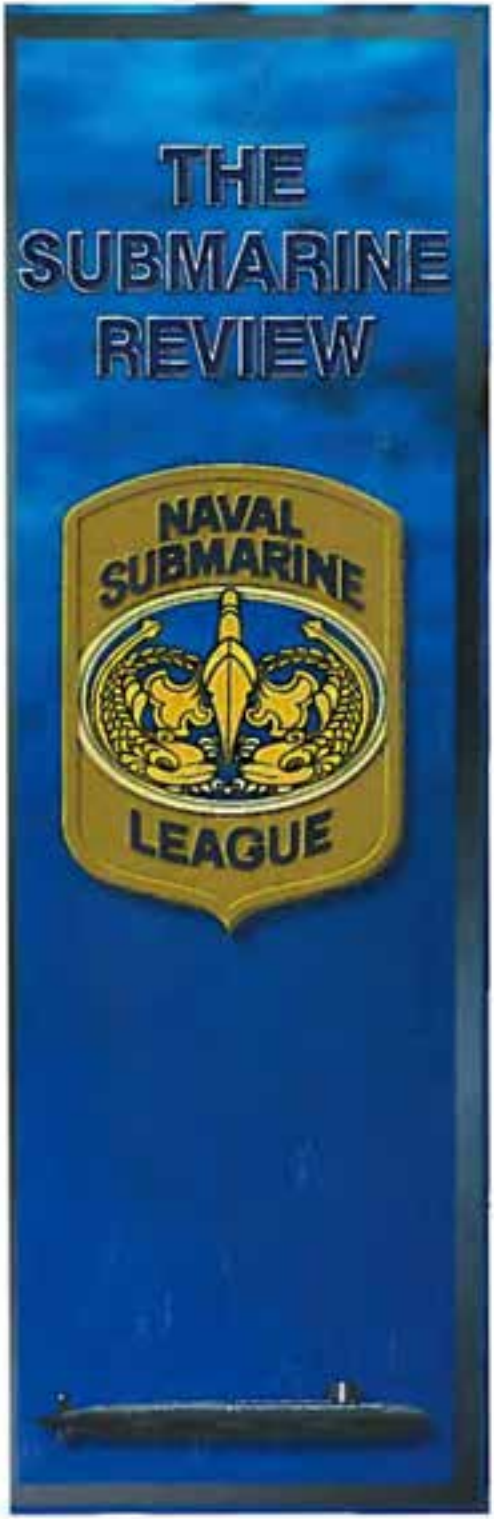

JANUARY 2007 PAGE

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EDITOR'S COMMENTS

We are very fortunate to be able to bring to our readers a particularly noteworthy piece of history and commentary as a SPECIAL FEATURE in this Issue. For the Centennial of the Russian Submarine Force Dr. Igor Spassky, his country's leading submarine designer, has put together the story of one hundred years of Russian and Soviet submarine development. His first-hand experiences and his insights as to the whys, hows and problems of that process are most enlightening as history, interesting for the technology and, just as importantly, instructive in the lessons we can learn from them. Admiral Bruce DeMars is the one who has made possible bringing this work to THE SUBMARINE REVIEW and he has written an introduction which precedes the *History* of the Russian Submarine Force. That a US submarine officer of ADM DeMar's experience and stature wishes to give this essay wide exposure to our submarine community is high praise indeed for the work of Dr. Spassky. Dr. Spassky's letter to Admiral DeMars granting permission for this republication follows that Introduction.

As regular FEATURES for this issue we have two very interesting policy papers. The first is a reproduction of a presentation by VADM Chuck Munns, Commander Naval Submarine Forces, to the Undersea Defense Technology Conference in San Diego in early December. His main subject is Global Maritime Security. His emphasis is on the unique capabilities which Undersea Technology can bring to bear on the problems of Maritime Security and he places our submarines squarely within that framework. He also defines the challenges which need to be met to "fully network the coalition of Undersea Defense Partners". It's not an easy job but VADM Munns has laid out a plain-speaking, do-able roadmap for addressing the task.

Fitting perfectly with VADM Munns' presentation on Maritime Security is Commodore Jamie Foggo's essay on the Navy's ongoing process for "Developing a *New* Maritime Strategy for the 21st Century". In also noting the usefulness of *coalition actions* in the maintenance of Global Maritime Security, CAPT Foggo cites some specific examples being exercised today and proposed for the future.

In addition, he puts forward a vision in which "...we are no longer a Navy solely dependent upon the Carrier/Expeditionary Strike Group concept of operations." This is mainly a call to action for submarine adherents to participate as fully as possible in the process of developing a new maritime strategy. THE SUBMARINE REVIEW welcomes comments and discussion on this important matter.

Our ARTICLES section is led off with a commentary by RADM Jerry Holland on the results of a Navy-sponsored essay contest on the *Principles of War*. Jamie Foggo observed in his piece on a *new* maritime strategy "We live in a more dynamic environment, a century *after* Mahan, and there are distinct differences between his era and our." Jerry Holland says that the essays judged as winners in that contest "...could as well have been written at the time Clausewitz wrote On War (1832)." He specifically decried the lack of mention of nuclear weapons, the impact of modern technology and the training of warriors. We do live, and train to fight, in very modern, some might even say in *post-modern,* times. Holland's commentary strongly and plainly backs up Foggo's call for submariners, the quintessential ***warrior technologists***, to get into this effort to articulate a Maritime Strategy which is credible, forward-thinking and uses the asymmetric advantages which our technology, rigorous training and intensive professionalism allows us. Again, THE SUBMARINE REVIEW is ready to give voice to those who wish to get *out in front of the Fleet* on this Strategy thing; that's where submariners usually are–far forward.

The next article in our January menu is Part I of a brief history of Oceanography; and that's another field of real concern to submariners. One point easily seen is that concepts which we accept as articles of faith in warfare applications of ocean principles were brought forward only relatively recently. May it then be inferred that there is more to learn about this big medium in which submariners conduct their business? Perhaps our future strategies may direct our thinking to new things we should do within the ocean mass, and thus instruct the research oceanographers to look for new principles on which we can improve our effectiveness. There's always something to learn and innovation to be done. Speaking of innovation, CAPT Jim Patton has some things to say about our use of our *other* ocean interface which we might not have thought about before.

The league's Executive Director, CAPT Mickey Garverick, has prepared a description of the League's new look in websites and has given us some directions in its use. This has come about through a lot of hard work and experimentation It will continue to evolve and better serve the community as we all use it, so try it now and let Mickey hear about your experience and comments.

And, there are two BOOK REVIEWS of interest. CAPT Dave Smith has written an essay, rather than a more formal review, about a book which was written almost thirty years ago. Dave's point is that a World War II disaster to the Royal Navy offers some very cogent lessons which were buried in official secrets for the previous thirty years. The other book review is of Dan Gillchrist's Power Shift, his collection of interviews with those who went through the Submarine Force change from diesel boats to nuclear power. CAPT Bill Noriss recommends the book "for the human stories about the *Power Shift* that Dan Gillchrist has brought to light and life." In the final analysis it **was the people,** on both sides of the *shift,* who kept the Force going in those days of massive expansion and dramatically new operations.

Jim Hay
Editor

FROM THE PRESIDENT

2006 was a great year for the Submarine Force! USS TEXAS (SSN 775) has been commissioned, HAWAII (SSN 776) was delivered early to the Navy, and USS FLORIDA (SSGN 728) returned to the fleet in April. USS MICHIGAN (SSGN 727) and USS GEORGIA (SSGN 729) will re-enter the fleet this year. NORTH CAROLINA (SSN 777) is next in line to be delivered in 2007. The Navy and industry have been making steady progress in delivering ships on time and budget. Submarine shipbuilding programs shine!

The operating tempo for submarines is eye watering. Submarine Force Commanders are making every effort to have their submarines meet the needs of the Combatant Commanders. They report some tasks are not accomplished because of lack of force structure. There are just not enough SSNs in the Fleet.

During the symposium briefings this year we were shown that without increasing the build rate to two Virginia Class submarines per year, Submarine Force structure will drop below the 48 submarines needed to meet Combatant Commanders urgent requirements. The longer Congress and the Administration defer spending to reach two submarines per year, the earlier the Navy will breach the 48 submarine threshold.

The Submarine Force has lots of good news. Retention is excellent, at all levels; material condition of the submarines is good now. Recruiting is meeting the quotas set by the Navy, with a significant increase in accessions from the Naval Academy. The bad news is maintenance and refueling overhauls continue to be deferred.

Your Naval Submarine League completed a full and profitable 2006. All services were provided within budget. The League's financial status continues to slowly improve. The League authorized two educational grants this year; one to the INTREPID Museum in New York to support the GROWLER museum submarine education program and the other to the Oregon Museum for a Science program to build a periscope in conjunction with the BLUEBACK museum submarine. We intend to continue the grant program.

Admiral Rich Mies will relieve Admiral Bruce DeMars as Chairman of the Board of Directors after the Corporate Benefactor Recognition Days on 30/31 January 2007. Admiral DeMars has provided innovation and energy during his tour as Chairman. The NSL, its membership and the Submarine Force are all in his debt for his contribution. On his watch the League moved forward on many fronts including upgrading NSL capabilities to serve the membership, a greatly improved webpage, refurbished headquarters and meeting the NSL objective to restore cash reserve. It has been a pleasure for me to work with Bruce. The NSL is fortunate to have Admiral Mies take the reins as Chairman.

I am pleased to report that the major events for this year are progressing well. The agenda for the Corporate Benefactors Recognition Days includes Admiral Donald, Congressman Randy Forbes (R-4th VA), VADM Munns, RADM Walsh, RADM Mauney, Ms. Allison Stiller, Deputy Assistant Secretary of the Navy (SHIPS) and VADM Greenert in his new role as Deputy Chief of Naval Operations for Integration of Capabilities and Resources (N8).

The Annual Submarine History Seminar will be 11 April 2007 at the Navy Memorial. The topic is *"How Submarine Intelligence Collection Made A Difference - Lessons from the Past"* featuring a historical perspective of how Cold War intelligence was used by the Submarine Force. Speakers include VADM Roger Bacon, RADM Tom Brooks and Mr. Richard Haver with RADM Tom Evans as the moderator. It should be an interesting evening.

The Submarine Technology Symposium will be 15-17 May 2007 at The Johns Hopkins University Applied Physics Laboratory. The theme is *"Enhancing the Submarine's Military Value"*. The Sessions will include Offboard Technologies, Expanding Mission Capabilities, Force Needs, International Submarines and Technologies. For the first time, a Session is dedicated to Allied Submarine Perspectives. This session will feature international speakers discussing their Submarine Forces and capabilities. The CNO, Admiral Mike Mullen, will be the Banquet Speaker.

The Annual Symposium has been moved from June to the Fall. The format will be the same as in the past except the Submarine Force Cocktail Party will be included as the social event on the first evening. We are still deconflicting dates. We will inform you of the

dates for the Annual Symposium in a NSL Update as soon as possible. I encourage you to make every effort to attend the 2007 NSL event.

The membership initiative undertaken with the Submarine Force Command Master Chief to recognize newly selected Master Chief Petty Officers with a one year NSL complimentary membership has been launched. The first applications have been received. The NSL is actively supporting submarine reunions with announcements in THE SUBMARINE REVIEW and a special section on our website. NSL membership materials are provided to recruit new members at these events. Look for more web based membership initiatives in the near future. I ask for your support for growing the NSL membership. Mention the NSL to shipmates, friends and associates.

THE SUBMARINE REVIEW provides a forum for discussing topics of interest to the Submarine Force. Captain Jamie Foggo challenges you in this issue to write your thoughts on the new maritime strategy. Quarterly NSL Editor Jim Hay publishes a quality journal with timely and relevant articles about issues important to the Submarine Force. Seize the opportunity to express your views on subjects important to undersea warfare.

Jan joins me in wishing you a very Happy, Healthy, and Prosperous 2007.

J. Guy Reynolds
President

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SPECIAL FEATURE

INTRODUCTION TO DR. I. D. SPASSKY'S THE FIRST CENTURY OF THE RUSSIAN SUBMARINE FLEET

THANK YOU DOCTOR SPASSKY

In May of last year I had the distinct pleasure of attending the 100th Anniversary of the Russian Submarine Force. I came across a booklet published by the Rubin Central Design Bureau that contained Dr. Igor D. Spassky's treatise on the 100 Years of Russian Submarining. It is a seminal work to be read by all submariners, designers, builders and suppliers to Submarine Forces worldwide. To that end I knew it should have wide distribution. Unfortunately, Dr. Spassky was not available at the time. Upon return home I communicated with him by letter requesting permission to print his essay in the U.S. Naval Submarine League's, The Submarine Review. He responded promptly with the following warm letter.

In my view Dr. Spassky is an historic figure, a uniquely preeminent submarine designer and a true patriot. I take great pride in the Submarine League providing wide distribution to his thoughtful history. I offer Dr. Spassky the profound thanks of the Submarine League for his permission to distribute his *History* of the Russian Submarine Fleet.

Bruce DeMars
Admiral, U.S. Navy (Retired)
Chairman

Dear Mr. Bruce DeMars,

In the days when the 100-years anniversary of Russian Submarine Force was celebrated in Saint-Petersburg, I was in the town of Severodvinsk and could not take part in the International Meeting of Submariners. It's a pity that I could not meet you personally and make your acquaintance.

In the late 1980's I frequently came across your interviews in different magazines where you were upholding the concept of SSN 21 SEAWOLF and shared your views on the development of US Navy Submarine Force. I read these materials with great interest and I am still very interested in the latest achievements of US shipbuilders and submariners. I have no doubt that the concept of SSN SEAWOLF in the promotion of which you have played an important role had determined the further development of US Navy Submarine Force to a large extent.

I am glad that you like my essay devoted to the 100-years anniversary of Russian Submarine Force and wanted to publish it in the Naval Submarine League, The Submarine Review. I am eagerly giving you the permission to publish it.

I am of the opinion that the publication of my essay in the League's Review will permit the American submariners to get familiarized with my views on certain landmarks in the history of Russian Submarine Force and help to further develop the mutual understanding of the shipbuilders and sailors of our countries.

Let me thank you for the high appraisal of my essay and your cordial words addressed to me. I hope we will be able to meet during your next visit to Saint-Petersburg.

Best regards,
I. D. Spassky
General Designer
Head of CDB ME "Rubin"
Academician RAS

Editor's Note: For ease of reading the History of Russian/Soviet Submarines for those accustomed to the NATO designations, a Nomenclature Guide which relates project numbers to NATO names, is provided on page 61 of the text.

THE FIRST CENTURY OF THE RUSSIAN SUBMARINE FLEET

by I. D. Spassky

About the Author

I.D. Spassky was born on the 2nd of August 1926.

I.D. Spassky, General Designer-Head of Central Design Bureau Rubin-Academician of RAS

It is symbolic that the author of this article, who is a prominent scientist and specialist in the area of submarine design and construction, received his secondary and higher education in naval schools and colleges and came to work in the industry from the USSR Navy (Senior Engineer-Lieutenant). In 1944 I. D. Spassky graduated from the Baku Naval Preparatory School. After his graduation in 1949 from the Dzerzhinsky High Naval College (Steam Generation Plant Department) and a short service on cruiser FRUNZE (under construction) Engineer-Lieutenant I. D. Spassky was assigned to work in SDB-143 where he participated in the creation of the experimental high speed submarine of Project 617. In 1953 he retired from the Navy and was transferred together with Project 617 to CDB-18 (now SOE CDB ME RUBIN) where he works at the present time.

Passing through all the stages of a designer's career, in 1956 he became the Deputy Chief Designer of a nuclear submarine of Project 658 (NATO named HOTEL) armed with ballistic missiles; after that, in the same position, he continued to work on the development of Projects 667A and 667B (YANKEE and DELTA) submarines.

In 1968 he was appointed the Chief Engineer and since 1974 he has been the Head of Central Design Bureau for Marine Engineering RUBIN, first as the Chief Designer and Head of the Enterprise and since 1983—as the General Designer—Head of SOE CDB ME RUBIN.

The fundamental contribution of I. D. Spassky to creation of the marine component of the missile-nuclear potential of Russia and Naval Submarine Forces is widely known. He developed a number of fundamental scientific and technical directions in submarine shipbuilding. Under his leadership a huge scope of research and development works were carried out and new technology of submarine construction was developed that considerably reduced the construction time and cost. The contribution of I. D. Spassky to the development of Naval Submarine Forces was realized in construction of more than 200 nuclear and diesel-electric submarines based on 20 projects developed by CDB ME RUBIN under his leadership.

In many respects, due to efforts of I. D. Spassky, the transition to the complex design was accepted in submarine shipbuilding. A striking example of such an approach to the design process was creation of system TYPHOON accomplished with a huge creative and organizational participation of I. D. Spassky.

The substantiated and strong position of I. D. Spassky determined the preservation and successful development of diesel-electric submarines within the Navy and creation of a whole family of the most silent and highly efficient SS that are highly appreciated in Russia and on the world market.

At present, the work on creation of the newest designs of nuclear and diesel-electric submarines of the XXI century are carried out under his leadership and with his enormous personal involvement. Under direct scientific and technical management of I. D. Spassky in 2001, a unique project that does not have analogues in the world's practice was fulfilled. It was the international project of lifting, transportation and docking of the nuclear submarine KURSK.

I.D. Spassky Engineer-Lieutenant, 1951

I. D. Spassky is a Doctor of Technical Science (1978), Professor (St. Petersburg State Maritime Technical University, 1984), Academician of the Russian Academy of Science (1987).

The scientific and production services of I. D. Spassky were acknowledged by awarding him the Lenin prize (1965), the USSR State Prize (1983), and the title of Hero of Socialist Labour (1978). He has been awarded two Orders of Lenin, Order of the October Revolution, Order of the Red Banner of Labour, Order of the Patriotic War Second Class, Order For Services to the native Land Second Class and many medals.

In 2002 I. D. Spassky was honoured with a title of Honourable Citizen of Saint-Petersburg.

He is married, has a son and a daughter.

Preface

We are used to celebrating anniversaries: 50, 60, 70 years since the time of some event. There is something significant and, may be, even a little *mystical* in such numbers that end with zero. It seems that a date with a zero at the end *resets* all that previously was done and opens a new blank field for further deeds. A *rounded* date is a milestone of a kind that delimits the past and the future.

DOLPHIN, the first combatant submarine of the Russian Navy, on sea trials, 1904

For submarine designers the 100th year anniversary of the Russian Submarine Forces is an extremely important event. Not only, and not so much, due to the fact that this date is marked by two zeros but rather that so many things were performed during these one hundred years—the time span that exceeds by just a little a normal duration

of a human life. Out of the 300-year history of the Russian Navy one hundred passed under the sign of submarines. With confidence one can call the last hundred years of the Russian Navy's history *A Century of Submarines*. In total, for a hundred years, submarines traveled a road from *the grandmother of submarines*—submarine DOLPHIN—up to heavy missile-carrying undersea cruisers. The evolution of submarines for the century-long historical interval can be characterized by the following numbers:

- Submerged displacement had increased by more than 250 times;
- Full submerged speed - by 5 times;
-Endurance - by 15 times;
-Duration of the submarine staying in the submerged condition that practically equals the endurance for nuclear-powered submarines-by 180 times.

In terms of capabilities, the progress of submarine shipbuilding and submerged sailing is even more impressive - a submarine that was capable of solving the tasks of a coast defense only, at the beginning of the historical way, the further evolution, was transformed into a ship intended for solution of tactical and strategic tasks. During each stage of the submarine *maturing* they in fact accumulated those qualities that were demanded by the Navy.

A November SSN in the Arctic

An objective history is always *made* by real people. The story of the Russian Submarine Forces was created by submariners—people of really courageous and very special profession. They mastered a new technique, performed long cruises, dived to new depths, sailed under ice cover. During World War I and the Great Patriotic War (WWII) they bravely sailed to sea to fight against enemy submarines and surface ships, laid mines at exits from enemy bases, carried out reconnaissance and disembarked scouting groups to a shore occupied by the enemy. A number of complicated and important combat missions were carried out by

Russian submariners after the war. Patrolling, around-the-world submerged cruises, transarctic cruises—that is a far incomplete list of deeds performed by Russian submariners after the war.

Crew of a Victor II of the North Fleet

Paying a tribute of respect to submariners, we have to remember those people who created the ships, many of which were and still are the pride of the Russian Submarine Forces. About people who often stood side-by-side with submariners, went to sea for trials and cruises helping them to master new technique and weapons. For the hundred-year period more than one generation of submariners and shipbuilders has grown up. And an important place in this constellation of people whose life is inseparably linked with submarines is occupied by engineers and designers.

Unfortunately, the frames of this article do not allow listing the names of all heroic submariners whose feats of arms and labour won the glory of the Russian Submarines Forces.

But it is impossible to pass over in silence such outstanding creators of the Navy as Nikolai Gerasimovich Kuznetsov and Sergei Georgievich Gorshkov. Large periods of the country and Navy history are closely connected with names of these two Commanders-in-Chief of the Navy of the USSR. The Soviet Navy passed through severe years of terrible war ordeals and became a force that could not be ignored by our enemies when N.G. Kuznetsov was in the office. When S.G. Gorshkov was the Commander-in-Chief of the Navy the Soviet Navy became a blue-water and missile and nuclear fleet.

N.G. Kuznetsov, Admiral of the Fleet of the Soviet Union, Commander-in-Chief of the Navy, 1939-1946, 1955

S.G. Gorshkov, Admiral of the Fleet of the Soviet Union, Commander-in-Chief of the Navy, 1956-1985

V.N. Chernavin, Admiral of the Fleet, Commander-in-Chief of the Navy, 1985-1993

It is impossible to leave non-mentioned the name of another Commander-in-Chief of the Navy—Vladimir Nikolaevich Chernavin—Hero of the Soviet Union, the first submariner on this high and responsible post of the Commander-in-Chief of the Navy. V.N. Chernavin, who participated in the first stage of putting into operation nuclear-powered submarines of the 1st generation, performed many remarkable submerged cruises (including under the Arctic ice cover), was familiar with the specifics of the submarine service, but at the same time he understood the engineers who created the designs of submarines for our Navy.

It is impossible to mention all outstanding creators who designed submarines for the national submarine fleet; scientists who conducted researches and developed the theory of submarines and other fields of science, without whom creation of modern submarines is unthinkable; shipbuilders who implemented the designers' ideas into real ships. We remember these wonderful people and practically every day we see the results of their work in this or that form. The hundred year history of the Russian Submarines Forces is both a source of pride of our predecessors' creations and, at the same time, the treasure-house of invaluable experience out of which we can derive ideas and approaches to creation of new underwater ships.

Submarines as a new, independent class of naval ships obtained recognition in 1906. By the Order No. 52 of the 11th March issued by the Marine Ministry and signed by the Marine Minister Vice Admiral A. A. Birilev, with *the Royal Assent*, a category *submarines* was included into the Classification of Naval Ships. By this time 7 submarines (DOLPHIN and 6 submarines of type KASATKA) were in service with the Russian Navy. These submarines were on the list as torpedo boats. It was the date of *the Royal Assent* (the 19th of March, new style) that was considered the official birthday of the Russian Submarine Forces and for many years the birthday had been celebrated on this day.

The history of the Russian submarine shipbuilding is counted from the 4th January 1901 (new style). On this day the Commission established based on a proposal of Vice Admiral I. M. Dikoy, the Chairman of the Marine Technical Committee, and N. E. Kuteinikov, Chief Shipbuilding Inspector, commenced the work on the design of the first combatant Russian submarine DOLPHIN. The

following persons were included into the Commission: Naval Architect Senior Assistant I. G. Bubnov (Shipbuilding), Senior Mechanical Engineer Assistant I. S. Goryonov (Engineering) and Lieutenant M. N. Beklemishev (Electrical).

