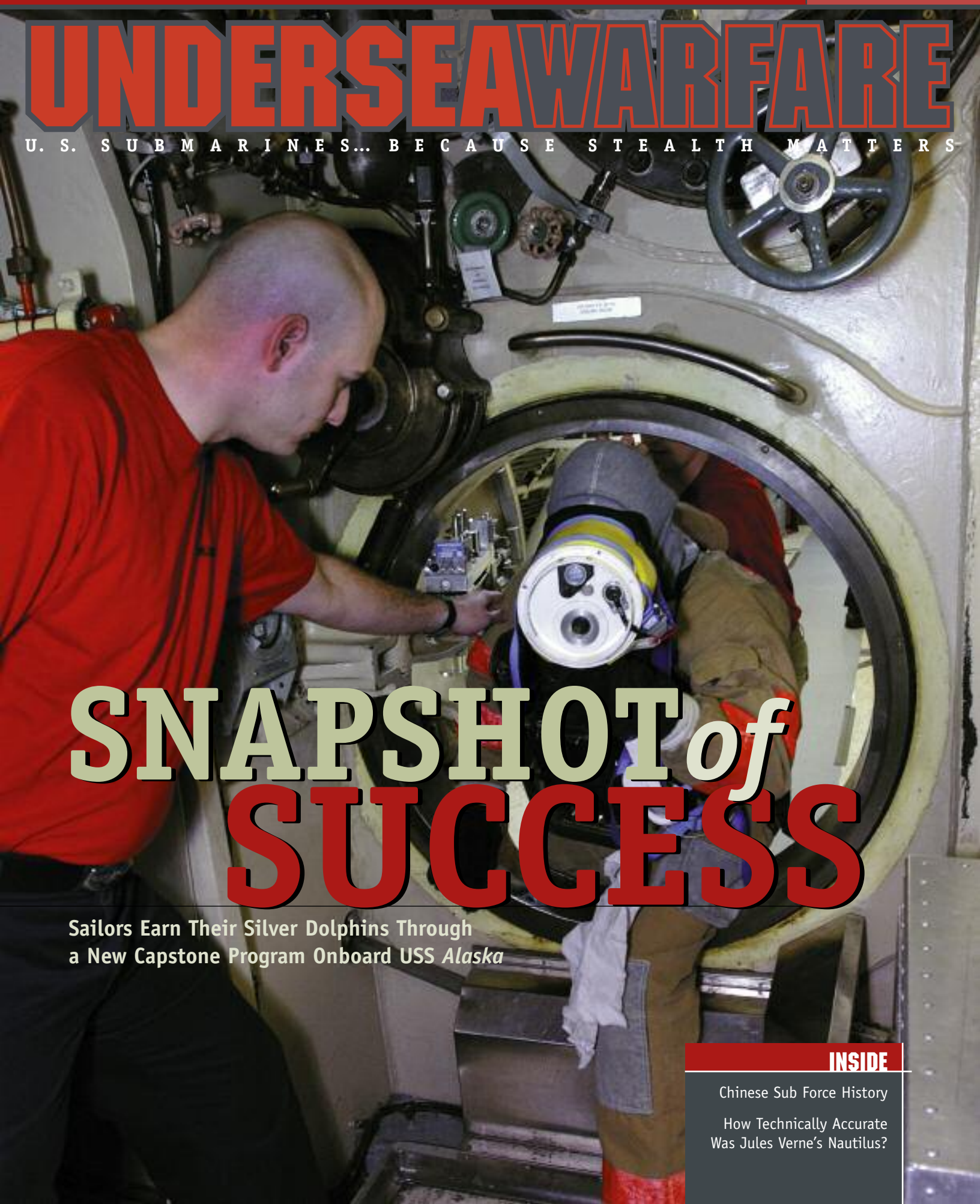
SUBMARINERS IN IRAQ pg. 7

WINTER2004

UNDERSEA WARFARE

U. S. SUBMARINES... BECAUSE STEALTH MATTERS



SNAPSHOT of SUCCESS

Sailors Earn Their Silver Dolphins Through a New Capstone Program Onboard USS *Alaska*

INSIDE

Winter2004 *Vol. 6, No. 2*

SNAPSHOT of SUCCESS

by LCDR Tom Monroe, USN, and CMDCM Dave Lynch, USN, with the assistance of JO2 Mary Popejoy, USN

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2002 CHINFO Merit Award

On The Cover

MM1 Tom Madden safely guides EM3 Mark Quarles as he exits the engine room aboard USS *Alaska* (SSBN-732)(G) during his SNAPSHOT qualification board. To learn more about this challenging new capstone program onoard *Alaska*, see page 4!

Photo by Brian Nokell, Submarine Base Bangor, WA Visual Information

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THE OFFICIAL MAGAZINE OF THE U.S. SUBMARINE FORCE

UNDERSEA WARFARE

U.S. SUBMARINES...BECAUSE STEALTH MATTERS

Charter

UNDERSEA WARFARE is the professional magazine of the undersea warfare community. Its purpose is to educate its readers on undersea warfare missions and programs, with a particular focus on U.S. submarines. This journal will also draw upon the Submarine Force's rich historical legacy to instill a sense of pride and professionalism among community members and to enhance reader awareness of the increasing relevance of undersea warfare for our nation's defense.

The opinions and assertions herein are the personal ones of the authors and do not necessarily reflect the official views of the U.S. Government, the Department of Defense, or the Department of the Navy.

Contributions and Feedback Welcome

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2004 – A Year of Transition

We stand at the beginning of 2004 – a year that will mark the start of a new chapter in the history of the Silent Service. It has now been almost six years since the United States commissioned a submarine - the Seawolf-class USS *Connecticut* in 1998 - the last of a venerable string of Cold War nuclear attack submarine classes that began fifty years ago with the transformational USS *Nautilus*.

The surprisingly abrupt collapse of the Soviet Union brought with it the prospect of an unstable multi-polar world where regional conflicts were no longer held in check by superpower pressure. For the Navy, this meant that the "front lines" would move from the deep ocean to the littoral seas – and that the design of our submarines needed to follow suit. By 1993 we had decided to interrupt the *Seawolf* class and go back to the drawing board to craft the design of a New SSN (NSSN) specifically built to handle the challenges of operating in crowded and shallow coastal waters. This was the beginning of the *Virginia* class.

"You will see more evidence of why submariners will look back on 2004 as a pivotal year."

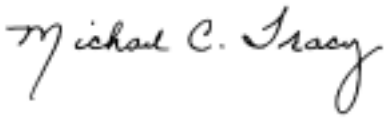
Later this year our six-year drought will be over and Virginia will be commissioned – the first of the flexible new submarines designed after the end of the Cold War to face the security environment of the 21st century. Although *Virginia* looks much like her advanced predecessors, beneath the black paint and rounded hull, she is a fundamentally different ship. Equipped with an integrated chin sonar enabling her to "see" her way safely through uncharted shallows, precision automatic depth control, and a radically different two-man ship control station, *Virginia* has greatly enhanced ability to penetrate safely deep into the littorals. The torpedo-room is really a "payload bay" designed to support all of the standard submarine weapons, as well as a full range of unmanned underwater vehicles, Special Operating Forces (SOF) support equipment, and other transformational systems still only in the concept stage. Her diver/SOF support capabilities include an integral lock-out chamber capable of supporting an entire team of equipped SEALs and the ability to carry either Advanced SEAL Delivery System (ASDS) or the Dry Deck Shelter (DDS).

Add to *Virginia* the arrival of the USS *Jimmy Carter* next year and the excellent progress on the refueling and conversion of SSGNs, all four of which should be in service by 2008, and you will see more evidence of why submariners will look back on 2004 as a pivotal year. The warfighting value of SSGN has grown over this past year as we have learned from Sea Trial experiments, demonstrations, and various war games that the role of SSGN will extend far beyond the SOF/Strike missions initially envisioned. Just as important have been the opportunities created by the ability to use large diameter UUVs with greater payload and endurance, UAVs, and other transformational unmanned vehicles to expand radically the way we can exploit SSGN as a stealthy "Sea Base."

Together, *Virginia* Class submarines and the SSGNs will provide the Joint Force Commander with exceptional operational flexibility. Submarine missions, whether they involve surveillance, special forces, or the application of force, can be undertaken without the expensive and vulnerable burden of defensive and logistic support. This smaller support organization means greater flexibility, lower cost, and reduced risk. Perhaps more importantly, the ability to mount substantial operations without a provocative presence will ensure that the adversary remains unalerted – the kind of unpredictability that provides an extraordinary military advantage in peacetime, wartime, or anytime in between.

Hail and Farewell

Finally, UNDERSEA WARFARE welcomes our new military editor, LCDR Scott Young, and bids farewell to LCDR Dan Montgomery as he heads back to the fleet for duty as Executive Officer on USS *Toledo* (SSN-769). Dan did superb work here on my staff – not only heading the magazine team, but also playing a key role in congressional liaison, US-UK relations, and special operations support. I encourage those of you approaching shore duty to strongly consider coming to Washington, D.C. It's an exciting place to live, you get exposure to the full spectrum of issues, and there is a real opportunity to make a difference.



RADM(sel) Michael C. Tracy, USN
Director, Submarine Warfare

SEA SHIELD:

by JOC(SW/AW) Mark O. Piggott, USN

VADM Kirkland H. Donald, Commander Naval Submarine Forces (CNSF), recently addressed the National Defense Industrial Association (NDIA) 2003 Joint Undersea Warfare Technical Conference in Groton, Connecticut. He spoke about the current status of the Submarine Force and what lies ahead for submariners in conjunction with the Chief of Naval Operations "Sea Power 21" concept for the Navy.

"We have a new class of attack submarine, led by the *Virginia*, that's very nearly ready for sea," he said. "We have *Ohio*-class ballistic missile submarines being converted to SSGNs, a platform with capability potential we have only begun to imagine.

"You have, we all have, very much to be excited and proud about," he concluded.

The NDIA's primary areas of interest are the business and technical aspects of the government-industry relationship, encompassing government policies and practices in the entire acquisition process, including research and development, procurement, logistics support, and many technical areas.

In looking at the recent conflict in Iraq and Operation Enduring Freedom, VADM Donald noted the Navy's capability to form a "Sea Shield," enabling our forces to amass unprecedented firepower within range to support the campaign. The submarine's role in the Sea Shield concept is to prepare and dominate the undersea battle space by denying an adversary's use of warships, submarines, and mines.

"We must be able to operate, with impunity, across our mission spectrum, in the contested littoral," he stated.

To VADM Donald, this means collecting accurate intelligence, neutralizing any threats, and ensuring a clear path to the enemy through stealth.

"A submarine's stealth and endurance will be essential to early and persistent access to the increasingly important pre-hostilities phase of any operation. We can't be deterred by the presence of mines. We can't be deterred by enemy submarines.

"Whether operating independently or as an element of a combined arms task force, we must be able to locate, hold at risk, and destroy on call, any submarine that leaves port to threaten our forces," he continued. "We must use our honed surveillance capabilities and the resultant profound situational awareness we develop to inform and advise the Joint Force Commander of the capabilities and intentions of our adversaries."

Looking across the globe, VADM Donald knows that the U.S. Navy has the edge in technology and advances in all areas of undersea warfare, especially special operations.

