problems. The most profound of these lessons from the past is that we must recognize that the character of the submariner may be more important to success in war than the equipment he employs.

Not only ought the crew of submarines be molded by the performance of past submariners, but a large number of areas involved in submarining might be made more effective if it is understood how they affected past submarine operations. Included in these areas would be: weapons, doctrine, tactics, strategies, policies, damage control, electronic warfare measures, mines, etc.

As for the importance of men in war: Sub Duty by Grover McLeod (April '87) notes that "the success of the fleet boat was more due to the courage of officers and the men that sailed it than the submarine itself." Captain Wayne Hughes in his Fleet Tactics (same issue) says that "Battles are won by the best warriors, not the best mathematicians or technologists."

The importance of the crew versus the boats they sailed in is illustrated by Mike Sellars A Saga of the S-34 (July '83). Such an old S-boat had to be continually repaired at sea, had no air conditioning, had miserable living conditions, and yet the additional numbers of submarines on station which S-boats contributed had an important effect on the war. By patrolling in widely diverse areas of the Pacific they spread out the Japanese ASW forces, making it easier for the big Fleet Boats to get at their ship targets with less risk of being destroyed by Japanese ASW forces. Just keeping the S-boats going to sea was a war in itself -- but it was a war mastered by the crews of such boats.

Jan Breemer notes in The Submarine in World War I (October '84) that submarines in war are likely to change their basic mission -- from that decided on in peacetime and practiced for in exercises. "The German naval high command began the conflict using its submarines against the warships of the Royal Navy. It was also agreed that the submarine would be employed mainly as an auxiliary for patrol and reconnaissance on behalf of the battle fleet." But on February 1, 1917, the Germans initiated an unrestricted submarine war against merchant shipping "... sinking over 8 million tons of Allied shipping in that year."

Then in WW II submarine accounts, it is noted that before the war our submarines were trained to be far out scouts for the battle fleet. But just after Pearl Harbor this role was changed to one of destroying ships in unrestricted submarine warfare. Fortunately, U.S. submarines sank Japanese ship targets of opportunity whether merchantmen or warships. Will the ASW mission of nuclear submarines be changed to an anti-ship one in The Third Power wars of this decade?

Admiral Brooks Harral in his Submarine Power -- The Final Arbiter (July '90) focussed on the importance of American submarines being used in "a two-pronged attack" against Japanese merchant ships and Japanese warships. As a result of this policy, "the U.S. submarine fleet established and maintained control of a vast sea area -- the South China Sea, without surface ship or air support." Admiral Harral also makes the point from his survey of World War II submarine operations, "No historian appears to comprehend the extent of the benefits conferred on other and much larger operations by widely scattered submarine operations." Harral's article describes how the antiquated S-boats, operating in the South Pacific, not only profitably added to the number of U.S. submarines on station in widely diverse sea areas but also established the threat of submarines against Japanese invasion forces and the Japanese strategies for consolidating their acquisitions.

The value in war of deploying considerable numbers of submarines, low grade ones like the S-boats as well as high performance Fleet Boats, is convincingly shown. And the effect on the enemy of posing a submarine threat which complicates enemy planning, affects the wisdom of the strategies used, and degrades the enemy's tactical decisions, is even more impressive.

For example; when the 69,000-ton Japanese aircraft carrier SHINANO was being pursued by Joe Enright's ARCHERFISH in 1944 (July '87), the SHINANO's skipper, Captain Abe, began to imagine that a wolfpack of American submarines was closing in on his ship. Abe's belief that he faced not one but several U.S. submarines caused him to give up his steady, rapid straight-running course -- which Enright couldn't close -- in favor "of a zig towards the ARCHERFISH" which proved his undoing.

Dick O'Kane in his WAHOO story (October '87) notes that a skipper who keeps tenaciously after the enemy puts him into a state of confusion and makes him easier to sink. O'Kane emphasized how taking risks gives very high payoffs and cites the outstanding successes of Mush Morton's WAHOO because of the great risks taken by her skipper. O'Kane also noted the value of using the Exec on the scope because he, O'Kane, was about the best periscope man on the WAHOO, if not in the entire submarine force. This was an innovation subsequently followed by other submarines.

As for taking high risks; The BONEFISH in WW II by Tom Hogan (July '84) states that "The Japanese were fully aware of the danger of night surface attacks by U.S. submarines. Where possible, they would bring their convoys into protected anchorages overnight. Cam Ranh Bay was one such convoy anchorage." BONEFISH "penetrated the Bay and sank a very large tanker, a medium freighter and got two hits in a tremendous ship, a converted whale factory with a raised deck platform carrying 26 Zero-type aircraft." George Street's going into a harbor with TIRANTE to sink a large merchant ship and two frigates earned him the Medal of Honor and his Exec, Ned

Beach, the Navy Cross. And Hank Munson's night surface attacks and reattacks against a large convoy to garner almost 80,000 tons of Japanese shipping and warships -- sunk and damaged -- is a saga of risk taking with very high payoffs during RASHER's Fifth (January '90).

BOWFIN by E. W. Hoyt (April '85) tells of "the great pressures brought to bear on the aggressive successful CO" -- Walt Griffith, the BOWFIN's skipper. Hoyt states that skippers are affected by a "loss of physical energy which is restored quickly by short periods of rest," but that "The restoration of nervous energy requires a longer period of time for recuperation and tends to have a much greater cumulative effect on the individual than loss of physical energy -- and may well reduce (a skipper's) effectiveness as consecutive patrols are completed."

WW II torpedo performance was thoroughly wrung out by many SUBMARINE REVIEW articles. In WW II Steam Torpedoes vs Electrics (January '87), it is observed that the wakes of steam torpedoes in attacks against destroyers alerted them in sufficient time to make their evasions effective and then allow them to counterattack rapidly. Also, that sighting the wakes of American torpedoes alerted ships in convoys who then took action to avoid further torpedo attacks. SEADRAGON's fifth war patrol in 1942 produced this observation: "Three Mk 14s fired at DD. DD spotted torpedo wakes quickly, swung to miss all 3 torpedoes, then charged back at SEADRAGON dropping depth charges very close." On REDFISH's first patrol: "When the two steam torpedoes were almost at their targets in a large convoy, steam was observed coming from one of the AKs -- indicating a single-toot which warned the rest of the convoy that the ship was being attacked from the starboard side. With such a warning, the entire convoy would be zigged away." USS RAY (July '84) by Rosy Kinsella records: "Attention was diverted to RAY's heavy torpedo wakes on the glassy sea. At 0623 the RAY received the first of 126 depth charges. The mighty RAY was tough and took them in her stride." How many subs were lost during WW II because the wakes of their torpedoes were sighted early?

However, submarines using the wakeless electrical Mk 18 fish had somewhat different experiences: on CROAKER's First War Patrol (January '87), "Four Mk 18s fired. All missed. All probably ran under the target which sailed unconcernedly on its way." SPADEFISH confirmed this advantage of electric torpedoes. "Fired four Mk 18s at a Mutsuki DD. All missed. No evidence DD detected the torpedoes." The Mk 18 torpedo also proved to be a capable anti-warship torpedo despite its 29 knot speed. "ATULE fired four Mk 18s at 2540 yards range, at Hatsuhara class DD. 2 1/2 minutes later his stern went under." In fact, "electrics were preferred by the submarine skippers over the 14s -- from mid 1944 on." Dick O'Kane fired 23 Mk 18s on TANG's fifth war patrol getting 22 hits. "With the advent of the Mk 26, 45-knot electric, the problem of low speed was solved."

Significantly, at the start of WW II in the Pacific there was a shortage of steam torpedoes and by the end of 1942 about 500 torpedoes were required to meet patrol needs but only about 290 were produced. During the war, 14,393 torpedoes were expended at a rate of about 10 per patrol and 10 for each ship sunk. What should the Mk 48 stockpile be?

The specifications for a quiet, wakeless torpedo for shallow-water, Third Power sea wars in the '90s can draw heavily on WW II torpedo experience. Moreover, such wars are likely to put a premium on surface warship destruction rather than on that of enemy submarines. And the noisy wake-making torpedo is likely to lose its efficiency in the environment of developing technology for countering such a torpedo.

U.S. submarines, it is noted, were fitted with four small sound heads on their outer hulls to detect "loud" torpedoes and indicate the best direction to take, to avoid such torpedoes.

Importantly, Submarine Lessons of the Falklands War (April '83) notes that: "the high mobility of the nuclear submarine (the CONQUEROR) allowed the use of simple, very low cost torpedoes in the antiship role."

The value of midget submarines in WW II is well described by Richard Compton-Hall in his The Menace of the Midgets(April '89). Additionally, many of the midgets' operational successes are listed in Jurgen Rohwer's The U-Boat War in the Atlantic -- 1939-1945 (April '90). The tiny subs, for example, penetrated harbors and did damage to enemy warships out of all proportion to the crews involved -- i.e. the several crew members of a midget were capable of destroying battleships with thousands of men aboard. "Two Italian midget submarines sank the British battleships VALIANT and QUEEN ELIZA-

BETH in Alexandria Harbor." A German midget "seriously damaged the British battleship RAMILLES in Diego Suarez," and a British midget "put the 40,000-ton German battleship TIRPITZ out of action," -- in a Norwegian fjord. Though modern submariners may think of them as mere "toys", their value in today's possible sea wars could be considerable. Using a satellite receiver, for positioning within fifty feet, remedies the problem of navigation which proved the greatest failing of the midget in World War II. The use of midgets from a mother submarine to project submarine power into port areas is thus suggested for the environment of the '90s.

Jurgen Rohwer's account also provides these insights: "The best protection against depth charges was to dive deeply." Deep diving nuclear submarines will also reduce the efficiency of enemy torpedoes by making them attack at great depths, and "The utmost priority must be applied to the development of an effective anti-destroyer torpedo -- or the future of U-boat operations," according to Admiral Doenitz, "is in jeopardy." Admiral Doenitz, in fact, admitted near the end of the war that it was a mistake not to attack the escorts of convoys. His antishipping campaign would have been far more profitable, he felt, had his skippers been directed to attack enemy warships and particularly their destroyers.

<u>Pirate Submarines and Non-Intervention</u> by Jon Boyes (October '83) examines the use of unidentified submarines in the Spanish Civil War. The Italians were accused of covertly using their submarines against Soviet shipping. The Soviet merchant ships KOMOSOMOL, TUNIYAEV and BLAGAEV were torpedoed in the Mediterranean. "The attacks were carried out by the Nationalists and Italians to cut down shipments to Republican Spain." How these pirate submarines were employed should be understood in light of the greater possibility of wars of liberation in the '90s.