It is interesting to note that one of the Commission members (M. N. Beklemishev) later was appointed the Commanding Officer of submarine DOLPHIN. This fact is one more proof of a very close links between the engineers-shipbuilders and submarine designers with submariners.

Generally speaking, the history of the Russian submarine fleet and submarine shipbuilding contains a lot of instructive and useful facts. The roots of our modern achievements go deep into the distant past, and a lot of examples can be derived from the retrospective review of the history. Even now these examples did not lose their topicality. It looks like the history of submarines sets the vector for their development and, analyzing the past, we are able to understand and imagine the future of the Russian Submarine Forces much better.

Leaving aside the details and peripetia of transformations and renaming of design bureaus who designed submarines in Russia (USSR), I'd like to note that before 1948 CDB-18 was the only submarine designer in the country and it originated from the Construction Commission established in 1901. In 1948 the second design bureau was established—SBD-143—for designing submarines with high submerged speed (Project 617). It was organized by transfer of a number of employees of CDB-18 who studied captured equipment in Germany (so-called *Antipin's Bureau*) and a department of CRI-45 (now the Krylov Research institute) that was developing *single* engines for the surface and submerged submarine cruise. Getting ahead, I'd like to mention that subsequently SDB-143 was switched to nuclear projects and developed the design of the first national torpedo nuclear-powered submarine (Project 627).

In 1953 two more organizations joined the submarine design field—CDB-16 and SDB-112. The latter was formed on the basis of the design bureau of shipyard *Krasnoe Sormovo* and was headed by Z. A. Deribin (former Chief Engineer of CDB-18 and Chief Designer of Project 613). He brought with him to SDB-112 a group of designers from CDB-18. The first large work of this SDB was the creation of Project 633.

CDB-16 is known for the development of the design of the first high-speed nuclear-powered submarine with a hull made of titanium alloy (Project 661) and a number of modification designs of diesel-electric submarines to be used for ballistic missile trials. Subsequently CDB-16 and SDB-143 were merged into one Design Bureau—SPMBM *Malakhit* (now—FSUE SPMBM *Malakhit*).

About 1,100 submarines were built in Russia for 100 years, and over 900 of them—based on designs of CDB-18 (now SOE *CDB ME Rubin*).

At present in Russia the practical submarine design is carried out by two design bureaus: Central Design Bureau for Marine Engineering *Rubin* and St. Petersburg Marine Machine-Building Bureau *Malakhit*.

It is impossible to show in full colour the rich history of the Russian submarine shipbuilding in a short article; therefore I'll try to outline in *wide strokes of a paintbrush* the basic historical events, to set out a *short course* of the Russian submarine shipbuilding history.

A SHORT COURSE

I will not dwell at length on the first steps of the national submarine design school—this period is rather deeply studied and described by our historians. The only thing I'd like to say is that Russian designers had to *step* very fast. First, the Russian-Japanese war speeded-up the process of developing the Russian submarine shipbuilding; then—the approaching World War I. Submarines being the operational strength of the Russian Navy (including 32 submarines built in Russia before 1917 by designs of Russian designers), in this period already had confidently declared themselves to be a formidable naval weapon.

I.K. Grigorovich, Admiral, Marine Minister, 1911-1917

I'd like to pay tribute to the Marine Minister of Russia Ivan Konstantinovich Grigorovich, because the importance of the contribution made by him into the establishment of the Russian Submarine

Submarines GEPARD and BARS in base

Forces and the Russian Navy in general can hardly be exaggerated. It was while I. K. Grigorovich (whose remains were brought to the native land in 2005) was the head of the Marine Ministry when the Russian Submarine Forces developed so dynamically.

The development of the national submarine shipbuilding in the period between the World War I and the Great Patriotic War (WWII) is also characterized by high rates of progress—a new class of ships (submarines) that experienced the baptism of fire formed the basis of new naval forces of the Soviet Union. By the beginning of the Great Patriotic war the Soviet Navy had the most powerful submarine fleet in the World, and for the period from 1925 to 1945, a total of 325 submarines of 20 types had been built. The submarine fleet had been growing up not only quantitatively but qualitatively as well. Tactical and technical characteristics of submarines and their weapons were considerably increased; skilled submariners were trained, the operating area of submarines increased considerably (submarines joined all the Fleets—the Baltic, Black Sea, Pacific and North Fleets).

The Great Patriotic War (WWII) not only proved high qualities of submarines designed by Russian engineers but also revealed the direction of further submarine improvements. The Navy became a factor facilitating the solution of the warfare outcome and the dominating role was played by naval Submarine Forces. It goes without saying that it did not mean the rejection of harmonic development of submarine and surface forces of the Navy and maritime aviation.

The development of designing and construction of the first post-war submarines was characterized by the principle *from simple to complex*. The first submarine of the Soviet Navy built after the war became a torpedo diesel-electric submarine of a medium displacement of Project 613 (*Whiskey*). The development of Project 608 submarine design (started back in 1942 but suspended in 1944, until the completion of studying captured German submarine *U-250*) preceded the development of this project. Later on the design was corrected with account of the analysis results of German submarines of Series XXI. Thus, the best technical solutions both Russian and foreign (in the first place, German) submarine designers were accumulated in the developed Project 613.

A Whiskey class submarine approaches a submarine tender

Following the submarines of Project 613, in 1953 construction of large diesel-electric submarine of Project 611 (ZULU) began. The structures of these two boats are very similar, but the displacement of Project 611 submarines was practically two times larger and it allowed them to more than double the cruising range (22,000 miles instead of 8,600), endurance (75 days instead of 30), torpedo salvo power (10 torpedo tubes in place of 6) and ammunition (22 torpedoes in place of 12). In order to improve the habitability conditions for the crew during long-term cruises, two distilling plants were provided on Project 611 submarines.

At the same time, Projects 613 and 611 cannot be called *revolutionary* designs—a lot of features specific to submarines of the World War II (e.g., artillery armament that was later dismantled) were still present in them. Similar to submarines of World War II submarines of these projects remained to be ships intended for fighting surface ships and vessels.

A Foxtrot during transit from the North Fleet to the Pacific via the Arctic route

In the fifties one more of the directions of improving tactical and technical characteristics of submarines was the increase of time of their continuous stay underwater (submerged endurance). This parameter at the time was one of the major ones in providing the submarine stealthiness.

At that time the increase of submarine stealthiness was achieved on the account of the following:

-Increase of the store of energy for submerged propulsion;

-Economical consumption of the storage battery energy for the submarine propulsion and ship's needs.

The first direction included the improvement of storage batteries (SB) (increase of their specific energy) and increase of the number of SB groups. The approach related to increasing the number of SB groups led to a dead-end as it resulted in increase of submarine displacement and cost and deterioration of her other tactical and technical elements. The second direction included the development of ship's equipment with a lower power consumption level and its rational use (e.g., galley equipment consuming a lot of power for cooking the food was used, mainly, when the submarine was running under diesel engines). The possibilities of creating equipment with a low level of power consumption were rather scarce as it was restrained by a general level of the electric industry development at that time. High efficiency propellers were used in the designs of diesel-electric submarines (SS) and the propulsion plant included main propulsion motors and economic speed motors that provided high and low submarine speed respectively.

The listed measures allowed obtaining a very limited effect only and, therefore, Russian designers were looking very actively for schemes of propulsion plants (PP) that were able to ensure the sufficient store of energy for the submarine long-term continuous submerged run. The second task that was set forth to the designers of submarine propulsion plants was to obtain large power allowing the submarine to have high submerged speed required for launching the attack at enemy ships and for darting off the pursuit after the attack.

The SB improvement could not ensure the required effect. Even replacement of lead-acid batteries with silver-zinc cells that possessed both higher energy indicators and much higher cost did

not solve the problems. Thus, submarine designers were forced to turn their attention to the development of a propulsion plant for the submerged propulsion with heat engines.

The creation of PP with heat engines for the submarine submerged run has a long history in many countries related with sea.

In Russia (USSR) these works were started before WWII by the search for variants of the diesel operation in closed cycle when the submarine was running in submerged condition. In the post-war period propulsion plants were made after likeliness to a steam-gas-turbine plant of German engineer Walter. The operation of this plant was based on an open cycle using the high-test hydrogen peroxide as an oxidant. Since the second half of the previous century works on creation of so called *fuel cells* had been continuously in progress. The fuel cells generate the electric power based on the chemical reaction between hydrogen and oxygen.

A Quebec-class submarine in the Naval Parade on the Neva

A distinctive *crown* of the above activities was appearance in the Soviet Navy of submarines of Projects 615 and A615 (*Quebec*, 30 units), Project 617 (*Whale*, 1 unit) and Project 613E (*Beluga*, 1 unit). The appearance of these objects made the shore infrastructure of naval bases much more complicated (high-test hydrogen peroxide, cryogenic oxygen and hydrogen). At the same time, it's worth noting that the level of the machine building in general (pressure-tight valves and fittings, thermal insulating materials) and monitoring systems did not fully correspond to the specifics of these plants and that is why their reliability was not very high.

Submarines with such propulsion plants played their role as they indirectly, and in a very short time, provided for the preparation of scientific and production facilities of the country for the creation of the first nuclear-powered submarine. And this, essentially, put the end to works on other types of propulsion plants.

A special role was played by a submarine of Project 617 on which very high (for that time) submerged speed was achieved. It allowed the designers to get better understanding in the field of sea-going abilities and steerability of high-speed submarines. All these things were very important for the development of nuclear-powered submarines (SSN).

Searching for a propulsion plant that was able to meet the full extent of the Navy's requirements for submerged endurance and submerged speed resulted in an idea of utilizing nuclear power. Profound works carried out in the USSR in the fifties ensured the creation of first nuclear propulsion plants (NPP) and SSN. Tactical and technical capabilities obtained by submarines with NPP allowed the Soviet Navy to solve more efficiently the missions on ocean lanes and optimize the composition of Submarine Forces.

One of the characteristic features of the naval Submarine Force development during the after-war period was reconsideration of attitude to submarine weapons. The artillery armament traditionally fitted on submarines in addition to the torpedo and mine weapon had lost its topicality when submarines were converted into submerged cruise ships.

Almost simultaneously with rejection of the artillery armament a search for the possibility to use a new type of weapons—missiles and rockets—onboard submarines had been started. These types of weapons were able to provide a qualitatively new level of submarine efficiency due to sharp increase of the target hitting range.

Project P-2, executed in 1949, became a *prelude* of some kind to the creation of strategic submarines. Nevertheless, the novelty of this subject and imperfections of missile weapons of that time did not allow designing truly combatant submarines.

One of the problems the designers faced was the problem of selecting the missile weapon type for submarines. The development of cruise and ballistic missiles progressed in equally dynamic ways at that time. However, solving the technical problems of the cruise

missile layout onboard the submarine seemed to be easier. As a result, the development of submarines with cruise missiles progressed faster than of submarines with ballistic missiles.

The development of first special designs of submarines with cruise missiles intended for firing at shore area targets was started at the beginning of the fifties, but the first implemented projects of Soviet submarines with cruise missiles were submarines that underwent refitting based on projects P-611 and P-613 (*Whiskey One Cylinder*). These submarines were intended for testing of cruise missiles P-10 and P-5.

Based on the results of the carried out tests the preference was given to missile P-5, wings of which automatically opened after the missile left the container. Conversion of diesel-electric submarines of Project 613 into carriers of these missiles began. The submarine converting design got the number 644 (*Whiskey Twin Cylinder*).

A Whiskey Twin Cylinder of the Northern Fleet

*Note: There is an interesting story how an idea of mechanism of cruise missile wing opening was born. Once Academician V.N. Chelomey came to Leningrad on a business trip to CDB-18. He was accommodated in hotel *Oktiabrskaya* that was located opposite the Moscow Railway Station. The window of the corner room (looking from Ligovsky Prospect) on the third floor of the hotel, in which academician Chelomey was living, had a vent (small opening window pane). And the mechanism of the vent opening was absolutely unique. Chelomey with interest studied this mechanism

> and immediately he got an idea. Early the next morning he came in a hurry to CDB-18. Here Chelomey drew a scheme how the missile wing should be open. The solution that Chelomey *spied* in the hotel room made the missile elegant and sharply reduced the diameter of a launching container that was very important for container location onboard submarines.

Submarines of Project 644 represented only one of the possible variants of a submarine armed with cruise missiles. They had an evident drawback—they managed to locate onboard the submarine only two missiles. For considerable improvement of the military and economic efficiency it was required to increase considerably the number of missiles. This problem was to be the major one during development of all subsequent Russian submarines with cruise and ballistic missiles. Its solution was related to the search of an optimum submarine architecture and structural layout schemes of missile silos and containers.

The initial stages of the submarine design development ensuring the possibility of firing at shore targets passed under uncertainty conditions: what missiles (cruise or ballistic) should be preferred. It was the reason of *parallel* works on the development of missile submarine designs. In particular, development of diesel-electric submarines for Project 644 (1956) and Project V-611 (1954)—submarine—carrier of ballistic missiles R-11FM—were carried out practically simultaneously.

While creating first submarines with ballistic missiles the designers had to solve a large number of new technical problems. They included: layout of missiles with a relatively large diameter and length in the submarine hull; missile launching from an oscillating and moving platform; keeping the depth under the action of a powerful launching pulse; ensuring that missile weapon is continuously ready for launching; minimizing the pre-launch preparation time. In order to avoid discrediting the idea of submarine arming with ballistic missiles in case of failure, it was decided to master the surface missile launch first. On the 16th of September 1955 for the first time in the world a ballistic missile was launched from submarine *B-67* (Project V-611).

The modified Zulu-class B-67 in preparation for launching a ballistic missile R11FM

To gain the experience of a submarine operation with ballistic missiles and training the personnel for service on ships of new projects, it was decided to re-equip five more diesel-electric submarines based on the improved design AV-611 (*Zulu V*). These works were completed in 1957 - 1958, and as a result, the Soviet Navy became the first navy in the world having in its strength submarines with ballistic missiles.

Subsequently, the events developed in even faster pace—in 1957 a launch of a full-scale missile mock-up with a solid-propellant engine was carried out from a submarine in submerged condition; and in 1958 a missile mock-up with liquid propellant engine was launched. In September 1960 a ballistic missile was successfully launched from a running submarine from the depth of 30 m.

Creation of the first diesel-electric submarine with ballistic missiles (SSB) had shown that the task of striking missile attacks at objects located deep in the enemy's territory is quite possible. As compared to cruise missiles intended for hitting shore fixed objects, ballistic missiles had a considerable advantage—it was practically impossible to intercept them using air defence aids available at that time. This important quality of ballistic missiles made them the main strategic weapon, the weapon of inevitable head-on attack or counter strike. Submarines carrying this weapon first became the full member of the strategic nuclear triad (together with the strategic aviation and land-based strategic missile forces) and after that, in essence, the major element of the triad.

The first Soviet nuclear submarine with ballistic missiles, a Hotel

At the end of the fifties the Soviet Navy was no more satisfied with either technical and tactical capabilities of Project AV-611, or the number of these submarines. This problem could be solved only by creation of new designs of ballistic missile submarines (SSB). A new project of DES with ballistic missiles became Project 629 (SSB *GOLF*) and its nuclear analogue—Project 658 (SSBN *HOTEL*). Appearance of submarines of Project 658 signified a new revolutionary stage in the development of the national submarine design school. With appearance of Project 658 the development of new designs of SSB was stopped.

I was lucky to be one of the major participants in the development of the design of the first national nuclear submarine armed with ballistic missiles, Project 658. I clearly remember this complex but extremely interesting period of work. Being a Deputy Chief Designer, during the initial design stages, I actually *kept in hands* the entire ship using for this purpose a cross-section profile paper made with my own hands. Both the submarine hull and her major equipment were drawn on this cross-section paper. It was this cross-section paper where the main issues related to the ship configuration were solved.

A Yankee-class SSBN at sea

According to contemporary notions, a submarine of Project 658 was a relatively *weak* ship on which only three ballistic missiles were located with a rather short range. But we should keep in mind that this project was a *pioneer* project for us and a lot of things, if not all the things, were made for the first time. Project 658M was similarly innovating for us. On this project we implemented on practice the ballistic missile launching from a submerged nuclear submarine. Gaining certain experience during the development of Projects 658 and 658M, further we bravely solved more complicated tasks on missile-carrying submarines of subsequent projects (667A—*YANKEE I*, 667AM—*YANKEE II*, 667B—*DELTA*, 667BD—*DELTA II*, 667BDR—*DELTA III*, 667BDRM—*DELTA IV*).

A Delta I SSBN surfacing through ice cover

A Delta IV SSBN in base, North Fleet

Getting ahead in my story, I'd like to say a couple of words about Project 667A that became the basis for a whole family of strategic submarines. This project implemented a number of new technical solutions that allowed multiple increases of the ship's combat power (16 ballistic missiles instead of 3), reliability (in the first place, the reliability of a steam generating plant), survivability (due to echelonment) as well as other combat and operating parameters. Considerable changes took place in radio electronic armament of the submarine (navigation complex, sonar systems, radio communication). The control system of ship's technical facilities was also changed: the level of the control automatisation considerably increased. All the changes resulted in the growth of displacement and principal dimensions of the ship that seemed to be very large for us at that time.

SSGN Echo I with cruise missiles for striking land-based targets

Nowadays, looking back, one can say that we managed to find an optimum in Project 667A: ships underwent the modification, were refitted into submarines of different purposes (including into a cruise-missile submarines—Projects 667M, *YANKEE SSGN*, submarines with increased torpedo-missile weapons—Project 667AT *YANKEE NOTCH*), but the reserve for modifications was sufficient for more than 20 years and the submarine displacement was not excessive. Moreover, the right bases laid into Project 677A allowed in future to develop this direction very fast creating designs

of missile-carrying ships of this family. The last projects that inherited an essential number of technical solutions of ANNUSHKA (a tender woman's name—so lovingly in the Navy they called submarines of Project 667A), were missile-carrying submarines of Projects 677BDR and 667BDRM that are on the combat duty up to now.

Simultaneously with SSBN of Project 658, submarines of Project 659 (*ECHO I*) with cruise missiles were developed. Contrary to the US Navy where the appearance of the first sea-based ballistic missiles was accompanied by a full rejection of the cruise missile development, the Soviet Navy changed the orientation in the cruise missile development: this type of missile got a new purpose—hitting sea moving targets (enemy's ships and vessels). Architectural and design solutions that became firmly established during creation of a cruise-missile submarine after completion of Project 659 development, were widely used subsequently on SSGN of Project 675 (*ECHO II*) with cruise missiles of complex P-6 and its modifications. The same solutions were used during creation of a cruise-missile SSG (Project 651 *JULIETT*) as well.

A new task of hitting missile strikes at surface ships was ensured by using cruise missiles P-6. It was reasonable to fire at hard-to-kill targets (e.g., strike aircraft carriers) from distances exceeding the operating radius of antisubmarine and air defense of these ships. Solution of a complicated task of hitting missile strikes at a manoeuvring target from a large distance required not only obtaining external data for the missile launch but also for the missile flight control and guidance using a radar sight at the target beyond the

SSGN Echo II at sea

visual contact with the cruise-missile carrier. If several targets were detected the possibility was provided of their selective kill using the transmission of the target radar images in the direction *from missile to submarine* and control commands in the direction *from submarine to missiles*.

Juliett-class SSG with launching containers of P-6 missiles lifted for firing

Thus, the combat task became more complicated. As a consequence of this the submarine herself became more sophisticated. Additional components were included into the set of radio electronic submarine aids including ship's equipment of target indication system *Argument*.

The creation of submarines of Projects 651 and 675 was a next stage in mastering techniques that were new for the submarine shipbuilding. In particular, in the process of design a lot of attention was paid to the problem of decreasing the primary and secondary acoustic fields of the ship. So, for example, the outer hull of these submarines for the first time was covered with a non-resonance anti-sonar coating and low-noise propellers in shrouds were included into their propulsion systems that allowed increasing considerably subcavitation speeds of submarines. New structural materials, in particular, low magnetic steel, were actively used.

SSBN and SSGN of Projects 658, 659, 675 (so-called submarines of *the 1st generation*) played, in essence, a role of the first step in formation of the Soviet ocean-going submarine fleet. Submarines possessing long endurance provided fulfilment of combat missions practically in any point of the World Ocean. Technical solutions implemented in these projects allowed considerable improvement of the submarine crew habitability conditions.

Non-nuclear submarines were not forgotten as well. New ocean-going submarines of Project 641 (Foxtrot) and new SS of medium displacement of Project 633 (ROMEO) replaced successful SS of Projects 611 and 613. Generally speaking, SS acted as an efficient supplement to torpedo nuclear submarines (SSN) that could solve anti-ship tasks practically in all areas of the Ocean. Later submarines of Project 641 passed on the baton to new SS of Project 641B (TANGO).

A large SS of the Foxtrot-class

The major efforts in the development of Project 641B were directed towards further improvement of the ship's qualities in submerged condition: improvement of acoustic stealthiness (in particular due to application of hull coatings), and use of new sonar systems. More efficient weapons and radio technical aids were used, hull lines were improved as well as the crew habitability and operating conditions, the storage battery capacity was increased.

The development of nuclear multipurpose submarines is a separate didactic story. At the beginning of this narration, I'd like to mention that lately at various, including academic, levels they discuss the issue that a notion of rationalism has to be given a scientific status. Being guided by my large practical experience of creating the most complex engineering systems, including submarines, I am deeply convinced that notwithstanding any *statuses* the notion RATIONALISM as a method, technology, tool, in combination with a logic comprehension and substantiation of principal solutions, is the most proper thing for planned realizations especially under conditions of strict financial programs. The latter condition in the second half of the last century during arms race, in essence, was

absent and this fact, among many others, explained a number of NON RATIONAL decisions during creation of SSN.

The first nuclear torpedo submarine—Project 627A (*NOVEMBER*)—by her creation determined and ensured a great breakthrough in underwater technologies and, practically, was the *foremother* of the rest of nuclear submarine projects and, in the first place, of the entire series of SSN of Project 627A (the 1st generation).

At the same time the decision was taken to develop a nuclear submarine of Project 645 with a nuclear propulsion plant based on a heat-transfer metal not being under pressure. It was both logical and rational as they looked for a nuclear plant that could be an alternative to plants with water coolant under high pressure. It was a natural process as at initial stages of creation of plants with water under pressure, many of units and systems had a low reliability.

While creating designs of multipurpose submarines of the 2nd generation, a clear picture is not so evident.

Project 661 (PAPA). The development of this nuclear submarine with cruise missiles of complex AMETISTS (first cruise missiles with submerged launch) was carried out at the end of the fifties—beginning of the sixties. The main aim of this project was to master application of titanium alloy for a submarine hull and obtaining an extra-high speed nuclear submarine (about 40 knots). Besides, all new equipment had to be qualified at this project (main propulsion plant, ship's machinery, radio electronic equipment etc.).

The one-of-a-kind Papa-class SSGN. The first submarine with a Titanium hull and cruise missiles for submerged launch.

By her manoeuvring qualities the SSGN of Project 661 at that time had no analogues either in the national or in foreign submarine shipbuilding and played an important role in the fate of the submarine shipbuilding.

Project 671 (*VICTOR I*). Works on this project were started in 1958. The project was a considerable step forward as compared to the series of SSN of Project 627A being under construction: a single-shaft submarine with increased hull diameter, graceful lines,

powerful torpedo weapons and sonar. Nevertheless, the design was carried out without attempts to *step over the verge of rationality*. It was clearly revealed in Project 705 (*ALFA*) that was developed a little later (I'll tell about Project 705 further).