"We in the United States do have a competitive advantage in undersea warfare," he said. "We have the best littoral torpedo in the world with the MK 48 ADCAP, and it is getting better.

"Our relationship with special operations forces has never been closer," he continued. "We've got an aggressive experimentation effort; it's a leader among the services in integrating innovative technology into submarines and testing them in realistic joint operating concepts.

"We are pursuing a disciplined, determined, problem-solving approach with focused management attention in all of these areas as we build ever more robust, real capability," he added. "We must not just get better – we must dominate in this area."

VADM Donald challenged the defense industry to help make SSGNs the leading platform for special operations forces and joint forces operations.

"What I need for you to do is open your apertures looking for opportunities to exploit what we have in the huge undersea volume and large ocean interface of the SSGN and to demonstrate the true joint warfighting capability it brings," he said.

"ADM Bowman has urged us to 'get real' with technology and get real hardware and software in the operating environment quickly, test it, and build on successes. This is particularly applicable to the SSGN."

He suggested, "That same attitude applies to development of joint operating concepts. We need smart people looking beyond the obvious, developing and testing new ways to integrate into the joint force and ensuring that our solutions remain compatible in the joint architectures of the future."

The one thing needed to ensure communication in these types of operations is connectivity. According to VADM Donald, lessons from Operation Iraqi Freedom have shown the need for effective communication.

"If we are going to be effective in this

VADM Donald Addresses Pivotal Seapower 21 Concept

joint force, we not only have to be there, but we have to be connected and able to exchange information with it," he said. "Warfighting today demands real time, high-bandwidth communications, and that demand is only going to increase."

"Further, we are going to have to be able to communicate without yielding our stealth. We have to continue to pursue communications at speed and depth. We need technology to increase our communications capacity and make more efficient use of the bandwidth we have.

The submarine's role in the Sea Shield concept is to prepare and dominate the undersea battle space by denying an adversary's use of warships, submarines, and mines.

"This connectivity is not only critical outside the hull; it is critical inside the hull as well," VADM Donald added. "What I mean by that is our tactical systems must be fully integrated inside the ship. The days of developing and delivering independently operating and single-function tactical decision aids should be over."

Maintaining and updating weapon systems to conform to each mission requirement is essential to the Sea Shield concept.

"If submarines are going to be a persistent force in the contested littoral… we are going to need a wider variety of sensors and weapons that give us more response options and keep us in the fight longer," VADM Donald said.

"For instance, we should be able to engage small, high-speed vessels or aircraft that could threaten our battle forces or be impediments to either our freedom of movement or the movement of our Special Operations Forces," he added. "We need a fires capability that is immediately responsive, at the tactical level, to the land component commander's requirements at any time in the campaign."

"Off-board sensors, aerial, underwater, unattended, which expand our reach and accelerate our sweep rate, will significantly improve our effectiveness."

According to VADM Donald, the most valuable resource is not the technology, but the Sailors operating it. System engineers have to think of the Sailor first when designing a new technology for future submarines.

"I marvel every time I go on one of our ships and see the proliferation of advanced technology and the exponential progression of capability that it brings with it. However, in the same vein, I am concerned with that same explosion of capability and what it means in terms of preparing our fine Sailors to get the most warfighting utility from what it is we are giving them.

"If you combine the multi-mission responsibility we put on our crews these days and add to that the rate of change of capability that we are now able to deliver to our ships, I question whether we can achieve true competence in our employment if we train the way most ships are training today," VADM Donald continued. "It's kind of the same way I was doing it when I was in their shoes. There's a little more automation. But I think we're only nibbling around the edges."

"ADM Bowman's folks at Naval Reactors are taking a bite out of it with the Interactive Display Equipment for propulsion plant training," he stated. "Similarly, higher fidelity shore tactical and navigation trainers have great potential.

"But along with those, we need better sharing of knowledge and best practices among our crews, better tools and techniques for self assessment, and better leveraging on knowledge residing in our shore school and in our technical institutions."

VADM Donald concluded with a few final thoughts, first noting that the Submarine Force has a vital role to play in the CNO's Sea Power 21 concept. Then he stated, "We need to be careful shepherds of the Force's fiscal resources as we embark on spiral development projects to rapidly field capability to the fleet." And finally, he challenged the industry to always think about the operators. "If we haven't made it measurably more capable, easier to operate and more efficient, then we probably need to take another look at it before we deliver it to the fleet. We owe it to our Sailors."

Chief Piggott is the Force Journalist serving under Commander, Naval Submarine Forces.

by LCDR Tom Monroe, USN, and CMDCM Dave Lynch, USN, with the assistance of JO2 Mary Popejoy, USN

SNAPSHOT of SUCCESS

Photos by Brian Nokell,
Submarine Base Bangor, WA Visual Information

(above) EM3 Mark Quarles checks for a proper face seal on his Oxygen Breathing Apparatus (OBA).

Wake-up Call

It's 1830 and two Sailors in distinctive red shirts arrive at a rack in berthing to deliver a special wake-up call. One slowly pulls back the curtain and says, "Petty Officer Quarles, you need to get up. It's time for your SNAPSHOT board."

EM3 Mark Quarles has been waiting for this moment since he arrived onboard shortly after the boat's last patrol. Like many who have gone before him, he has worked hard to prepare himself for his final qualification board. Months of study, checkouts, and walk-throughs have readied him to prove that he has the required knowledge of the ship's systems and damage control procedures and the ability to function under stress. When this evening is over – and if he has passed his SNAPSHOT board – he will exchange the red dolphins that he has worn since starting his final walk-throughs two weeks ago for his silver dolphins.

Preparations for this four-hour board require substantial personal efforts from many more crewmembers than just Petty Officer Quarles. Each set of silver dolphins earned onboard USS *Alaska* (SSBN-732) (G) represents an incredible amount of work by both the individual and his shipmates, who devote countless hours to check-outs and instruction, plus setting the stage for the board itself. Each event on every board is formally reviewed and approved by the Chief of the Boat, the Executive Officer, and the Commanding Officer and is designed to test for the same basic skills.

With the approved plan for Petty Officer Quarles' board in hand, the SNAPSHOT Team has already met after dinner with their team leader, ETC(SS) Troy Harrel, and formally briefed the sequence of events, safety considerations, and basic skills the Sailor will be expected to prove in each event. There is no doubt that qualifying submariners this way involves a great deal more effort by the ship, but the pay-off in ship-wide *esprit d' corps* and damage control readiness is incredible in comparison with the way submarine qualification boards are normally done with only a formal interview.

The SNAPSHOT Board Begins

Petty Officer Quarles is now dressed and makes his way to Damage Control Aft in Machinery-Two Upper Level. His board begins with an introduction that emphasizes how Quarles will become part of a heritage of heroes who have offered their very lives to save their ship, their shipmates, and the mission. The six members of the SNAPSHOT Team – dressed in their red tee-shirts, blue and khaki utility pants, and black boots – will serve as both his evaluators and his peers in carrying out tasks he directs.

The introduction picks up: "On 4 April 1924, the Medal of Honor was awarded to TM2(SS) Henry Breault for the following acts of heroism, quick thinking, and self-sacrifice. These acts have served as symbols of what is best in submarining… If you succeed in all areas of the test, you will be awarded your dolphins and join the fraternity of submariners. Let's begin!"

The crackle of the 1MC is heard throughout the ship announcing, "There is a ship's qualification board in progress. Disregard all 4MC announcements until further notice." A few minutes later, the Executive Officer is not surprised when he hears the speaker next to his desk come alive with Petty Officer Quarles' voice saying, "Emergency report, emergency report.

Injured man in Engineroom Upper Level." The board is underway.

The concept for this crucible event grew out of the Navy recruit-training graduation exercise known as "Battlestations," where each recruit works with his team to complete a series of drills over a very long night to demonstrate hands-on what they have learned. When CMDCM Dave Lynch came onboard as Chief of the Boat, he recalled his tour as the Recruit Division Commander for the first group of recruits to participate in Battlestations and set out to create the same experience onboard *Alaska*. Book knowledge is necessary, but without the ability to apply it under stress, it's not worth much to us out here at sea, so he inspired a core group of superior Sailors to take the idea and turn it into reality. Making up this team were STSC(SS) Chris Shanklin, MM1(SS) Jeremy Bennett, MM1(SS) Tom Madden, MM2(SS) Nick Wallace, MT2(SS) Ken Ekhart, YN2(SS) Jon Simons, STS2(SS) Alex Dudder, MM2(SS) Mark Pearson, MM2(SS) Eric Stanton, MM1 Justin Buckman, ET2(SS) Tommy Erikson, MT2(SS) Nate Capps, and STS2 Chris Juroshek.

So far, 47 *Alaska* Sailors have completed a SNAPSHOT qualification during two strategic deterrent patrols – MM3(SS) Brian Haug was the first, and MT3(SS) Kelvin Coleman was the most recent. Because of all the hard work that goes into the preparations, there is a natural desire to see everyone get through, but in fact some will not make the grade – a disappointment for all concerned. To date, 17 boards have been failed, however in all but one case, we were able to provide detailed feedback and develop a plan for qualifiers to get through on a subsequent attempt.

Getting Down to Business

EM3 Quarles comes down the ladder, turns into the Machinery Room, and sees a small "fire". He makes a deliberate 4MC announcement from the scene: "Emergency report, emergency report. Fire in Machinery-One. Fire in the external hydraulic plant." He puts the handset down and races for the nearest fire extinguisher, securing the external hydraulic plant in the process. One of the SNAPSHOT team members prevents him from actually discharging it but provides him a simulation that the carbon dioxide is being applied to the fire, even as it grows out of control, with smoke assumed to be filling the compartment. The Sailor pulls an Emergency Air Breathing (EAB) mask from the nearest locker, plugs in, and continues to fight the fire with another extinguisher. However, when a fire on a submarine grows beyond the capability of a couple of fire extinguishers, it is time to start fighting it with water. Quarles directs several of the facilitators to take out and pressurize the fire hose while he, as the man-in-charge, makes a full damage control report to Damage Control Central on the 4MC. Now there's a new problem – only a trickle of water comes out of the hose. Quickly inspecting it, he deduces that that the nozzle is clogged. After showing the facilitator – who feigns ignorance – how to clear the nozzle, he continues to lead the attack on the fire, and it "goes out."

Next, Quarles is sent to Missile Compartment Third Level to monitor atmospheres with portable equipment and then back up two levels to Machinery-Two Upper Level, where Damage Control Aft is located. "Petty Officer Quarles, don a fire-fighting ensemble and an OBA [oxygen breathing apparatus] and conduct a search of the forward compartment with a NFTI (Navy Firefighters Thermal Imager)," directs one of the SNAPSHOT Team members. Quarles suits up quickly, signaling that he had completed the final step of lighting off his OBA by tapping on his face shield with the cotter pin from the canister and testing his new atmosphere. A fresh canister is expended for each board.

Without a knock, the wardroom door bursts open, interrupting a qualification board for Diving Officer of the Watch. Petty Officer Quarles, encased in his OBA and bearing the thermal imager, is conducting the search. He looks around and then backs out. With his hand on the D-ring on the back of the OBA, ETC Harrel carefully tends the Sailor for safety while he navigates the ship looking only through the NFTI. Entering the Torpedo Room, Quarles sees a warm figure lying on the deck, motionless. He quickly checks on his shipmate and then calls for help from the Emergency Medical Assistance Team on the nearest 4MC. He is then sent back to DC Aft to remove the heavy gear. The board is going well, and this opportunity to cool off and get dry is most welcome – but it doesn't last… "Rig a portable submersible pump in Missile Compartment Lower Level"… then, "Combat a flooding casualty in the Torpedo Room." And after that follows Quarles' knowledge interview in the Officer Study.