These samplings of the history of submarines, as described in past SUBMARINE REVIEWs, should serve to generate some contemplation as to how submarine warfare has changed with the advent of the nuclears -- and yet, how it is still much the same, despite the differences between the old boats and the new ones.

■

IN REMEMBRANCE

Rear Admiral Curtis B. Shellman, Jr., USN(Ret.)

Loyal member of NSL since 1983

Member of NSL Advisory Council

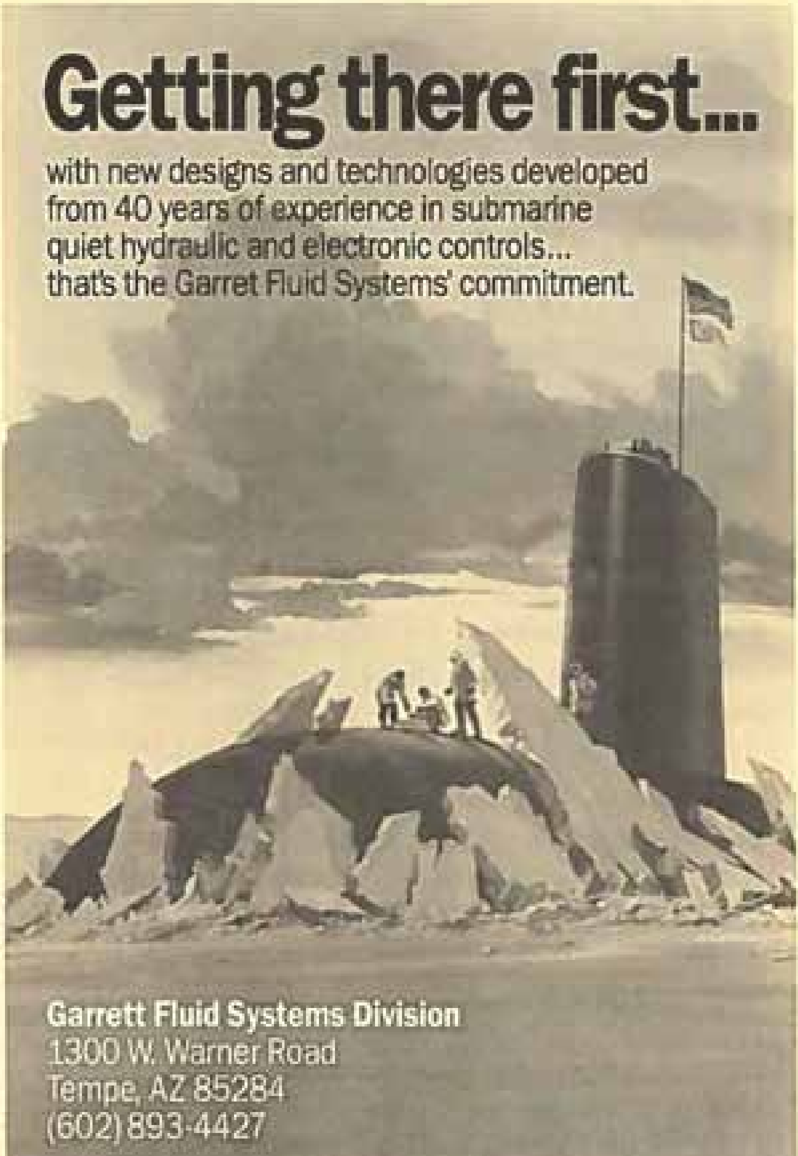
Curtis B. Shellman, Jr., Electric Boat Division's vice president of operations, died November 29, 1990 after suffering a heart attack in the main shipyard. Following retirement from his final Navy position as Deputy Chief of Naval Material for Logistics and Operations, Rear Admiral Shellman joined Electric Boat in 1980. During his stewardship of all divisions of shipyard operations, he delivered 18 LOS ANGELES-class and 11 OHIO-class submarines to the Navy.

In his expression of grief at the news of Curt's death, James E. Turner, Vice President and General Manager of Electric Boat said:

"Curt's distinguished career in the Navy was followed by an equally distinguished career at Electric Boat. By adhering to uncompromising standards for quality and safety, he built and maintained a reputation for himself and the division as the best builder of submarines in the U.S. The performance of the U.S. submarine fleet is in large part attributable to his efforts. We will all miss his companionship, his valued counsel and the capabilities he brought to Electric Boat."

■

[The preceding excerpt from Employee Bulletin Vol. 1, No. 16 Electric Boat Division, General Dynamics is printed here as a tribute to Rear Admiral Curtis B. Shellman, Jr., USN(Ret.)]



Allied Signal Aerospace

THE SUBMARINE IS THE MOST COST-EFFECTIVE WARSHIP IN *ANY* NAVY.

A U.S. submarine with cruise missiles has — on a much smaller scale — military characteristics which are a lot like those of a carrier battle group:

- **can mount an air attack on targets hundreds of miles inland**
- **rapid deployment without basing issues**
- **virtually unstoppable by any nation**

While the air strike power of the SSN is far less than that of a carrier battle group, the cost is even further less. So, if you don't have enough carriers, send an SSN or two.

With SEAWOLF's much greater weapons payload, SEAWOLF's ability to handle larger, longer-range cruise missiles, and with more countries becoming able to attack our carriers with nuclear weapons, the SSN air strike option will become even more important in the late 1990's.

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DISCUSSIONS

WHO SAYS SMALLER IS BETTER?

by Jerry Holland

Proposals for smaller, lighter and above all cheaper submarines abound, even in maritime publications. Recent examples include Richard Compton-Hall's promotion of two man mini-subs in the Naval Institute Proceedings and the simplistic demands for a less-capable-than-SEAWOLF ship in the Heritage Foundation's "Mandate for Leadership III: Policy Strategies in the 1990's", published in part in the December 1988 Seapower Magazine. These propositions are significant to the Submarine League because they testify to the need for more effective efforts to educate our fellow citizens on the physical and fiscal truths involved.

Common to all these proposals for smaller, lighter and cheaper submarines is their lack of endorsement by persons who are operationally experienced and technically competent. This situation is unique among weapons systems debates. In the Army, one can find a vocal "Light Cavalry" community offering operational arguments against the Main Battle Tank. The two place heavy fighter versus the one man interceptor generates lively discussions in any Tactical Air Command Officer's Club. In the Navy, surface warfare officers argue heatedly about the operational advantages of the nuclear powered cruisers over gas turbine driven destroyers (as well as a dozen other capabilities). But it is virtually impossible to find an officer who has served in a modern nuclear submarine who wants something smaller, lighter and cheaper than SEAWOLF or OHIO.

Submarine operators know they need room. Increased speed requires bigger engines, heavier reactors, larger heat exchanger surfaces. To become quieter, the next generation submarines require larger machinery mounts, additional weight of dampening and coatings, space to allow smooth fluid flows (not an all inclusive list). More weapons are a must. The limit of any warship is magazine capacity and the more capable the ship the more serious this limit becomes. No where is this limitation more constrictive than in submarines which operate far from replenishment facilities, engaged in enemy waters (a "target rich environment") from the first days of the war and from which targets can escape only by fleeing to port. In less-than-total war environments, the variety of weapons which will be needed argue for larger stowages.

Sensors too need more space to exploit larger bandwidths and lower frequencies because the physics of both of these parameters depend upon longer antennae or hydrophones. Even in the area of computational processing there is a need for more space and weight. Today's computers, so densely packed they have to be refrigerated, are two to twelve times heavier per cubic foot than their analog predecessors. Even with great computing power packaged tightly, the ability to sense and use the information developed demands more and more space for sensors, fire control and navigational purposes. Shooting at a target on intermittent bearings only at ten miles demands several orders of magnitude more sensing and computing power than a periscope approach to shoot at a thousand yards. Networking a couple of PC's is not the answer to any of these demands. The real answer requires space, weight and dollars.

Engineers and architects who design and build these ships know that you can't have any of this technological edge without more room. Those engineers who promote smaller submarines ALWAYS acknowledge that they are promoting a force which is operationally limited, one which is less capable than they know can be built. First Lord of the Admiralty Winston Churchill's epigram about coal fired destroyers applies: the proponents of smaller, cheaper, lighter submarines are advocating breeding slower race horses.

There is an instructive analogy in submarine design. In the mid-thirties the U.S. Navy's first construction since World War I programs made small incremental improvements to the "S" Class, a design which was 20 years old albeit a very good submarine for its time. In the third year of the building program there was a sharp departure from this incremental approach with TABOR, the immediate predecessor and prototype for the Fleet Boats. She was more than twice as big, faster, heavier, with substantially more weapons, four big diesels in the power plant and a crew which grew to twice the size of the "S" Boats. Had the choice been made to build a smaller, lighter, cheaper alternative, what would have been the effect in World War II? How much longer could the Japanese have held out against a submarine campaign spearheaded by "S" Boats?

How many more submarines would have been lost because of their lower resiliency to damage, slower getaway speed and decreased submerged endurance?

Officers who have served over the past thirty years have experience with "smaller, cheaper, lighter" submarines. Those of us who have tried to keep the TULLIBEE's main propulsion commutators operating or struggled to repair or clean outboard of the main condensers on a SKATE Class ship have firm opinions on the need for space to clean, quiet, maintain and stow. The "594" Class began too small in almost every respect -- and their crews paid for it. The last three ships of the class had to be elongated just to stay abreast of equipment requirements.

The STURGEON's were top of the line for their time. Before the class was completed they were too small to carry all the mission essential equipment. Only a generous design and fortuitous circumstances allowed installation of the vertical launch tubes in ballast tanks on the later Los Angeles Class ships. EVERY EXPERIENCE SINCE 1905 demonstrates that submarines will have to increase in size and weight to capitalize on technological developments -- they do not shrink.

Among concerns occasionally cited about these big ships is the perceived difficulty of operating them in relatively shallow water. While it is true that school boats no longer operate in the 120 foot "deeps" of Long Island Sound, STURGEON Class submarines have operated in narrower volumes in the Arctic as well as in waters even shallower close ashore in many areas of the world. The power, stability and superb handling characteristics of these big hulls more than compensate for their large size. Indeed, in this author's experience, no submarine was as difficult to handle as DARTER, the smallest submarine in which I served. A single very large Weapons Officer, Frank Rudolph, moving about the ship was enough to make trim difficult.

Knowledgeable submarine operators appear tongue tied because of an understandable reluctance to reveal operational capabilities. Because common experience has produced common understanding of a complex matter, submarine officers are often attacked as "hidebound" or "fixated". These allegations are made by those who are operationally inexperienced and who have no arguments to proffer other than budgetary ones. But these "ad hominum" attacks have been unusually effective in the political scenery around the defense budget, the need for the next generation submarine and the ASW threat posed by the Soviets and to the Soviets. Submariners need to repair that defect with knowledge, argument and cohesion.