A Victor II SSN

A responsible, weighted approach to the creation of Project 671 bore its fruits—these SSN built in a series of 15 units showed them perfectly well in operation. In terms of ship's systems and equipment the level of unification was very high for SSN of Project 671 and strategic SSBN of Project 667A. SSN of Project 671RT (*VICTOR II*, 3 units) and 671RTM (*VICTOR III*, 26 units) followed Project 671 submarines. All these submarines had kept their watch at sea for many years. It should be noted that many features characteristic for Project 671 and modifications were later on displayed in the next design of SSN—Project 971 (*AKULA*) of the 3rd generation.

It was quite possible to create SSGN with tactical cruise missiles based on Project 671, but the wish of the Gorky Industrial Group (CDB-112 and Krasnoe Sormovo Shipyard) to create an SSN with their own forces, as well as a concurrent wish of a very high ranking and highly respected Moscow leader to run for the Supreme Council of the USSR from the Gorky region resulted in the decision to create SSGN of Project 670 (CHARLEY I) in the city of Gorky. This decision was implemented though with difficulty. Having a good basic Project 671, this decision, for many reasons, was both illogical and irrational.

A Charlie I with P-40 cruise missiles of complex 'Ametist'

By the way, the similar situation was observed in respect to SSNs of the 3rd generation as well, but without political underlying reasons.

During construction of SSNs of the 2nd generation an idea appeared (I don't know exactly whose idea it was) to create a principally new extra-automated nuclear submarine with a minimum complement. High requirements for the speed defined the necessity of her development with a minimum possible displacement and it determined the utilization of a steam-generation plant (nuclear

An Alfa-class multi-purpose SSN in base, North Fleet

reactor) with a heat-transfer metal of the 1st contour. The best scientific, design and production forces were involved in the creation of this SSN that got the number Project 705. The works were under control of the highest authorities and financing was massive.

Here I express my purely personal feelings and opinion that was formed back at the time of Project 705 submarine development. The appearance of such a submarine was not adequately prepared both by the existing level of science and technology and by the entire infrastructure of shore support. Telemetry, robotics, information science and control system integration were not sufficiently developed in this period. There were a lot of concerns that the issues of sound insulation of a very high-capacity propulsion plant could not be efficiently resolved within the volumes of spaces where it was located.

In my mind I somehow got such a primitive and rough analogy. As if someone tried to put on a tail-coat on a man of the Stone Age. They managed to do so with difficulty—and around him were the walls of the cave, fire, hunting.

It is clear that a tail-coat did not last for a long time under such conditions—approximately a similar thing happened to SSN of Project 705. The first-of-the-class SSN of Project 705 was in experimental operation and covered 3,500 miles only. Other submarines of Project 705 were in operation for 9 to 12 years. In respect to Project 705K submarines (with water-cooled and water-moderated SGP) the situation was a little better. The submarines were in service for 14 years in average performing 6 to 7 patrols. Undoubtedly, Project 705 submarines, in terms of technology, pushed forward the automatics but this *push* was extremely expensive. There was too little rationalism and logics in the decision on creation Project 705, but what could we do, it was such a time...

Sometimes I think that if all the funds spent on Project 705 program were addressed to the shore infrastructure of naval bases and construction of cantonments with an adequate level of living for our heroic submariners and their families, we would not have, at the background of KURSK tragedy, such scandalous pictures of the way of life in the Vidyaevo settlement.

Actually, we approached the optimum structure of the naval Submarine Forces only by the 4th generation of submarines when only three projects were realized—SSBN with strategic weapons, multipurpose SSN and diesel-electric submarine (SS).

Now I come back to the chronology of the Russian submarine shipbuilding evolution and to the next stage—the 3rd generation submarines.

Akula-class multi-purpose SSN, North Fleet, in base

Project 971 (*Akula*). As compared to SSN of Project 945 (*Sierra*) with titanium alloy hulls that had been constructed at Krasnoe Sormovo Shipyard since the beginning of the eighties, submarines of Project 971 had steel hulls and it reduced drastically the submarine cost and allowed the construction of a series of submarines with involvement of several yards of the industry, to ensure the reduction of SSN noise level and interference level to the sonar system operation (due to

introduction of a number of design measures) as well as using of the major completing equipment already developed for other SSN of the 3rd generation. These design solutions predetermined the fate of Project 971 submarines that were accepted for a serial construction and were built at two yards (the yard *Leninskiy Komsomol* in Komsomolsk-on-Amur and yard *Sevmashpredpriyatie* in Severodvinsk). During trials of the first-in-the-class submarine of Project 971 high tactical and technical capabilities of this ship were validated. Then started serial construction of Project 971 submarines, which *duplicated* the tasks assigned to SSN of Projects 945 and 945A (*Sierra*), resulted in the only correct decision: construction of SSN of Project 945A at *Krasnoe Sormovo* Yard (city of Gorky) was stopped and the fabricated sections of these submarines were scrapped. A total of only four ships of Projects 945 and 945A joined the Navy.

Sierra-class SSN KOSTROMA in the North Fleet base

Submarines of Project 941 (*TYPHOON*) with ballistic missiles of complex D-19 became a certain *crown* of the design conception of the shipbuilders aspiring to create a strong ship with drastically increased survivability that could ensure the parity with strategic missile-carriers of system TRIDENT of the US Navy. They managed to do so—each heavy missile strategic submarine cruiser of Project 941 carried 200 re-entry vehicles, and her missiles allowed her to hit any target located in the northern hemisphere, even when missiles were launched, so to say, from a jetty position (dock or pier in a Naval Submarine Base). The peculiarity of the geographical position

of the USSR and weight and dimension characteristics of those missiles could not help influencing the very special architecture of these underwater giants.

The Typhoon-class heavy SSBN SEVERSTAL at sea

Nuclear submarine cruisers (SSGN) of Projects 949 (*OSCAR I*) and 949A (*OSCAR II*) belonged to a subclass of ships designed for fighting a strong sea enemy. These submarines carrying 24 cruise missiles created a real threat to large surface action forces and, in the first place, to aircraft carrier forces. Submarines of these projects performed a hard duty of defending our marine boundaries, went to long cruises, covertly penetrated into the Mediterranean Sea.

I have a profound respect for submariners who served and continue to serve on Project 949A submarines: it is not so easy to fulfil the mission assigned to these submarines taking into account the opposing forces. Speaking about Project 949A submarines it is impossible to pass over the catastrophe with SSGN KURSK in silence. This tragedy shook sailors, shipbuilders and the entire world community. In order to carry out very thorough investigation of the catastrophe causes, it was required to perform a unique operation of KURSK salvage from the Barents Sea bottom. The profound study of all the materials including those obtained after the ship lifting and her examina-

Nuclear submarine cruiser K-141, KURSK, in the North Fleet

tion in dock PD-50 allowed finding the truth—nuclear submarine cruiser KURSK was lost in the result of explosion of a practice torpedo and catastrophic events entailing that explosion. The materials of the catastrophe investigation showed that the crew members who remained alive after the explosion till their last minutes preserved their courage and fought both for the ship's survival and their own rescue.

The loss of a submarine of Project 685 (*MIKE*), more widely known under the name KOMSOMOLETS, still causes pain in the hearts of people, The same way as the loss of KURSK, this catastrophe that occurred in April 1989 and took away the lives of 42 sailors, was very thoroughly analyzed both by the sailors and scientists.

SSN K-278, KOMSOMOLETS, in the North Fleet base, 1988

Contrary to the Project 705 (*Alfa*) submarines, creation of SSN of Project 685 (*Mike*) similarly to SSGN of Project 661 (*Papa*) was not aimed at obtaining an absolutely new ship in all her components. In particular, in Project 685 the main task was to increase sharply the diving depth. The task mainly involved the pressure hull. A new quality of this SSN—to sail in the ocean below the thermal (sound) layer—resulted in the impossibility of her detection using existing sonar facilities. In the rest part the technical outfitting of this submarine was at the level of an SSN of the 2nd generation and therefore she was easily adapted to the shore infrastructure and successfully fulfilled her duty for 4 years.

According to the results of the submarine loss that, unfortunately, due to a number of reasons, was not possible to lift, conclusions were made based on the analysis of available materials, performed calculations and experimental works. These conclusions became the

foundation of a program that was aimed to increase the survivability of sailing and designed submarines. In many respects we managed to implement this program.

These two examples from the after-war history—SSGN KURSK and SSN KOMSOMOLETS, unfortunately prove the fact that the profession of a submariner still bears certain risk. All the people involved—both sailors and shipbuilders—have to understand this. The shipbuilder's task is to minimize the risk by design solutions laid into the design. But, most probably, such a risk will still be present in the future. A submarine is a complex man-machine system. Reliable technical solutions and fast and confident actions of the entire crew trained up to automatism are equally important.

Submarines of Project 877 (KILO) continued the line of national torpedo diesel-electric submarines. I'd like to talk in a little more details about submarines of this project. In the process of the project development the state-of-the-art design and construction technologies, the most perfect equipment, weapons and radio electronic aids were used. Similar to their predecessors, the ships of these new project were created with account of the possibility of their operation in any climatic zones—from the Arctic to the equator.

A Kilo-class SS goes to sea

While creating Project 877 a special attention was paid to the underwater qualities of the boat. For this purpose the hull shape was optimized (ratio of principal dimensions, axially symmetric smooth lines, improved shape of the mast fairwater), a single-shaft propulsion plant was applied, the number of openings in the outer hull was optimized. The listed measures allowed not only growing the full submerged speed but increasing the submerged cruising range as well, reducing hydrodynamic noise generated during the ship motion. The perfect lines of the forward end allowed improving the operating conditions of the forward sonar array.

The design measures on increasing the level of the submarine acoustic stealthiness as per the primary and secondary fields included the application of improved sonar coating on the hull, use of the latest methods of fighting the noise level of machinery and ways of its propagation, use of a low-noise propulsors and a number of other measures.

The electric propulsion scheme was used on Project 877 for the first time in the USSR. Use of diesel-generators allowed providing *a flexibility* of electric power systems of the submarine, optimizing propulsion modes under snorkel and during SB charging. The ability of the submarine propulsion plant to change speed was improved (the time of picking up the speed on the shaft was reduced).

The control of the submarine combat system and technical facilities was arranged at a new level. The submarine designers managed to find an optimum combination of automated and manual operations performed by the crew during the cruise, and it provided the possibility to reduce the complement considerably without compromising other qualities of the ship. The reduction of the personnel number, in its turn, allowed creating more comfortable conditions for operation and rest for submariners during an endurance cruise.

Practically all the radio electronic equipment of Project 877 submarines was developed on a new elementary base, that allowed change to its characteristics qualitatively and to minimize the volume occupied by the equipment. A low level of the own ship's interferences to the sonar complex operation and high sensitivity of sonar array made possible a search of the most *silent* targets.

A successful combination of tactical and technical parameters of the ship makes it efficient both in the ocean (very far from her base) and in a restricted water areas (in fjords, near reefs). As for the spectrum of the performed missions, Project 877 submarines are practically universal. They are able to solve both anti-submarine tasks and anti-surface ship tasks.

Solution of the listed design tasks demanded from the designers a lot of effort and the ship designing was not so easy. The design development required involvement of a large number of industrial enterprises and scientific organization and very punctual coordination of their activities.

The recognition of high qualities of Project 877 submarines and their modifications is proven by the fact of their purchase by the navies of many countries in the world. In 2005 the number of constructed submarines of Project 877 reached 55 units. 25 of them are successfully operating abroad.

Thoughts About Future

I am used to thinking that the future, for sure, has to be better than the time when we live. Probably, this optimism is determined by the fact that every day we perform dozens of acts the after-affects of which we can feel practically next day. Making decisions today, fulfilling a work planned for a day we always estimate what the results of these decisions and work will be. We always tend that our acts make our future better.

For a submarine designer *orientation for future* is quite natural: submarines have to be in service with the Navy for many years and successful or non-successful operation of submarines depends not only on technical solutions implemented in their designs but also on the Navy's ability to solve the task assigned to it. The submarine designer is obliged to look into the future, to weigh on the scales of his own experience and knowledge, all the factors on which the submarine appearance, structure and equipment will depend.

The non-nuclear submarine ST. PETERSBURG, a modified Kilo-class (Project 667) on the International Maritime Defense Show in St Petersburg, 2005

Many times I had to express my views on what future submarines should look like, but every time I had to make corrections in the appearance of possible submarines of the future. And it is quite clear—the science and technique do not rest in peace, quite to the contrary, their development picks up speed. The political situation changes both in the world and in the country, the economic conditions keep changing, technology develops. Submarines being *a product* of their own time, as a rule, reflect all the above listed factors.

Forecasts say that in the nearest future the general character of international relations will remain practically the same—the polarity will be and must be preserved in the world where one of the *poles* obligatory has to be Russia. It means that Russia still needs powerful armed forces. It is required because of one more consideration: Russia possesses huge resources in the bowels of the earth and water, and that will be a constant factor of longing for foreign forces. The role of the Navy within the armed forces of the country will remain invariably important. It goes without saying that the quantitative composition and structure of the Russian Navy will be considerably different from that of the Soviet Navy of the *Cold War* period, and it is defined by the Military Doctrine of Russia and missions assigned to the Navy. It is necessary to note, that the importance of Submarine Forces within the Navy will inevitably grow.

These particular new conditions put many questions to the Navy and Industry. It is difficult to choose quick and correct answers to all the questions but I think that it is advisable to outline some part of the tasks that already have revealed.

Special features of the submarine creation process today

1. The principle of reasonable sufficiency accepted at the present time (for our country having 4—5 sea regions, of course, the sufficiency shall be determined with account of this factor) determines the minimization of the quantitative composition of the naval Submarine Forces. At the same time the reduction of the number of submarines within the Navy requires that combat abilities of new submarines, without doubts, should exceed those of earlier designed and built ships. Actually a well-known principle applies: *Better less but better*.

It is not a must that the improvement of tactical and technical capabilities of future submarines shall be expressed in such a way that all their parameters will be higher as compared to previous ships. A number of technical parameters of modern submarines already correspond to the limit that is sufficiently efficient. Such parameters include, for example, a full submerged speed and endurance. Moreover, some of the submarine parameters can be even lower in respect to submarines of previous generations. At the same time a number of parameters of new ships, for sure, should be different *by times* as compared to the predecessor ships. In the first place, such parameters are those that are the determining ones from the point of view of combat efficiency, namely, within the context of solving main tasks assigned to the Navy.

As applied to future submarines, the prioritized direction in the increase of their combat efficiency will be, as previously, characteristics of their weapons and stealthiness. We already managed to achieve certain success in this direction, but a lot is still to be done. For example, in the area of acoustic stealthiness the last submarines of the 3rd generation practically matched similar submarines of the US Navy built at the same time. But for submarines of the XXI century, especially taking into account massive and intensive activities in this field, these achievements cannot be considered satisfactory any more. In the first place, for new projects of submarines even lower noise level at low speed have to be achieved. Second, taking into account the appearance in arsenals of foreign navies of new means of the submarine search with active sonar facilities, works on reduction of the acoustic visibility of a submarine and on outfitting submarines with more perfect sonar complexes have to be continued. Third, the submarine's ability to remain stealthy (especially by multi-purpose submarines or SSN) has to be widened and cover not only a slow speed mode but modes of higher speeds as well both during transient modes and manoeuvring. Activities directed toward increase of the submarine stealthiness are not exhausted with this list. Though the submarine acoustic field will remain the most informative even in the future, it is not the only one source of information. Therefore we have to continue works on reducing parameters and other physical fields of ships.

Speaking about the increase of the submarine stealthiness, it is

not possible to leave aside the necessity of further improvements of the external situation observation means. Even today a modern submarine in many respects recollects *acoustic telescope*—she should be able to carry out search for solely low noise targets in the ocean. Operation with weak acoustic signals, a large scope of information derived from the water medium, difficulty of discrimination of useful signal at the interference background—all these things require not only powerful computing resources but application of complicated mathematical algorithms and software as well. Creation of such sonar complexes that are able to solve tasks under hard hydrological conditions and in the real time scale is a very complicated process, but Russian companies already achieved appreciable success in this direction. The fleet orientation, under the present conditions, to solution of strategic tasks (deterrence of probably enemy) and tactical tasks mainly in a close-range sea zone, influences the technical appearance of future submarines in certain respect as well. The formation of the balanced ship composition of the general purpose Submarine Forces should be carried out taking into account the necessity and possibility of the mutually supplementing use of multipurpose SSN and non-nuclear submarines. At the same time, it should be noted that a resemblance between a new non-nuclear submarine and diesel-electric submarines that we all are used to will be very distant. A non-nuclear submarine of a new generation, which will be in operation in the first half of the XXI century, will be a new ship in terms of the quality, with a considerably higher combat abilities and with comparatively low cost. In the first place, new non-nuclear submarines have to possess the ability to remain submerged practically during the entire endurance cruise. This quality as well as acoustic stealthiness inherent to non-nuclear submarines will allow them to solve successfully their tasks in the coastal areas (and at present this task becomes more and more important) and at the same time to sail under the ice cover, if required. In order to ensure this new quality of non-nuclear submarines designers put a lot of effort into studies of various options of propulsion plants for these ships. We hope that the Customer will provide more active support to these studies initiated by the Industry.

2. The principle described in the previous paragraph and which can be re-formulated as *a principle of refuse from quantitative and qualitative redundancy* receives a logic continuation in the principle of *a reasonable cost of a submarine*. Prospective submarines have to be created not only with account for the minimisation of the cost of completing items and materials, minimization of cost of the construction yard own works, but with account of minimization of a submarine life cycle cost. This task can be with confidence related to a category of *arch-complicated*, as achievement of high tactical and technical characteristics of submarines growth of their *scientific intensity* inevitably will *turn up* the cost curve. The reduction of the number of constructed submarines, i.e. drop of a number of submarines to be constructed as a series, will create additional difficulties. Solving the problem of reducing the cost of a submarine design, construction and operation lies, mainly, in the plane of application of highly efficient technologies. Design measures also may have certain effect (e.g., measures directed towards reduction of the ship displacement, such as selection of small-size equipment and devices, reasonable completing the submarine with equipment, rational layout of submarine compartments).

Of course, it is necessary (but we can only dream about it) to liquidate monopoly in the design and production of all completing equipment for submarines that can restrain the irrepressible growth of the equipment cost.

3. What can be actually said about the influence of technology and work arrangement of the submarine construction cost? It is well known that the submarine construction cost, to a considerable degree, is determined by the duration of the submarine stay on slipways. The decrease of the slipways period is able to reduce in reality the construction costs of the yard. It can be achieved by application of the modular construction principles that were used in the process of construction of a number of 3rd generation submarines. In this case a lot of construction activities are carried out in parallel, the labour content is reduced and the quality of installation works is increased as these activities are transferred from the crowded space of a submarine hull into a shop where the most favourable conditions

for aggregate assembly can be provided. Moreover, application of a block approach to the submarine construction creates necessary prerequisites for *paralleling* of tests and trials as well. It is known that the duration of trials has a lot of influence on the duration of the submarine stay at the construction yard.

An approximately similar effect can be achieved due to rejection of hydraulic pressure tests of the submarine pressure hull, but deletion of this checking operation is possible only when a high production efficiency is available at the construction yard that allows to guarantee the quality of important hull works.

Use of a block-module method in the submarine construction is inseparably linked with a high working efficiency of the design bureau and the construction yard and with the discipline of equipment supplies of the entire cooperation. The modular-aggregate method of submarine construction requires strict observation of scheduled terms of equipment supply from manufacturers to the construction yard, and it means very strict control over execution of experimental design works by the design bureau and control over serial supplies by the construction yard.

Of course, speaking about cost and technology of the submarine construction we cannot leave aside the necessity to improve the production facilities of the submarine construction yards. During the *golden age* of the national submarine construction the growth of production facilities was very dynamic—the machine tool fleet was improved, both individual technological complexes and entire production lines were incorporated into production.

Nowadays the shipbuilding technologies (especially in part of hull and pipe production) made a large step forward, but... unfortunately, not on Russian yards that build submarines. Of course, in order to transfer the shipbuilding onto a higher level of quality, the financing is required. And we should say, a lot of financing. The construction yards that barely started stand up after the production collapse of the nineties, do not have funds for the production facility development. One shall not count on bank loans under the present conditions because there won't be money to pay back the loan. A conclusion inevitably comes to mind: the state-owned companies that work in the submarine shipbuilding sphere need a real state support.

Using words *high design efficiency* and *technological discipline* I consider them not as abstract terms but as absolutely specific notions that have a lot of influence on the duration and cost of the submarine construction. Mistakes in design documents of the design bureau (unfortunately, there are some) result in the necessity to correct these mistakes at the construction yard. Of course, it means a loss of time, labour and certain materials losses. Taking into account complicacy of a modern submarine (a large nomenclature of equipment and devices, complex connections that connect equipment into systems and other factors) it is impossible to exclude completely appearance of mistakes using traditional design technology. A possible way out of such a situation is a transition to 3D modelling systems and computerized control system of engineering data (PDM-systems). The listed systems are already in use during execution of individual design works. The next in turn—transition to a full-scale industrial use of these systems

Modern information technologies are able to provide realistic acceleration of the submarine construction process. For example, a communication channel that was arranged between CDB ME *Rubin* (Saint-Petersburg) and PA *SEVMASH* (Severodvinsk) in reality demonstrated its efficiency. The process of information integration, and the submarine designers and builders were the first to join this process, inevitably will continue *catching* other enterprises participating in the ship construction. The next in turn—strong engineering companies developing equipment for submarine propulsion plants as well as scientific and production associations creating radio electronic aids.

Of course, the submarine design and construction efficiency is not limited by the ability to use actively state-of-the-art information technologies. In the first turn it is necessary to talk about the professional skills and responsibility of those who take part in the submarine creation, about their ability of *a team work*. And the latter quality shall show itself not only in relations between companies creating the ships but internally between employees of factories, institutes and design bureaus.

The efficiency of the submarine designers and builders has to be supplemented by a high level of the *staff efficiency* of the Customer. We need to talk about it because the real *staff efficiency* is replaced

with bureaucratism. Papers, and in the process of the ship construction we give birth to a lot of them, do not assist in keeping the required order but serve to some other purpose that cannot be understood by a human mind. Approval of these papers, drawing up contracts, payments for executed works—all these things sometimes require as much time as was spent for the actual technical work.

4. The previous paragraphs once again confirmed the unbreakable link between the Industry and the Navy, the necessity of unity of opinion of sailors-submariners and shipbuilders on the way of the Russian Submarine Forces development. The system of GOST (State Standards) and General Tactical and Technical Requirements (GTTR), developed by the Navy and agreed upon with the Industry, always acted as the bases for the unity of opinion of submariners and shipbuilders. Unfortunately, both GOST and GTTR are hopelessly obsolete. A number of other normative naval documents used by the designers indirectly also became out of date. Such normative documents include, in the first place, *Manual on the Submarine Damage Control*. A lot of technical innovations that make the damage control for the submarine crew easier and reduce the probability of heavy consequences in case of emergency are incorporated into the new submarines being under construction at yards in Saint-Petersburg and Severodvinsk. Nevertheless, these technical features of new submarines had not been reflected yet in the naval documents that determine the tactics of the damage control. By the opinion of designers, it is important in the nearest future to revise the normative base of the submarine design and construction to validate its correspondence to modern conditions and to reissue the basic documents.

5. The submarine damage control is just one of the examples of the fact that in the process of the future submarine design they have to be considered as an element of a complicated man-machine system. Within these systems both a man and a ship have to fulfil particularly those functions that are optimal for them. At the same time it has to be noted that continuous growth of the technique sophistication, use of very highly technological equipment results in the necessity to complete the submarines by professional crews only.

Under *professional* we understand not a crew that was formed out of service men hired under a contract but a crew every member of which is a real professional, expert in his trade. If one wants such people to come to the Navy and serve in the Submarine Forces, one should create for them normal and even better than normal financial conditions and special conditions of life. This is not the task of the submarine designers but of the State, which these people will defend. Quite recently the designers, who knew perfectly well the conditions of the submariners' service, tried to create onboard certain comfort that shore services were not able to provide. This practice was good for the Soviet times but nowadays such an approach *cannot remove from the agenda* the issue of attractiveness of service on submariners.