The Knowledge Interview

The 1MC barks the following announcement: "Ship's qualification board is complete. Regard all 4MCs." Our candidate has completed most of the practical part of his board and moves on to the academic portion. The corresponding announcement last evening came one hour earlier – because that Sailor's board ended abruptly when he made too many errors and didn't quite meet the standard. (But he'll do his re-board in about two weeks and do well.)

A submarine-qualified officer is required to certify the knowledge level of each enlisted Sailor before he can earn his dolphins. Normally, onboard *Alaska* Gold, two junior officers or a department head sit on each board. Tonight, the Weapons Officer and two senior enlisted submariners

(left) MM3 Williams fights a simulated fire (identified by the red lights) in the three-inch launcher space.

(above) MM2 Wallace monitors MM3 Williams' fire-fighting skills.

wait patiently for EM3 Quarles to arrive in the Officer Study for his interview. Having just applied a bandit patch – successfully – to a ruptured, flooding pipe in the Torpedo Room bilge, he is very wet and very tired, but he's been provided a towel to dry off with as he gets ready to demonstrate his knowledge of the ship's systems and damage control procedures.

Quickly getting down to business, the interview team first probes his knowledge of the trim and drain systems by asking him to draw the system diagram and then answer a battery of questions. How would you pump forward trim if the trim pump failed? What is the purpose of the priming pump and header? How do you pressurize the fire main? This portion of SNAPSHOT sounds like a conventional qualification board, but now, the Sailor's physical and emotional fatigue adds another dimension of stress.

The interview begins at 2130 and will last about 45 minutes. During this time, the SNAPSHOT Team caucuses and reviews how Quarles has done on each event. Not surprisingly, some went better than others, but was he able to perform under stress? How much help did he need to get through? Did he find all the injured men? Was he able to pump the bilge in the Missile Compartment with the portable submersible pump? All things considered, it's clear that EM3 Quarles has done very well so far. If he sustains the knowledge interview, the team leader will begin passing the word that there will be a dolphin presentation in the Crew's Mess at 2300.

Taking charge

Some of the things that we see during these boards are amazing. When stressed and a bit confused, Sailors do things like plugging EAB hoses into their own "buddy" connection – we call this recirculating, and it doesn't work – or trying to connect a non-collapsible hose to the submersible pump without first removing the foot valve that is screwed on at the bottom of the pump.

But stress can also bring out the best in people. At some point during the board, they really "get into" the scenario and do whatever is required to survive and get the job done. The most dramatic performance was by ET3 Jason Smith in rigging a submersible pump, when he took charge of the COB and other SNAPSHOT facilitators by directing, "You guys come with me!" The ability of these junior Sailors to take charge and lead casualty actions has been an unexpected but very welcome result of the SNAPSHOT boards.

As expected, EM3 Quarles passes his knowledge interview easily and is taken to the Sonar Equipment Space, where he demonstrates how to operate a main ballast tank vent manually, following each step of the procedure methodically while supervised by MM1 Madden. Following procedures to the letter is the standard for all operations onboard a submarine, and no less is expected here.

The next task: "Execute a submarine escape from the Mid-Logistics Escape Trunk. Petty Officer Capps will be egressing with you and you will need to lead him through it." The ship is at 190 feet going 10 knots, and since actually flooding down the trunk and leaving the ship would be considered going a bit too far, most of the procedures are simulated. Both men enter the trunk through the lower hatch with their buoyant "Steinke" hoods and walk through each step of the evolution. By the time they are done, both are glad to leave the cold damp and dim light of this tiny unheated space.

One more hurdle remains – the EAB walk, where Quarles must traverse every compartment of the submarine, plugging himself into many of the hundreds of air connections throughout the ship. Everyone who's done this knows that it's an exhausting exercise, but making it to this point also means that the board is nearly over.

(far left) MT3 Coleman rings the bell at the successful completion of his SNAPSHOT board.

(left) MT3 Cuthbertson removes his dolphins from the "fishtank," at the completion of his board.

Photos by MM1 Tom Madden, USS *Alaska*

Awarding the Dolphins

Tired, sweaty, emotional, and fired up by adrenaline, Petty Officer Quarles pushes into the Crew's Mess, pulls the EAB from his face, and vigorously rings the bell on the aft bulkhead signifying that his board is now complete. Immediately and without any order given, all officers and crew come to attention in honor of the Navy's newest submariner. Flanked by the Chief of the Boat, Quarles opens a hinged shadowbox, known as the "fishtank," and carefully removes a set of dolphins engraved with his name and the date. He proceeds forward to where the Captain is waiting and hands him the insignia. The Executive Officer then recalls an episode from submarine history by reading a passage from Theodore *Roscoe's United States Submarine Operations in World War II* about USS *Wahoo* (SS-238), commanded by CDR Dick O'Kane. *Wahoo* singlehandedly sank nine ships in 10 days of action, including one engagement in which the 20-mm machine guns jammed in a close-range surface attack, and the crew finished off a 100-ton trawler with a crate of "Molotov Cocktails" presented to the them by U.S. Marines on Midway.

Alaska's Captain, CDR David Solms, unpins the red dolphins and sets them aside. He likens Petty Officer Quarles' efforts in completing his qualification to those of the determined and resourceful crew of the *Wahoo*, and as he pins on the dolphins, the 1MC crackles to life again, "Electrician's Mate Third Class Mark Quarles, qualified in submarines." Two blasts of the diving alarm provide a biting exclamation point to the announcement. Before ending, EM3(SS) Quarles takes a moment to thank all those who led and encouraged him in completing his qualifications. He has now fully earned the right to be called a submariner, and each member of the crew, some wearing dolphins, some not, congratulates him personally.

As for the battered and beaten-up red dolphins, they go to another Sailor just now starting final walk-throughs. He puts them on proudly, knowing that they've served as a badge of courage for many shipmates before him.

LCDR Monroe and CMDCM Lynch are Executive Officer and Chief of the Boat, respectively, onboard *Alaska*. LCDR Monroe is also a previous Military Editor of UNDERSEA WARFARE Magazine.

SAND-CRAB SUBMARINERS

Three Sub Sailors Volunteer for Shore Duty – in *IRAQ*

by JOC Michael Foutch, USN

The gritty, sandy soil of Iraq, far from any ocean, is an unlikely place to find a trio of submarine Sailors.

And yet these three undersea warriors have joined the Coalition Military Assistance Training Team (CMATT) in that war-weary nation in a daunting mission. Trading their duties in the relative comfort of shore stations in the United States for the unexpected perils and occasional rewards of a front-line position in the Global War on Terrorism, the three submariners have exchanged their coveralls for desert camouflage to help rebuild the Iraqi military and its infrastructure. Headquartered in Baghdad, CMATT works under the guidance of the Coalition Provisional Authority to supply buildings, weapons, equipment, and training for Iraq's new security and defense forces.

ETC(SS) Jason Taggart, YN2(SS) Randy Murray, and YN2(SS) Karl Rosenkranz, who served together onboard USS *Henry M. Jackson* (SSBN-730), volunteered for this unique assignment. After a week of training and processing at Fort Bliss, Texas, they climbed aboard a plane for Kuwait and then moved on to Baghdad.

Taggart, who left the Trident Training Facility in Bangor Washington, was assigned to the British Brigadier personal security team. Murray, stationed at Submarine Base Kings Bay, found himself with the administrative group at CMATT in Saddam Hussein's former presidential palace in Baghdad, overseeing administrative needs for the 300-person joint multinational command.

In late October, Rosenkranz, who departed the Naval Intermediate Maintenance Facility, Pacific Northwest, for temporary duty in Iraq, began an e-mail correspondence with UNDERSEA WARFARE. Over several months, he has been telling his story of training Iraqi military recruits and administering pay records for thousands of new soldiers and sailors. Perhaps the most compelling aspects of his e-mails are the pictures and descriptions of smiling – grateful Iraqi people, to say nothing of the day his unit came under attack outside a checkpoint at Baghdad International Airport.

Rosenkranz sent his notes from a forward-deployed unit at the Kirkush Military Training Base, 25 miles away from the

(clockwise from above)

YN2(SS) Karl Rozenkranz, who volunteered last fall to leave his shore job in the Pacific Northwest for Iraq, examines the workings of an AK-47.

Along with sand shipmates YN2(SS) Randy Murray and ETC(SS) Jason Taggart, Rozenkranz became one of a handful of submarine-qualified Sailors to become adept at firing not only the foreign-made rifle, but the 40-mm grenade launcher and the AT-4 anti-tank missile.

None could believe that a Navy

border with Iran and a complex from which Saddam Hussein's forces were launched against that country during their eight-year war in the 1980s. Kirkush was abandoned during the first Gulf War, and CMATT moved in following the collapse of the regime last spring.

"At first, conditions were rough," with no running water and only MRE packets for food, Rosenkranz wrote. But any lack of creature comforts was more than compensated by the people the yeoman encountered in his unusual assignment.

"I think the greatest reward," he noted, "is talking to the Iraqi soldiers, who tell us about life under the former regime. How they waited and waited for the Americans to come – stories of how their lives have improved… I mean, you should have seen their faces when we told them that they have a right to complain, to free speech, and so forth. It put it all in perspective, especially when you drive through the towns and see the children run up to the Humvees asking for chocolate and waving at us.

"But it is still scary as hell, don't get me wrong. Everyday it is something – mortars, RPGs, AK-47 fire. When I first got here I thought – 'cool, I'm gonna be the first submarine YN to see ground combat in history' – that I know of at least. But when it actually happened it wasn't as cool as I thought. Nonetheless, I am proud to be here representing the submarine service, and believe me, every one I come across will remember working with submariners."

Rosenkranz also joined what must certainly be a small number of dolphin-qualified Sailors trained to fire a 40-mm grenade launcher and the AT-4 anti-tank missile.

His next e-mail reported how he spent his Thanksgiving holiday. Instead of enjoying turkey with all the trimmings in front of a football game on TV, "mine consisted of a 10-mile road march" and welcoming some new friends. "We have received our third (battalion) recruits, some [from] the new Iraqi Coastal Defense Force, their navy," he wrote. In response to the need for administrative support for these new recruits, Rosenkranz created the Kirkush base's first personnel support detachment and, "I now maintain the pay and personal records for over 4,000 soldiers. This entire system was based all on the Navy way of handling pay and service records, with an Arabic twist."

Not all his time was spent processing paperwork, however. In the same e-mail, the yeoman wrote, "Last week, we had the chance to go to the local town and hand out soccer balls. They were paid for by the coalition troops, who donated them to the children of Balad Ruz. I never knew the power of a soccer ball, but when we handed them to the kids, I realized the entire reason we are here was for moments like that. Their smiles and cheers and thumbs up will stay with me forever. None could believe that a Navy submariner was

submariner was here with them – I had to explain what a submarine was first.

here with them – I had to explain what a submarine was first. Just look at the photos and you will see what I mean.