The ultimate "smaller, lighter, cheaper" argument came during the Congressional testimony of the Director for the National Endowment for the Arts a few years ago. Tongue in cheek, he requested all submarines then under construction be shortened three feet. He calculated their cost relative to their length ($/foot) so that shortening each just a little would yield enough money to fund his shortfall in the arts. He was as knowledgeable as many of those who propose building smaller, lighter, cheaper submarines.

Proponents of the smaller, lighter, cheaper model always advance as their chief argument that it is numbers that count. But the model for naval warfare in general and submarine warfare in particular is not infantry battles. Nelson was outnumbered and outgunned at Trafalgar; but the issue there was never in doubt. At sea numbers count only when both sides are evenly matched technically and professionally. In the sophisticated and demanding environment of the ocean, the slower, louder, sensor-starved submarine becomes cannon fodder for the more capable ship. There is no guarantee of continuing this monopoly of capability during the life of any submarine now building. DREADNOUGHT was not the last naval development which will outmode its predecessors at a stroke. Those of us who know the requirements should vigorously advocate never building less than the best submarine that we know how to make. ■

THE U.S. SSN IN THIRD WORLD CONFLICT (TWC)

by Jim Patton

In July of 1989, a new five year GLOBAL War Game series was commenced at the Naval War College at Newport. In a nutshell, its objective was to investigate national security issues in an increasingly multipolar world as the hegemony of the Soviet bloc slowly unravelled. The five year nature of the series suffered an early death when virtually all of the "unravelling" spontaneously occurred in a 2-3 month period over the '89 Christmas season.

During 1990, with the "fuzziness" of the future having been empirically demonstrated, a new series commenced whose central theme was to project a "set" of possible worlds which were overlaid with a relatively large group of possible crises. With the "warp and woof" of these two sets of variables, a "tapestry" of credible scenarios was created in direct contrast to the more traditional fixed point of a specific crisis in a given world scenario.

Several macroscopic findings leapt from this excursion. Since the planning of force structure has a time constant of tens of years, the only reasonable assumption is that the specific (and properly economically limited) force structure that will exist for any actual future crisis it must cover within this tapestry will be non-optimal. The "vernier" vector which allows this non-optimum set of forces to adequately deal with the actual emergent situation is tactics, "...the art and science of coping with the imperfect." Fortunately, when properly done, the time constant of evolving appropriate tactical concepts into promulgated tactical doctrine is measured in months, not years.

Other insights included the observation that the term "Limited Intensity Conflict (LIC)", as the events in and around Kuwait are dramatically proving, is a poor way to describe likely scenarios in any post-cold war world. If anything must be limited, it is the duration of such conflict, and not the intensity. In fact, as in the Persian Gulf Crisis, the perceived high intensity of a likely response to adventurism is the deterrent factor in these scenarios. Ten thousand raps with a one pound hammer does not equate to one rap with a ten thousand pound hammer even though the work expended might be the same by the laws of physics. Third World Conflict (TWC) far better conveys the large spectrum of contingencies for which national political, economic, diplomatic and military force must be prepared. Also, the paradigm that "strategic" equals "atomic" must be broken. All TWC in which the U.S. chooses to participate is strategic in nature or we would not commit such assets to protect U.S. interests. "Nuclear" certainly remains a subset of "strategic", and in a very real sense, all wars since August 1945 have been nuclear wars. As in chess, the fact that a piece is not played does not eliminate its participation in the game.

An observation of no small concern to submariners is that in both this year's GLOBAL, and a "Technological Initiatives Game" that preceded GLOBAL at Newport by about a month, a perception was generated that U.S. SSNs did not contribute as significantly as would be expected from such a large chunk of U.S. force structure. In fact, a statement heard was that "...present tactical doctrine precludes the effective use of U.S. SSNs in Third World Conflict!"

The above is a painful phrase for submariners to hear, particularly when we have fought so hard for so long to successfully protect the concept of a "multi-purpose" platform against those who would have had us tweak the "goodness" of the U.S./USSR "Battle of the Barents" naval laydown with a collection of mission-specific boats expressly tailored for certain precisely defined scenario-specific applications. To a certain degree, we are now at a point analogous to where we were in 1946. A victim of our own success, submarines largely won the cold war as an "uncorrelatable force," and we now find ourselves focussed on a still important, but increasingly unlikely mission.

Other damaging perceptions seemed to be that we could if we wanted to, but would really rather not engage diesel-electric submarines. Also, a recent news release by the Gannet News Service quoted an "expert" retired nuclear submarine CO to the effect that it was unlikely that U.S. submarines would want to enter or operate in the Persian Gulf due to the "narrow" straits and "shallow" (300-600 foot) water depths involved. It must be remembered that we had fielded more than a dozen SSNs in an ASW role and were commissioning the 588 class before there even was a non-U.S. nuclear powered submarine; and remember that NAUTILUS entered the deep Arctic basin only after passing through uncharted waters of the Chuckchi and Beaufort

Seas where clearances dropped to only a few feet under the keel and a few feet over the sail. There are more than a few of us who have made routine submerged passages through straights narrower and shallower than Hormuz.

As in 1946, it is of the highest possible urgency to review for continued applicability the "postulates" from which we have conceptualized, constructed and executed the most successful peacetime naval operation of modern history -- the neutralization of the Soviet fleet. First, there is a subliminal feeling that if we could do the Battle of the Barents, than any other military employment would be a some lesser subset of that engagement. This is as convoluted an assumption as made by SAC in the late 40s when the ability to deter the Soviets through threat of nuclear annihilation "certainly" included the ability to deter lesser powers (N. Korea, Cuba, N. Vietnam). For submarines, the answers to such basic operational issues as the degree of command and control or connectivity are dramatically different when the venue of the question is changed. We cannot afford to rest on our laurels at this point, and claim that our "contribution to TWC will be to land a few SEALS, shoot a few TLAMs and to employ a whole family of as-yet undeveloped "widgets on a wire" ROVs/AUVs. We need to articulate a substantial and meaningful participation with what we now have on hand.

One such issue is "survivability" -- submariners, even when victorious, have always taken huge losses when committed to significant combat use. The Germans lost more than 75% of their U-Boat personnel in WW II, and we lost about 20%. Virtually all credible evaluations of the now unlikely Battle of the Barents point towards a virtual destruction of the Soviet Northern Fleet quickly, but at the cost of U.S. SSN losses which are not out of keeping with historical precedent. The attitude of "War is Hell, and we'll take our lumps while getting in our licks" is entirely unacceptable in a TWC context however, and unless Force Commanders can look the National Command Authority (NCA) squarely in the eye and promise virtually no reasonable probability of losses, the risk of domestic opinion and geopolitical response to such losses will strongly argue against SSN employment.

Fortunately though, other variables in the TWC combat algorithm change in addition to survivability. Masters of stealth warfare, we would use that characteristic in a general war with the Soviets to greatly enhance the probability of mission accomplishment through a platform intensive campaign in a "target-rich" environment. That same stealth can be used to buy great survivability -- particularly since any likely TWC scenario would not be target rich -- and a weapons intensive campaign could be orchestrated, accepting a lower Pk per weapon launched in return for a near-zero probability of loss per encounter. As has been seen in recent years, TWC does tend to be a war of attrition, and even relatively few losses, imposed quickly and decisively, have a profound effect towards encouraging the "loser" to remove his remaining assets from harm's way. This effect is particularly pronounced when he is obliged to carefully weigh his position in some local strategic balance. If four of six on-station KILO submarines returned to home port on the surface after the other two were lost in a day or so to U.S. SSNs, the SSNs concerned would not be taken to task for the fact that those two sinkings required six attacks with 4-torpedo salvos fired from maximum range. One cannot sustain that level of weapon expenditure per kill in a Battle of the Barents, but it would certainly be acceptable in the Battle of the Indian Ocean or Yellow Sea. Such tactical doctrine against "quiet" targets might require the evaluation and refinement of doctrine from a tactical concept which involved opening to a maximum firing range position following detection -- even though this meant that target contact would not be held at, or for some period of time prior to, the firing point. If cruise missiles can be fired at surface ships on statistical considerations of where the targets used to be by someone else's report, why not torpedoes based on where you knew the target was a bit ago? It would appear that the only two tradeoffs necessary are the confidence level desired from some expanding "area of uncertainty," and how many weapons one is willing to release to "cover" that area.

Tactical concepts such as these have historically spawned in the bright young wardrooms of the Submarine Force and at Submarine School. Those concepts that passed some credibility check, perhaps at SUBSCOL's attack centers, were then handed off to DEVRON TWELVE for material possibly worthy of exercises, evaluation, refinement and eventual promulgation as available doctrine. Even if the attrition rate of concept to doctrine is 90%, that is both acceptable and desirable, and this fleet input from the LT/LCDR level remains a critical element if we are to avoid operational stagnation.

Since the requirement for U.S. participation in TWC can occur suddenly, and at virtually any place on the globe, other "truths" emerge. As with fires in the Main Lube Oil Bay, timeliness of response is critical. However, the only conservative assumption is that no U.S. forces will be in the immediate area. Historical precedent and recent exercises show that fully ready submarines can roll in hours to arrive in days. It is entirely feasible that desired missions (read as weapons loadout) would not have been determined by the time they are otherwise ready to depart. This consideration, plus the ability to release salvos of twice current size in a weapons-intensive encounter, is perhaps the strongest possible argument for SEAWOLF in the coming decades, since the doubling of her magazine capacity would allow her and her sister ships to be sailed with a large on-board mix of weapon types for greatest flexibility of NCA options while on station.

In all this talk of TWC, a tempting mistake is to claim that a type of weapon system can conduct it "better" than another. There are synergisms and complementary capabilities -- for decades, the "Strategic Triad" provided both an intellectually satisfying and practical synergism in the spatial domain -- land, sea and air. Certainly, the B2 is a survivable and quicker way than by submarine to deliver 20 tons of high explosive from CONUS to a distant target set, but does not have the presence and endurance of the SSN; the SSN, though much more responsive and covert than a Carrier Battle Group (CVBG), does not have nearly the firepower or the sustainability of the CVBG. This "quick, quicker, quickest" nature of three complementary capabilities could easily provide the core concept of a Strategic Triad for TWC in the temporal domain. Coordinated operations by no means need to be conducted simultaneously, and it can easily be envisioned that part of the mission of each subsequent "wave" would be actions that would enhance the survivability and effectiveness of the next.