Let's assume that the State will be able to solve this problem and submariners will actually become the elite of the Navy as, e.g., in the Navies of NATO countries. Does it mean that the designers of future submarines will not have new questions related to the presence of a man in a technogenic medium of a submarine? No, questions will always spring up and both changing technique and changing man will give rise to them.

The submarine saturation with a sophisticated equipment is growing and even today it is difficult to imagine that the crew is able to know the hardware they are responsible for very thoroughly, at the level of developers. After all, the personnel have to be able to operate their ships competently and to solve combat tasks using them. It is difficult to demand from the submariners the same depth of the hardware understanding as from those people who developed the equipment. The conclusion suggests itself: it is necessary to release the submarine crews from the equipment repair. And not only has the crew to be released from this work but naval repair yards as well. These works have to be performed by qualified specialists of Industrial enterprises within the framework of accompanying support during the entire life cycle of ships commissioned to the Navy.

It is time to resolve the issue of handing over to the Industry naval ship repair yards and technical support of the ship operation, as it was done recently in Great Britain. It improved the quality of all types of repair and increased the level of combat training of crews.

Akula-class multi-purpose SSN in the North Fleet base

Taking into account the increasing *shortage* of multi-purpose submarines I think that it is very important to have a very clear program of a long-term support to keeping in the combat strength of the Navy SSN of Project 971 (*Akula*) and SSGN of Project 949A (*Oscar II*).

Oscar II SSGN with tactical cruise missiles

6. Talking about future submarine and submariners who will serve on them, it is necessary to keep in mind that both these boats and these people will not be absolutely the same as we know them today. Nowadays in the US Navy and in navies of some other countries women serve on submarines, and this fact is taken in account during

the submarine design. People's views on comfort are also changing. Today many people cannot imagine their life without such means of communication as Internet and it influences the fleet requirements to the habitability conditions on surface ships and submarines. In particular, the British standard for the surface ship and submarine habitability in line with usual requirements set forth a requirement that is formulated as follows: *A dedicated computer access connection point shall be provided for each occupant in sleeping accommodation providing on-line information including, but not limited to, ship administration data, on-board training material, personal development and external news, etc.*

7. An abstract from the British standard given in the previous paragraph is just an illustration of those new tasks that the designers of future national submarines may have. I deliberately avoid using a word *generation* when mentioning future submarines. As I understand it, the word *generation* has lost to certain extent its former meaning. When first nuclear submarines (Projects 627, 627A, 645, 658, 659) were designed and built we did not meditate over the fact that later on they would be related to *the first generation*, that submarines of the second generation would follow them and then—*third* and *fourth*.

The notion *generation* was clear and logical when the massive construction of submarines was carried out. It united submarines of different types—nuclear submarines with ballistic missiles, nuclear submarines with tactical cruise missiles, nuclear submarines and diesel-electric submarines with torpedo and missile weapons. In spite of different purposes of the nuclear submarines of the listed subclasses, they were united by the unity of design approaches, design solutions, main used equipment and radio electronic complexes.

The submarine construction in large series and within a very short time (e.g., there were built 34 SSBN of Project 667A (*Yankee*)) required minimization of differences between ships under construction. But it was such *conveyer assembly* of submarines on the slipways that to the largest degree met the conditions of the naval arms race. At the same time the minimization of differences in serial construction ships as well as a high degree of inter-project unifica-

tion of nuclear submarines of different types allowed to operate submarines and carry out their repair with the minimum number of problems. Transition from a generation to a generation took place only when necessary prerequisites appeared for the achievement of a qualitative leap in tactical and technical parameters of ships, and it required decades of tenacious efforts of scientific centres and industrial enterprises.

In the present situation (reduction of the number of submarines in each subclass, construction of submarine series very protracted in time and dynamic development of element base for radio electronic equipment) maintaining the high level of unification of equipment and complexes of ships of one series does not provide any more the same effect that was achieved during the massive construction of submarines. On the contrary, striving for maintaining the same level of unification at any cost starts to hamper the introduction of more progressive solutions and technologies.

Even today, especially in the world practice, the pace of development of individual types of engineering (and in the first place of radio electronic equipment) is so high that approximately in 3 to 5 years a change of generations of this technique takes place. It mainly pertains to radio electronics and software. For example, changing of computer processors takes place practically every two years with doubling the computing abilities. With so fast engineering development we observe, figuratively speaking, *an inflation* or *devaluation* of old technical achievements: new systems and complexes demonstrate higher tactical and technical capabilities that drastically increase the efficiency of ships on which they are installed. At the same time the displacement and principal dimensions of the ship remain unchanged.

An approximately similar effect was obtained during creation of a diesel-electric submarine of Project 636: the submarine hull remained unchanged as compared to Project 877 submarine but the boat's combat efficiency was considerably increased.

High paces of engineering development are reflected in economics. New technique *washes out* the old one not only because it is better but because it is impossible and economically unreasonable to keep the production facilities for the old equipment. The impossibility *to get* spare parts to an old TV set brings us to a shop for buying

a new one. Similar processes are observed in the defence industry. We are forced to use the state-of-the-art samples of technique just because we are not able to find spare parts for the old equipment.

For sure, the rates of improvement of submarine equipment are not uniform. As I already said, radio electronics develops much faster. The rates of development of machine building and structural materials are considerably lower. It was noted that the larger was the submarine's equipment the lower were the rates of its development. Taking this fact into account in the present conditions the submarine improvement can occur not in leaps (generations), as in the not so distant past, but in the process of construction of a submarine series. Apparently, it will be reasonable to create submarines in sub-series with transfer to the next sub-series every 5 to 7 years. This sub-series will be equipped with more sophisticated weapons and computers without changing the appearance and contents of the basic design of the ship. Such a technology, but expanded for a large time interval, reminds the creation of strategic missile submarines of the 2nd generation, when the way from SSBN of Project 667A (*Yankee*) to Project 667BDRM (*Delta IV*) was covered within 15 years.

Torpedo loading on a Kilo-class non-nuclear submarine

Similar ideas already hover in air with foreign submarine designers. In the USA, for example, the construction of SSN's of VIRGINIA type is planned to be carried out in small sub-series, with introduction of a certain number of new equipment and devices into

each next constructed submarine. So, starting from the seventh hull of SSN of Virginia class, they will be equipped with a new propulsion plant based on electric propulsion principles with a powerful propulsion motor.

May be, a similar approach will be logical in application to our national nuclear submarines as well? At least an interval of 7 to 10 years seems to be rather sufficient for a considerable modifying change of the project appearance.

The described approach puts new tasks in front of designers of future submarines. Design works on modifying changes of the next submarine have to be carried out fast, ensuring the required rates of the ship construction in series. It is technically possible with acceptance of a new design technique. I will repeat that the design should be carried out using modern computer technologies.

8. I talk a lot about the tasks of future submarine designers and builders. Nevertheless, it does not mean that the rest of co-operation participating in the submarine creation will stay aside from this process. Undoubtedly, geopolitical changes that caused some movements in views on a modern fleet, on Submarine Forces, effect the entire Industry and Science related to the future ship creation. All participants of the process should move forward as a united front.

The confrontation between the USSR and USA, the Warsaw Treaty and NATO countries existing during the *Cold War* determined requirements to the Navy and, in particular, to the composition of ships. The corresponding industrial base was established in our country for the creation and maintaining in combat readiness of the strong Navy. The lessening of tension in international relations after the end of the *Cold War* resulted in a sharp reduction of the number of ships, and economical process in the country brought to sharp reduction of financing allocated for maintenance of the fleet readiness and for the development of new ships.

The existing industrial base, in certain case, happened to be excessive for the new Navy. Attempts to use the existing production facilities for production of civil goods were made by enterprises with different degrees of success and, practically, without any thought-out State policy in this respect. As a consequence of these painful economic processes, many enterprises that produced items for the

submarine shipbuilding were re-directed to other spheres of activities and many of them had lost their production potential.

In addition to this, changing the form of ownership to these enterprises made its negative contribution into the abilities of the submarine shipbuilding. We do not fully feel and fully overcome consequences of all these factors. However, the backbone already exists for a new cooperation for creation of submarines. Today it is important to complete the process of *regrouping forces* oriented towards creation of modern ships. It is required that the Government takes careful and thoughtful approach to avoid damaging newly established links by its controlling actions.

Strategic submarine K-44, RYAZAN, A Delta III SSBN, goes to sea for patrol

Drawing the Line

Coming back to the anniversary of the Russian Submarine Forces. One hundred years.... It is much or little? Glancing back one can see that for these hundred years sailors and shipbuilders made a lot of things. There were glorious victories and bitter defeats and losses on this century-long way. But the road goes on. We already see what we have to do within the next few years. And the outlines of more distant prospects are also visible though less distinctly. We are realists and we understand that the Submarine Forces will be required by our country for long-long years. That's why we strive to look into the future and we work for the future. I am sure, we will be able to solve the appearing questions and our submarines of the XXI century will add vivid pages into the history of the Russian fleet. Only those who keep walking can cope with the road, and our task is to show them the correct direction.■

Nomenclature Guide
Soviet/Russian Submarine Classes
By Project Number with NATO Designations

Soviet/Russian Project Designations	NATO Class Designations	USN Ship Type Designation
611	Zulu	SS
613	Whiskey	SS
615	Quebec	SS
617	Whale	SS
627	November	SSN
629	Golf	SSB
633	Romeo	SS
641	Foxtrot	SS
641B	Tango	SS
651	Juliett	SSG
658	Hotel	SSBN
659	Echo I	SSGN
661	Papa	SSGN
667A	Yankee	SSBN
667B	Delta I	SSBN
667BD	Delta II	SSBN
667BDR	Delta III	SSBN
667BDRM	Delta IV	SSBN
670	Charlie I	SSGN
670M	Charlie II	SSGN
671	Victor I	SSN
671RT	Victor II	SSN
671RTM	Victor III	SSN
675	Echo II	SSGN
677	(Modified Kilo)	SS
685	Mike	SSN
690	Bravo	SS
705	Alfa	SSN
877	Kilo	SS
941	Typhoon	SSBN (Heavy)
945	Sierra I	SSN
949	Oscar I	SSGN
949A	Oscar II	SSGN
971	Akulu	SSN

Today, in their own very quiet way, U.S. Navy submarines are involved in more critical covert operations than ever before. From the gathering and sharing of real-time intelligence with joint operations to the ability to serve as sea bases for ballistic missile defense and more, submarines' contribution to the big picture remains absolutely vital. For a detailed overview of how Electric Boat is quietly expanding the range of stealth, visit www.gdeb.com.

Nothing's as powerful as stealth. GENERAL DYNAMICS
Electric Boat

FEATURES

Undersea Defense Technology and Coalition Forces in Maritime Security

VADM Chuck Munns
Commander Submarine Forces
06 Dec 2006

Good Morning. I am so delighted to be here today. I would like to talk about one of my favorite subjects ... what Submarines can do for the Nations of the World.

It's a subject which fits the theme of this conference. I will simply answer the questions posed by UDT Pacific 2006 ... how best to bring Undersea Technology to bear on the problem of providing Global Maritime Security with coalition forces.

I will postulate a short scenario as background for the discussion. It's a scenario that illustrates just one aspect of Maritime Security.

Bad actors hijack ships of various international registries and hold the passengers and crews hostage for ransom. This is a problem – not of a major superpower standoff or global conflict with kinetic strikes being traded back and forth... This is a problem of ***commerce*** and ***security***. This is a problem where global ***prosperity*** is threatened by small groups that take advantage of the wide open ungoverned maneuver space afforded by the high seas and the seas of nations that are unable to enforce the rule of law. They take advantage of these spaces to operate against the rule of law for various purposes that range from illicit trade to forwarding a fundamentalist religious agenda.

Agenda

- *Why Maritime Security?*
- *Why Coalition?*
- *Why Undersea?*
- *Technology*
- *Challenges*

COMNAVSUBFOR

While this scenario sounds familiar today, it also drove our fore fathers. It describes a time from the early days of the United States of America… when the Frigates commissioned under our second President, John Adams, were employed by our third president, Thomas Jefferson, in this country's first efforts to achieve our National Security by working beyond our nearby coastline. This was not a superpower asserting itself across the globe. This was a fledgling country, protecting freedom of navigation and commerce through an area that was not deemed of strategic importance by the powers of that day. It was a time when we took our first steps at influencing the external world through seapower as a global partner. We did it by enforcing Global Maritime Security.

Today the problem is much different, but so many elements remain the same. There is much more global commerce, and it is continuing to grow as fast as technology and physics will allow. Maritime commerce directly employs 2 million people globally and indirectly makes possible the employment of many times more than that. Taken in total, the world's Trading Fleet displaces more than 598 Million Tons. More than before, this economy is driven over the ocean highways, and as before these routes go through and near troubled waters. Ideologies, countries, companies, peoples meet and compete on these highways.

We all depend on the Global Economy. It provides our livelihood; it determines our nation's policies. And the Global Economy depends on the Oceans Highways.

Maritime Security is central to our very existence... it provides for nothing less than our **Prosperity** and our **National Security**.

But why do we need to do this as a coalition? Simply put, a coalition gives us the right *Capacity*, and it gives us the right *Character*.

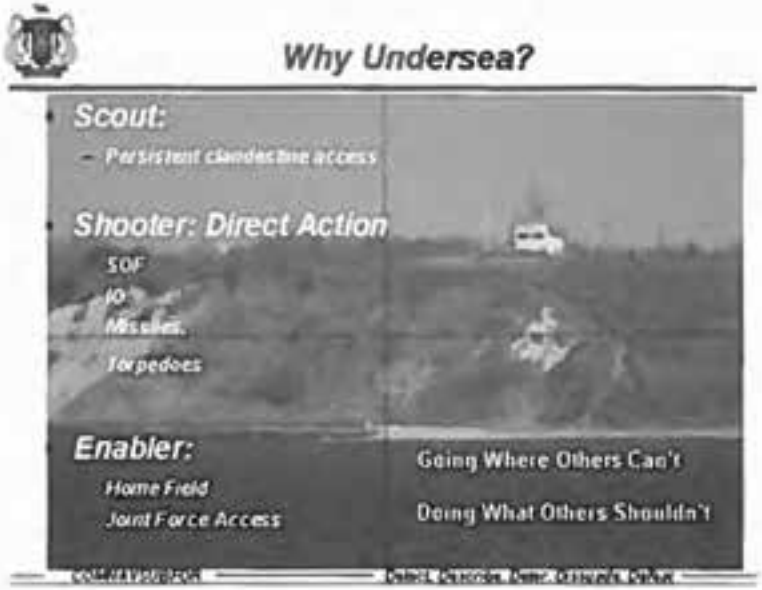
If we put a monetary value on the collective efforts of Transnational Criminal Organizations, they are on a par with the collective revenues of these eight multi-national companies. The IMF (International Monetary Fund) estimates that the laundered proceeds from criminal activities are between 2.0% to 4.8% of the world's GDP annually. That would be between $860 Billion—$2.07 Trillion in 2005.

With assets on that scale for both the global legitimate and illegitimate trading partners, coupled with the diffuse, permeating nature of the threat, the only way to address the problem is through coalition partnerships. Today's security *challenges are too diverse to tackle alone* and require more capability and resources than any one nation can deliver.

Here, Nations of the world are bound together by our dependence on the seas and in our need for security of the vast common area they

represent. Like in a capitalist free market, where actions made for the purpose of individual gain serve the overall good of the marketplace and nation, actions to bring security to the seas serve the local national interests at the same time they serve the global good. Nations exercising sovereignty do not detract from global security, they produce it.

Economies provide **Prosperity**
Economies require **Maritime Commerce**
Maritime Commerce requires **Maritime Security**



Undersea Technology brings some unique capabilities to bear on the problem of Maritime Security. Those capabilities are Persistence, Mobility, Stealth, Power, and Payload—and they are *critical*. Those capabilities allow us to fill many roles.

If you missed it, last week one of the news items was the Mars Global Surveyor project. The probe was launched over 10 years ago and was expected to last for two years. In the 10 years the planet rover portion of it operated, it has sent back over 240,000 pictures and scientists say it revolutionized what we were thinking about Mars. This project has given us the best topographic map of any planet in the solar system. The most unique contributions of the lander come from actually operating within the environment it is studying with *persistence* and *mobility*. It can sample it's area over extended periods of time and move to other areas to identify variation. Because of it's *persistence* we can see things that are not always happening - like dust storms. Because of it's *mobility* we can visit places you can't land near—like gullies.

By operating inside the study medium, we learned something not discernable from orbit—Mars once had a magnetic field.

Our undersea forces do the same on earth, as the Surveyor did on the moon.. the scout for our nations.

Beyond Persistence and Mobility, in the problem of Maritime Security we also need to have Stealth, Power and Payload. The common denominator across these roles is the sustained ability to observe without affecting the behavior of the subject—To see what is happening when the subjects don't think anyone is looking.

They also give us the ability to anonymously observe without attribution back to our Nations.

So the answer to Why Undersea? ... **Undersea provides Scouts that can act for our national interests and do it with Persistence, Mobility, Stealth, Power, and Payload**

One of the things that has changed since Preble, Decatur, and Somers is the distance to the horizon. I'll talk more on this later, but networking communications and sensors has pushed the area of awareness and knowledge much farther for both the bad actors as well as for our Maritime Security Enforcers.

This expansion of the horizon is the primary change that necessitates the use of Undersea Technology to help solve the problem. With expanded sensor ranges and communications networking, bad actors have the ability to cease or redirect their illicit activity based on the presence of surveillance or law enforcement units. Undersea Technology brings some unique capabilities

(and unique challenges) to counter those response options of the bad actors.

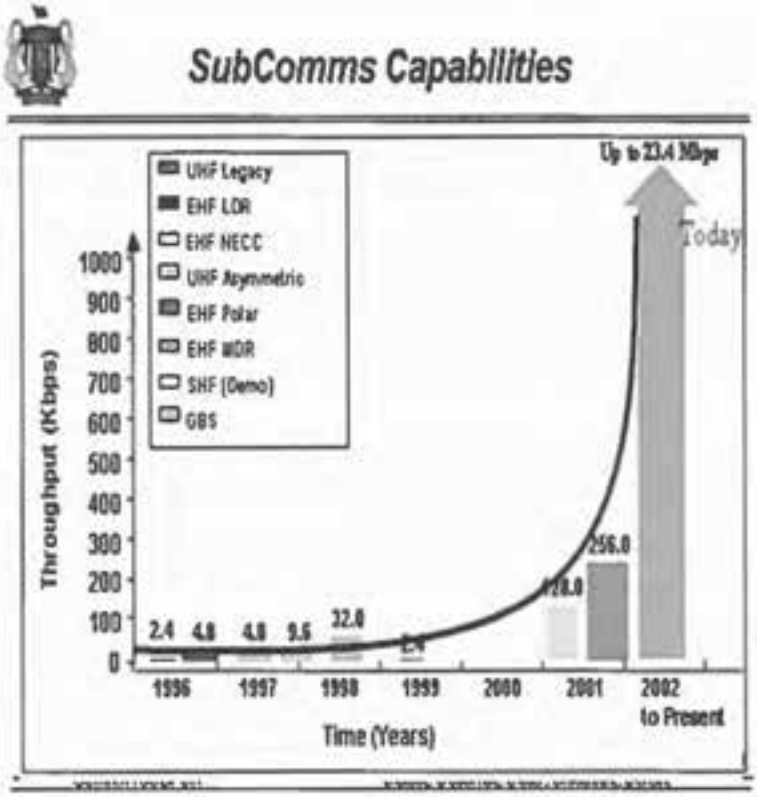
As just one example, this year a US SSN's Intelligence, Surveillance and Reconnaissance activities made her the Scout for SOUTHCOM Counter Narco-Terrorism operations in the Caribbean. Her participation led to the seizure of over 2.8 tons of narcotics. Narco-Terrorists, are affluent criminals with significant monetary resources and a clear incentive to avoid being observed. Defeating them requires Persistence, Mobility and Stealth. Winning against other terrorist networks requires similar capabilities.

Technology has been a great contributor to capability from under the sea.

Sixty years ago the Pacific was a big ocean for a Submarine Force to cover. Shown here are the spheres of influence—sensor and weapon ranges of 5 of our submarines.

Their sensor range was essentially visual and it exceeded the acoustic range of their equipment. Even with functioning radar, targets would frequently be picked up first visually if the weather was good. Weapons were effective to less than 2 miles.

Now, if we plot today's sphere of influence over those same positions from 60 years ago we see quite a different picture. Not only are our sensors much better, but the range of our weapons makes the Pacific Ocean a much smaller place. Acoustic Sensors can reach over 100nm (with processing that allows us to sort the wheat through the chaff), and EM sensors can go even further depending on the signals and conditions. Conventional weapons can reach out to 1,200 nm.



The same improvements have occurred with communications connectivity. The communications throughput of WWII wouldn't even be visible on this chart. Today's submarines are IP connected; their crew can chat, browse, email, view and send pictures.

Some key technologies today that support this partnership in Undersea Warfare by coalition forces are the ones that allow precise common references, identification, collaboration, and visualization.

Challenges

- **Increased Operational Availability**
- **Communications at Speed and Depth**
- **Coalition Communications**
  - UHF SATCOM
  - CENTRIX
- **Better Information Security**
- **Harvest Open Architecture**

COMNAVSUBFOR — Detect, Deceive, Deter, Dissuade, Defeat

My last slide and last point ... Our challenges. I'll let you study this list for a few moments. Addressing these challenges will help us fully network the coalition of Undersea Defense Partners. To meet these demands of Coalition Maritime Security, we need to be able to develop *Capacity* and *Compatability*.

For Capacity, Undersea capability is expensive. We need the submarines that we have to be more available. They need to be cheaper to build and to maintain. That means reducing the lifecycle cost and includes things like protective coatings, corrosion engineering, and durable equipment.

For Compatability, the Coalition needs communications connectivity. We need the capability to share information. That capability should be provided with an open architecture that allows flexible development and affordable modernization.

Summary

- ***Maritime Security = Prosperity***
- ***Coalition = Capacity***
- ***Undersea Technology = Persistence, Mobility, Stealth, Power and Payload necessary for Security***
- ***Challenges***

COMNAVSUBFOR — Cmdr. Quarles, Cmdr. Stewart, Cmdr.

The follow-on mission to the Mars Global Surveyor is the Mars Polar Lander—due to launch within the next year. That's planned to be a much larger vehicle because they will need more *Power*, and more *Payload* in their search for water beneath the surface.

In the 201 years since Lieutenants Richard Somers, Henry Wadsworth, and Joseph Israel brought the fight to the enemy a lot has changed. To accomplish the task they set out to do with Commodore Perry's Frigates and the first USS INTREPID, we will need a coalition. The threat has matured with the same technology that has made the world flat again. Horizons are broadened and awareness abounds. To truly deliver Maritime Security now requires Stealth, Persistence, and Payload in the platforms enforcing it. Those capabilities are here today in the form of Submarines and Undersea Technology.

Thank you for your support to Undersea Capabilities.■

MAHAN LIVES! DEVELOPING A *NEW* MARITIME STRATEGY FOR THE 21ST CENTURY

by Captain James Foggo, USN
Commander, Submarine Squadron Six

Something exciting is happening in the halls of the Naval War College (NWC) in Newport, Rhode Island—a healthy debate on a *new* maritime strategy that is! The father of Naval Strategy, Admiral Alfred Thayer Mahan, lives on! His renewed presence is electrifying the classrooms, the offices, and the hallways of the Naval War College as Navy and Marine Corps officers and their academic counterparts enter into lively discussions on what course our Navy should take in the 21st century.