"Recently, I went on a convoy to Baghdad and got to go inside the former Saddam Hussein International Airport. What an experience to go inside this place that was the site of a big battle during the war and to see them rebuilding it. The other day, we received a call that some soldiers found [unexploded ordnance] in an irrigation ditch, so naturally, we went out to the scene. It turned out to be six type-6 Iraq hand grenades – all of them booby trapped. What a thrill it was to see this stuff up close! Also this week, I got to make a security sweep up the Iraqi-Iranian border."

Rosenkranz' next report arrived on December 14, the day Saddam Hussein was captured by a force of 600 soldiers in a remote farm near Tikrit.

"We gathered all the [Iraqi] soldiers and read the announcement. There was so much cheering and dancing and singing… the looks on their faces! – if only you could have seen them. Some cried, others shouted 'Death to Saddam.' If I could only express how excited these people are to actually have true freedom now. I am truly glad to be a part of history instead of watching it." But despite the euphoria that resulted from capturing the tyrant in his spider hole, Rosenkranz cautioned his unit that they, as well as coalition troops in the country, could expect counterattacks.

On New Year's Day, the yeoman found himself in the middle of one such attack. His convoy had departed the Kirkush outpost for Baghdad for a brief mission visit and had just begun their return journey when it was interrupted with a deafening explosion.

"On our way out of the main checkpoint about two klicks out, we heard a large BOOM – then dust flew all around us, [and] there was ringing in our ears. Then, we heard small arms fire break out. At this point, everything slowed down, and I realized that I was scared. Our convoy returned fire and the insurgents were liquidated. I was the only one in an unarmored Humvee – and I count my blessings.

"Afterwards, we went back to camp and unpacked and tried to wind down. I cried in my tent for at least an hour. I realized that no matter how tough I thought I was, it can all disappear. I tell you this not to worry you, but to show you that all your prayers and thoughts have and will continue to protect me, and I thank you."

Even after the attack, Rosenkranz stayed optimistic about his mission, and that of the coalition helping to rebuild Iraq.

"This new year will bring more hope and prosperity to the Iraqi people then they have ever had, and chances they never dreamed of. When we do civil affairs missions, and we tell them they have rights – like free speech, voting, humane treatment, etc. – their eyes light up, and it is just a moment you have to be there to see. So in closing, I hope each and every one of you a Happy New Year, and may you all live happy and fulfilled lives."

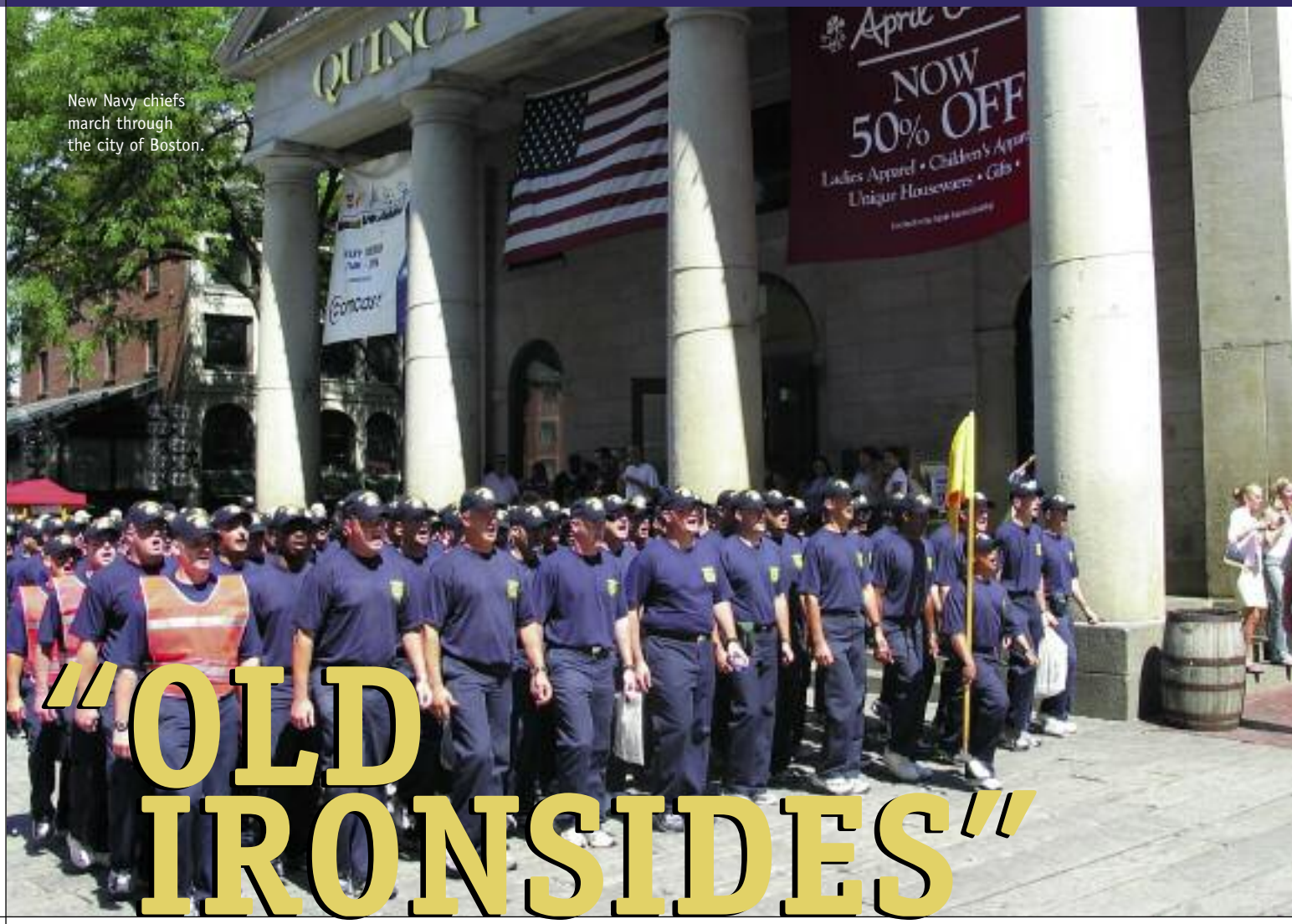
As incongruous as it may seem to have U.S. submariners serving in the sands of Iraq, Petty Officer Rosenkranz and his shipmates have contributed not only to the reconstruction of that struggling country but also to restoring hope to a people who had precious little remaining. They'll leave with fearful memories of the dangers they faced – but also remembering the grateful expressions on the faces of the Iraqis they risked their lives to help.

(left) Jubilant Iraqi children hold their presents above their heads. Coalition troops delivered a shipment of soccer balls during a trip to a local village.

(below) YN2(SS) Rozenkranz helps deliver soccer balls to the Iraqi children.

Chief Foutch is a Military Editor of UNDERSEA WARFARE Magazine.

by JOC(SW/AW) Mark O. Piggott, USN



New Navy chiefs march through the city of Boston.

"OLD IRONSIDES"

The History of USS *Constitution* Teaches New Chiefs About Navy Traditions

Honor, Courage, Commitment… This is the code of a United States Navy Sailor. It has been a part of our heritage since the Navy was founded in 1775. Yesterday and today come alive everyday for Sailors onboard USS *Constitution*, the oldest commissioned warship afloat in the world.

Recently, "Old Ironsides" played host to over 300 chief selectees from Navy ships, submarines, shore commands, aviation squadrons, and reserve units around the world. This is the seventh year that *Constitution* has hosted the event, giving the new chiefs vital training and lessons in naval history.

"The *Constitution* fought in 33 engagements and never lost," said BM2(SW) Andrew P. Dingman, one of the tour guides onboard *Constitution*. "Two hundred years ago, the *Constitution* fought against the terrorist Barbary pirates. As a symbol of our war against terrorism today, it is a reminder that we will remain undefeated as a Navy."

Of the 150 chief selectees from the fleet, 44 were submariners. From Kings Bay to Norfolk, from Pearl Harbor to Groton, these senior Sailors took pride in representing the "silent service" during their visit. "The submarine community is very close knit," said EMC(SS) John P. Peckham, 39, of Submarine Squadron Support Unit (SSSU), Norfolk. "We are standing in for our fellow submariners, so we have to step up and not fall behind."

During the four-day event, the new chiefs learned about the life of a Sailor serving onboard the *Constitution* in the 1800s. From climbing the mast and setting the sails, to manning the guns and even sleeping onboard, these chief selectees filled the shoes of their 19th century counterparts. It was an eye-opening experience.

"I have a greater appreciation for what Sailors did before all the technology came along," said HMC(SS/SW/AW) Rodger A. Buck, 29, from USS *Newport News* (SSN-750) in Norfolk. "I would recommend this for all Sailors to come and see, especially future chiefs," the Ft. Walton Beach, Florida native explained.

"It's been truly rewarding to step back in time," said YNC(SS) Douglas C. Frisbie, 33, from Commander, Submarine Fleet Pacific. "It's hard to believe that a ship from the very beginning of our Navy is afloat today and in service."

"On a submarine, you have a lot of computers and fancy formulas to help you destroy an enemy with a torpedo or Tomahawk," said MMC(SS) Richard T. Abrahamsen, 36, of SSSU Norfolk. "Lining up one of these guns takes a lot of muscle and keen eyesight. It's a lot different from what we're use to."

"They were a different breed of Sailor," Peckham added. "I challenge any Sailor today to do what they did. In rough seas, climbing across the yardarms, setting the sails – it's amazing that they were able to do it," the Weymouth, Massachusetts, native continued.

The one factor that brought the chief selectees together was teamwork, and it reflected the teamwork it took to make the *Constitution* a fighting warship. "Absolute teamwork," Abrahamsen noted. "Everyone has to know what everyone else is doing to get the job done, whether its rigging the jib or firing one of the ship's 24-pounder long guns."

"We have to work together as a team on a submarine," the Magnolia, New Jersey native continued, "so once we start working together as a team, we can get any job done. We've been able to do that here with all the new chiefs."

Teamwork really came into play when the chief selectees were divided into gun crews and learned how to fire the ship's long guns. They drilled the same way their 19th century counterparts did, trying to match their best speed. "A gun crew in the 1800s could fire a single round in thirty seconds," Buck said. "That's unbelievable. It's amazing what they could accomplish."

Some of that teamwork was applied to some community-service projects. The new chiefs went out to Warren-Prescott Elementary School and spent part of their day cleaning, painting, and generally getting the school ready for students coming back to class in less than a week. "We have the manpower, they have the need," said ETCM(SS/DSW) Steve Brandt, *Constitution*'s Command Master Chief. "We're emphasizing teamwork with the new chiefs to get done whatever they need to get done."

"They are getting a lot of work done that normally would never have been completed due to budget shortfalls," said Dr. Domenic Amara, the school principal. "I think the whole experience has been nothing short of excellent."

"Overall, it adds a whole lot of meaning to why we're here," said SKC(SS) Jason P. Buonvino, 32, of SSSU Norfolk. "The team is really coming together, especially for these kids."

USS *Constitution* is just one feature of the "Freedom Trail," a 1-1/2 mile walking tour of Boston's historical landmarks. The new chiefs marched through the streets of downtown Boston, past Paul Revere's House, the Old North Church, and Quincy Market, singing and calling cadence for all of Boston to hear. People stepped out of their homes, stopped at a corner, or peered out of a restaurant window to see the chief selectees marching by. Some would clap and cheer; others would just say thank you. It was quite a spectacle.