The continuing occurrence of TWC is a reality. The U.S. will learn to do it well, or else we will do it frequently. Submarines have critical but as yet poorly identified or articulated roles in this TWC. If we do not effectively rise to correcting this oversight, submarine programs will suffer continuing budgetary pressures, much to the detriment of U.S. security.

■

REUNIONS

SMMSO Twenty Year Reunion

The Submarine Monitoring, Maintenance & Support Program Office is having a twenty year reunion on June 12, 1991, and will piggyback with the League Symposium. We need to hear from you NOW if you can attend. Please contact:

Sue Conger Austin
c/o SMMS Office (PMS 390)
2011 Crystal Drive, Suite 911
Arlington, VA 22202
Telephone (703) 746-3240
Autovon: 286-3240

USS TRITON (SSR(N) 586)

USS TRITON (SSR(N) 586) - All crewmembers are notified of a reunion to be held August 2, 3 and 4, 1991, at the Groton Motor Inn, Groton, CT. Please contact:

TRITON Reunion
P.O. Box 991
Groton, CT 06340

USS TINOSA (SSN-606)

USS TINOSA (SSN-606) will hold a deactivation ceremony on 10 May 1991 at 1300 at State Pier, New London, Connecticut. All previous crew members, veterans of USS TINOSA (SS-283) and interested parties are invited to participate. For more information, contact MMCM(SS) Silvernail, Submarine Squadron Ten, State Pier, New London, Connecticut. Telephone Comm. (203) 449-2720 or Autovon: 241-2720.

■

APPROACH OFFICER RANGING

by LCDR P. Kevin Peppe

We in the business of fighting submarines have become increasingly reliant on gadgets to arrive at estimates of target motion. Whether it's the ultra-sophisticated BSY-1 fire control system or the Hewlett Packard 9020 with its lovely multi-color display or even the Sharp calculator, more and more we find ourselves waiting for these machines to tell us the answer.

Mental agility, far from dated, has become the benchmark against which the successful Commanding Officer is measured. His ability to rapidly arrive at an estimate of target solution which is "good enough" clearly sets the standard to which the rest of his wardroom will be held. To this end I offer a couple of simple thumbrules which might prove useful, and describe a ranging concept which may enhance the pursuit curve type of target closure without sacrificing the confidence of frequent ranging.

D/E Ranging: The straight line D/E range problem is represented as figure 1. The equation which describes the geometry is;

$$\tan(D/E) = \frac{\text{Water Depth}}{1/2 \text{ Range}}$$

Assuming water depth is given in fathoms, we can solve for target range in yards as;

$$\text{Target Range} = \frac{4 * \text{Water Depth}}{\tan(D/E)}$$

Let's build a table of the (4/tan(D/E)) factor for some D/E's which the captain might exploit.

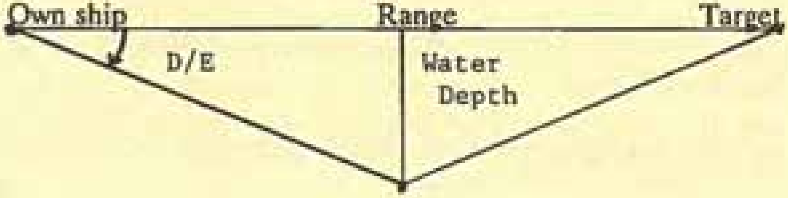


Figure 1.

D/E TABLE

D/E	tan(D/E)	4/[tan(D/E)]	D/E Factor
-45	1.00	4.0	4
-30	0.58	6.9	8
-20	0.36	11.1	12

It doesn't take a rocket scientist to see that I've used a liberal amount of RADCON math to arrive at the D/E factor column in the table above. My defense, sometimes referred to as 'Fischbeck's Rule' is that an easily remembered falsehood is often better than a difficult to remember truth. I would simply point out to the user that the easy to remember falsehood gives ranges which are a little too long.

Granted there are more accurate means available to determine D/E range. Corrections for SVP are developed in the 9020. Bottom slope approximations can be made. In fact, the fire control system can give us a better straight line approximation automatically.

However, consider some of the benefits this simple estimate gives us. It's quick. Pick the best D/E and multiply the D/E factor by water depth to get range. It provides an invaluable check against all other range sources. Perhaps most importantly, it provides a reasonable bracket for the Approach Officer. If the target is showing up best somewhere between -20° and -45° his range is between four and 12 times water depth. Surprisingly this bracket estimate may be 'good enough' for certain combinations of weapons and targets.

<u>D/E Range Example 1</u>

S-1 is held in the -30 D/E. Water depth is 2000 fathoms. What is target range.

-30 D/E correction factor; 8. Eight times 2000; 16,000 yards (really closer to 14,000 yards).

D/E Range Example 2

S-2 is held in the -37 D/E. Water depth is 1500 fathoms. What is target range.

Didn't list a -37 D/E factor. About half way between -45 and -30. Use factor half way between 4 and 8; D/E factor = 6. Six times 1500; 9,000 yards (actual straight-line range 8,000).

Triangle Ranging: Excellent estimates of target range are available if he is held on both the spherical array and the towed array. Submarine ranging exercises have consistently demonstrated this method is among the most accurate sources available. It is rare that this range is not "good enough". The triangle range problem is depicted in Figure 2. The equation describing Figure 2 is:

$$\text{Range} = \frac{2x}{\tan(\Delta/2)}$$

Here Δ is the difference between the spherical array and towed array bearing. Note that for some angle x less than about 15°, tan(x) is approximately equal to sin(x).

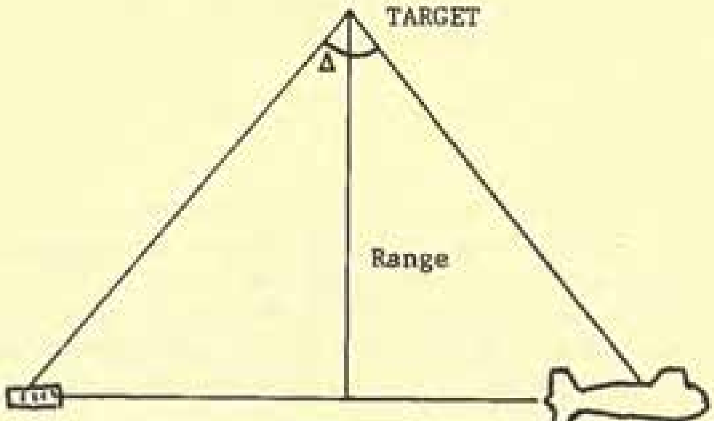


Figure 2.

TRIG TABLES

Angle x	tan(x)	sin(x)
5°	0.09	0.09
10°	0.18	0.17
15°	0.27	0.26

Further, for angles less than 15° we can approximate sin(x) as x/60. These simplifications lead us through the following equations;

$$\text{Range} = \frac{\text{Scope}}{2^{*}\tan(\Delta/2)}$$

$$\text{Range} = \frac{\text{Scope}}{2^{*}\sin(\Delta/2)}$$

$$\text{Range} = \frac{\text{Scope}}{2^{*}(\Delta/60)}$$

$$\text{Range} = \frac{60 * \text{Scope}}{\Delta}$$

If we assume towed array scope, really distance from the sphere to the center of the towed array, is given in feet and we would like target range in yards, we simply divide by three to get the following approximation for triangle range.

$$\text{Range} = \frac{20 * \text{Scope}}{\Delta}$$

It's important to note that we have assumed the target is broad on the beam, thus fully utilizing the baseline given between sphere and towed array (see Figure 2.). If that is not the case then we simply take the uncorrected range we found above and multiply by the sine of the targets relative angle. If the target is within 15° of the beam then the correction need not be applied.

Some will probably despair that this "thumbrule" is too difficult. I contend that with a little practice any submarine officer can develop accurate triangle ranges in most cases in less than five seconds. Simply bear in mind the number of feet between sphere and towed array, double it, add a zero, and divide by Δ. If necessary, correct for baseline using the rule of sines.

<u>Triangle Range Example 1</u>

Own ship is on course 020. S-1 is held on the towed array bearing 120. S-1 is gained on the sphere, bearing 125. Distance between the sphere and the center of the array is 2000 feet. What is triangle range?

Double scope; 4000. Add a zero; 40,000. Divide by 5; 8,000 yards. No correction is necessary since the target is within approximately 15° of the beam.

<u>Triangle Range Example 2</u>

Own ship is on course 130. S-2 is held on the sphere bearing 070. S-2 is gained on the towed array bearing 075. Cable scope is 1500 feet. What is triangle range.

Double scope; 3000. Add a zero; 30,000. Divide by 5; 6,000 yards. Not within 15 degrees of the beam, multiply by sine 60 = (60+25)/100 = .85; 5100 yards.

As acoustic parity drives engagement times down, the ability to think on your feet, to be mentally agile, will grow in importance. This article is not an attempt to discredit the automated devices we have and currently employ in the fleet. Far from it, the author strongly believes that <u>every</u> possible source must be used to gain tactical advantage. It can be contended, however; that to rely on those devices like a blind man his dog is to invite disaster.