The Current Challenge

During the annual Current Strategy Forum NWC in June 2006, the Chief of Naval Operations, Admiral Mike Mullen, stimulated a packed auditorium of officers to think about the challenges we face, as a Navy and a nation, from globalization and the Global War on Terror. Globalization drives the need for critical thinking and the development of a *new* maritime strategy.[1]

The CNO's initiative is an important intellectual *and* practical exercise. Facing the kinds of asymmetric threats that we do as a modern Navy, it is absolutely imperative that this discussion be robust, thorough, and honest. In the midst of the Global War on Terror, we are at a critical crossroads in the history of our nation and we must chart a viable course for the Navy over the next few decades.

The CNO's effort to develop a new maritime strategy is based on a sound research design and is intended to be both inclusive and transparent across all warfare specialties. Not only have line officers from all Navy communities been invited to the table to hash out the details of the strategy, but so have warfighters from the United States Marine Corps, the United States Coast Guard and members of the Interagency. Furthermore, the CNO is reaching out to industry and

business leaders, the academe, and most importantly, *John Q. Public*—the American taxpayer—for constructive feedback on the future course that our Navy should take. In a recent Proceedings article entitled, *Laying the Keel for a New Maritime Strategy*, former naval officer and veteran reporter Art Pine quotes an unnamed source critical of this approach as saying "that in seeking outside advice from so many groups, Navy leaders may have 'punted away their responsibility'".[2] I couldn't **disagree** more with this statement!

There is tremendous value to opening up the aperture in the beginning of this process. This is a huge undertaking and will require much coordination, but failing to take account of the experience and insights of both the active *and* retired community of Navy and Marine Corps officers, outside agencies, and even our allies would be a big mistake. All parties to this process would be well served by consulting one of the books on the CNO's recommended reading list, Thinking in Time, by Ernest May and Richard Neustadt. Not unlike George Santayana's famous mantra that "Those who cannot remember the past are condemned to repeat it," Neustadt and May underscore the importance of understanding history and the mistakes that policy makers have made in the past by embarking upon ill conceived plans that ultimately result in costly mistakes for the nation.

In light of this important caveat, if an examination of the historical foundations of our nation's maritime strategy is in order, then this discussion naturally brings us back to the writings of Admiral Alfred Thayer Mahan, the father of maritime strategy. Here's what he had to say about the subject in 1911:

> *I am not particularly interested here to define the relations of commerce to a navy. It seems reasonable to say that, where merchant shipping exists, it tends logically to develop the form of protection which is called naval; but it has become perfectly evident, by concrete examples, that a navy may be necessary where there is no shipping... More and more it becomes clear that the functions of navies are distinctly military and international, whatever their historical origin in particular cases. The navy of the United States, for example, took its rise from purely commercial considerations. External*

interests cannot be confined to those of commerce. They may be political as well as commercial; may be political because commercial, like the claim to "the open door" in China; may be political because military, essential to national defense, like the Panama Canal and Hawaii... or traditions like the Monroe Doctrine.[3]

In summary, at the turn of the 20th century, Mahan professed three interconnected rationale for maintaining a strong navy—*the commercial, the military, and the political*. Now let's fast forward to 2006 and review some of the CNO's remarks at the Current Strategy Forum. Admiral Mullen affirmed that there are three major effects of globalization: The first is *the undeniable expansion of interdependent world markets and economies on a truly global scale which binds nations, corporations and peoples together.*[4] This mirrors Mahan's *commercial* rationale.

The second is competition in the market for increasingly scarce energy resources that will ultimately play a role in the determination of our own, our allies', and our adversaries' national security posture. This is aligned with Mahan's *military* rationale.

Finally, through globalization and the proliferation of technology—presumably high speed means of communication like the Internet, cellular phones, and a wide variety of television programming via satellite dish—the ability to proliferate ideas to the masses can stimulate conflict.[5] Certainly, this latter thought is completely in keeping with Mahan's *political* rationale.

Adapting to the *Current* Threat

One might conclude that Mahan's strategy has therefore withstood the test of time but this is not 1911. We live in a more dynamic environment, a century *after* Mahan, and there are distinct differences between his era and ours. Accordingly, our most recent National Defense Strategy, as its strategic objectives, has to:

1. Secure the United States from direct attack.
2. Secure strategic access and retain global freedom of action
3. Strengthen alliances and partnerships
4. Establish favorable security conditions.[6]

In support of the first strategic objective, the CNO has defined a different kind of threat in the modern era. This new threat emanates from *fourth-generation enemies—terrorists, proliferators of WMD and other weapons, organized criminals, smugglers, drug traffickers and pirates.*[7] We must therefore modify our thinking and our approach in terms of the Mahanian commercial, military, and political order, as we counter these asymmetric threats. This will require innovation and change on the part of the United States Navy.

Change implies that we are operating from some sort of benchmark or baseline of a maritime strategy. Our last really serious effort to produce a maritime strategy occurred while CNO Admiral James Watkins and Secretary of the Navy John Lehman stood the watch in the 1980s, as we strived to build a 600-ship Navy. During this era of bi-polarity, the main aim of the strategy was to deter the Soviet Union with a powerful blue-water Navy that extended our presence in any ocean of the world and maintained *control* of the sea lines of communication (SLOCs). It was incontrovertibly the right strategy for that particular era.

In recognition of the differences between past and present, Admiral Mullen made the following distinction: "Where the old Maritime Strategy focused on sea control, the new one must recognize that the economic tide of all nations rises, not when the seas are controlled by one, but rather when they are made safe and free for all."[8] This is a compelling argument and wholly consistent with the second objective of our National Defense Strategy, but one that does not go without caveat—as the CNO also pointed out—that while "protecting trade routes is an absolute necessary function of a naval force, it is far from sufficient."[9]

In other words, there are many more reasons to maintain a powerful Navy. For example, we must also ensure that as a naval power, we can either anticipate or react quickly to protect our interests in the *next* conflict or crisis. This may be one involving war between two smaller states that could have devastating spill over effects on a much larger region of the globe such as another war between *Hezbollah* and Israel in Lebanon or a catastrophic natural disaster resulting in great loss of life and a refugee crisis of epic proportions like the recent Indonesian *Tsunami*. We may be called upon to protect ourselves or our allies against fourth generation

enemies with access to WMD as well as a variety of delivery systems. Just knowing that trouble is brewing can be enough to preempt it. For this very reason, the U. S. Navy must remain on the tip of the spear conducting Phase Zero operations (a.k.a. battlespace preparation) and developing Maritime Domain Awareness (MDA) worldwide. In the event that we cannot deter aggression, we must be prepared to act—to take the quantum leap to Phase Three (combat) operations—when called to do so in any theater of operations.

Strike and Theater Ballistic Missile Defense (TBMD) are of paramount importance in such scenarios. It is easy for the planners to compile Navy Mission Essential Task Lists (NMETL), but it is harder to prioritize them and resource them. We face tough decisions on where to place the right emphasis in the Navy of the future. Can we afford a force that will be able to conduct both deep water and littoral missions? Should we invest in *hybrid* vessels, capable of multi-mission tasking in both blue *and* brown water? Some programs will ultimately end up on the cutting room floor because of resource limitations. One nation cannot do it all—hence the need for a *trans-national* effort.

The 1,000 Ship Navy—a Global Maritime Partnership

In October 2005, Admiral Mullen articulated the desire to create a "1,000 Ship Navy"—but not one solely from our own industrial base. Rather, this venerable force would emerge from a series of *free form* cooperative agreements with allies and partners, capable and willing to contribute to a global effort.[10] Our participation not only reduces the burden on the United States to be the *World Cop*, but also supports objectives three and four or our National Defense Strategy.

A prime focus of the 1,000 Ship Navy are those rogue state actors and fourth generation threats that facilitate the proliferation of WMD, smuggling of contraband, illegal narcotics, or even trafficking in persons, all of which threaten more than just *our* borders. This is a real problem. The International Monetary Fund estimates that the present level of global money laundering is in the realm of 2 to 5 percent of global GDP. That figure represents a whopping $2 Trillion![11] Legitimate nation states, operating in accordance with the rule of law lose revenue, while the criminal element profits. One

wonders how much of this money is then funneled into support for terrorist activity worldwide? Clearly, something must be done.

The technology that would bind the 1,000 Ship Navy together is already available on the market. It consists of two disruptive technologies—the Automatic Identification System (AIS) and the Internet. AIS is required by the *International Maritime Organization* (IMO) for all vessels over 300 metric tons.[12] It is similar to the Identify Friend or Foe (IFF) system currently used by military vessels and military *and* civilian aircraft worldwide for avoidance of blue-on-blue incidents. Similarly, AIS labels and broadcasts the name of equipped military and civilian vessels and provides a plethora of information including registry, name of the master, cargo and destination. The vision is to one day have all legitimate traffic on the high seas properly *tagged*—in essence, we will know who, what, and where the *good guys* are, thereby making the *bad guys* stand out like a sore thumb. Sharing of AIS information can be accomplished through widely accessible websites on the Internet. The beauty of this combination of two systems is that it is low cost, interoperable, and unclassified.

Proof of Concept—*Active Endeavor* and the Proliferation Security Initiative (PSI)

On a smaller scale, precursors to the 1,000 Ship Navy concept have existed for years. For example, the Commander, U. S. Naval Forces Europe (CNE) and Commander, Sixth Fleet have been integrally involved in NATO's Operation *Active Endeavor* at the gateway to the Mediterranean since 9/11. Since 30% of the world's shipping traffic passes through the Straits of Gibraltar annually, it is absolutely essential that we maintain a vigilant watch to prevent the negative effects of fourth generation enemies. This NATO effort is a viable model for the 1,000 Ship Navy and one that includes the cooperation of our former Cold War adversary—Russia. Imagine the positive spin offs if this kind of effort could be expanded into other potential areas of clandestine illegal activity such as the Black Sea?

The Proliferation Security Initiative (PSI) is another such effort that differs slightly from but has been equally as successful as *Active Endeavor*. Established by President Bush in March 2003, the PSI supports established United Nations Security Council declarations

that the proliferation of all WMD constitutes a threat to international peace and security. Like the 1,000 Ship Navy concept, PSI is intended to be a non-binding cooperative effort to make the borders, sea space and airspace of participating nations more secure, while cracking down on trafficking of materials that support the proliferation of WMD. The spin offs are great: shared intelligence, access to technology in the form of state-of-the-art detection equipment, and training by some of the world's most renowned experts in the field of counter-proliferation.

While serving on the Joint Chiefs of Staff from 2003 – 2005 and representing U.S. interests in Western Europe and the Balkans, I watched with interest during numerous bilateral Joint Staff talks with NATO Allies or potential PfP nations in Balkans as PSI was put on the table for discussion. While some briefers enjoyed limited success in soliciting allied or PfP nation contributions for Operation Enduring Freedom (OEF) and Operation Iraqi Freedom (OIF), the Proliferation Security Initiative, on the other hand, sold itself! When put in terms that clearly portray the contribution to the participating nation's national interest, there was no need for additional salesmanship. PSI presents an important case study for the authors of the 1,000 Ship Navy. If the 1,000 Ship Navy is portrayed in the same light as PSI, in other words: a non-binding agreement, with something in it for me—to include technology, training and enhanced sovereignty and security—then it has the potential to be an incredibly successful program.

Developing Dispersed and More Flexible Forces

As the new maritime strategy begins to take shape, I think it will become apparent that we are no longer a Navy solely dependent upon the Carrier/Expeditionary Strike Group concept of operations. Our inherent ability to aggregate and disaggregate naval forces while deployed is a *force multiplier*. Admiral Mullen recently pointed out that the Non-Combatant Evacuation Operation (NEO) during the Israeli-*Hezbollah* conflict in Lebanon involved about 170 ships from 17 nations. From the perspective of a humanitarian refugee crisis, the operation was smoothly executed without significant incident and once personnel had been evacuated, the international force, including U.S. Navy assets, dispersed.[13]

If this is to be the future face of naval operations, i.e. operating in consort with other naval forces *or* independently on the tip of the spear, then we must empower our unit commanders with the right training, the right rules of engagement, and the confidence to make informed *real-time* decisions as they navigate the battlespace. The tyranny of distance from CONUS or from the big-deck carrier will become easier to deal with as we become more network-centric and as we embrace another new idea—the Global Fleet Station.

The Global Fleet Station is a concept of operations that brings together current doctrine and contributions from the U.S. Coast Guard, other Services, the Interagency, and the 1,000 Ship Navy. The Global Fleet Station would form "a hub where all manner of Joint, Interagency, International Organizations, navies, coast guards and non-governmental organizations could partner together as a force for good."[14] Strategically located throughout the world, Global Fleet Stations would lend themselves perfectly to architecture of regional cooperative security agreements with the *teeth* to make them work. The Global Fleet Station initiative is refreshing in that it can provide more flexible and adaptive forward presence while encouraging the Interagency, other Services, allies and maritime partners to participate in a *Global Neighborhood Watch*. Inter- and intra-governmental buy-in of the Global Fleet Station concept is a *must* for its success.

The Need for Good Intelligence *and* Intelligent Warriors

As we think through all of these options, we cannot forget that one of the most important commodities in the execution of a successful maritime strategy is the ability to garner actionable intelligence and even more importantly, to know what to do with it when we get it. Wherever we are going to operate, we must have a thorough understanding of the region. We must not only know the order of battle of our adversaries [and our allies], and how they train and how they fight, but we must also gain an appreciation for the customs, traditions, language and culture of the region. This may require some retooling of the officer corps. It will no longer be sufficient to be just the consummate warrior and master of our weapons systems, we must become more intelligent warriors—i.e. warriors who are completely attuned to the environment in which we

operate—warriors who are easily integrated into the ships, Global Fleet Stations, the battle staffs of our allies, coalition partners, the Interagency, other Services and vice versa. This transformation of the warfighter must root itself at the earliest stages of our training pipeline.

The Way Ahead—What Comes Next?

When the CNO began this project, the Navy already had a vision statement in the form of SeaPower 21. Formulated in 2002, and refined over the course of four years. SeaPower 21 deals more with capabilities and less with platform specifics. It articulates three pillars of the modern Navy—Sea Basing, Sea Shield, and Sea Strike—all of which provide a firm foundation for the development of a new maritime strategy.

Building on the vision and developing a new maritime strategy requires a robust intellectual effort and it can't be done in short order so there will be no rush to the printing press. The CNO has allocated a year to vet different ideas and approaches. Yale University Professor and prolific author on security studies, Dr. Paul Bracken, made the following observations about the process:

> The distinctive feature of the US Navy's new maritime strategy is that it did not start with the answer. In this, it is quite different from much strategic thinking in the United States in recent years. Instead off jumping to the right answer—*the global war on terror, strategic balancer*, it calls for a productive conversation over the next year to identify the concepts and issues that go in to a maritime strategy. This marks a turning point in the style of American strategic thinking of giving instant answers with little attention to their risks or consequences.[15]

The productive conversation that Dr. Bracken refers to will be accomplished in a number of different ways, primarily employing the Naval War College as the Executive Agent to facilitate debate and discussion and the Deputy Chief of Naval Operations for Information, Plans and Strategy (N3/5) for the final writing and presentation phase. What is really special about the inclusiveness of

this effort is the fact that Navy leadership has agreed to hold a series of *conversations with the country* to be held in major cities across the country in the next few months. The first conversation took place in Newport, Rhode Island in November 2006. The next conversation with the country was in Phoenix, Arizona in January 2007. Nationwide, these conversations give the senior leadership an opportunity to tell the community of businessmen, scholars, government and private sector employees and the American taxpayer what the future holds for the United States Navy. This grass roots effort will not only inform, *but*, build trust and confidence in the process and the final product. Feedback from the audience is important and will be incorporated into the Navy's strategic thinking.

Is There a Place at the Table for the Submarine and Submariners?

I believe that the answer is yes, and this is where you - the readership of THE SUBMARINE REVIEW - come in. In a recent Proceedings article on the subject of the new maritime strategy, Captain Roger Barnett, USN (Ret) and Professor Emeritus of the Naval War College is quoted as saying, "The preparers of the strategy should be practitioners—Navy and Marine Corps officers with salt in their veins and relevant education."[18] The Naval War College solicited nominations for officers to attend the Military Options Workshop in support of the strategy development in December 2006.

This workshop represented a high impact opportunity for Component and Operational Commanders to voice their input to the gaming process and the maritime strategy. Submariners are invited and will be present at the table.

In order to capture important feedback from all warfighters who cannot attend workshops like this one, the following Maritime Strategy website exists for you to provide *direct input* from the Fleet:

http://www.jhuapl.edu/maritimestrategy/index.htm

Additionally, you have the option to express your views, opinions, and professional experience in this forum (THE SUBMARINE REVIEW) and others like it. There is a lot of food for thought here so think *out of the box* and think about what the

submarine brings to the table in the context of a new maritime strategy in these dynamic times.

Submarines are serving today as the maritime *Scout*, operating forward, where the Navy will fight. It is the premier platform for the conduct of Phase Zero operations—this includes Battlespace Preparation, Intelligence, Surveillance, and Reconnaissance (ISR) and Indications and Warning (I&W). A common operating picture through globally networked connectivity allows the submarine the luxury of wide dispersal, yet rapid assembly by virtue of its speed and stealth. Either independently (disaggregated) or as a member of the Strike Group team (aggregated), submarines and submariners are conducting operations in support of the Global War on Terror (GWOT) and Major Combat Operations real time. In fact, during OEF and OIF, almost one-third of the Tomahawk missiles launched came from submarines.

The Submarine Force fully supports the 1,000 Ship Navy concept of building alliances in its liaison with 28 maritime nations capable of fielding a total of 228 *friendly* submarines. COMNAVSUBFOR's Diesel Electric Submarine Initiative (DESI) is one such program that provides an opportunity for Latin American countries to conduct direct support operations with the U.S. Fleet assets. Furthermore, the NATO-led *International Submarine Escape and Rescue Liaison Office* (ISMERLO) provides a non-threatening venue with which to build trust and confidence among 35 of 40 submarine capable nations worldwide. For example, ISMERLO was critical to the recovery of the trapped Russian PRIZ submersible in August 2005.[17] We have a good story to tell. We should tell it.

Conclusion

The development of a new maritime strategy for the 21st century is long overdue. Whereas A. T. Mahan's basic rationale for maintaining a powerful Navy—the military, the commercial and the political—have not changed, the emerging threats we face in the 21st century have increased in complexity. As threats evolve, so does the Navy and Marine Corps, but we are currently spread thin and must re-evaluate what we can do with what we have. It is necessary to turn to friends and allies for help in maintaining the rule of law and freedom of the seas. The continued success of global commerce

depends on this. The 1,000 Ship Navy concept is advantageous because it leverages off the resources of all participating nations for the greater good. As these new concepts develop over the course of the year, several common threads of consistency emerge—the importance of intelligence and a common operating picture; the need to maintain presence, but with smaller numbers of assets dispersed over longer distances; the ability to operate in deep or shallow water; and finally, when the call for fire comes, the answer must be potent and immediate. There are many platforms that fulfill these requirements and the submarine is certainly one of them. The development of the maritime strategy will continue for the next six months. The outcome will not only affect all of our futures but the future of our Navy. Considering this, as naval officers, we should ensure that there is as lively a discussion and exchange of innovative ideas at the wardroom table as there is at the Naval War College. In the final analysis, I think A. T. Mahan would be pleased.■

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ARTICLES

"THE PRINCIPLES OF WHAT WAR?"

by RADM William J. Holland, Jr., USN(Ret)

Rear Admiral Holland is a submarine officer who commanded PINTADO (SSN672), Submarine Squadron One and the Submarine School. He has been a frequent contributor to THE SUBMARINE REVIEW.

Last year, the Navy sponsored a contest soliciting short essays on the principles of war. This effort was to elicit views of a wide audience and foster innovative thinking and exposition in the new era of insurgent and terrorist adversaries. The winning essays of this Principles of War contest that appeared in the October 2005 Naval Institute *Proceedings*, elegant in expression and interesting in exposition, could as well have been written at the time Clausewitz wrote *On War* (1832). Nowhere in the three prize-winning essays is there any mention of nuclear weapons, any clue as to the influence of technology, any mention of the role of public communications and only one allusion to the training of the soldiery.

These writers seem to assume that the principles of war are insulated from the world where war is waged. But in relation to the shortcomings mentioned above, when Clausewitz formulated his principles, the technologies involved had not changed for two hundred years and would continue with little change for another forty or so until the rifle and machine gun were fielded ashore and steam propulsion and armor went to sea. Further, the monarchial governments of the eighteenth and early nineteenth century did not depend on support of anyone except a small elite. And perhaps most significantly, in Clausewitz's time, blind obedience was the most desired attribute of the soldier.

While thinking about nuclear weapons seemed to have slipped into oblivion with the end of the Cold War, now as North Korea tests and Iran continues to seek a nuclear capability, interest and concern are being rekindled. However, if the results of this contest are

examples, those thinking about military affairs are placidly unconcerned with their importance and impact. To assume future conflicts will be confined to conventional weapons by wishing it so is pollyannaish. The first necessity in the approach to, planning for or executing any future war will be to address the potential role of nuclear weapons. Because of their individual explosive potential, nuclear forces need not be equitable to have great influence. Similarly, targets for nuclear weapons are not evenly distributed among nations: a desert sheikdom has vastly fewer aim points than New England. The vigorous intellectual thought that was a mainstay of the Cold War considerations seems to have vanished from our strategic landscape—but the weapons have not.

While Clausewitz's fog and friction will remain even in an idealized network centric battlefield, technology does determine tactics. Modern war cannot be planned or fought ignoring the effects of continually improving technologies on space, time, weaponry, communications and logistics. Technology's importance and influence grows as the world becomes more politically complicated and military capabilities expand in nature and scope. Failure to recognize and exploit technology leads to fighting today's war with yesterday's weapons. Nowhere is this ignorance more evident than calls from persons who consider themselves knowledgeable for the United States to construct conventionally powered submarines.

Unfortunately, the experience of the present Iraq War demonstrates that Clausewitz's first principle of war, "The strategic objective must be clear" is honored more in speeches than in strategic analyses. Today, clarity of objectives articulated persuasively not only provides the necessary information to direct operations, but more importantly serves to convince the people who will have to fight and support the war effort of the necessity for and value of the sacrifices involved. In this age of mass communications and instant analysis, the importance of communicating the war's aims and progress clearly to the general public on both sides cannot be overstated. Since "...war is nothing but a continuation of policy by other means"[1], the policies need to be carefully formulated, well stated and widely understood.

Finally, while the best soldiers of Clausewitz's time were, as they had been for two hundred years, unthinking automatons, modern

battlefields require a high degree of individual initiative and skills. No longer is it enough to be brave and do what one is told. War is too complex, too technical and too diverse in occupations and geography to win through simple bravery. Those with experience in highly technical equipment and operations easily echo Admiral Rickover who was known to say, "You can't whip the reactor into performing".

The individual and collective skills of the forces, their use in single actions and their ability to operate in conjunction with each other, count for more today than ever. Because the battlefield is much less dense, individual soldiers must contribute to the collective effort through force of their own will and not because of fear of punishment or shame. The complexity and dispersion of the battlefield today ashore and afloat are beyond what Clausewitz and his heirs up through World War II could grasp. Individual skill and knowledge are defining assets on the battlefield and the key to gaining and maintaining momentum. If there is a first principle among the principles that govern war, it is *train*.