The new chiefs served aboard *Constitution* for four days, climbing the mast to set sails, manning the guns, even sleeping onboard.

"When you're in a city like Norfolk where there's nothing but Navy, you don't get that kind of appreciation from people," Buck said. "The people of Boston don't get to see the Navy that often, and they're letting us know how they feel."

"We're not only doing this for ourselves," Buonvino added, "but it allows us to show off our 'Navy Pride.' And it's a good feeling."

This wasn't just a chief's event, but also a family affair. Two brothers, ETC(SS) Christopher O. Leggett, and HMC(SS/FMF) Michael A. Leggett, both made the trip to Boston. For these brothers, it was the first time in their 13-year careers that they've actually been together in one place except for home in Raeford, North Carolina.

"We've never served together," said Christopher, "at any time in our careers. The pleasure of being with my brother is first and foremost, and to learn from chiefs of all specialties while surrounded by all this history is highly motivating," he continued.

Another new chief got his father involved. ETC(SS) Eric B. Jones, 32, Pre-Commissioning Unit *Texas* (SSN-775), was surprised when his father, AWC Kirby Jones (retired), showed up at the *Constitution*. "I'm just as proud as can be," Kirby said. "I'm jealous he gets to do all this. I wish they had it when I made chief."

"Being here means so much to me, and sharing it with my father makes it even more special," Eric said. "Here on the *Constitution*, looking at the things these Sailors used to do is incredible. It gives me more appreciation for what my father did in the Navy and what those Sailors did in the 1800s. By being here with my father, the traditions of the past go on from generation to generation, and will not be lost," he explained.

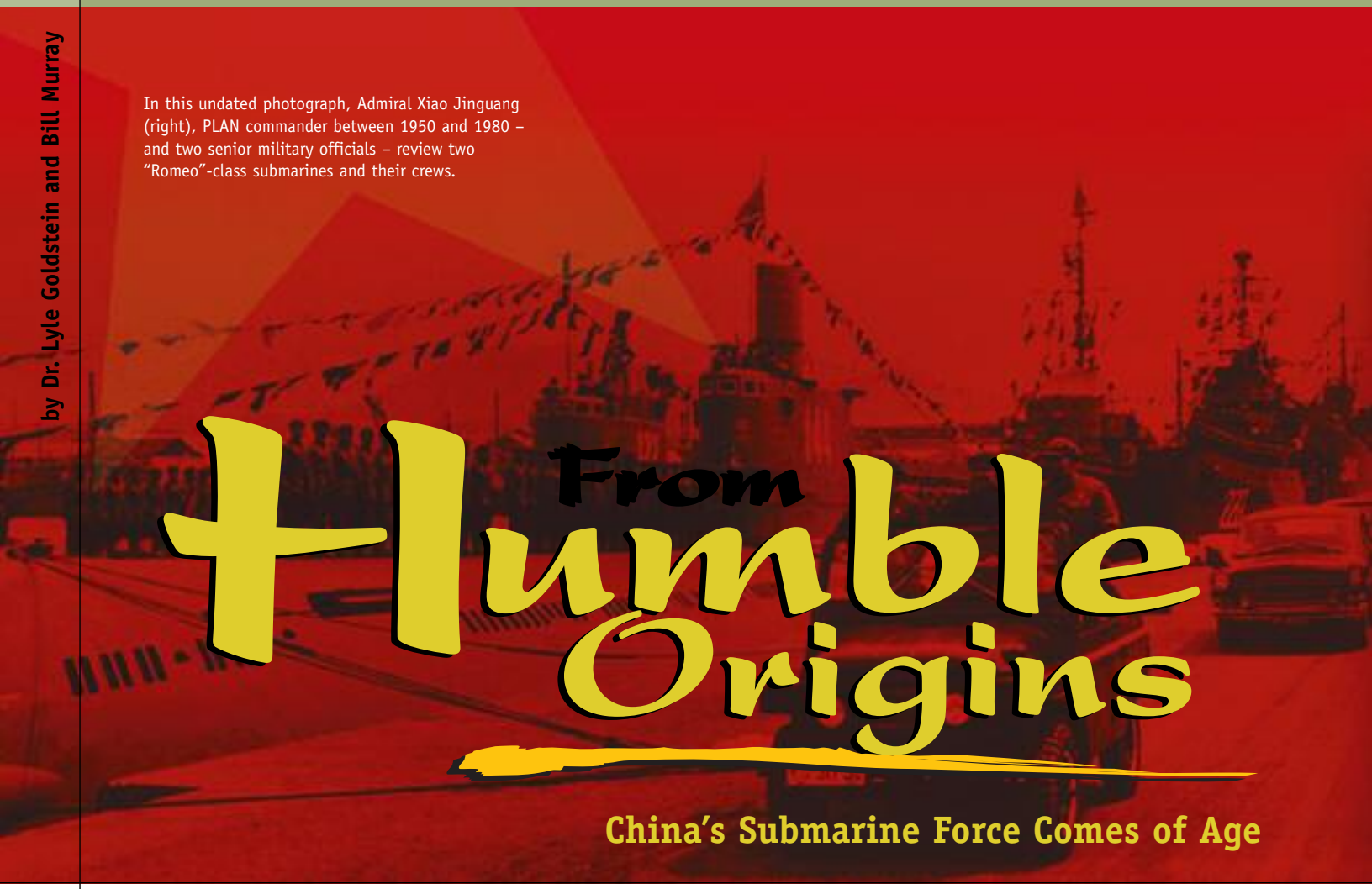
The final day of the event culminated in a "turn-around" cruise, in which the chief selectees manned the ship and actually got "Old Ironsides" underway. The ship sailed out over two miles while the new "crew" manned the yards and fired a 21-gun salute to the United States of America.

"This is what it's all about," Abrahamsen said. "All the hard work we've done to get this great ship underway, the training in the ropes and the guns – it was definitely worth it."

"This ship is a living representation of the core values of the Navy," Buonvino added. "It's an honor for all of us just to be here."

Chief Piggott is the Force Journalist serving under Commander, Naval Submarine Forces.

by Dr. Lyle Goldstein and Bill Murray



In this undated photograph, Admiral Xiao Jinguang (right), PLAN commander between 1950 and 1980 – and two senior military officials – review two "Romeo"-class submarines and their crews.

From Humble Origins

China's Submarine Force Comes of Age

The maritime balance of power in the East Asian littoral is undergoing slow, but steady change in Beijing's favor. Numerous indicators, including the imminent sea-trials of the first of China's 2nd-generation nuclear submarines, the first serial production of its indigenous *Song*-class diesel boats, and the ongoing purchase from Russia of eight "Kilo"-class diesel submarines, all confirm PRC progress in undersea warfare across a broad front.

Because of a centuries-long history of neglect, incompetence, and defeat at sea, there is a strong tendency in Washington to rate the Chinese as poor mariners. The recent accident and loss of all hands onboard a *Ming*-class submarine in April 2003 only serves to reinforce these stereotypes. However, besides obvious safety lapses, the incident also shows that the submarine force of the Peoples Liberation Army Navy (PLAN) is engaged in a vigorous program of realistic at-sea training, under battle-like conditions. Moreover, despite this recent mishap, the appointment of Admiral Zhang Dingfa – a nuclear-trained submariner – to head the PLAN suggests growing momentum in undersea warfare.

Indeed, it was the emerging "ASW problem that we have out there in the Western Pacific," that moved Pacific Fleet Commander ADM Walter Doran to call on the U.S. Navy to "rededicate ourselves to getting back into [the ASW] business." With undersea operations a key element of China's emerging maritime strategy, the U.S. submarine community must learn more about this prospective competitor. Since the origins and development of any large and complex institution over time will have a strong influence on its future evolution, this article reviews the known history of the PLAN submarine force.

200 Submarines for Imperial China

Following the humiliating Opium War of the mid-19th century, China faced continual encroachment from Western nations, and total defeat at the hands of the "upstart" Japanese in 1895. The occupation of Beijing by an alliance of powers in 1900 only added insult to injury. China's profound maritime weakness, however, encouraged surprisingly bold thinking about emerging technologies for undersea warfare. Over the last decades of the 19th century, Chinese leaders attempted vainly to gain the support of foreign powers, particularly Britain and France, for constructing a modern navy. In 1915, a former U.S. naval attaché, CDR Irvin Gillis, arranged for the visit of Vice-Admiral Wei Han and 30 Chinese student officers to Groton, Connecticut to observe submarine building and operations. According to one account, Wei Han "delighted [Electric Boat] officials by announcing that China needed a fleet of 200 submarines." An initial purchase of 12 vessels was inked, and plans for training Chinese crews were put into place. Unfortunately for China's navy – and for Electric Boat – these agreements collapsed as the imperial regime gradually gave way to the so-called warlord era.

Years of desultory internecine warfare among the warlords were followed by a period of growing consolidation during the late 1920s and early 1930s under the leadership of the Chinese nationalist, Chiang Kai-shek. Submarines continued to be of significant interest. Chiang attempted to purchase German submarines in 1934 and hired a German naval advisor. Although nothing

materialized, Chiang did succeed in sending a number of young naval officers to Germany for training on submarine technology. Some of these officers would later rise to prominence in the PLAN. After these false starts, China finally received its first two submarines from the British after World War II, but following the Communist civil war victory in 1949, China would look to Russia for submarine assistance.

Little Brother

In fact, close cooperation with Soviet submariners predated the Communist victory in China. Stalin's Red Army had entered northern China during the final weeks of the war against Japan in mid-1945. By 1948, a significant force of 14 Soviet submarines patrolled the Yellow Sea, operating out of Lushun at the tip of the Liaodong Peninsula. In the fall of 1948, Chiang Kai-Shek's Kuo-Min Tang (KMT) faction, fielding a number of surface combatants, attempted to blockade Manchuria and insulate central China from Communist infiltration. This effort failed, probably because of intelligence on the KMT patrols from Soviet submarines, and when the Peolples Iberation Army (PLA) also succeeded in landing large contingents of Communist organizers on the nearby Shandong Peninsula, Chiang's armies were soon defeated in central China.

The Communist Party approved the preliminary formation of a Chinese submarine force in June 1949, four months before the official founding of the PRC.

Mao Zedong's focus on submarines reflected both his determination to end the "Chinese nation's total failure to create maritime defenses" and the strong influence of the Soviet "New School" approach to maritime strategy. The doctrine was encapsulated in a three-character phrase to guide the PRC's new navy: "Qian, Kong, Kuai" – "Submarines, [Land-Based] Aircraft, and Fast [Attack Patrol Boats]." In 1951, several hundred officers were selected from the ground forces to form the nucleus of the new submarine corps. Many were sent to study with the Soviet Pacific Fleet and trained aboard Soviet submarines. However, a year later, the submarine force suffered its first major institutional setback when the extraordinary demands of the stalemated Korean conflict forced the PLA to divert funds from shipbuilding to aircraft production.