VIRTUAL RANGING

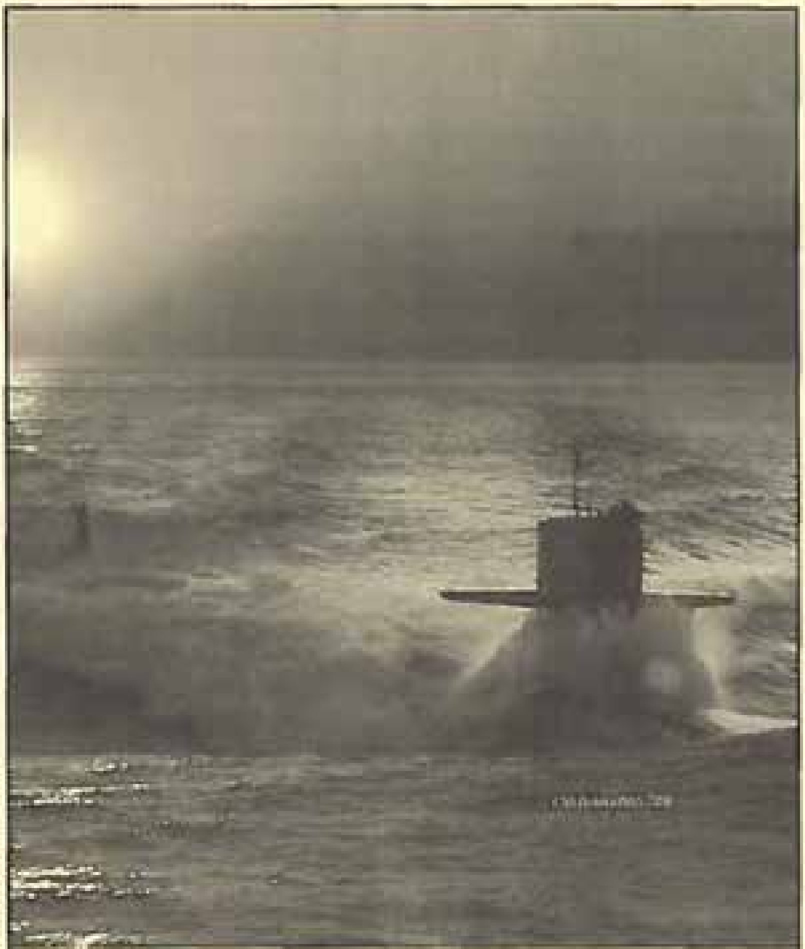
Classic target ranging methods employed in solving the TMA problem rely, in one sense or other, on changing ownships speed across the line of sight. While yielding rather accurate estimates, they no longer meld with newer methods of target approach (pursuit). In other words, the TMA/approach problem now consists of distinct and somewhat disjointed phases. A line of sight ranging maneuver is performed to establish both target range and direction of motion. Based on this classical estimate, own-ship will follow a collapsing spiral into the targets stern area and establish a reasonable firing position. Finally, another range estimate is obtained to verify solution and, if favorably positioned, the target is engaged.

PXO class 90040 found that while this methodology generally worked, there was a definite discomfort in the long pursuit phase. The absence of classic, across the line of sight ranging maneuvers lent the sense that you were stumbling into the target rather than conducting a deliberate approach. The following methodology, to be used in bottom bounce towed array situations, relies upon a ranging method which requires a steady speed across the line of sight. This seems more in keeping with the pursuit approach methodology.

We enter the problem after having established initial target range and DRM. We assume that the target is abeam to port. Own-ships speed is six knots. With the target abeam we gain both an accurate bearing and bearing rate. The ship is now maneuvered to put the target 30 degrees off the port bow, speed is increased to twelve knots. Note that own ships speed across the line of sight remains unchanged. With the array steady a best bottom-bounce bearing or hyperbola is derived. If we had a direct path bearing at the same instance we could accurately determine target range (Hybrid hyperbolic cross-fix).

Let's pretend that own-ship had remained on it's initial course and speed. If certain assumptions are invoked (namely linearity of bearing rate) then we could have predicted bearing at any time in the future. Clearly as the time interval over which we make this prediction grows the extrapolation will increasingly suffer from non-linearity effects. However, if we keep the prediction interval reasonable (generally less than 15 minutes, strongly a function of geometry) and accurately estimate bearing rate on the initial leg, our estimate of target bearing in the not-too-distant future should be close to actual.

It follows, then, that while as actual direct path bearing is not available with our hyperbola, there is a virtual bearing, generated from a virtual own-ship, which provides a reasonable approximation. The key clearly is keeping a relatively constant own-ships speed across the line of sight and minimizing the interval over which the direct path bearing is predicted. Given these rather liberal constraints, an accurate estimate of range is derived from cross bearings.



Submarine Technology in a League by Itself.

General Dynamics has been designing and building nuclear submarines for more than 35 years, and is the sole designer and builder of Trident ballistic missile submarines. We also build the SSN688 class, the Navy's premier fast-attack submarine since the mid-1970s.

Now the Navy has awarded us the lead-ship construction contract for Seawolf, the first of a new class of fast-attack submarines. At our Electric Boat Division, we continue to set the standard of excellence in submarine construction and technology.

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THE SSBN "SEAMAN GUNNER"

A Speech to the Submarine Strategic Weapons
Training Conference
12 April 1990
by Captain Melville H. Lyman, USN

The U.S. Navy used to fire salutes at three second intervals and the gunner's mates had a cadence they used to time the shots. "If I wasn't a gunner, I wouldn't be here! Fire!"

"If I wasn't a gunner, I wouldn't be here!"

I've taught that expression to many of you -- it's my way of instilling pride in being a gun boss. We, you and I, represent the corps of submarine force professional gunners. That's a neat title and we are some pretty elite people.

When the Commanding Officer of an SSBN asks his Engineer for advice, it's either because the CO is training the engineer to think, or else the CO hasn't bothered to figure out the answer for himself, but could.

When the Commanding Officer asked the Weapons Officer for advice, the buck stopped there. No one else was going to help with the answer. No one else on board even knew the answer. The professional gun boss had a mystique about his job that the average Commanding Officer could not comprehend and that the submarine force utterly failed to grasp.

Note that I use the past tense when I refer to the professional seaman gunnery officer in submarines. I fear that that era has passed in favor of assigning the billet of Weapons Officer to a generalist who sees it as one more ticket in the path to command.

John Prebble, in his historical masterpiece, *CULLODEN,* understood the mystique of the weaponeer as compared to the generalist. He describes Brevet-Colonel William Belford, Commander of the Train, Royal Regiment of Artillery, who stood at Drumossie Moor the morning of 16 April 1746, by writing that:

> *"He was thirty-four years of age and he was not like officers of Foot and Horse to whom military service was often an exciting extension of their social life. He was*

dedicated to his profession and close-mouthed about his art, believing, like most men who are servants of machines, that they imposed upon him certain spiritual obligations. These he had read when a cadet, as they had been set down by Captain Thomas Binning who asked of a gunner, 'that he be one that feareth God more than his Enemy, that he be Constant and not given to Change, that he be Faithful, True, and Honest.'

Being a gunner on board an SSBN encompassed much of that and more. Nothing quite compares to being a true expert in a field when no one else is, and that described the strategic missile gun boss of a few years ago.

And what years they were! We lived on the cutting edge of innovation. While the nuclear power side essentially froze its technology between the late 50's and February 1982, the strategic weaponeers pushed forward the frontiers of science. We learned how to deal with new forms of propellent and new concepts in targeting. We developed operating procedures and casualty procedures as each new system came along, while backfitting what we learned into the systems that existed already. We worked hard and we played hard.

We had fun doing all this, although some of the humor was at our own expense. I remember DASO in September 1972, when those of us in USS GEORGE BANCROFT were adjusting to the Poseidon missile. My Assistant Weapons Officer was lying on his back in the equipment section of a launch candidate doing a close-out inspection when he decided to grab a bundle of confined detonating fuse and to shake it to ensure it was tightly secured. It moved slightly. Simultaneously and coincidentally, the ship lost shore power and those events common to a 640 class loss of shore power occurred -- the lights went out momentarily as the ABT shifted and the breather valves all failed to automatic -- permitting the residual air in the header to make a loud bang as it vented into the tube. The AWeps knew only that, as he grabbed the fusing, darkness and a loud bang had occurred. He never quite recovered from his fear that he had started a twenty-five hundred mile ride downrange.

We, the professional corps of submarine gunners, suffered some unreadiness due to our equipment, and we suffered some due to our stupidity. But -- we never had an accident or significant incident. Most importantly, we kept the free world free. That sounds like flag waving, but it's true. Glasnost, which marks the start of what may be a new era of peace, was made possible by those of us in this audience, and our predecessors, who bored holes in the ocean while the diplomats and the forces of history worked towards today's developments. We can, and we should be proud of that. We showed up at a time when our country needed us, and we leave as our job winds down.

We must not concern ourselves that we leave as unknowns. Tell me the name of any gunner in the U.S. Navy in any year of the 1850s. Tell me the name of any gunner in the U.S. Navy in any year of the 1920s. Our predecessors kept the peace, did their job, and retired unheroically. I hope there is honor in preserving the peace, even if there is little glory in doing it. "What did you do in the war, Daddy?" "My son, I kept it from being one."

If I wasn't a gunner, I wouldn't be here. I'm proud of that. I'm proud of having had a career where I can say that I tried to "fear God more than my Enemy, be constant and not given to change, be faithful, true, and honest."

We, the professional submarine weapons officers, are about to go away -- victims of changing times, changing attitudes, and a system that works too well. "Morituri te salutant" -- We, who are about to die, salute you.

So who gets to take over now? There really is an answer and it's an answer that has worked in the Navy since John Paul Jones. When all else fails, when the chips are really down, go find a Chief Petty Officer. Go find someone who really is a specialist, both technically and managerially. Tell him to carry forth the torch. Ask the Chief.

We have never expected our Communicators to copy morse code or be able to repair a teletype. Our Sonar Officers rarely have had the ability to put on a headset and derive meaningful information therefrom. Few food service officers know how to cook. We've assigned those billets to officers whose job it is, and has been, to manage divisions and departments. The officer took care of his men and ensured their well being. He, in turn, required that his organization run smoothly and efficiently. When something didn't work, he stuck his head in enough to satisfy himself that the right people were repairing it and then he ran interference for them while they did the maintenance. The officer, perhaps, was directly responsible for some small aspect of the division's duties, such as crypto custodian in radio, but rarely did he get that intimately involved. So who did? Ask the Chief!

And that's where we must consider ourselves to be today in the strategic weapons world. Our Weapons Officers, henceforth, will be officers passing through billets. If there is to be a cadre of professional gun bosses in the future, the group will be so small that many of you will never meet one. The mantle, the honor, the glory, and the work of the professional gunner has moved back down where it probably always belonged -- to the Chiefs' Quarters.

Perhaps in five years, some Chief will be standing here on the podium. Hopefully, he'll be discussing the role of the professional gunner. He'll be talking of keeping the system on line in the face of difficulties with equipment and personnel. He'll stress that he cannot do his job unless the wardroom lets him know what's required. He'll complain about it no longer being the good ol' days. He'll say, "If I wasn't a gunner, I wouldn't be here!"

We need to restructure to make that happen. We need to recognize the reality that the Chiefs must take over a role that they lost, for whatever reason, when the submarine force underwent some fundamental changes in the late 50s and early 60s. Chiefs, and now I am speaking directly to you, you must become the keeper of the flame of professionalism. You must recognize that you are not "twidgets", and you must refuse to let your people think that way. The main battery of a standard hull SSBN is sixteen 72-inch, 5.85 caliber, single shot, muzzle loading, smoothbores. A TRIDENT II submarine has twenty-four 83-inch, 6.44 caliber, single shot, muzzle loading, smoothbores. You need to know that, because <u>every</u> gunner knows his main armament. You may be aiming them with computers; you may be firing them with gas generators instead of silk bags of cordite; but you are still gunners; the honorable carriers of that title. The minute that you let your troops believe that they are simply twidgets, that's the minute you stop being a professional with wide ranging responsibilities and traditions and become just another routine guy with a routine job. Your heritage comes from the gunners of the Royal Navy, described by A. R. Hall as:

"Recruited from the hard service of the seas ... or a line of martial ancestors, such men as these, with the intellectual cream of other crafts, were the aptest interpreters of science and the discoverers of its utilitarian charms."