None of this suggests that Clausewitz's dictums have no place in modern thinking or that the discussions in the prize-winning essays are of no value. However, for all their elegant sociological discourse, if these essays represent the thrust of the current thinking about the principles of war, then the policy and analytical community seem to be steering by the wake. The challenge to those with technical expertise and operational experience is to influence the *crystal ball gazers* at every opportunity and let no proposition that fails to acknowledge the realities of the modern world or the laws of physics go unchallenged.■

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The Naval Historical Foundation
and
The Naval Submarine League
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"In the Cold War, the submarine became the direct agent of strategy as the guarantor of the strange two-sided peace which ended in the 1990's ...," Thomas Parrish, 2004
That strategy was based on surveillance and reconnaissance by the submarines of the United States and its allies.

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"Knowing the [characteristics and] disposition of the enemy's nuclear armed submarines was a primary intelligence imperative for both sides."

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U.S. NAVY AND 20th CENTURY OCEANOGRAPHY: SUMMARY 1900-1960

by Mr. John Merrill

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"This new big science is called oceanography. It is the whole business of getting into the sea, finding out what is there, what is underneath, studying its chemistry, its physics..."[1]

PART I
Environment

Oceans with an average depth of 13,000 feet comprise about seventy-one percent of the total area of the earth and this provides an enormous challenge for ships on the surface and submarines below. Naval operational success at sea is dependent on knowledge concerning the sea's natural and man-made ambient noise, current, tides, turbulence, depths, temperature, salinity, underwater ridges, winds, ice, and internal waves. Today, precise details and understanding of the sea is required for successful strategic and tactical operations with modern naval technology. At the start of the 20th century knowledge of the sea was at best fragmentary.

Although oceanography began when some first fact about the sea was observed and recorded, "...it was not until about the middle of the nineteenth century that systematic examination even of the surface of the sea was seriously undertaken, or that scientists awoke to the fact that the underlying waters offered a whole new world of exploration."[2] Twentieth century technology advancements aided the broadening of marine research about the physical, chemical, and geological aspects of the seas. This new knowledge addressed Navy needs.

Throughout the entire 20th century that included two world wars, almost continuous improvements and advances in military technology; ships, aircraft, submarines, and weapons brought new challenges. The Navy required a more complete knowledge of the oceans to address at-sea operational requirements.

An effective relationship gradually developed between the Navy and the growing marine science community, each with divergent needs, one with science as the goal and the other with at-sea operational requirements. The Navy needed knowledge of the sea.

Preface

In April 1900, John Holland delivered HOLLAND VI, his modest but practical submarine, to the United States Navy. By the start of World War I (WWI), there were about 400 submarines worldwide. During the entire 20th century, along with the universal acceptance of the submarine there was an increasing demand for detailed knowledge of the nature of the submarine's operational environment, the sea. Detecting and evading submarines became an imperative of the 20th century.

In 1973, an oceanographer assessing support for marine science in the United States for the period 1850-1940 concluded, "For marine science, a half-century of active if not sympathetic government support was over. In the next 40 years, those before the beginning of World War II (WWII), oceanography in the United States was largely supported by private institutions."[3]

WWII and the remainder of the 20th century witnessed a significant increase in Navy joint ventures with private sector marine science laboratories. An article in the November 1980 issue of Fortune noted that oceanography, an expensive science, was receiving a good portion of naval funds available for research on that science.[4]

Roots for government support of gathering and disseminating ocean information became more highly focused in 1866, when an Act of Congress established the Hydrographic Office. The Act expanded hydrographic work and included "the carrying out of surveys, the collection of information and the printing of every kind of nautical chart or publication." The Hydrographic Office provided oceanic support for the Navy by focusing on physical conditions,

boundaries and currents; oceanography in addition includes study of marine life, physical chemistry of the ocean, and the geology of the ocean bottom. In 1962, the Hydrographic Office was designated the U.S. Naval Oceanographic Office.

The U.S. Coast and Geodetic Survey (C&GS) authorized in 1878 under the Treasury Department provided scientific support for marine research. In 1882, C&GS sponsored USS ALBATROSS, built exclusively for fisheries and marine research. At Woods Hole, Massachusetts, in 1885 the Survey constructed the first marine fishery research laboratory. These government agencies brought focus to marine research.

In January 1902, industrialist Andrew Carnegie, in the interest of science founded the Carnegie Institution of Washington. The endowment of $10 million dollars eclipsed the endowments at five Ivy League universities and was ten times greater than James Smithson's bequest to the United States ultimately leading to the Smithsonian Institute.[4] The Carnegie Institution authorized the construction of the wooden brigantine research ship CARNEGIE for making magnetic field measurements at sea. The vessel was commissioned in 1909 and widely used for research until 1929, when it was destroyed by fire. Throughout the 20th century and continuing into the new century, the Institution has steadily and broadly supported science research, including marine science.

Two small privately supported Marine Biological Laboratories were conducting marine research, one at Woods Hole, Massachusetts (1888) and one in La Jolla, California (1903). As late as the 1930s, " ... both were small, isolated institutions, each with staffs of about a dozen people, one ship, and limited research facilities."[5]

The California laboratory became part of the University of California in 1912 and the name was changed to Scripps Institution of Oceanography (SIO) in 1925 to reflect a broadened research focus. The Navy Hydrographic office supported research projects at SIO as early as 1920. In 1931, SIO had one main laboratory building, one small research vessel, a staff of twenty-six, and an unsteady annual budget of $75,000.

In 1930, the Woods Hole laboratory filed articles of incorporation for the Woods Hole Oceanographic Institution (WHOI). Half of the support for Scripps came from the University of California while the

Rockefeller Foundation was the principal patron for WHOI. Both institutes needed multiple sources of support.

Willard Bascom, noted scientist and oceanographer, observed "Until World War II, American oceanography consisted mainly of a few marine biologists based at the Scripps Institution of Oceanography in La Jolla, California and the Woods Hole Oceanographic Institution in Massachusetts.[7]

Prior to substantial direct support for oceanography by the Navy during WWII, Hydrographer Admiral Walter R. Gherardi provided WHOI and SIO with seawater temperature, salinity, and dynamic-sounding data gathered by the Hydrographic Office crews. In the 1930s, SIO scientists conducted research on board Hydrographic vessels.[8]

WWII operational requirements for surface ships, submarines, and naval aircraft (weather needs) created extensive and time-urgent needs by the Navy for oceanographic assistance. This wartime oceanographic support by the marine scientists heavily contributed to naval victory during the four-year war.

By mid-century, both WHOI and SOI became significant laboratories and known nationally and internationally. Before 1930 the number of United States oceanographers was about six.[9] Prior to WWII, the Hydrographic Office was the primary government agency interacting with private marine research. The onset of the war marked the beginning of a substantial involvement with the Navy and the marine laboratories which continued for the remainder of the century.

Marvin Lasky, in a review of scientific effort for ASW, 1939-1945, points out "Prior to 1939 technical people in the field of underwater sound probably numbered fewer than 150; by 1945 more than 3,000 were involved."[10]

Peace in 1945 did not end the Navy's need for further information about the seas. Shortly after several years of an uneasy peace, international politics and technological innovations applicable to ships, submarines, aircraft, and weapons collectively brought additional high priority Navy requirements for knowledge about the sea. Answers were found in the expanding multidisciplinary field of oceanography. At this time, the number of people trained to be oceanographers was limited. Oceanography was growing and the

Navy supported its development.

In the last half of the 20th Century, the Korean, Vietnam, and escalating Cold War deepened the important relationship between the Navy and the oceanographic community. During this time, oceanography grew in importance to the Navy. Last century project names such as AMOS, CAESAR, CROSSROADS, HEARLD, LOFAR, JEZEBEL, SOFAR and SOSUS are some examples of Navy-Oceanographic joint efforts. In addition to in-house Navy laboratories, private oceanographic laboratories and university support, the role of industrial activities in the implementation of these projects was significant.

Oceanographic Needs

World War I (WWI) and the introduction of successful submarine operations especially by the German U-boats against navies and merchant shipping initiated a strong interest in the characteristics of the sea below in pursuit of sound detection as a potential weapon against the submarine. The surface ships pursuing the submarine and the submarine in search of targets needed the then-unknown characteristics of the seas and the paths of sound in the sea.

Mutual trust and understanding between the marine scientists and the Navy grew throughout the century but not rapidly. A time line of the relationship shows a gradual increase in joint efforts during the 1920s and 30s, a huge common effort during WWII with an adjustment period during the immediate postwar years. By mid-20th century, the body of knowledge about the ocean's characteristics was no longer fragmentary and a scientific discipline known as oceanography was developing. Then in 1954 the nuclear submarine, new high technology weapons, and international tensions, Cold War, and Vietnam War brought increased Navy need for oceanography.

World War I (1914-18)

The enormous success of the German U-boat throughout the war established the submarine as a successful weapon in several regards. The submarines were small in size and crew requirements and effective. In February 1917, with 150 U-boats and unrestricted warfare, the Germans were sinking one of every four merchant ships leaving England. As the war ended, there was no assured counter-

measure for submarines. In 1917, the depth charge, the convoy system, the mine and seamanship were the basis for antisubmarine warfare (ASW).[11]

In 1915, George Ellery Hale a member of the National Academy of Sciences (NAS), recognized the significant success of the German U-boats. To accelerate antisubmarine warfare effort in the United States, then a noncombatant, with President Wilson's approval, Hale set up a partnership between science and industry in the military that accelerated the antisubmarine warfare effort.

To facilitate this, NAS in June 1916 established the National Research Council (NRC). For the first time, the Council brought scientists and engineers from industry and academia to address a broad array of challenges related to upgrading military preparedness prior to and following the April 1917 entry of the United States in the war. On May 11, 1918, President Wilson signed an executive order providing for the Council's perpetuation in peacetime.[12]

The NRC, from its inception, continuously backed Navy underwater interests in a variety of ways. Through the years, this assistance came primarily in the form of a respected and listened-to scientific voice in the Washington arena where Congressional fiscal support for science-related work was frequently critical. During the mid-1920s, NRC's science support was helpful. The NRC organized according to fields of science, not around the administrative and scientific problems of government.[13] Navy oceanographic needs found positive support from the Council for the rest of the 20th century. The NRC has been referred to as the operating arm of the NAS.[14]

Wartime antisubmarine research and experience pointed to further investigation of underwater sound as a tool for detection of enemy submarines. The need for more accurate data about the sea was required.

Interwar Years

In the 1920s, government agency support for marine science usually had an applied practical aspect: safety at sea, making maps, and the needs of the fishing industry. Privately supported marine scientists' orientation was in basic research. Modest post- WWI interest stemmed in part from the successful U-boat performance

mentioned above and the realization that detailed knowledge about the sea environment was lacking. Primary Navy interest was in underwater detection of enemy submarines. In addition to federal involvement, support for marine research came from business, private sources, and academic interest. The 1920s were also marked by a significant reduction in federal funding following the end of the war. Historically, it is almost a tradition to reduce military funding following the end of a war.

During the 1920s and 1930s, work related to the Navy's continuing interest in the underwater detection of enemy submarines was at the newly constructed (1923) Naval Research Laboratory (NRL) in Anacostia, Maryland and the Submarine Signal Company of Boston. The work started during WWI on radio signaling and submarine detection provided a basis for NRL's primary mission to perform applied research and support naval operations. The scientists and technicians who worked there were primarily civilians.[15]

Between the World Wars, three important nautical instruments were introduced. Each device provided new information about the seas. Sound detection and echo ranging equipment required extensive knowledge regarding the propagation of sound in the sea. The Navy began cooperative work with oceanographic institutions.

Major New Devices

Detection equipment performance gradually revealed the impact of the various properties of the sea, sea life and topography on system performance. For the Navy, particular oceanographic knowledge was a prerequisite for best operational use of the evolving equipment.

The U.S. Navy's WWII operational requirements around the world for surface ships, submarines, and naval aircraft (weather) created extensive and time critical need for expanded oceanographic assistance. This wartime oceanographic support provided by the scientists contributed significantly to naval victory during the four-year war.

During WWII, system development and implementation were heavily influenced by important participation by physicists and oceanographic (marine science) personnel. Marine scientists participation included going to sea on Navy as well as laboratory

ships in addition to laboratory effort. In the post-war era, both professions were heavily pursued and the number of universities offering marine science and related fields of study increased.

New Instrumentation

Successful U-boat operation during WWI against the merchant and naval shipping encouraged continued investigation of submarine detection using sound. Results of testing the newly developed equipment pointed towards oceanographic investigation to find answers to problems having to do with attenuation of sound in seawater and other related topics. The surface ships pursuing the enemy submarine and the submarine in search of targets required more information about the then-unknown characteristics of the seas and the paths of sound in the ocean.

Sonic Depth Finder (Fathometer)

The Fathometer and the BT contributed to the collection of data about the sea. The efficiency of data collection and the amount of data collected was improved by orders of magnitude. Measuring the depth of the ocean was always demanding and labor intensive and the measurement of great depths not always feasible.
The 1920 device for depth measurement had its beginnings in a 1913 acoustic oscillator patent application by Reginald A. Fessenden.

In 1914, Fessenden installed his oscillator on the United States Revenue cutter MIAMI while on the first International Iceberg Patrol operating on the Grand Banks off Newfoundland, Canada. The oscillator was suspended underwater from the side of MIAMI and for three hours successfully received underwater echoes from an iceberg 430 feet long and 130 feet high.

Harvey C. Hayes

Hayes, a physics professor from Swarthmore College, developed underwater submarine detection equipment during WWI at the NRC's Fort Trumbull laboratory at New London, Connecticut (1917-18). When WWI ended, he continued his investigations, initially at the Annapolis, Maryland Naval Engineering Experiment Station and then, in 1923, at the new Navy Research Laboratory (NRL) in Anacostia, Maryland.

In 1922, at Annapolis, Hayes developed a sonic depth finder (SDF) based on his work in 1918 at New London, CT. The sound source for the echo ranging was a Fessenden 540 Hz oscillator developed and demonstrated earlier in 1914. An MV hydrophone, invented by Max Mason at New London during WWI, was used for reception. The MV is a non-electric binaural listening system. The Hayes depth finder also included a timing device to determine the time interval; from that the distance from the source to the target could be determined.[17]

Depth finder performance was further enhanced by the tables Hayes developed to assist the depth finder operator to quickly determine the depth from the observed data. "A single deep-ocean sounding with line and sinker had taken a better part of a day: with the Hayes Sonic Depth Finder sounding could be executed in a minute."[18] The finder evolved into the Fathometer patented and manufactured by the Submarine Signal Company of Boston. Within a few years, Fathometers were widely used by merchant shipping and navies. By 1929, the U.S. Hydrographic Office received daily reports of deep-sea soundings.

During the period June 22-29, 1922, on board the destroyer U.S.S. STEWART (DD224), equipped with a Navy SDF, Hayes made the first continuous profile of 900 deep-sea soundings to depths greater than 3000 feet,[19] across the entire ocean basin from Newport, Rhode Island, to the Azores, and then to Gibraltar. Hayes left the destroyer at Gibraltar. Next, without interfering with its routine, the destroyer continued on to China Station, taking a total of 6500 nautical miles of continuous soundings.[20]

The ease of the sonic soundings by the STEWART, contrasting with an earlier effort by the HMS CHALLENGER using line and sinker demonstrates the huge advantage of the Hayes equipment. The marine exploration vessel HMS CHALLENGER, in a cruise of about four years (1872-76) made 300 soundings every 100 miles using line and sinker. The STEWART's rapid profiling introduced a new dimension in gathering data about the ocean depths. At the 1904 VIII International Geophysical Congress in Washington, DC a sound chart plotted 18,400 points; by 1932 the number was 370,000.[21]

The Fathometer, in addition to much improved efficiency in measuring depth, provided a way to reveal the undersea contours and

greatly helped the underwater cable laying industry, reducing cable slack required by half. Before WWII, private marine scientists using fathometers to investigate submarine topography and marine geological processes found financial support from petroleum companies.[22]

Hayes Memorandum

Hayes, aware of the decreased fiscal support for the Navy following the end of WWI, felt strongly that congressional support for NRL was critical for continuing his wartime research in the use of underwater sound to detect enemy submarines. He addressed these issues in a February 19, 1923 memorandum citing the value of oceanographic research to advance maritime safety and naval operations. He cited the political, economic and scientific value of oceanography.[23] Along with scientists from other government agencies, Hayes made an effort to establish an oceanographic office within the Navy but failed for lack of financial support.[24]

With his status as a scientist, his recent development of the SDF followed by his at-sea depth measurements made his memorandum credible. Hayes clearly pointed out the value to the Navy of more science orientation and a convivial approach to the marine science community members to work jointly towards common goals. While the memorandum did not result in the creation of an oceanographic office, it did have beneficial effects. Congressional and public awareness to the Navy and marine science was raised. In August 1923, U.S. Navy participation in a Pan-Pacific Science Congress in Australia included sending the new light cruiser MILWAUKEE (CL5), using the SDF en route, to make a series of ocean bottom profiles and to present the findings at the Congress.[25]

The following year, under the aegis of the NRC and others, a federal Interagency Conference on Oceanography was held to determine the nature of naval commitment to oceanographic research for the next two decades. The planning included a positive attitude toward cooperative oceanographic work with the Navy by the private oceanographic sector.

An increase in joint civilian and Navy oceanic research followed this heightened awareness about marine science, but it did not grow

rapidly until WWII and beyond. Basic sea research with modest fiscal support during the interwar years provided useful information about the performance of underwater detection equipment. In some of the areas researched, including salinity, hydrostatic pressure, turbulence, air bubbles, and temperature gradients, knowledge grew.[26] The global scale of the coming war quickly indicated the importance of oceanography and the operational needs of the military that included more than the underwater detection requirements.

Navy-Princeton Gravity Expedition 1932

At that time, there was interest in making gravity measurements at sea to increase knowledge about the earth's underlying structure. A submarine was suitable for the instrumentation available to make measurements. Measurements from surface craft were hampered by surface wave action. The Navy provided the submarine S48 for six weeks of measurements from February 7 to March 17, 1932. With civilian scientists aboard, gravity measurements were made in the region of the West Indies. Submarine gravity measurements at depths in excess of 100 feet used a gimbaled multiple pendulum device gravimeter. Submarine gravimeters were in use from 1923-1950. Hyman Rickover on a three-year tour was the executive officer and navigator.[27] By mid century, surface ship equipment for gravity subsurface measurements was available.

Later in the century with underwater missile launches aimed at targets thousands of miles away, gravity variations assumed significant importance. "Knowing gravity variations helps a submarine stay on course when it is underwater and sailing blind, and when the time comes to launch a missile...that knowledge is essential."[28]

1936-37 Crucial Oceanographic Events

Bathythermograph

Understanding how the ocean moves and mixes heat requires accurate and continuous measurements of temperature as it changes with depth. With this in mind, in the summer of 1934, Carl Rosby a summer resident of Woods Hole and Massachusetts Institute of Technology (MIT) meteorologist, constructed and took to sea aboard

the *Atlantis* (the Woods Hole oceanographic research vessel) a boxlike structure, an oceanograph, designed to record continuous tracings of temperature versus depth in the surface layers of the ocean. The objective was to be an improvement over the current methods for measurement.[29]

The device consisted of a compressible bellows with a pen arm and a stylus at one end. The stylus moved horizontally to temperature changes and rested on a smoked-glass slide recording the changes. Vertical stylus movement recorded depth.[30] Rosby gave the device to Athelstan Spilhaus at MIT to redesign. By 1937, a Spilhaus-patented prototype called a bathythermograph (BT) was available to go aboard the ATLANTIS.

The BT soon evolved into an important device for surface ships seeking enemy submarines and equally desirable for submarines in avoiding detection. Thousands were manufactured during WWII. They were classified secret for some period after the end of the war.

USS SEMMES (AG 24)

In late 1936, SEMMES (a 1919 destroyer) was converted to a research and experimental sound vessel attached to the Navy Research Laboratory. It was equipped with highly classified underwater sound echo-ranging gear (sonar) and working with a submarine out of Guantanamo Bay Naval Base in Cuba. An abnormal operating condition with the equipment was encountered. The equipment worked well every morning. Later in the day, with the *Semmes* steaming right over the target submarine no detection was made. When the Semmes returned to New London, Connecticut (the ship's homeport), Lieutenant William Pryor of the *Semmes* took the problem to the director of WHOI. The Institute was interested and arranged to conduct almost two weeks of joint testing with the *Semmes*, the *Atlantis*, and a submarine early in 1937 near Guantanamo, Cuba. Additional tests were made following August off Long Island. Institute underwater sound and submarine detection experiments continued into 1940.

Columbus Iselin, the assistant director at WHOI, participated in the test and his conclusions were seminal. He put forward that the sonar problem stemmed from the way sound traveled through water and the layers of cooler and warmer water near the surface caused

bending and distortion of the sound beam. The phenomenon was called "afternoon effect." The about-to-be patented and improving BT with the capability to provide a record of the depth and temperature certainly loomed on the horizon as an important tool to assist the submarine hunter (the surface ship) and the target submarine to successfully hide from the searching hunter. Research pointed to temperature and pressure as two main variables influencing underwater sound transmission.[31]

A noteworthy aspect of this 1937 successful cooperative venture by the Navy and Woods Hole laboratory was that it marked the beginning of a continuing relationship between the Navy and the marine science community as it grew in the years leading up to WWII. The Navy considered water temperature of the upper layers critical information. By 1940, expedited and expanded effort vastly improved the BT for use from moving surface ships and later for use on submarines.[32]

Maurice Ewing

On October 17, 1937, geophysics professor Ewing from Lehigh University joined Columbus Iselin aboard the ATLANTIS for a test cruise. His interest was to conduct seismic refraction experiments to determine the thickness and makeup of sediments at the ocean bottom at depths of three miles in the North Atlantic. He used underwater explosives (10 pound TNT blocks) as sound sources and noted that a chain of echoes was generated by repeated reflections between the ocean bottom and the sea surface especially at the lower frequencies and traveled long distance underwater with limited loss. Further, if hydrophones were carefully located in this deep sound channel the signals could be detected. Important implementation of this channel identification followed but not immediately.■

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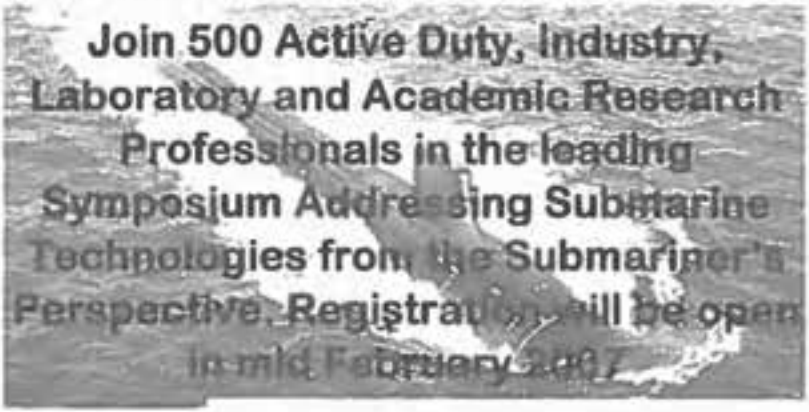

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WHAT'S IN *YOUR* SIGNAL EJECTOR? THE SHAPE OF 3-INCH THINGS TO COME

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

Captain Jim Patton is a retired submarine officer who is an active consultant in submarine matters to government and industry. He commanded USS PARGO (SSN 650).

In the very successful DARPA *Submarine Payloads and Sensors* program that ran from 1999-2001, one of the subjects investigated for inclusion into future submarine concepts was *improved access to the ocean environment* from within the watertight envelope – a capability vastly improved in JIMMY CARTER (SSN23) and the SSGNs. However, the Submarine Force doesn't consist entirely of JIMMY CARTER and SSGNs, and even if subsequent flights of VIRGINIA's are given significantly better access to the ocean environment, the Force will consist mainly of 688s well into this new century, and it is unlikely that any new holes will be made in their hulls. What needs to be achieved in the near term then is to acquire more operational capability through existing openings.