Nonetheless, step-by-step progress under Soviet tutelage continued during the 1950s. Over the course of the decade, 275 Chinese students traveled to the USSR to study submarine building and operations. In 1953, the PLAN received its first submarines, (one M-class, and three S 1-class) from the USSR and founded the submarine academy at Qingdao. The following June, the PLAN declared its first, four-ship submarine squadron operational, although some authorities believe that submarines operating in the Yellow Sea before 1954 may well have had joint Sino-Soviet crews. On the whole, China's initial submarine efforts were concentrated in the North Sea Fleet, probably to counter U.S. forces based in Japan. Mao's recognition of the importance of the developing submarine force was underscored by his January 1956 visit to the Jiangnan shipyard in Shanghai, where the PRC's very first submarine was being built from a Soviet kit. China would eventually build 21 of these Soviet "Whiskey"-class boats.

As early as 1956, even before China had produced its first diesel boat, nuclear propulsion for submarines was adopted as a national priority by Mao himself. The daunting challenge that this entailed only became fully clear after Moscow refused Beijing's explicit request to share nuclear propulsion technology, on the grounds that it would be premature for the PLAN. Foreshadowing the imminent souring of Sino-Soviet relations, Mao reacted indignantly: "We will have to build nuclear submarines even if it takes us 10,000 years." In July 1958, the Politburo approved an ambitious plan to develop nuclear propulsion and an SLBM simultaneously.

Problematic Adolescence

By 1957, the year that culminated a "golden age" of relatively rational governance and steady development under the Communists, the Chinese had established a strong foundation for their submarine force. However, this period was followed by the gravely-destructive Great Leap Forward (GLF) in 1958 and later by the Great Cultural Revolution (GCR) of 1966-69. These periods of tumult had lasting, deleterious effects on the PLAN submarine force.

Mao's GLF was an attempt to accelerate China's modernization process by turning away from the Soviet model of development in favor of an effort to harness the ideological will of the Chinese people. Accordingly, Mao rejected Khrushchev's offer to create a joint Sino-Soviet fleet in exchange for a renewed Soviet naval presence in Chinese waters. As a result, Russia was prevented from locating submarine broadcast transmitters on the Liaodong peninsula, and China lost a unique opportunity to augment the strength and operational capabilities of the PLAN undersea force.

Moreover, the fiscal chaos that resulted from numerous irrational economic methods – ranging from community dining

Photo from Guoji Zhanwang

Photo from Jianchuan Zhishi

(left) Soviet-designed "Romeo"-class conventional attack submarines were produced in significant quantities by China between 1965 and the early 1980s, and the PLAN eventually had more than 60 of these boats in service. The "Romeo"s displaced 1,319 tons surfaced and 1,712 tons submerged on a length of 252 feet. China continues to produce the *Ming* class, which originally was simply a wider "Romeo", but has been continuously upgraded with advanced quieting and weaponry.

(far left) The PLAN's first nuclear-powered attack submarine – of the *Han* class – was laid down in the mid-1960s but did not enter service until 1974. The first two of these five ships were troubled with serious propulsion defects, lacked basic weaponry and electronics, and were never entirely reliable. The latter members of the class displaced 5,550 tons submerged on a length of 295 feet, and in 1985, one of them made a submerged voyage of 84 days.

China's only SSBN, the *Xia*, was laid down in 1971 but only entered service in 1988. Displacing approximately 7,000 tons submerged on a length of 394 feet, she carries 12 Ju Lang-1 strategic missiles. The first of a new SSBN class, which will carry 16 JL-2 missiles, is already under construction and may be at sea as early as next year.

The first of the indigenously designed and produced *Song*-class conventionally-powered attack submarines was launched in 1994, and the ships have entered series production. They displace 1,700 tons surfaced and 2,250 tons submerged on a length of 246 feet and can launch anti-ship cruise missiles while underwater.

The PLAN ordered four "Kilo"-class diesel submarines from Russian in 1993, and all were delivered by 1998. In 2002, Beijing agreed to purchase eight more "Kilos", with delivery scheduled for 2005-07. These very capable ships displace 2,350 tons surfaced and 3,126 tons submerged on a length of 242 feet, and they may be capable of firing the Russian SS-N-X-27 supersonic anti-ship cruise missile.

Photos from Jianchuan Zhishi

rooms to back-yard steel furnaces – quickly led to a famine that killed millions of Chinese during 1960-61. During the "three lean years" that followed, the government diverted resources away from the military in order to stave off total economic collapse. Naturally, the production of naval vessels, including the W-class submarines, was slowed considerably. Shipbuilding was also hindered by the sudden evacuation of all Soviet advisors in 1960 as the Sino-Soviet rift widened. Reportedly, operational readiness also suffered after the Soviet advisors pulled out, and there may have been an increase in submarine accidents. The extreme economic duress of the early 1960s nearly liquidated China's nascent nuclear-propulsion program, but though pared back significantly, it continued to lurch forward.

China's relations with the United States during this time were also very tense. In addition to testing its first atomic weapon in October 1964, Beijing was actively supporting North Vietnam in its escalating war. Just before the great rift opened between China and the USSR, the PLAN had received a kit and associated plans for a "Golf"-class ballistic missile submarine from the Soviets, and it was launched at Dalian in 1964. Washington was so perturbed by this development that a serious proposal was made – but subsequently rejected – to execute a preemptive attack against this vessel on its maiden voyage.

The Cultural Revolution of the late 1960s dealt another major shock to the Chinese submarine force during its troubled adolescence. Due to its reliance on technically skilled personnel and foreign assistance, the Navy was much more vulnerable to this crusade against intellectuals and foreign influence than the dominant army. Beginning in 1966, approximately 3,800 naval officers were investigated and purged, including at least 11 senior admirals. The troubled nuclear propulsion program was also affected by the resulting chaos. In 1966, the lead designer for the PLAN's prospective nuclear submarines, Huang Xuhua, was tried and retried by mobs of Red Guards, who accused him of being an enemy agent; only the intervention of Premier Zhou Enlai saved him from serving a sentence raising pigs. Additionally, factional violence broke out during January 1967 at the nuclear fuel plant in Baotou, interrupting research on fuel rods for submarine reactors. Given that China's first-generation nuclear submarines were developed against this backdrop, it is hardly surprising that their operational performance was considerably inferior to that of contemporary American or Russian vessels.

There were, however, significant areas of progress, perhaps the result of increasing defense expenditures during the period. In 1968, China broke ground on massive, hardened shelters for its nuclear submarine fleet not far from Qingdao and completed the installation in the mid-1970s. Of the 16 major combatants constructed during the Cultural Revolution, 12 were submarines, including the new "Romeo" class, which appeared in 1968. That same year the Chinese laid the keel for their first SSN.

But overall, the Cultural Revolution had a devastating impact on the development of China's submarine force. In a broad assault against military education, the Qingdao submarine academy, which had 2,000 students at the time, was closed down in 1969 and did not reopen until 1973. Training and maintenance also suffered during this tumultuous period and exacted a long-lasting toll from the PLAN submarine force. As elsewhere in Chinese society, the submarine force inherited a "lost generation" that had been poorly educated and trained. Perhaps even more debilitating, the Navy was forced to commission ideologically acceptable "left-leaning" officer recruits whose incompetence would impede technical and organizational progress in the force well into the 1980s. The disaster of the Cultural Revolution for Chinese maritime power has long been recognized in PLAN publications.

Back from the Brink

China's submarine force benefited significantly when the chaos of the Cultural Revolution was replaced by the rigid and total militarization of Chinese society in the early 1970s. This change was due partly to a growing perception of threats from the Soviet Union. Production rates of the PLAN's "Romeo"-class submarines trebled, to approximately six per year by 1974, and by 1978, China had more than 60 of these ships. China's first indigenous anti-ship torpedoes, the Yu-1 and Yu-2, also entered serial production at this time, to be followed a decade later by an ASW homing torpedo, the Yu-3. During the mid-1970s, Chinese submarines began to venture further afield, penetrating the first island chain (the line from the Philippine Islands, through Taiwan to the Ryukus), and even the second island chain (formed by Indonesia, the Marianas Archipelago, and the main islands of Japan) for the first time. Most signifi-

cantly, the first, long-delayed *Han*-class SSN became operational in 1974, although its propulsion system was highly susceptible to steam and primary leaks and reportedly exposed the crew to significant radiation dangers. The ship also lacked weaponry and basic electronic systems.

Deng Xiaoping's ascendance in the late 1970s signaled a welcome turn to more pragmatic policies in all aspects of Chinese governance. Even so, the submarine force could well have suffered from both significant reductions in China's defense budget and a new emphasis on China's ground forces after Vietnam successfully fought China to a bloody draw in 1979. Indeed, the nuclear propulsion program did suffer serious budget cuts during the early 1980s, but since decommissioning the oldest diesel boats increased overall efficiency, the PLAN submarine force made incremental progress. First, there was the successful submerged launch of the JL-1, China's first SLBM from the "Golf"-class SSB in 1982. In 1985, a *Han*-class SSN stayed under for 20,000 nautical miles and 84 days. Taking advantage of China's new openness to foreign technology, the PLAN bought French DUUX-5 sonars for its submarines, while initiating a major program to decrease the acoustic signatures of its existing submarine fleet. As the Soviet threat receded under Gorbachev, the PLAN's SSBN project apparently faced the threat of termination, but the successful submerged launch of a JL-1 from the new *Xia*-class SSBN in 1988 kept it alive. Concurrently, major geopolitical shifts were underway that would provide new impetus to Chinese seapower as it neared the 21st century.

China's "Great Cultural Revolution" decimated the ranks of the PLAN's fledgling submarine force, but subsequently, strong emphasis has been placed on increasing the professionalism of non-commissioned officers and raising the educational level of the officer corps.

Today and Tomorrow

Pivotal events at that time were the Tiananmen Square Massacre in June 1989, the Persian Gulf War, and the collapse of the Soviet Union in 1991. These developments both eliminated the perception of a Russian threat and raised the specter of ideological and even military conflict with the increasingly powerful United States. Moreover, the ongoing Chinese economic miracle that started in 1978 created plentiful resources that could now be devoted safely to maritime defense, at a time when the poverty-stricken Russians were eager to oblige with aerospace and maritime technology at cut-rate prices.

Under the direction of submariner Admiral Zhang Lianzhong, the PLAN placed orders for four diesel submarines from the Russians in 1993: two export-version type 877 "Kilos" and two improved type 636 "Kilos," all delivered by 1998. In 2002, Beijing agreed to purchase eight more type 636 "Kilos" with delivery to occur in 2005-07. As part of this deal, the Chinese reportedly will also acquire Russia's lethal SS-N-X-27 supersonic anti-ship cruise missiles with a range of over 100 nautical miles. Moscow is also selling its advanced Test-71 and 53-56KE wake homing torpedoes to Beijing, and China may have acquired Skval super-cavitating torpedoes.

These efforts are complemented by domestic production. In addition to retaining approximately 30 aging "Romeos" and continuing to build the derivative *Ming* class – with 20 now in the force – China has begun series production of its indigenously designed and manufactured *Song* class, the first of which was launched in 1991. The *Songs* – probably at least five, with eight or more under construction – incorporate advanced foreign technology and can launch anti-ship cruise missiles while submerged. China is also building the Type 093 SSN, with the first already nearing sea trials. Beijing boasts that this submarine will have performance equal to a *Los Angeles*-class SSN. Also on the ways is the Type 094 SSBN, which analysts expect at sea as early as 2005 with 16 8,000-kilometer nuclear-armed missiles.