I say to you, "Morituri te salutant." Now it is your turn to say back to me, "If I wasn't a gunner, I wouldn't be here!"

I challenge you to figure out how to operate the SSBN weapons systems as the professionals you are. I challenge you to develop the curricula and the dogma that will permit the chief petty officer to reclaim the role of the professional seaman gunner. You won't get the officer corps to help -- we're history. We did our job, and now we're virtually gone. The job, Chiefs, is yours.

I say to you, "Morituri te salutant." But I also say, "Pass the word from gun to gun, this will be a firing run!" Go get 'em -- and good luck.

■

THE DIVING OFFICER

by Captain George Graveson, USN(Ret.)

The officer standing watch as a diving officer in a submarine has the very important job of taking the submarine to the depth that the Officer of the Deck or Commanding Officer orders and maintaining that depth until directed to change it. That position as diving officer is significant to the operation and control of the submarine, but, because of differences in configuration of the submarine resulting in the close proximity of the ship control station to the conning station in today's submarines, the job is different in some aspects than it was in the diesel boats of yesterday. This essay attempts to describe the position of Diving Officer as it was in the Fleet Type submarines which preceded the nuclear submarines of today, and to portray what that meant to the young submarine officer.

Prior to the 1960s, officers did not go directly to submarines for duty. They first went to sea in the surface Navy, where they got their sea legs and received their early training after commissioning. When a young officer applied for submarine duty, he had to meet certain requirements. He had first to be recommended by his Commanding Officer and he also had to be designated as a qualified Officer of the Deck, in port and underway. If accepted for submarine officer training, he would then proceed to Submarine School for an intense course of instruction leading to his eventual assignment to an operating submarine, where he continued his education and training in the art of operating a submarine. This phase of his training was spread over the greater part of a year, after which, if recommended by his submarine Commanding Officer, he would go before one or more other submarine Commanding Officers for testing of his knowledge and his ability to operate the submarine in all of its aspects. If the officer got through all this and the examining Commanding Officers recommended his qualification, his Division Commander would recommend to the Squadron Commander that he be designated "Qualified in Submarines." The recommendation would then go to the Submarine Force Commander and the coveted DOLPHINS would become a part of his uniform and a part of his soul.

The officer graduating from Submarine School had gained a wealth of knowledge about submarines, their operations and the equipment and systems contained therein. In addition to the theoretical, he also gained important practical instruction on the propulsion system, the trim and drain systems, the communication and navigation systems, the electrical system, the high and low pressure air systems and weapons systems. Probably the most significant new field of knowledge and understanding that the young officer was exposed to was that of controlling the diving and surfacing of the submarine. When he completed Submarine School, he would be considered to be a qualified diving officer, but many hours in the Diving Trainer and a few at sea, leading the on-board diving teams, is not quite the same as it is when one gets to his first boat, and his Captain expects him to **reach and maintain ordered depth.**

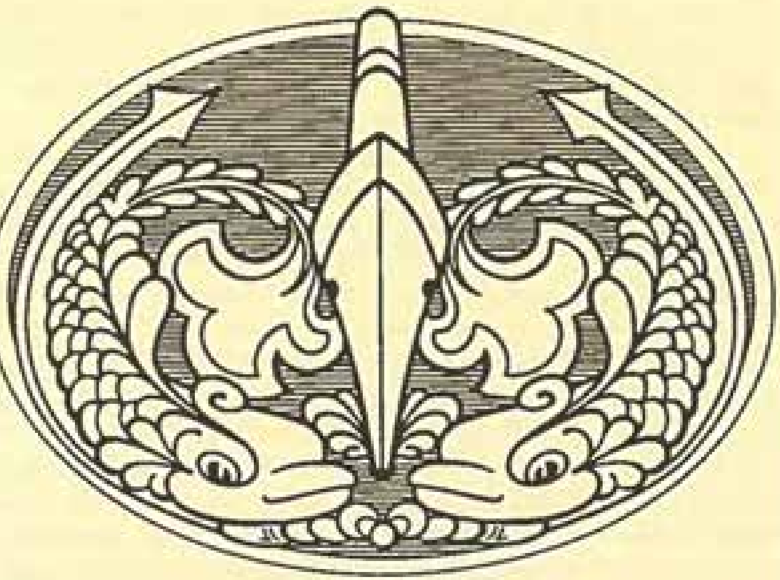
The ship's **Diving Officer** was usually the Engineer Officer. Other than the Captain and the Exec, the Engineer was usually the senior officer in the wardroom. He had been on board longer than the other junior officers and knew the boat better than any of them. This was not always the case, but generally so. At any rate, the junior officer on board had a long way to go to be considered a "diving officer" much less "THE Diving Officer."

It took a lot of watch standing to learn the individuality of the boat and how it reacted to the various stimuli imposed upon it. The answer to the junior officer's question, "How do you know?", was usually, "You feel it in your feet." And this is what it finally boiled down to. You had to learn about it first hand. You had to be there, to feel the boat react, to understand your planesmen and how they would react to your commands and your prodding them to respond faster and more appropriately to the reactions of the boat. You had to learn to know the men and to be able to give them just the right amount of guidance or the right harsh word or word of encouragement at the right time in order to get their response transferred to the planes and then to the hull, so that the boat responded to your will. It was more than just a position of leadership. It was more than just a man leading others to a particular task. It was as if you became a part of the very being of the boat. You did "feel it in your feet" as well as with every part of your body and the very essence of your being.

When you really became a diving officer, in every meaning of the words, you became a part of the boat. When this happened, you were never going to be anything other than a submarine officer. You were captured forever. You were a part of the mystique, a part of a whole structure, greater than the sum of its parts. You were, at the same time, an individual capable of thinking for himself and making decisions, and yet an integral part of the submarine -- a complex accumulation of machines and men integrated into a living organism.

And this is what your Captain asked for. This is what he demanded. This is what you must be to the man taking his ship into battle. When he raised the periscope to see his target, he had to trust that his "Battle Stations" diving officer would have the boat positioned at just the right depth for the scope to be out of the water, but not too much exposed. There was a certain independence in the position of diving officer, located as he was in a space separate from the conning station. The diving officer had to have one ear in the conning tower and the other listening to all the noises and information coming to him from below. He had to be in two worlds -- the world of the control room, keeping track of the on-going ship's evolutions and the control of the dive; and the world of the conning tower, where the battle was paramount and the Captain was the only link between the outside world and the life of the submarine. As the Captain was the link to the world above, the diving officer was the link between the conning tower and the rest of the submarine and the crew. He was a part of the boat and a part of the men he led in the control room and, during the pursuit and the attack, he had to anticipate the Captain's every thought and command. He had to be ready to put that extra pressure on the sailors on the diving planes when the periscope was about to be raised to catch its fleeting glimpse of the target. He had to be ready, in a fraction of a second, to "take her deep," or to bring her up an ever so little bit, to keep the scope just out of water, for the Captain's one final look, before shooting. He had to keep the submarine ready to respond to the Captain, ready to continue with the approach, to make a successful attack and to escape from any counter attack.

Once the young officer had integrated into the life of the submarine through the process of learning and developing that special ability to "feel" the boat, until he got to be the Captain, no other job or position would quite measure up to being **THE DIVING OFFICER.**



FRYE'S SLCM DILEMMAS

The logic of Dr. Alton Frye's argument (SLCM DILEMMAS: FORESIGHT AND FOLLY; July 1990) that it is to our advantage to submit nuclear-armed SLCM to arms control limitations is severely flawed. Dr. Frye's main point appears to be that the relative vulnerability of important U.S. assets and the relative invulnerability of Soviet ones to SLCM attack militates in favor of arms control. The truth is just the opposite. The difference in relative vulnerability between U.S. and Soviet targets militates against limitations on SLCM. The reasons for this are as follows: First, the difference in the vulnerability of the two sides means that the Soviets could wreak massive damage on the U.S. with only a few nuclear armed SLCM while the U.S. would need much larger numbers to ensure the same damage level. Thus, any limit on the numbers of such systems short of a complete ban (which neither side has proposed) would be to the net benefit of the Soviet Union.

Second, even a ban on nuclear-armed SLCM would likely benefit the Soviets. The reason for this is that, since such a ban could not be comprehensively enforced or verified, the Soviets might well be capable of producing a small covert stockpile of such weapons. However, given the geographic asymmetries between the U.S. and Soviet target bases, the U.S. is relatively more vulnerable to cheating or breakout than is the Soviet Union. As a result, the Soviets might be able to do massive damage to the U.S. with undetectable numbers of illegal SLCM while the U.S. would likely need a much larger, and more detectable level, of cheating to achieve the same degree of damage against the Soviets (assuming that the U.S. was politically capable of cheating in the first place).

Third, an unverifiable ban on nuclear-armed cruise missiles (which, once again, neither side has proposed) could well leave the U.S. public with a false sense of security regarding SLCM attacks. As a result, that public might lack the will necessary to build the required defenses.

Fourth, including SLCM in arms control could result in a dramatic reduction in crisis stability. This is the case since most current proposals involve limiting the types of naval platforms on which nuclear-armed SLCM could be carried. This would significantly reduce the complexity of the targeting problem now faced by Soviet planners. A ban on SLCM would be even worse, reducing from over 200 to around 14 (aircraft carriers) the potential number of platforms which would have to be attacked in a first strike.

Finally, dramatic reductions in the numbers of nuclear armed SLCM could make it much more difficult for the U.S. to deter nuclear attacks on its naval forces. This is the case since it is easier to believe that a President would employ SLCM than central strategic systems in response to such attacks.

Dr. Frye's second main point is that, while the requirements of verification would only be "intimidating," "go against the grain of tradition," "disturb operational procedures," or simply be "a nuisance," arms control is necessary since "...failure to ... regulate SLCMs jeopardized the conclusion and implementation of meaningful strategic arms reductions..." There are at least two problems with this argument. First, SLCM are not strategic weapons. Because they are carried on multi-mission platforms, they could not possibly be operationally coordinated with other forces in a SIOP-like operation. Instead, their purpose is to provide the Theater CINC with an additional nuclear asset which he might employ against force concentrations or fixed targets within his Area of Responsibility. Thus, there is not, nor should there be, any relationship between SLCM and "strategic arms reduction." This would be the case even if limitations or a ban on SLCM could be perfectly verified.