There has already been a great deal of effort towards employing torpedo tubes for more than just torpedoes—witness the Long term Mine Reconnaissance System (LMRS) and the Mission Reconfigurable Unmanned Underwater Vehicle (MRUUV)—both involve vehicles although (being unmanned) might be *losable*, but because of their monetary value are certainly not *expendable*. A more recent development has been to greatly increase the options available to operators for true expendables launched from the venerable and ubiquitous 3-inch signal ejector. Both the range and affordability of these options has been enabled by the same Moore's Law that is responsible for increasingly more powerful and cheaper home computers, and by dramatic reductions in the cost and producibility of reliable fiber optics.

The type of capabilities that are currently *on the table* for development and deployment (nominally from operational stances in the order of 400-600 feet and 10-12 knots for 10-20 minutes) include:

- Two-way IRIDIUM comms
- Two-way VHF comms
- Two-way high data rate UHF connectivity
- 360° roll-stabilized panoramic optical views
- Automatic Identification System (AIS) receiver
- Basic ESM receiver
- Global Positioning System (GPS) receiver
- Environmental data collection sensors
- Variants where two or more of the above are combined

In fact, there are so many present options (not to mention yet to be imagined applications and the probability of various *special purpose* variants some entities might want to employ in limited numbers) that the concept of a *mission reconfigurable* device has received favorable attention. In this concept, both to mitigate on-board storage and supply system problems and to motivate further innovation in *payloads*, a common afterbody is being developed with an *open architecture* analogue of non-proprietary interface upon which, at sea, the various payloads could be mated as the mission and the tactical situation warrant. For example, even though some conceivable payloads might not require some features of the common afterbody (i.e. a *one-way* comms buoy not requiring the fiber optic link), the total program cost would be well served by the economics of quantity and simplicity of logistic support provided by a common afterbody. Besides, as an operator having sometimes launched *two* legacy SLOT buoys at a time decades ago each with the same brief tape-recorded VHF message just to raise the probability that the word would get through from at least one of them, there is something to be said for having a fiber optic link to a buoy intended for only one-way or totally autonomous use just to know that the *phone has been picked up on the other end* or that the buoy actually reached the surface and began its intended task—at which time the link can be severed and the ship can be back on its way.

Some interesting issues have arisen as this concept has been more fully developed. One, for example, involves the speeds and depths from which *the Navy* directs that the devices must be capable of being launched from—all of which can be met, but at some not insignificant cost in not only monetary form, but also in weight. This

additional weight degrades the positive buoyancy of the device which directly affects rise rate and also, for optical or RF applications, the *freeboard* at the surface which impacts the efficiency of any antennas or the visible distance to the horizon. While it is often tactically important to operate as fast and as deep as feasible while employing these expendable devices, it would not be an onerous requirement—where there are significant capability/cost advantages available to be gained—to make transient excursions to a slower/shallower stance for the brief period required for the actual launch, after which a faster/deeper condition could be reestablished.

Another issue, given the small and fixed volume available in a 3-inch device, is it containing enough stored energy to support, for instance, two-way RF comms to a geosynchronous satellite some 25,000 miles distant. Many of the attractive battery chemistries (such as the Li-ion cells that power most newer laptops) are barred or heavily restricted for submarine use. While caution is appropriate when considering using potentially hazardous material such as mercury et. al. in the closed environment of a nuclear submarine, enough periodic review of hazards versus risk management must be conducted, as was done for the Otto fuel monopropellant in Mk 48 torpedoes, to guard against missing the opportunity to obtain greater operational capabilities while accepting whatever additional safeguards are required for safety. Perhaps this is done—one would hope so. After all, the new 8 ton Li-ion battery fabricated for the ASDS has *more* stored energy capacity than the 126+ ton main storage batteries currently installed on U.S. submarines, and some European companies are reportedly on the verge of building and installing Li-ion main storage batteries in their diesel-electric submarines.

There are many options coming as *ammunition* for the 3-inch signal ejector, and still more that haven't yet been conceived. The lessons learned and payloads developed for employment of such expendables will not only immediately serve the Submarine Force well, but will also favorably affect tactics, techniques and procedures when future submarine designs do allow for greater access to the ocean environment with larger expendables and even recoverable devices.■

SUBMARINE NEWS FROM AROUND THE WORLD

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From the October 2006 Issue

UNITED STATES—2007 Defense Budget Approved, USN Gets 7 Hulls

In September 2006, Congress approved US$532.8B for the Fiscal Year (FY) 2007 defense spending bill, including US$70B to fund the wars in Iraq and Afghanistan. The US Navy (USN) is slated to receive nearly US$11B for Shipbuilding and Conversion, Navy (SCN). Of this amount, approximately US$6.4B will be for the construction of new ships. A total of seven ships are now authorized beginning in FY 2007 including:

- One Virginia class submarine at US$1.8B.
- One Lewis & Clark dry cargo ship (T-AKE) at US$455M.
- Two Littoral Combat Ships (LCS) at US$521M.
- Two DDG 1000 class destroyers at US$2.6B. The DDG 1000 class destroyers are being funded over a 2-year period in 2007 and 2008 in order to begin both hulls at Northrop Grumman Ship Systems (NGSS) and Bath Iron Works (BIW) under the USN's dual-ship strategy.
- One LHA–6 (LHA-R) class amphibious assault ship at US$1.1B. The LHA–6 was moved forward from 2010 to 2007 and a San Antonio class LPD was pushed back to 2008 from 2007.

Current planning under POM-08 also calls for a total of seven ships in 2008 that will include one CVN-21 aircraft carrier, one Virginia class submarine, three LCS, one Lewis & Clark T-AKE and one San Antonio class LPD. Beginning in 2009, the shipbuilding plan becomes much more aggressive with a total of eleven units to be built, increasing to 12 units in 2010 and thirteen units in 2011 before leveling off at 12 units in 2012 and beyond. This aggressive plan is expected to help grow the fleet from the current 281 vessels today to back over 300 by 2035.

In order to attain these numbers through POM-08 and beyond, the USN will need to increase SCN funding from today's level of around US$11B to an average of US$13.4B. The question remains, will the USN be able to receive the increased funding required to meet the POM-08 shipbuilding plan?

SOUTH KOREA—Six More Type 214 Submarines

In late October 2006, AMI received information that South Korea decided to move forward with the acquisition of six additional Type 214 submarines under the KSS-II submarine program. Negotiations between South Korea and HDW will commence by the end of 2006. Unlike the first three units that are being built at Hyundai Heavy Industries (HHI), the six additional units will be split between Daewoo Shipbuilding & Marine Engineering (DSME) and HHI. The entire class is expected to be commissioned by 2017.

This information substantiates earlier reports received by AMI that the Type 214 program would be extended to nine units and the later units of the class would be built in conjunction with a newly designed 3,500-ton South Korean submarine under the SSX program.

It must be noted that DSME built eight of the nine units of the Chang Bogo class submarines (Type 209/1200) from 1992 through 2001 and HHI was selected to build the initial units of the Type 214. With the continuation of the Type 214 submarines in conjunction with the beginning of the SSX program, it appears that South Korea fully intends on keeping two qualified submarine construction yards in business.

GREECE—First Type 214 Continues to be Delayed

In late October 2006, AMI received information that the first Katsónis Class (Type 214) submarine PAPANIKOLIS remains at HDW in Germany as the Greek Ministry of Defense (MoD) and Hellnic Navy (HN) refuse to accept the submarine. AMI sources indicate that the HN has identified the following continuing problems with the first unit of the class:

- The submarine is reportedly highly unstable while surfaced
- The AIP system has lower output power than specified, the unit

must be shut down after several hours of sailing due to higher than normal operating temperatures
- Increased propeller cavitations
- The CMS ISUS is not functioning to specification
- Attack periscope vibrates at speeds greater than three knots making it difficult to lock onto targets
- Seawater leakage into hydraulic systems
- Problems with the proper function of the flank arrays

HN sources indicate that the sea service will not accept delivery, until at a minimum the stability problem is resolved. The delivery of unit one is now more than 18 months behind schedule and the second unit (built at Hellenic) is expected to be launched by the end of 2006. The question that must be considered is will the second unit experience the same problems as unit one? Further, it could be these problems are being over-inflated due to contractual or relationship problems between HDW (ThyssenKrupp) and the HN. AMI will continue to follow and update this story as it progresses.

FRANCE—Defense Budget Increases for Fifth Straight Year to Lock in Programs

In mid-October 2006, AMI received information that France would increase its 2007 defense budget to US$46.3B, 2.5% over 2006 levels. This is the fifth strait year that the budget has been increased and is in line with President Chirac's promise to increase the defense budget every year under Military Program Law (MPL) 2003-2008.

The increased budget is required in order to pay for continuing programs such as Rafale multi-role combat fighters, AS 665 Tiger combat helicopters, LeClerc main battle tanks and France's new Armament Air-Sol Modulaire (AASM) bomb guidance kits. For the French Navy, the budget includes €700M (877.7M) for the new aircraft carrier (PA2) and approximately US$2.7B for the first three Barracuda class submarines.

This will be the last defense budget under the Chirac Administration as a new government will take power following elections in May 2007. As with any election, the outgoing

administration and defense officials are concerned that an incoming government could cut defense spending, making some programs susceptible to cutbacks or cancellation.

The French carrier, with an estimated cost of around US$2.4B, and the six Barracuda class submarines with an estimated cost of around US$5.5B would be attractive targets as both are very expensive and at such an early stage of the program. The government's large financial commitments and attempts to formally launch both programs by May 2007 are clearly intended to make it much more difficult for the incoming administration to cancel either of the programs, both deemed necessary to maintain France's shipbuilding workforce as well as a modern naval force.

It must be noted that while the majority of Europe was cutting back defense expenditures, force levels and procurement programs, France under the Chirac Administration was able to keep its promise by increasing the defense budget during the five-year period allowing for the modernization of the French Armed Forces. The French Navy for example, has been able to move forward on all of its planned procurement programs including the PA2 carrier, Forbin (Horizon) class destroyer, Multi-purpose frigate, Le Triomphant class SSBN, Barracuda class attack submarines and Mistral class LPDs.

INDIA—Seeking Defense Budget Increases from 2007 through 2012

In September 2006, AMI received information that India's Planning Commission approved a defense budget for the eleventh five-year plan that covers the years 2007 through 2012. The budget is planned to increase from US$79B in the tenth plan (2002-2006) to US$142B in the eleventh plan. It must be noted that this plan assumes that the Indian economy will grow by eight percent annually during the entire five-year plan.

Although the budget is expected to increase from the current US$79B to US$142B, the Defense Ministry maintains that it will still be short by around US$22B to accomplish all the goals envisioned. Currently, India has very aggressive plans to modernize its army, navy and air force with the sea service taking the lead in programs that are underway or planned in the short-term.

The Indian Navy is currently involved in many procurement programs and will need its funding maximized if it intends to remain on schedule. The following programs are currently underway or planned:

- Vikrant Class Aircraft Carrier (Air Defense Ship): Began in April 2002, with the first unit under construction and the second unit beginning around 2010. These two vessels cost around US$1.2B each considering the cost of the airwing.
- Kolkata Class Destroyer: The first two units are under construction with the third unit commencing in 2007. These three units will cost around US$400M each with the first unit probably almost fully funded.
- 1800-ton Corvette: This program is expected to start by the end of 2006 or early 2007 and involves the procurement of up to six units. The entire class is expected to be started by 2012 indicating that funds will be needed under the eleventh plan. Each corvette will probably cost around US$100M.
- Talwar Class Frigate (Batch II): In 2006, the Indian Navy ordered three frigates from Russia under a US$1B contract with the majority of the funding probably coming in the 2007-2012 time period.
- Shivalik Class Frigate: The first three units of the 12-unit program are already under construction and have already been funded. During the 2007-2012 timeframe, the sea service will probably begin construction on four additional units costing around US$300M per ship.
- Nuclear Powered Attack/Guided Missile Submarine (Advanced Technology Vessel): Estimated to cost around US$1B per unit, this program could start over the next several years and will entail at least five units with only the first unit starting in the eleventh five-year plan.
- Scorpene Class Submarines: The first unit began construction in early 2006 and will be followed by five additional units in the first batch. The vessels cost around US$300M per unit. Some of the cost was paid for in the tenth five-year plan with the remaining under the eleventh.
- Landing Platform, Dock: The sea service is planning for the acquisition of two large amphibious ships of a foreign design.

The program will probably begin before the end of the decade and will cost at least US$500M.

- Magar/Modified Magar Class LST: A fifth unit of the class is under construction and a sixth unit will probably be funded and started in 2007. The sixth unit, at around US$50M will be funded under the eleventh five-year plan.
- Future Mine Countermeasures Vessel (MCMV): This program is expected to begin by the end of the decade and will entail up to eight units, with the first four beginning by 2012. Each unit will probably cost around US$75M.
- Maritime Patrol Aircraft (MPA): The Indian Navy is expected to make a decision on a new MPA over the next several years. This program is expected to cost US$800M.

Assuming current construction rates for ongoing and future procurement programs, it is estimated that the Indian Navy will require a minimum of US$2.1B annually for procurement purposes under the eleventh plan (2007-2012) in order to keep the sea service on its replacement schedule. Current plans call for the acquisition of 30 major surface vessels and submarines over the next five to seven years in order to replace its aging fleet.

Assuming that the Ministry of Defense receives the entire budget of US$142B projected under the eleventh plan and the Indian Navy receives its traditional 16-17% of budget, the sea service will receive around US$24.1B over the five-year period. With procurement programs costing at least US10.5B in the same period, it appears that more funding will have to be shifted to the general navy fund as procurement costs are projected at around 43.5% of total navy budget, quite high and not sustainable as operations and personnel costs generally utilize the majority of the budget.

From the November 2006 Issue

INDONESIA - Indonesia Selects Russian Submarine Designs

Following AMI's 2005 and 2006 Indonesian Submarine Report projections, in early October 2006, AMI received information that the Indonesian Navy (IN) had made the decision to acquire Russian-built submarines in order to modernize its Submarine Force. The decision, announced by the Navy Chief of Staff, indicates that the

sea service will acquire four Kilo class and two Amur class submarines in the near term and up to six additional units (Batch II) by 2024.

It appears that Indonesia made the decision to procure Russian submarines due to Russia's offer to provide military equipment under an export credit offer. The Russian Government has reportedly offered up to US$1B in credits for the purchase of the first two submarines as well as fighter aircraft for the Indonesian Air Force. Although Russia has offered to finance two of the initial six submarines, it is uncertain if the four follow-on units will be financed the same way.

Assuming a construction contract is in place for the first two units by 2007; both units could be delivered to Indonesia by 2010. Given no special financing on the four follow-on units, these may slip to the right until Indonesia can come up with financing. If the four follow on units are funded, AMI expects it would occur in 2009 or later with deliveries through 2014.

The six Batch II units will probably not be addressed again until after 2015. AMI would expect the IN to look into the possible construction of submarines in Indonesia when discussing the Batch II deal in 2015 or later.

The decision on the Russian solution follows Indonesia's attempts over the past several years to supplement and then replace its two Cakra (Type 209/1300) class submarines that have been in commission since 1981. Sources indicate that South Korea, China and Germany had also made offers to Indonesia prior to the decision on the Russian solution. South Korea is currently overhauling the first Indonesian Cakra class submarine at Daewoo Shipbuilding and Marine Engineering (DSME) under a US$60M deal and offered to build the Type 209/1200 class submarines similar to the Republic of Korea Navy (ROKN) Chang Bogo class for the IN. German (probably Type 209/214) and Chinese (probably Song or Yuan class) offers were also rebuffed in favor of the Russian solution.

Circles within Indonesia have stated that the financing method offered by Russia (15 year loan at 5.6% interest) was the best available and helped lead to the decision. In addition, Indonesia has made it clear over the past several years that it intends on developing several supply chains in order to reduce any future risk due to

military embargoes. Under this new policy, South Korea is providing the IN amphibious vessels, the Dutch are providing the IN amphibious vessels, the Dutch are providing new corvettes and now Russia with the future Submarine Force.

From the December 2006 Issue

UNITED KINGDOM–Future SSBN to Follow Vanguard Class

In early December 2006, the UK Ministry of Defense (MoD) published a new white paper entitled The Future of the United Kingdom's Nuclear Deterrent. This white paper makes clear that the MoD intends to maintain Britain's nuclear deterrent beyond 2020.

The nuclear deterrent capability equates to a new SSBN that replaces the Vanguard class ballistic missile submarines currently in service on a one-for-one basis. However, the white paper states that the MoD will investigate to see if the requirement can be satisfied with a fleet of only three total submarines, vice four. A decision on the final number of submarines to be procured will be made when more information is available on the detailed design.

Current estimates place the cost of the procurement of four new submarines, along with the associated equipment and infrastructure, at around US$29.4B. The majority of the funding for the new submarines is expected to fall between 2012 through 2027. Of note, it is expected that in service support costs between 2020 and 2050 will remain relatively equal to those of the submarines currently in service today.

The first of the Vanguard submarines will begin decommissioning around 2022 followed by a second unit in 2024. It is estimated that it will take approximately 17 years from the initiation of detailed concept work until the first operational unit is in service. With those estimates in mind, the MoD will begin initiating detailed concept work on the replacement submarines beginning in 2007. The MoD will likely place a contract for detail design work between 2012 and 2014. The first unit to replace the Vanguard SSBNs should be in service by 2024.

As previously mentioned in the Defence Industrial Strategy (DIS), published in December 2005, the MoD has been urging industry within the UK to consolidate. Only through industrial

consolidation does the MoD believe that a new replacement submarine can be delivered "on time and at an acceptable cost." Also mentioned within the DIS was that the UK would begin searching overseas for suppliers of sub-systems for naval programs within the UK. Although hull construction and major systems will be maintained within the UK, the MoD will likely seek cost reductions by looking overseas for sub-systems for the SSBN replacement program.

SOUTH KOREA-Naval Update

3000-Ton Submarines (KSS-III) Delayed:

In mid-December 2006, AMI received information that the Republic of Korea Navy (ROKN) was delaying its 3000-ton submarine program (KSS III). Press reporting from South Korea in late December confirms that the Joint Chiefs of Staff announced the deferment of the KSS III program in lieu of additional Type 214 submarines.

AMI received information in October that the ROKN had decided to move forward with the acquisition of six additional Type 214 submarines under the KSS-II submarine program bringing that class total to nine units. These additional Type 214s undoubtedly pushed the KSS III program to the right until around 2020 when the final 214 will enter service.

Assuming that the nine Type 214s will be constructed on schedule and commissioned by 2020, it can be anticipated that the ROKN will resurrect its 3000-ton program in 2018 in order to have a continuous flow of submarines under construction at Daewoo Shipbuilding & Marine Engineering (DSME) and Hyundai Heavy Industries (HHI). Of note, the first three Types 214s were built at Daewoo but the six remaining units will be split between DSME and HHI.

CHINA–New Building Programs Continuing

The People's Liberation Army—Navy (PLAN) continues its course of building up its fleet at an accelerated rate. Sources indicate that the following programs are continuing to progress much more rapidly than originally anticipated:

Yuan Class Diesel-Electric Submarines (SS):

Information received by AMI in early December 2006 indicates that the PLAN has begun construction of the second unit of the Yuan class SS. This is nearly a year behind the original estimated schedule for hull two.

The Yuan class was first seen in mid 2004 and came as a complete surprise to western intelligence agencies. With China's naval build-up, the PLAN has added more than 14 new submarines since 2002 with many more under construction or in the planning stage.

The Yuan is very similar in looks to the Russian Amur and is approximately 75 meters (250ft) in length displacing around 2,300 tons. It is equipped with six 533mm (21 inch) torpedo tubes for YU-4 anti-ship or YU-1 acoustic homing torpedoes, mines or YJ-8 submarine launched anti-ship missiles.

Anticipated to be a class of up to twenty units, the class should be completed, barring any additional delays, by 2020. With the construction of the Yuan as well as the purchase of the Kilo class submarines from Russia, the PLAN will be in a position to decommission its aging Romeo class SS that are well beyond their effective service ages, being commissioned in the 1970s.

Type 095 Class Nuclear Powered Attack Submarine (SSN):

AMI has received information that the PLAN is actively in the process of developing its next class of SSN as follow-on to the Type 093 (Shang class) currently under construction.

The new Type 095 is said to be of a more Western design hull with improved noise reduction and weapon systems. Current plans indicate that five units of the class will be built and will incorporate a newly designed 195mw reactor unit. It will be armed with six torpedo tubes for anti-ship and anti-submarine torpedoes as well as anti-ship missiles and possibly the new HY-4 cruise missile.

If sources are correct that the initial planning stages are completed and long-lead equipment is being procured (listed in the 11th *Five Year Plan*), the first unit of the class could commission as early as 2015 with all units commissioning by 2020.

RUSSIA/SOUTH AFRICA — Satellite Launched from SSBN

In mid-December 2006, AMI received information that the Russian Navy (Rosiyskiy Voennomorsky Flot - RVF) is in the process of working with South Africa (SA) to launch the 81kg (178.2 pounds) SumbandilSat, low-earth-orbiting micro-satellite from one of their ballistic missile submarines in 2007.

The satellite left for Russia on 07 December 2006 where it will be taken to the Russian naval base at Murmansk and integrated into the launch rocket. From there the assembly will be shipped to the submarine base at Severemorsk where it will be loaded into a Russian ballistic missile submarine (SSBN) and subsequently launched just off the Russian coast sometime between April and May 2007, weather dependent. The rocket will likely be launched from one of the RVFs six Delta IV class SSBNs.

This is the first time a satellite will be launched from an SSBN and could herald in a new enterprise for the RVF to increase revenues and subsequently their budget.

VARIOUS DID YOU KNOW?

Russia

On 10 November 2006, the third Lada class submarine (Project 677), RFN SEVASTOPOL, began construction at Admiralty Shipyard in St. Petersburg, Russia.

India

In late December, the first Indian-built SCORPENE (unit three) class submarine began construction at Mazagon Dock Ltd (MDL) shipyard in India. Construction of parts for the first two units began at DCN on 28 April 2006.

Chile

On 13 December 2006, the second SCORPENE submarine (Carrera) built by DCN and Navantia for the Chilean Navy arrived in Talcahuano Chile.■

THE SUBMARINE COMMUNITY

NAVAL SUBMARINE LEAGUE HAS A NEW WEBSITE
www.navalsubleague.com

Captain C. Michael Garverick,USN (Ret)
Executive Director

On Friday, 8 December 2006 the Naval Submarine League (NSL) transferred their domain name to a new server containing a redesigned webpage and database that culminated over two years work by two of our Corporate Benefactors and League staff. The NSL webpage was redesigned with a new look and a lot more capability to help keep it updated. A relational database that allows the League to keep all of their data in a web-based system with easy access to a number of features that are discussed in this article. It is recommended that you log on to the website to view the capabilities that are available to you as a casual user and also the additional benefits that are available once you log in with your membership information.

A principal benefit of the new site is its upgraded appearance with a capability to change much of the information on the site by a dedicated webmaster. As you scan the tabs at the top of the site, you will note that most of the links that were on our former webpage are still there with some logical associations. *About NSL* has all the basic information about the organization, Officers, Directors, Activities and a list of Corporate Benefactors linked to their web pages. *Join NSL* provides all the information needed to join the League.

The next tab will have the *Membership Directory* that is under construction. The League intends to join with the developer of *Deck Log* to provide an improved resource to locate submarine personnel for our members. This site already supports the Levering Smith Chapter and the owner, a former member of the ROBERT E. LEE (SSBN 601) crew, has offered to provide this capability to the League. Members will have the opportunity to select what information is available for public viewing. Deck Log also hosts the USSVI website and other USSVI Bases. We will be providing additional

information to our members as this capability is developed. The *Chapters* page provides a link to Chapter websites, where available.