PLAN leaders are ambitiously developing the human dimension of their underwater force as well by elevating the status of their professional non-commissioned officers in an effort to enhance and retain their skills. China's admirals have also acknowledged that they have to compete for skilled labor by increasing the pay of some ranks by 100 percent in 1999-2000 – and the PLAN is aggressively increasing the number of officers holding advanced degrees. Training in the PLAN submarine force is strongly influenced by U.S. capabilities and operations. There is significant emphasis on mine warfare, anti-surface warfare, and anti-submarine warfare – the latter a new mission for China's undersea force. By as-signing two separate crews to train on one submarine, the PLAN is potentially laying the groundwork for a major future expansion.

Conclusion

A group of PLAN strategists summarized their analysis of the mid-1990s revolution in military affairs (RMA) as follows: "We can conclude that during the First World War, the dominant vessel was the battleship, and in World War Two, it was the aircraft carrier. In future global wars, the most powerful weapon will be the submarine… [because] submarines will experience less impact from reconnaissance technology than other platforms." Current developments suggest that this view reflects the dominant thinking of the PLA high command.

Even while suffering from slavish imitation, bizarre happenings, and tragic loss, the PLAN submarine force has embodied some of China's most impressive technical achievements. Indeed, last April's submarine accident was not the PLAN's first nor will it be the last. However, the borrowed genesis and troubled adolescence of PLAN submarines should not obscure the fact that China has created a viable foundation for building a potent undersea fleet. Moreover, this newly-wealthy nation is well into a thorough modernization of its infrastructure for basic and applied research and its educational and management practices. China is well-positioned for rapid progress.

Since the 9/11 attacks, the U.S. and China have entered an unexpected period of bilateral cooperation. But even as Washington is clearly focused on more immediate problems in Iraq and elsewhere, Beijing's military modernization continues at a rapid pace. War between the United States and a rising China is hardly inevitable, particularly if our diplomats find a creative solution to the Taiwan issue, but if

continued on page 31

2003 BATTLE "E" WINNERS

Bangor, WA

SUBDEVRON-5

Parche (SSN-683)
CDR Chas Richard (CO)
MMCM(SS) Morris Pollard (COB) (D)
ETCM(SS) Jack Sanzalone (R)

SUBRON-17

Michigan (SSBN-727) (B)
CDR Thomas Calabrese (CO)
MMCM(SS) Tom Price (COB)

Michigan (SSBN-727) (G)
CDR Dietrick Kuhlmann (CO)
CMDCM(SS) Kurt Dessert (COB)

Pearl Harbor, HI

SUBRON-1

Los Angeles (SSN-688)
CDR Chris Thomas (CO) (D)
CDR Thomas Stanley (CO) (R)
STSCM(SS) Mark Flemon (COB)

SUBRON-3

Louisville (SSN-724)
CDR Michael E. Jabaley (CO)
CMDCM(SS) Tom Vatter (COB)

SUBRON-7

Cheyenne (SSN-773)
CDR Chaz Doty (CO)
STSCM(SS) Ron Spake (COB)

San Diego, CA

SUBRON-11

Helena (SSN-725)
CDR Timothy Bertch (CO) (D)
CDR Douglas E. Wright (CO) (R)
MMCM(SS) Dave Agnew (COB)

Arco (ARDM-5)
LCDR Charles Baker (CO)
CDR (sel) Peter H. Thomas (CO) (R)
CMDCM(SS) Randall Jones (CMC)

Deep Submergence Unit
CDR Hubert Clopp (CO)
CDR John M. Quigley (CO) (R)
STSCM(SS) Lance Reynolds (CMC)

Narwhal (TWR-842)
ENC(SW) Stephen Goodman
(Craftmaster) (D)
QMCS(SW) Nicholas Ramos
(Craftmaster) (R)
EM1(SW) Jim Wade (Cheng) (D)
EM1(SW) Samuel Galvan (Cheng) (R)

Guam

SUBRON-15

City of Corpus Christi (705)
CDR Robert Schmidt (CO)
MMCM(SS) Greaney (COB) (D)
ETCM(SS) Stefan Prevot (COB) (R)

Frank Cable (AS-40)
CAPT Kevin Ryan (CO) (D)
CAPT Paul J. Bushong (CO) (R)
CMDCM(SS/SW) David Kennedy (CMC) (D)
CMDCM(SW/FMF) Joe Campa (R)

Groton, CT

SUBRON-2

Submarine NR-1
CDR Dennis McKelvey (CO)
ETC(SS) Chad Samples (COB)

Philadelphia (SSN-690)
CDR Steven Oxholm (CO)
ETCM(SS) Patrick Agnew (COB)

SUBRON-4

Seawolf (SSN-21)
CDR Paul Stevens (CO)
MMCS(SS) Gerald Fresquez (COB)

SUBDEVRON-12

Augusta (SSN-710)
CDR Mike Haumer (CO)
MMCS(SS) Dave Bulkley (COB)

La Maddalena, Italy

SUBRON-22

Emory S. Land (AS-39)
CAPT D.M. Volonino (CO)
CMDMC(SW/SS) Joel J. Allison (CMC)

Norfolk, VA

SUBRON-6

Minneapolis-St. Paul (SSN-708)
CDR Dave Ratte (CO)
MMCM(SS) Kevin Kesterson (COB) (D)
MMCS(SS) Ulvi (COB) (R)

SUBRON-8

Resolute (AFDM-10)
LCDR Gary Eckert (Acting CO/former XO)
HTCM(SW) James Seahorn (COB)

Newport News (SSN-750)
CDR Fred Capria (CO)
MMCM(SS) Kevin Bond (COB)

Kings Bay, GA

SUBRON-16

Rhode Island (SSBN-740) (B)
CDR David Kriete (CO)
ETCS(SS) Buck Taylor (COB)

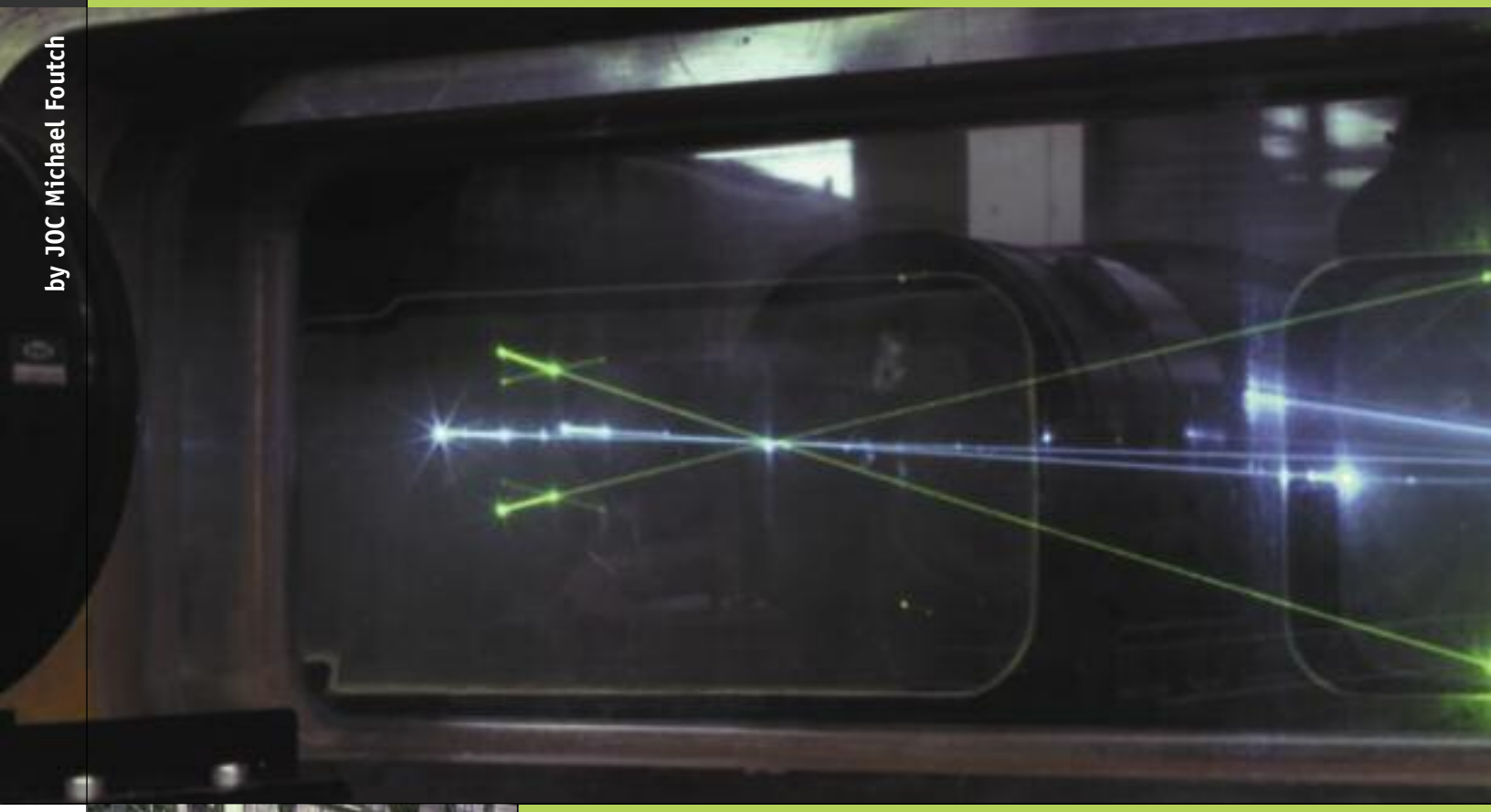
Rhode Island (SSBN-740) (G)
CDR Pete Clarke (CO)
SKCM(SS) Steve Lennon (COB)

SUBRON-20

Wyoming (SSBN-742) (B)
CDR Rich Kitchens (CO)
MMCM(SS) Martin Weaver (COB)

Wyoming (SSBN-742) (G)
CDR Wes Stevens (CO)
ETCM(SS) Timothy Logan (COB) (D)
MMCS(SS) Robert Lewis (COB) (R)

by JOC Michael Foutch



(top) The Applied Research Laboratory's Garfield Thomas Water Tunnel at Penn State has helped in the development of advanced instrumentation such as laser measurement systems.

(bottom) The tunnel, dedicated in 1949, was so large the building that houses it on campus was constructed around it. According to Penn State, the idea behind the tunnel was to provide a unique hydrodynamic facility to study cavitation phenomena in designing wake-adapted propellers that have led to quieter Navy propulsors. The tunnel has also been used to calibrate model-installed acoustic pressure and unsteady force transducers.

Photos provided by ARL, Penn State

Equipped with the most advanced weaponry and surveillance capabilities in the history of naval warfare, the Submarine Force patrols the world's oceans to defend our nation and preserve the American way of life. But the same technical advances now propelling the undersea force into the future may also have significant potential for making that way of life even better for us all.

Investments in military technology have often spilled over into everyday life to benefit all Americans. For example, the Internet grew from the desire of the Defense Advanced Research Projects Agency (DARPA) to design a network for allowing computers at different universities to communicate with each other without a central control node. As a result of the adaptation of this military technology for everyday use, today's wired world shares information at speeds unimagined only a few decades ago.