Second, verification does not involve merely inconvenience. The verification schemes proposed thus far amount only to a very complex and intrusive set of confidence building measures which cannot "verify" that nuclear-armed SLCM are not being produced, stockpiled or deployed, but could result in a compromise of operational security. Of course, if a truly effective verification regime could be constructed, it would, of necessity, be incredibly intrusive, involving the presence of inspectors on virtually all ships at all times. Such a regime would obviously result in a massive compromise of operational security. Further, while such a compromise would exist for both sides, we have far more to lose than the Soviets do, especially when it comes to submarines.

To conclude, the real question we should ask ourselves is whether it is more responsible to rely upon our own resources to deter the Soviets from making nuclear SLCM attacks on the U.S. or its naval forces (and, indeed, from making war on us or our allies at all), or to rely instead on the good will of the Soviets not to violate a more-or-less porous arms control regime. This is not an easy question to answer. Dr. Frye's cavalier implication that the leadership of the U.S. Navy is irresponsible if it does not select his preferred solution is hardly the way to conduct this debate. One can only hope that, in the future, Dr. Frye will limit himself to the merits of the alternatives even if, as is the case here, they do not favor him.

Michael F. Altfeld, Ph.D.
Assistant to the Director
Strategic and Theater
Nuclear Warfare Division
Office of the CNO

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KURILE ISLANDS SUBMARINE OPERATIONS

I am doing research on submarine operations around the Kurile Islands during WW II. Captain Oswald Colclough first had six S-boats, which were replaced by eight fleet vessels (including GROWLER, TRITON, and TUNA).

I would be interested in communicating with anyone who served on these vessels.

I can be contacted at P.O. Box 563, Allen Park, Michigan 48101.

Any assistance in this area would be greatly appreciated.

Kevin Hutchinson

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SUB SCHOOL SIGN

Thanks for your many phone calls and letters in response to my plea for help (October 1990 SUBMARINE REVIEW). I asked for the exact quotation from Thucydides' History of the Pelponesian Wars which hung over the main entry of the

Submarine School during WW II. Theresa M. Cass (Archivist, NAUTILUS Memorial Submarine Force Library & Museum) sent a WW II photo of two sailors looking up at the sign.

Judging from all of your comments, many of you still find the thrust of that sign is still meaningful in your current endeavors. If your memory needs refreshing, here is the quotation:

> *Their want of practice will make them unskillful and their want of skill, timid. Maritime skill, like skills of other kinds, is not to be cultivated by the way or at chance times.*
>
> *Thucydides 300 BC*

Many thanks to all who responded.

CAPT William A. Whitman, USN(Ret.)

PURPLE HEART AWARDS TO SUBMARINERS

Captain Stan Sirmans, USN, a submariner and member of the Naval Submarine League, is working on an article for THE SUBMARINE REVIEW on World War II submariners who were wounded and received Purple Hearts. No one has ever compiled a list and he is asking for any information members may have on Purple Heart awards to submariners during the war. He is also looking for a complete list of World War II submariners who were prisoners of war. His address is 2301 S. Jefferson Davis Highway, Apt. 1228, Arlington, VA 22202. His phone number is (703) 418-2088.

IN THE NEWS

• On August 6th, NAVY NEWS & Undersea Technology reported that the Soviet news agency TASS had announced that a Dutch salvage consortium will attempt to raise the MIKE-class submarine which sank in 4000 feet of water during April of 1989. The Soviet announcement quoted their shipbuilding officials as saying that the Dutch plan is "realistic ... and economically sound".

• The same newspaper, of 1 October, commented on a report by the Indian government that construction of a submarine in India is costing about four times as much as the first of that four ship class did at the HDW yard in Kiel, West Germany. Under a contract of December 1981, two submarines were to be built in Kiel and the second two in Bombay. The Germans built the first two between 1982 and 1986, and the Indians laid the keel for their first in 1984. NAVY NEWS goes on to state, "By July 1985 the pressure hull had to be torn apart when not a single hull weld passed X-ray inspection. A new keel was laid down in late 1985. The original estimate to construct (this boat) was 42 months with commissioning scheduled for 1988. This date has been progressively moved until now it is set for March 1992, 93 months after construction began."

• NAVY NEWS & Undersea Technology of 8 October quotes the General Accounting Office (GAO) as recommending a one year delay in the SSN-21 SEAWOLF program. The GAO report "Navy Ships; Concurrency Within the SSN-21 Program" was cited as: "We believe changing world events, the need to respond to the U.S. budget deficit, and the benefits of a less concurrent program warrant a one year delay in the award of the next SSN-21 production contract." The GAO is said to have reported that "Under the Navy's current plans, seven SSN-21 submarines could be under construction or contract before the first ship is delivered in May 1995." The GAO is also reported to be in favor of testing the ship and its subsystems before the government commits to mass production.

• INSIDE THE NAVY of 22 October reported that since the DOD-mandated review of the Navy's major shipbuilding programs reduced the planned build of three SEAWOLF submarines every year down to two submarines every other year, there has been a debate over whether or not the U.S. industrial base could be maintained at that low level of production.

- The same newspaper, on October 29th, commented on the General Accounting Office (GAO) report "Defense Acquisition: Fleet Ballistic Missile Program Offers Lessons for Successful Programs." They reported that the GAO also "labeled the BSY-1 advanced combat system for the SSN-688 (I) class submarine as a program that has been less than successful."
- SEA POWER, in its November issue, reported that: "The Navy has filled four of its most important four-star jobs with the reassignment of Admiral Charles R. Larson, Commander in Chief, U.S. Pacific Fleet, to duty as Commander, U.S. Pacific Command and the appointment of three highly regarded Vice Admirals to four-star rank." In addition to Admiral Larson, one of those three Vice Admirals is William D. Smith, currently DCNO for Navy Program Planning (is being reassigned) to duty as U.S. Representative to NATO."
- INSIDE THE NAVY, in its 12 November issue, conjectured that "As the Soviet threat continues to decline, especially in the realm of anti-submarine warfare, Navy and Department of Defense officials involved in the development of the next generation conventional cruise missile have reportedly begun to contemplate configuring the weapon for use from torpedo tubes on the Navy's SSN-21 SEAWOLF class attack submarine." They went on to cite their informed sources as seeing the advantage of putting the Long Range Conventional Standoff Weapon (LRCSW) on attack submarines as allowing those ships "to play an important role in conflicts against adversaries other than the Soviet Union while still retaining the primary mission of hunting and killing enemy submarines." The newspaper described the LRCSW as still in the concept definition stage, and "currently being designed for use only from submarine and surface ship vertical launch systems as well as in an air-launched variant for the Air Force."
- On November 19th, INSIDE THE NAVY reported that the Navy will soon release a Request for Proposal (RFP) for the award of the follow-on SSN-21 submarine. They went on to say that cost factors will play a "heavy hand" in determining who will build the second SSN-21. The paper quoted a SecNav letter to Congress as assuring that a full-out competition will take place between Newport News Shipbuilding and General Dynamics' Electric Boat Division.

• INSIDE THE PENTAGON of November 15th comments on the "just-released" spring 1990 testimony of Admiral Bruce DeMars, the Navy's director of its nuclear propulsion programs. The paper reports that DeMars told Congress that the SSN-21 is decades ahead of the next generation Soviet submarine in overall capability. It also quotes him as saying "...I would say we ought to build about 30 (SSN-21s), about three a year, and shift over to something better, if there is something better, in 10 years." This news item goes on to interpret that comment as proof that the Navy is "already planning for a new submarine class but is downplaying the subject until after the SEAWOLF program is fully underway."

• In its issue of 3 December, DEFENSE WEEK reported on the status of the SEAWOLF program, noting that the Defense Acquisition Board (DAB) will be meeting in December to either approve or modify the budget cuts outlined in SecDef Cheney's recent major warship review which cut SEAWOLF procurement from 10 every three years to three every two years. The article explained:

> "In preparation for the high-level meeting, Pentagon staffers are performing a wide-ranging scrub of the SEAWOLF, the most expensive attack submarine ever built by the Navy. With service input, staffers are doing a detailed cost analysis of the cuts as well as an extensive production readiness review."

In other portions of the popular press, submarines and submariners have been treated as features, with rather in-depth articles addressing the impacts, the technology, the history, and the people making up the submarine warfighting world.

• In FORBES of July 9th, a lead article was titled THE ULTIMATE WEAPON? that addressed both U.S. capabilities and the still extant Soviet threat. Both Captain Bill Ruhe and John Engelhardt are quoted as giving credence to the sophistication of the Soviet submarine programs, as is the weight of numbers cited for force levels from JANE'S. The article ends with a quote from John Keegan; "command of the sea in the future unquestionably lies beneath rather than upon the surface." Then goes on to ask "can any sensible person believe that a mere shift in command in the Kremlin makes control of the seas irrelevant?"

• POPULAR SCIENCE, in its August issue, highlighted quieting technology as a touchstone of modern submarining and went on to examine several aspects, including natural circulation on reactors and ducted propellers.

• Captain Ned Beach was featured in an article in the 27 August issue of NAVY TIMES. The title of the piece, "'RUN SILENT, RUN DEEP' AUTHOR STILL WRITING ABOUT HIS NAVY" tells the essential story, which covers Ned's dual naval/literature career from his USNA graduation in 1939 up to his current projects. Naturally, the submerged circumnavigation of TRITON in 1960 is given a prominent place, but the outline of his career could well have prompted the TIMES staff writer to probe a bit deeper into some of the noteworthy happenings with which he was associated during those days of change -- the last time around -- in the 40's, 50's and early 60's.

• THE WASHINGTON POST, on the 21st of August, published an article about the close-in World War II U-Boat campaigns off the U.S. east coast entitled THE SUBMERGED STORY OF THE U-BOAT WAR, and sub-headed HISTORIAN UNCOVERS AN EAST COAST MASSACRE. The article tells about the writing of a book by Professor Michael Gannon which describes the 1942 WestLant operations by the Germans as "a largely avoidable massacre." Admiral King seems to bear major responsibility for the problem, according to the POST piece; but perhaps the telling clue is a quote attributed to Dean Allard of the Naval Historical Center: "I have this feeling there's more of the story yet to be uncovered."

IN REMEMBRANCE

Captain John J. Herzog USN(Ret.)