The *Publications* tab links the viewer to the current index of THE SUBMARINE REVIEW and also to the NSL UPDATES that provide current news and information to our members. The NSL Annual Report is published each year in April with the results of our fiscal year finances and operations. The *Symposiums* tab links to pages providing further information on three annual symposia sponsored by the League. The *Awards and Recognition* tab provides a place to report winners of Fleet Awards and the Undersea Warfare Annual Photo Contest and Literary Awards.

The *Reunions* tab supports our submarines in announcing reunions and providing links to their sites for registration and further information. Members can report their reunion to the Operations Director at **nslops@cavtel.net** and we will post the event on this tab. The *Submarines* tab answers a request from many visitors for more pictures of submarines. This is a work in process as we load additional pictures for presentation on this viewer. If you have interesting photos of submarines that you are willing to share, please send them to me at **subleague@cavtel.net** .

The *Recommend This Site* tab allows members and others to forward a link to the website to their friends, hopefully with a recommendation that they consider joining the League if they are a Submarine Advocate. The Link tab provides some convenient links to other sources of submarine information. Recommendations for improvements and additions to this tab are solicited.

The *Home* tab is a new feature that rotates the pictures on the header each time you click it. Give it a try and note the variety that is now available.

Each member can log into the web page using their login name or member number and a password. Your member number can be retrieved from headquarters and if you have forgotten your password, we can reset that for you and send you an email with that information. Note that we encourage you to use your email address as the login name. That will be easier for you to remember. Also, if your current email address is not on file, we will have to update that information in order for you to receive the report of any changes you desire to make. We will help you with this process. Our toll free

number and email address is available on the login page. The first action you will have to take is to change your password from the one we provided you. Then you will be able to pay your dues, change your user name, and edit a resume', a capability that is being added to our support of our members. This link provides the League's toll free number for assistance if you need some help in getting this information. In this section you will be able to pay your membership dues using our secure server, change your password and login name and a new feature for editing your resume. Also on this page is a link to provide the member with a new password if they don't remember their current one. You must have a current email address on file to use this capability. If in doubt, please call the office for assistance.

Last year the League reported on an initiative to assist members in career transition and Corporate Benefactors to link up for possible employment opportunities. Members will be able to post a resume, as noted above, on their individual page. Corporate Benefactors will be able to provide a list of job opportunities and review the available resumes for these positions. Information on the startup of the *Second Career Network* will be promulgated as soon as the links are established and tested along with the policy for using them. This capability will be announced in an NSL UPDATE and on the webpage.

The League appreciates all of resources and effort devoted to developing this new capability for promoting the League and attracting new members. If you have recommendations on how we can improve its usefulness please send your ideas to **subleague@caytel.net** for consideration and implementation.■

ETERNAL PATROL

CDR James D. Hovater, USN(Ret)
LT Jon B. Jolly, USNR
CAPT Alfred M. Koster IV, USN(Ret)
Mr. James R. Leach
Mr. George L. Lengemann
Dr. Don H. Pickrell, Jr.
CAPT Don O'Shea, USN(Ret)
RADM Sumner Shapiro, USN(Ret)
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HEROES WITHOUT MEDALS

by LTJG Gary M. Trammell, USN(Ret)

Mr. Trammel served in the Navy from 1960 until 1980. He served aboard the USS ROBERT E. LEE, USS WOODROW WILSON, USS VON STEUBEN, and USS THOMAS A. EDISON. He completed his department head tour as the Weps QA Officer on SIMON LAKE AS-33, totaling 13 patrols. Mr. Trammel is retired from Lockheed Martin.

You look around the Navy today and you see many young sailors with a chest full of ribbons and can only imagine how that young sailor could have earned so many awards. Many are even the Navy Achievement Medal, which requires some truly significant effort to earn. At least that was the case in the 1960s through the 1980s.

At the beginning of the fleet ballistic missile program in the late 1950s and early 1960s the Navy went out to the fleet and selected the best-of-the-best to meet the manning requirements of the most complicated war machine ever built. These hand picked sailors and officers came into the fleet ballistic missile program, also known as the Polaris program, named after our steady dependable North star. They had already earned many awards and citations for prior service before entering the Polaris program. These sailors were already heroes with medals, not to short-change them as not being heroes. They were already heroes in every since of the word. Although these men were the best-of-the-best from the fleet, their numbers were not sufficient to fulfill the Navy's tremendous need for highly skilled technical billets. However, the young sailors that had to be recruited to meet the rapidly expanding requirements of the Polaris program had very little opportunity to earn many medals and citations. They were recruited, sent to basic training, and then entered into the training cycle to prepare them for the demanding duty required on the forty-one fleet ballistic missile submarines that would become the backbone of the nuclear deterrent force of the United States during the cold war.

Recruiting offices throughout the country began the massive job of selecting the young men that would be the future of the Polaris

program. They would become nuclear power plant operators, electronic technicians, missile technicians, internal communications technicians and the many other skills that would be required to operate and maintain the FBM submarine and its sixteen intercontinental ballistic missiles, and nuclear power plant. One of the requirements for these highly technical fields in the submarine service was a commitment of six-years service. Little did these recruits understand that they would spend many days, even months, beneath the world's oceans. Each submarine would bear the name of a President or other famous person that contributed to the United States during a time of need. Each had a hull number preceded by the designation SSBN, which is the abbreviation for submersible ship, ballistic, nuclear. However, this brotherhood of submarine sailors came to think it meant Saturdays, Sundays and a Bunch of Nights.

Each FBM Submarine, as we know, was assigned two crews of approximately 120 to 130 enlisted men and officers. Many of these sailors would serve their six-year obligation and reenter civilian life. Were they heroes? You bet! Even if some, after six years, only earned the Good Conduct Medal, the National Defense Service Medal, and maybe a Meritorious Unit Commendation, and/or Navy Unit Commendation. Sure, there were many letters of appreciation and/or commendation issued, but these pieces of paper were just that, pieces of paper with no accompanying medal or ribbon. When these heroes reentered civilian life there were no home coming parades or big news articles declaring their heroism. The same is true with those young recruits that continued beyond their six-year obligation and made the Navy a career. There were many 20-year plus enlisted men and officers from the FBM Submarine Force who, when they retired could only display a few medals and/or ribbons. Were they heroes too? Again, you bet! Many of these sailors made 10 or more patrols on one or more submarines, each lasting 60 to 75 days, or longer. They were separated from family many times. Gone when their children were born. Gone when their kids graduated from high school. Gone when the rest of us here in the United States were sitting down to a great Thanksgiving dinner. Gone at Christmas time, and someone else had to play Santa for their children. The other heroes, their wives, were without husbands for roughly half of their

careers, which is another story well covered by Mr. David R. Hinkle in the October 2006 issue of The Submarine Review. These sailors' perseverance and dedication to country and duty was the key ingredient that helped win the Cold War. Yes! They were all heroes, and there are still many out there beneath the world's oceans protecting America today in the great Trident Submarines that stand guard to insure America's freedoms. They also may not earn many medals or ribbons, but like our forty-one for freedom sailors, they too are HEROES!■

THE NATIONAL MUSEUM OF THE PACIFIC WAR

The Nimitz Museum has been designated as The National Museum Of the Pacific War

Admiral Nimitz Museum

The Nimitz Foundation is the not-for-profit entity that supports the Museum and is raising funds to support the creation of a WWII Submarine Memorial, featuring the sail of USS PINTADO (SS-387). The Foundation is raising $250,000 to develop this memorial and respectfully solicits donations to support this need. Tax deductible donations can be mailed to:

Admiral Nimitz Foundation
WWII Submarine Memorial
328 E Main ST
Fredericksburg TX 78624-4612

ANOTHER DAY FOR THE STINGRAY

by CAPT Jack O'Connell, USN(Ret)

It was 1956 in San Diego. John Shilling and I were junior officers in USS CAIMAN (SS 323) under LCDR Hap Perry as Commanding Officer. CAIMAN was assigned unusual duty that week. We were to serve as a pseudo USS STINGRAY (SS-186) in making a half-hour episode for Navy Log. The TV series was based upon real events in the Navy, many taken from WWII deck logs. STINGRAY had distinguished herself while carrying out Life Guard duties in connection with air strikes on Japanese facilities at Guam in June 1944. One day she rescued five downed airmen, one while under fire from Japanese artillery ashore. This episode would be titled *A Day for the Stingray*

The producer, director, actors and technical staff came aboard. A camera platform was built on the deck forward of the bridge cockpit to shoot bridge action and some alongside recovery action. All the filming would be done surfaced since we couldn't dive with the camera platform in place.

Some shooting went on in the control room. It was fascinating to see the actor serving as diving officer being sprayed with facial sweat so the camera could show typical submerged submarine tension to the viewing public.

There were a number of topside scenes. Several involved rescuing downed aviators, pulling them up off life rafts. One very exciting sequence involved a Navy SNJ, painted to resemble a Japanese Zero fighter, making strafing runs on the boat and the topside personnel scrambling to get below.

However, the scene that really resonated with John and me involved the two of us. We were extras, backing up the CO (actor) and OOD (actor) on the bridge. The script called for the XO (another actor) to stick his head up through the bridge hatch while holding a message form and say something like "Captain, there is another downed aircraft, 20 miles bearing 340 from us." He blew his lines twelve times. Take followed take *ad nauseam*. John and I were

convinced that there was a career for us in TV acting if we ever got tired of submarine duty.

My mother later wrote me that she had seen the episode on TV and recognized my ears sticking out in the background. Oh well, *sic transit gloria.*■

THE SUBMARINE REVIEW

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

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

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

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

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

BOOK REVIEWS

POWER SHIFT
BY DAN GILLCRIST
iUniverse, 2006
Lincoln, NE
ISBN-13:978-0-595-38574-4

Reviewed by
CAPT. Bill Norris

In a way the forward to this book should not be read until the reader has finished the book. It maintains a zero angle in summarizing the many fine and varied interviews that Dan Gillcrist has gathered. The book portrays the Power Shift for what it was; a transformation of the Submarine Force from diesel boats to nuclear power. It was an inevitable transformation driven by technology and the book tells of the price paid and rewards won by the people during such a transformation.

This is a trade publication and it will mean different things to different generations of submariners. Those who were submariners before there were nuclear submarines will enjoy the interviews about how it used to be when the world was pure. Those who lived through the transformation as diesel submariners and who didn't convert, for whatever reason, will find solace either in the interviews with the DBF'ers or those who understood necessity for the course of events. Those who lived through the transformation, either as nuclear submariners or those who converted to nuclear submarines, will relive the difficulties of a transformation of men and machinery. Those who never really knew a diesel submarine or a diesel submariner will feel they are reading about today's disputes between warfare communities, maybe even in an internecine sense, but at least the world is now pure again.

A few personal reflections:

Life is not fair, especially to those caught in transformation. Many who entered the Submarine Force after World War II were joining a very elite group that had played a key role in the defeat of the enemy (and we should always treasure that heritage). To many of these, the advent of nuclear submarines turned many super careers into fine or average careers regardless of their real performance. It also began the end of an era, and many good people are always lost in such a transition.

Those that started the *Power Shift* had a tough time not only because they had a great legacy to try to build on, but with nuclear power came an awesome responsibility. That required hard work that was beyond what the post World War II diesel boat was experiencing. But without that transition to nuclear submarines and that hard early work, the Submarine Force would have not been able to maintain its elite position (By the way, it's still hard work). There were too many advantages to a *true* submersible that could be further enhanced by the increased design space and electrical and propulsion power available. And thus, just as in World War II, submarines were a key element in the victory in the Cold War.

In every fleet and organization there are good and not so good ships and parts. Most of us served in both. There were good and not so good leaders in diesel boats and in nuclear submarines as well. One ship or organization does not stay good or not so good. People can and do change things. Whether ships or organizations are good or not so good, the experiences are what made us better, if we learned from them.

The camaraderie of the diesel submariners seems to be played much better than that of the nuclear submariners. Just as there was a *Power Shift* from diesel to nuclear, there was a change in what people saw as camaraderie. The harder work needed to make nuclear submarines a success begat a different closeness. Looking back, I would have judged the camaraderie on the diesel submarine I served on as fourth (of six submarines). I would bet that other submariners who have served on both sides of the *Power Shift* would vary and run the gamut from top to bottom.

There have been many who have written chronicles of Admiral Rickover. Dan adds some balanced anecdotes to the collection. A lot is made of whether Admiral Rickover stayed too long. Maybe he did, but where would we be today if he hadn't started us out with his firm hand and high standards. One should also not discount the *Grand Dolphins* of OP-02 who never received much credit but worked so hard to marry the right operational tools to the nuclear propulsion system, and also served as a check and a sounding board for Admiral Rickover.

Power Shift reveals many tales across the submarine spectrum. Every time one listens to the stories of the experiments, such as with *pancake* diesels, you suffer with the crew. The NAUTILUS experiment and the others of the early nuclear Submarine Force were equally painful for those crews. Many of Dan Gillcrist's interviews will stir memories, good and not so good. Great credit goes to Dan for his perseverance in telling a story that spans a generation of submariners and submarines.

Power Shift is neither a great book nor a classic. It is a book worth reading for the human stories about the *Power Shift* that Dan Gillcrist has brought to light and life. We older submariners will enjoy it more. We will all have our favorite stories within its covers. We will disagree with some of the portrayals and resonate with others. We will find lost shipmates and contemporaries and friends. We will remember similar tales from our past. This is another piece of our great submarine tradition.■

DAS SIEGREICHE U-BOOT
(THE VICTORIOUS U-BOAT)

Book Review by Captain David G. Smith USN(Ret)

Editor's Note: CAPT. Smith is a retired submarine officer who commanded JACK (SSN605) and HOLLAND (AS32).

Although printed some time ago, *The Royal Oak Disaster*, by Gerald S. Snyder, Presidio Press, 1978, is an interesting insight into the early days of WW II submarine warfare. More significantly, it conveys some of the frequently ignored management weaknesses that lead to tragic events (not unlike the recent fire at the BP refinery in Texas).

For 30 years after the sinking, the true story remained hidden from the public by the British Official Secrets Act. With the expiration of that Act, many British and German documents became accessible for the first time. Author Snyder conducted extensive research in the early 1970's, including interviews of survivors from both ROYAL OAK and U-47, in order to present a *minute-by-minute narrative of suspense, high drama, and extraordinary bravery.*

A natural harbor located within the Orkney Islands, off the northeast coast of Scotland is known as Scapa Flow. It's sheltered waters have been used over many centuries, from the Viking fleet of King Haakon in the 13th Century, to the present day. In the early days of WW II the British utilized the Scapa Flow as a major anchorage for their fleet. Although the Scapa was considered secure by most, a careful review by an independent contractor, in May 1939, reported that "... it is safe to assume that an intrepid submarine officer, in war time, would take risks which no discreet mariner would think of taking in peace time. The possibility of a hostile submarine entering Scapa Flow, if the Sounds are left as at present, cannot therefore be excluded ..." Nevertheless this warning was *largely ignored by the Admiralty.*

At the same time, Raeder and Dönitz were conceiving a plan to penetrate the Scapa. They selected Günther Prien, who was in command of U-47, as their choice for this special operation. The

author recounts in considerable detail the planning and execution of this daring penetration of Britain's *impenetrable* port. On the night of 13/14 October 1939, U-47 penetrated the Scapa Flow and sank the British battleship ROYAL OAK—one of the worst disasters in the history of the Royal Navy. The battleship sank with the loss of 833 lives, only 424 of the crew surviving. Prien became known as the *Bull of Scapa Flow* and returned to Germany a hero.

In the following months, Korvettenkapitän Günther Prien became one of Dönitz's top three aces, sinking, in addition to the sinking of ROYAL OAK, a total of 28 merchant ships for a tonnage of 160,935. Yet, in just over a year, 8 March 1941, U47 was sunk south of Iceland by HMS WOLVERINE with a loss of all hands.

After the sinking of ROYAL OAK a Board of Enquiry was convened. One of the determinations was that *various officers were responsible for various sections of the defense but that no one officer was responsible for the whole of it.* In reading the book one finds a number of significant issues that deserve emphasis as they relate to future submarine operations. In the early 1980's the Institute of Nuclear Power Operations (INPO) identified eight common attributes that contributed to poor management of commercial utilities. Of those attributes, the following contributed to the sinking of Royal Oak and need to be respected by submariners as *Lessons Learned*:

- Diffuse responsibility
- A *mindset* that success is inevitable
- An acceptance of known hazards
- Minimal risk assessment■

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DOLPHIN SCHOLARSHIP
ELIGIBILITY & APPLICATION PROCEDURES

Dolphin Scholarship Foundation grants are available, on a competitive basis, to high school or college children/stepchildren (unmarried, under age 24 at time of deadline) of: (1) members or former members of the Submarine Force who have qualified in submarines and have served in the Submarine Force for at least eight years; or of (2) Navy members who have served in submarine support activities (e.g., submarine bases, tenders, and rescue vessels) for a minimum of ten years. These years of service need not be consecutive. Qualifying time must have been served on active duty; time served as a Naval Academy or NROTC midshipman, in "Boot Camp", or as a member of the inactive or Selected Naval Reserve cannot be used to establish eligibility. The time in service requirement may be waived by DSF for qualified submariners who have been medically retired or medically discharged from the Navy due to injury or illness which occurred in the line of duty. There is no minimum period of service for children of personnel who died while on active duty in the Submarine Force.

Dolphin Scholarships are currently awarded at a level of $3000.00 per year and are renewable for up to four years of undergraduate study. Approximately 30-35 new students are selected each year, for a current total of 134 scholars. The scholarship is available to full-time students working toward a baccalaureate (bachelor's) degree at accredited four-year colleges or universities. In order to remain non-taxable to the recipient, the scholarship must be used for tuition and related expenses (such as fees, books, supplies, and course-required equipment.) Excess fees, if any, may be applied only toward room and board, but should be considered taxable income by the student. Scholarships are awarded on the basis of academic proficiency, financial need, and commitment and excellence in school and community activities.

Anyone desiring to request an application package should submit the following for to:

Dolphin Scholarship Foundation
5040 Virginia Beach Boulevard
Suite 104-A
Virginia Beach, VA 23462
or: call (757) 671-3200 ext. 111, FAX (757) 671-3330,
or download an application from our website at:
www.dolphinscholarship.org

Completed applications and all supporting documentation MUST BE RECEIVED ON PREMISES BY ***MARCH 15*** to be considered for the following school year!

2006 DSF "NAMED SCHOLARS"

"Endowed Scholarships"

ALOHA (SOWC Pearl Harbor)	Karl Sault*
BANGOR OFFICERS SPOUSES ASSOCIATION	Carolyn Schuetz
RADM JACK DARBY	Madeline Moreau
CARL DelSIGNORE	Caitlin Peddicord*
FOXWOODS RESORTS (5)	Stephanie Park, Alexandra Smrcina, Jeremy Ashinghurst*, Jacqueline Eory*, Joshua Valentine*
VADM & MRS. ELTON GRENFELL	William Wright
RICHARD & CAROL HAYWARD (4)	Chaunté Auton, Lithornia Simmons, Heather Morrison*, David Flannery*
KINGS BAY GOLD & SILVER	Abby Feine
ARNOLD KRIPPENDORF	Christopher Smith*
RADM & MRS. JACK LEE (5)	Angela Noakes, Alexis Steele*, Tony Koontz*, Traci Baldwin*, Katherine Sweet*
LOCKHEED MARTIN	Amber McColl
MASHANTUCKET PEQUOT TRIBAL NATION	Stephanie Carzoo*
NORFOLK SUBMARINE OFFICERS' SPOUSES' ASSN.	Justine Morris
KATHLEEN O'BEIRNE (SOSA New London)	Sirrah Laughery*
RM2(SS) ROLLA PARSONS	William Pittman*
US SUBMARINE VETERANS OF WORLD WAR II	Iain Greba
WIVES OF US SUBMARINE VETERANS OF WORLD WAR II	Sarah Mohon*

HONORARY/MEMORIAL SCHOLARSHIPS

CAPT. JOHN E. ALLEN	Marissa Mason
DOT ARTHUR	Jessica Squier
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MAX & VICTORIA DREYFUS FOUNDATION	Brittany Dunn
GEORGE AND PAT EMERY	Megan Greenwood
GENERAL DYNAMICS ELECTRIC BOAT	Stephanie Whitson
GROTON SILVER & GOLD CHARITIES AUCTION	Gregory Biggs
MRS. KAZ HARRIS	Janna Matthews
KE KELA (SOWC PEARL HARBOR)	Kristina Sault
KINGS BAY SILVER & GOLD AUCTION	Bertinarea Crampton
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NORTHROP GRUMMAN ELECTRONIC SYSTEMS	Karalyn Dennis
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L. MENDEL RIVERS	Samuel Buelk
CPL RANDAL KENT ROSACKER	Jeffrey Drummond*
CDR ORLANDO SUAREZ (BOSA)	Rebekah Alford
TOKYO AMERICAN CLUB	James Hosford
NANCY S. TOLLEFSON	Tara Lukens*
USS JEFFERSON CITY (SSN 759)	Michael Keough*
CAPT REGINALD L. WORKMAN	Cara Allen

**Dolphin Scholars originally selected in prior years*

REUNIONS

USS SEGUNDO SS-398
Apr 9-13, 2007
Laughlin, NV
Loc: Edgewater Hotel, Laughlin, NV
POC: Ken Owen E-mail: **kenowen1@cox.net**

USS SABALO SS-302
Apr 11-14, 2007
San Diego, CA
Loc: Holiday Inn-Bayside
POC: Jeff Owens E-mail: **owensj@epix.net** Web sit:
http://www.usssabalo.org

USS CHOPPER SS-342
Apr 16-21, 2007
Carnival Cruise Line
5 days, 4 nights with stops in Key West and Nassau
POC: James Murphree, 2129 Clarendon CT, The Villages, FL 32162-7718
Phone: 352-753-0751 E-mail: **jfmurphree@aol.com**

USS SEA DEVIL SS-400/SSN-664
Apr 19-22, 2007
Charleston, SC
Loc: Holiday Inn, Patriot's Point Combined reunion #3, all crews/all years
POC: Jim Schenk, P.O. Box 476, Morrisville, NY 13408
Phone: 315-824-3162, E-mail: **boatsailor@usadatanet.net**
Web Site: **http://www.seadevilssn664.org**

USS SENNET SS-408
Apr 22-26, 2007
Loc: Holiday Inn, Mt. Pleasant, SC
POC: Ralph Luther, PO Box 864, Summerville, SC 29484-0864
Phone: 843-851-7064 E-mail: **rluther@bellsouth.net**

USS POMPON SS/SSR267
Apr 26-29, 2007
Manitowoc, WI
POC: Bill Davy, Phone: 248-689-6369
E-mail: **Judydd@wowway.com**
Web Site:
http://www.hometown.aol.com/dgweg/myhomepage/pomponreunion.html

USS SEA FOX SS-402
Apr 26-30, 2007
Galveston, TX
Loc: Victorian Condo Hotel, 6300 Seawall Blvd., Galveston, TX 77551
Reservations: 1-800-231-6363
POC: Joe Cornelius E-mail: **seafox.ss402@gmail.com**
Web Site: **http://seafoxassoc.homestead.com/07Munster.html**

USS SEA ROBIN SS-407
May 2-6, 2007
Groton, CT
Loc: Groton Inn & Suites
POC: Paul Roggemann, 42 Hemlock Drive, Hopewell Jct., NY 12533
Phone: 845-226-5636 E-mail: **paulr@ss-407.net**

USS SCAMP SSN-588
May 2-6, 2007
San Diego, CA
Loc: Hanalei Hotel, San diego, CA
POC: Lou Minor, 3260 Hector Road, Newcastle, CA 95658
Phone: 916-425-2149 E-mail: **lou@uss-scamp.com**
Web Site: **http://www.uss-scamp.com**