Loyal member of NSL since its beginning, in 1982

SLIDE RULES AND SUBMARINES: AMERICAN SCIENTISTS AND SUBSURFACE WARFARE IN WORLD WAR II

by Montgomerey C. Meigs
Washington, DC: National Defense University Press, 1990
Pp. 220, 74 photographs

reviewed by LT Daphne Kapolka, USN
Naval Postgraduate School
Monterey, California

In March of 1943, "U-boats ravaged merchant ships crossing the Atlantic in a manner not seen since World War I: 42 ships in convoy and 16 stragglers, more than a half-million tons of shipping, went down. These losses represented one-twentieth of the ships attempting the round-trip across the Atlantic."

Meigs' book, Slide Rules and Submarines, is the compelling story of the race to slow these catastrophic losses of World War II and to form our own offensive capabilities in the Pacific theater. The heroes of the story are the scientists, whose objectivity cut through the traditional Navy paradigms to form innovative, effective solutions to subsurface warfare. In the preface, Meigs declares that his objective is, "to gain insights about how scientific developments became military capabilities in the campaign of subsurface warfare in World War II," and, in particular, to answer three questions:

- How were scientists best able to contribute to the development of new military capabilities that proved significant at the operational level of command?
- What institutional factors aided or abetted this process?
- Once technological innovations became operational capabilities, how did they influence the campaign in terms of their psychological, operational, and tactical effect on the battle?

He provides answers to all these questions throughout the book by giving us a detailed look at the personalities, institutions, and events which shaped the course of subsurface warfare.

Meigs sets the stage for his analysis with a look at the post World War I mindset. In spite of the devastating campaign the German U-boats launched against Allied shipping in the First World War, little was done in the postwar period to develop either the technology for subsurface warfare or a doctrine for such warfare. Maritime strategy focused on surface forces, and the potential of the airplane as an ASW platform was ignored, even though the terms of the Anglo-German Naval Treaty allowed the Germans to build a submarine force equal to 45% of the British submarine force by tonnage, as opposed to only 35% of the surface fleet.

Consequently, the start of the Second World War caught us unprepared to defend against the aggressive Rudeltaktik or "Wolf Pack" tactics employed by German Admiral Karl Doenitz. Institutional biases in favor of the traditional approach, particularly as reflected in the unyielding personality of the Commander-in-Chief, U.S. Fleet (COMINCH), Admiral Ernest J. King, impeded progress in our subsurface capabilities. Nevertheless, scientists began to organize themselves to contribute to the war effort. Dr. Vannevar Bush formed the National Defense Research Committee (NDRC) in June of 1940.

Unfortunately, the resistance of the Navy to what they saw as the interference of outsiders limited the effectiveness of the scientists' contributions during the beginning stages of the war. They had to force their way into the command structure gradually. In April of 1941, scientists in Section C-4 of NDRC, the section devoted to subsurface warfare, published their "Plan for Handling of a Comprehensive Investigation of Submarine Detection." In it they expressed their desire to apply the scientific method to all aspects of subsurface warfare, not merely to technological advances. But it was not until May of 1943 that COMINCH relinquished his tight control and created the Tenth Fleet as the organization devoted to subsurface warfare. This is portrayed as the crucial organizational step in increasing our effectiveness to coordinate subsurface warfare. With this institution the Chief of Staff for the Tenth Fleet, Rear Admiral F. S. Low, acquired the authority, resources, and focus necessary to take full advantage of the scientists' work. This work ran the gamut from operational analysis of tactics designed to maximize kill probabilities, to the development of new equipment and the training programs to ensure their effective use.

In his development Meigs includes the influence of intelligence gathering, most notably the cryptologic successes of both sides. He also describes the dynamic changes in tactics engendered both by technological advances and the psychological effects of the changing situation. This helps to flesh out the picture of the factors which ultimately led to our victories in World War II. The closeness of the contest is especially striking and leads one to worry about the course of future conflicts.

The greatest benefit to be derived from this book is the insight it gives into the factors which work against us in our own bureaucracies. It is perhaps for the best that this book, about the rigidity of Navy command structure and warfighting doctrine, was written by an Army Colonel. Certainly, we cannot claim that institutional bias and rigidity of thinking are totally a thing of the past. And, although we can rightly argue that we have learned from the mistakes of World War II (our on-going efforts to improve joint operations is an example), this book presents a timely reminder that we must be continuously on guard not to let past, traditional answers preclude better, innovative solutions.

Anyone aspiring to the upper levels of military command should have a keen interest in the message of this book. And for those having an interest in the early development and deployment of ASW equipment, this is an especially interesting account of the whole spectrum of ASW technology and its impact on tactical and strategic issues. I was disappointed with the brevity of the treatment of the Pacific theater. (It received only twenty out of 220 pages.) But this is a minor flaw in an otherwise fascinating and extremely well-written book.

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THE ART OF WARGAMING

by Peter P. Perla

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

It quickly becomes apparent in the book that, in what he describes as "Hobby Gaming", Mr. Perla is a true and acknowledged expert with a great deal of experience. In fact, his articulation of the background and refinement of that particular pastime, as well as a parallel effort for "Professional Gaming", is perhaps the single most valuable aspect of the book as a reference volume in the library of anyone involved in simulation and gaming for research, education or entertainment.

After the documentation of gaming's history, the central theme of The Art of Wargaming is the extent to which Hobby Gaming and Professional Gaming relate to one another. Early in the book, Mr. Perla identifies two terms, "War Gaming" and "Wargaming", that generate expectations that they would be used as a marvelous vehicle by which the overlap and mutual support of hobby and professional efforts could be compared and discussed. This is not the case, however, and it would appear that an excellent journalistic opportunity is missed.

Mr. Perla manages to nicely capture some key elements of the gaming process, both from the aspect of professional gaming and from that of hobby gaming, that are not necessarily intuitive to those who have not been formally involved in the process. These elements include:

- The pros and cons of deterministic (expected values) versus stochastic (random values) determination of engagement results.
- The critical nature of defining the "objective" of a "game" before determining the means and methodology thereof.
- The misconception that greater "detail" of a "model" yields greater "accuracy" of its output.
- The deleterious effect when the nature of game structure permits (or even encourages) participants to engage in "gaming the game".
- The magnitude of the spectrum of "games" from purely educational to purely research, and the different methodologies used across this spectrum.
- The importance of clearly identifying which of a vast number of possible "variables" for a given application are truly "critical" and which must be represented with an appropriate degree of fidelity.
- The often adverse impact of excessive "realism" when applied past the point of that required for credibility and the meeting of the game's objectives.

Mr. Perla does not treat the War College's Naval War Gaming System (NWGS) or its predecessor, the Enhanced Naval war Gaming Systems (ENWGS), very gently as a useable device -- it having been designed to be all things to all people. Having been nominally "in charge" of the device for a year and a half in 1984-85, I can only state that Mr. Perla significantly understates NWGS inadequacies -- violating all of the above bulleted critical elements and more. On the other hand, the effect and impact of the GLOBAL War Game series under "Bud" Hay is understated as a generator of key national military and geo-political issues.

As nice a compilation of people, facts and anecdotes that The Art of Wargaming is, it cannot completely escape criticism. It is a difficult book to read (the "fog of wargaming"?); is significantly redundant in many parts (reference is made on 5% of the books pages to a clear Guru of hobby games, Mr. James F. Dunnigan) and significantly overestimates the commonality of interests and motivations between that which is basically intended to entertain and that which must successfully train or extract valid issues for further investigation. Mr Perla shows an understandable bias, considering his documented devotion to the subject, in favor of hobby games and gamers. The very strong undercurrent sensed is that all professional games and gamers are but subsets of the "purer" hobby genre, and that the professional would do well to step aside and let the hobbyists solve their problems. The continuing reference to the "short-comings" of senior military personnel wore a little thin after awhile, and was somewhat out of place -- especially considering the glowing foreword by retired CNO Admiral Tom Hayward. A critical segment of the entire professional spectrum of "gaming" was left out by not addressing the different needs and forcing functions of such unit-level training devices as Submarine School's Attack Centers -- where the necessity of training specific operational "truths" completely override any requirement for stochastic "fairness" on the instructor's (umpire's?) part. Fire a torpedo at a target from short range and with no own ship protection, and the "Dungeon Master" will see to it that the computer target is "turned off" after weapon acquisition, and (a la RED OCTOBER) the reattacking weapon will see and eat up own ship.

Mr. Perla, with whom this reviewer worked for a period in 1984 at the Naval War College, has done a remarkable job in researching the genesis and subsequent development of his subject. In fact, a more appropriate title for his work might be The History of Wargaming. Shortcomings aside, The Art of Wargaming represents a valuable addition to the reference library of anyone involved in tactics, technology or training of military forces -- a large proportion of the Naval Submarine League's membership.

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1990 RECRUITING ALL-STARS

Our records indicate our top NSL member recruiters are:

- ♠ **Mid Atlantic Chapter**, with 18 new members credited (Jerry Spiegel is President)
- ♥ **George Graveson**, with 14 new members credited (George is our Public Affairs Director)
- ♦ **Hampton Roads Chapter**, with a credit of 7 new members (Mike Powell, President)
- ♣ **Submarine Force Library and Museum**, with 6 new members.
- • **Norman Polmar, 5 new members.**

The strength and effectiveness of our League relies on a strong and dynamic membership. **Let's each try to get 2 new members to join in 1991!!**

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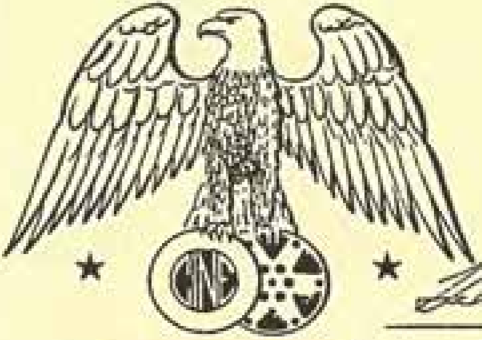

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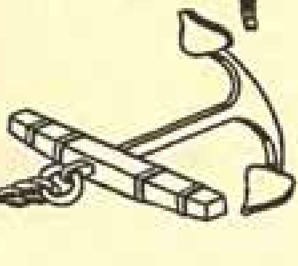

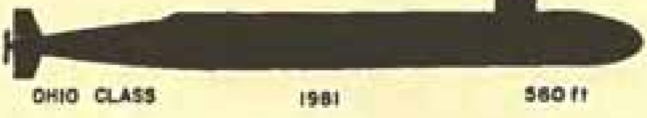

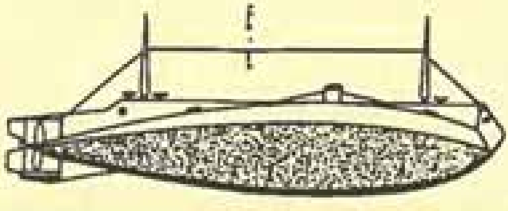

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