On the other hand, not every military development transferred to civilian use has been high technology. In World War II, a product called "duck tape" was used for water-proofing ammunition cases. Soldiers also found it useful for repairing jeeps, guns, and even aircraft, and the tape went on to commercial fame as "duct tape," for sealing seams in air ducting and an infinite variety of other household tasks.

Thanks to the know-how of a number of scientists who have spent their professional lives on advancing submarine technology, a number of other improvements in the quality of civilian life may be close to realization right now.

One place where this work is underway today is a nondescript group of buildings on a leafy campus in a rural valley of Pennsylvania. Some of these promising new technologies are still in the minds of scientists strolling the halls or sketched on a drawing board or computer screen. Others are tinkered with in the noisy laboratories inside. And a few are already in the fleet, under test by Submariners who will soon be using them in the near future. Unexpectedly, a handful of these new ideas may eventually be adapted for home use in cooling ice cream or building a quieter lawnmower.

During World War II, the Navy mobilized scientists and engineers from universities nationwide to join the war effort, and one group was located at Harvard's Underwater Sound Laboratory. These acoustics experts made major advances in wartime sonar systems for detecting German U-boats and acoustically-guided homing torpedoes to sink them.

With the end of the conflict, many of the organizations that were mobilized for the war effort returned to their civilian work. The Navy, however, was determined to continue

SUBMARINE FORCE TECHNOLOGY:

Building a better way of life for the future

its wartime joint ventures with Harvard and other universities. When the director of the Harvard research team, Dr. Eric Walker, left for a position at Pennsylvania State University, the Navy asked him to continue his undersea warfare research on its behalf, a partnership that continues to this day at Penn State's Applied Research Laboratory (ARL).

"We work with the submarine program in developing a range of technologies to meet the needs of the fleet, especially research on propulsor noise and new types of propulsors and propulsion systems," said Dr. Edward Liszka, ARL's director. "This is a technology-focused lab – that's our product. We believe you have to get out there and demonstrate new ideas, establish credible performance, and address issues that often prevent implementation of new technology in the fleet. Our goal is to get the technology out there and get people to use it. In that kind of development and testing, we often find issues that are fixable in the next technology upgrade."

Other universities across the country, such as Johns Hopkins and MIT, join Penn State in supporting the Navy by employing some of the nation's finest scientific talent to maintain the Submarine Force on the cusp of the possible. In these efforts, Navy-funded scientists use ARL equipment such as the Garfield Thomas Water Tunnel, the most active closed-loop test facility in the world, which serves a purpose similar to that of an aeronautical wind tunnel in studying hydrodynamics and hydroacoustics problems. This 48-inch diameter tunnel is so large that at the time of its construction in 1949, the building it is housed in had to be constructed around it. When operating at a velocity of 35 knots, more than a million gallons of water shoots through the test section every three minutes.

"We're looking to get the most out of the things we do, Dr. Liszka said. "The underlying science and physics we develop from submarine research often give us the opportunity to do things differently in other fields."

One such example is using ideas from submarine technology to build a better lawnmower.

Talk to ARL's Dr. Courtney Burroughs for a few minutes, and he will explain that the blades under a power mower are similar to those of a ship's propeller. His work to build quieter submarines gave him an idea. "The propeller blade under the deck of the mower is the thing that makes most of the noise. But a lawn mower works in a much more hostile environment than the ocean," he said. Nevertheless, his team applied to lawnmowers some of the same techniques they would use to study a noisy propeller. "We put sensors on the blades to look for unsteady pressure and impedance discontinuities," Dr. Burroughs explained. Understanding these phenomena led to a contract to develop a quieter mower.

Moreover, if lawnmower blades are analogous to a ship's propellers, then so are other fans – ranging from the ones used to scrub dust out of the air in a coal mine to those employed in a breathing machine to help people suffering from sleep apnea. But Dr. Burroughs was not satisfied with constructing a quieter fan for bedroom and coal-mine use. Using sensor data on unsteady pressure and broadband noise that he gathered from testing propellers in the ARL Water Tunnel, he discovered another use for his findings.

"Auto tires," he said. "There's a fairly violent reaction where the rubber meets the road." So, by embedding sensors inside some steel-belted radials and measuring the impacts of the underlying asphalt as if it were water rushing past the edges of a propeller blade, the same science used in reducing the noise of submarine propulsion could lead to a quieter ride on the highway.

Research into building a better submarine has also pushed the state of the art in metallurgy and provided stronger gears, which operate at lower temperatures,

Photo by JOC Michael Foutch

Dr. Arnie Fontaine demonstrates a model of an artificial heart valve. Through the study of cavitation effects and the measurements of the velocity of blood through a valve, ARL has advised manufacturers on how to avoid the life-threatening problem of blood clots in totally-implantable artificial hearts.

reduce contact and bending fatigue, diminish metal debris and wear, and minimize noise and vibration. Instead of grinding a hardened blank to finish the teeth of a gear, a new technique – called *ausforming* – uses an induction-heating process to heat the surface layers of gear teeth to over 1,700 degrees Fahrenheit to make them malleable for further finishing operations. "After this surface-layer heating, we submerge the gear in hot oil at about 500 degrees Fahrenheit and form-finish the teeth by rolling them against precision dies to highly-specific tolerance levels," said engineer Nagash Sonti. Sonti added that not only is ausforming much faster than grinding, it also makes the metal harder and stronger than conventional heat treatment. He also noted that this technology could hold significant promise for the auto industry. "Ausforming could reduce gear manufacturing costs by a third – yet you still could have the same gear strength. It is just too expensive to grind gears for cars, but with ausforming, we can make a gear with high tolerance, higher surface strength, and better specifications at a much cheaper cost."

As one result of another material-science breakthrough, ARL engineer Ken Meinert expects that submariners throughout the fleet will soon be walking all over his work. Laser Beam Welded Corrugated Core (LASCOR) sandwich panels are designed to reduce the weight of a ship's decks, bulkheads, and hatches without sacrificing strength and durability. In much the same way that a corrugated cardboard box develops its strength, panels of sheet metal spot-welded to a corrugated core show great promise for ample strength and stiffness with low weight. But the spot welding process is specialized and costly. Moreover, traditional arc welding tends to distort the shape of the panels. Using lasers, however, the necessary welding can be employed continuously to make a durable bond between the cladding and the corrugated core. "You can vary its strength, make the sheet wide or narrow, make the sheets as thick as you want – all making the product much stronger than a thin sheet itself," Meinert said. "With the same strength, it's considerably lighter than thicker sheet metal and eminently engineerable."

LASCOR material has been used for one of the radar platforms on USS *Mount Whitney* (LCC-20) since 1994, and data is being collected on that assembly to determine if the approach can be used to replace conventional materials in other applications for both surface ships and submarines.

Other submarine metallurgy investigations have even led to better sewage treatment!

"We used a physics-based analytical approach to problem solving when someone came to us and said, 'I have a problem with my bioreactor,'" said Dr. Victor Fishman, the head of the Industrial Support Office at the ARL. "We often see problems that require our scientists and engineers to make the leap from submarine technology to viable solutions in other areas – in this case, a better way to treat raw sewage."

A revolutionary new sewage-treatment plant design uses a rotating latticework drum to aerate the incoming sewage, thus ensuring the viability of bacteria that are used to break down the material. These bacteria convert raw, putrid sewage on one side to pure, drinkable water on the other. According to Dr. Greg Dillon, the structural design of this composite bioreactor and the selection of processes and materials for fabrication of its central shaft, netting, and interior pultrusions "incorporate advances that resulted from work we did for the Navy. Our experience on submarine programs definitely helped in finding the right filaments and processes for the drum to make this work."

Another leap from submarine technology to commercial use is the idea of using sound energy for refrigeration. The basic physics behind the phenomenon is simple – as a gas expands, it gets cooler; as a gas is compressed, it heats up. Since sound waves cause a gas to rapidly expand and contract, temperature fluctuations in the gas can cause heat to move between a surface and the gas. Furthermore, if the gas motion and temperature fluctuations are phased properly, the transfer of heat can be used as a refrigerator.

But there are challenges involved with trying to harness sound waves for this purpose. "There's not much energy available in ordinary sound at conversational levels," said Bob Smith, an engineer at the ARL who works with program lead Steve Garrett, "so we've built very powerful and efficient loudspeakers to create really loud sounds and instead of air we use a pressurized inert gas to propagate the sound waves." At the laboratory, a prototype of this cooling device is only a foot and a half tall and ten inches in diameter. The motor, a 200-watt loudspeaker, plays into one end of the cylinder, blasting out a note equivalent to a low G on the piano, at a level of nearly 200 decibels. A recent breakthrough in the implementation of the concept has enabled the lab to build an ice cream freezer that is 85 percent efficient. By contrast, ice cream freezers in common use today are about 70 percent efficient.

The possibilities for this technology are mind-boggling. Imagine a machine that "provides refrigeration without sliding seals, without concern for machinery tolerances, without concern for dust and dirt, and which doesn't harm the environment," said research associate Matt Poese. And paradoxically, for a device that generates 200 decibels internally, it gives off only a soft, low hum when operating. Further, the

"We often see problems that require our scientists and engineers to make the leap from submarine technology to viable solutions in other areas."

(above) ARL engineer Ken Meinert peers through a sample of LASCOR, a laser-welded corrugated sheet metal that could be used as lighter, durable deckplating.

(below) Engineer Nagash Sonti checks a machine gear wheel constructed through Ausforming, a process that uses induction heating to permit form-finishing the teeth to extremely high tolerance levels.

small size of this sound-powered cooling module permits placement anywhere in a submarine, thus improving the efficiency and reliability of the ship's refrigeration systems. "We didn't start out to solve an environmental problem," Poese said, referring to the lack of harmful chemicals in the machine. "But something like this was only possible because we have an intimate knowledge of acoustics."

That knowledge of acoustics was key to devising a new force-protection multiplier. By suspending a wire in a chain-link fence so that it can detect minute movements, scientists proved it was possible to turn a stretch of fence into a sensor itself. With special processing, the vibrations generated in the fence can localize a disturbance to within 30 to 50 feet, thus allowing the sensor to direct a remote camera toward potential infiltrators.

"The algorithm we developed localizes the source of the vibrations, so anyone can set up a system of their own," said Dr. Nick Nicholas, one of the developers of the sensor fence along with Dr. Dave Swanson. Soon, multiple, embedded wires, processed in much the same manner as the elements of a towed sensor array, could eliminate the need for large numbers of Sailors – or other security forces – to patrol long stretches of a perimeter.

Submarine technology is also being applied to the solution of health problems, notably in the field of artificial heart design. Studying the phenomenon of cavitation has produced a cadre of ARL experts regularly consulted by the cardiology community ever since the lab helped build a left-ventricular assist device some three decades ago. Today, the scientists at Penn State use knowledge gathered from submarine acoustics research to study potential damage to blood cells when prosthetic heart valves open and close in an artificial heart. "Our work on propeller blades over the past 30 or 40 years has helped us to develop the techniques that are standard in cavitation research today," said Dr. Arnie Fontaine.

To help solve the problem of blood damage, ARL scientists have used a high-resolution camera to "freeze a region in space" during each phase of the opening and closing of the artificial valve. This data is used in assessing the viability of occluder materials and designs in reducing cavitation damage and to make recommendations to artificial-heart manufacturers for improving their products. A side benefit of this particular study is better understanding of the life-threatening problem of thrombus – the formation of a blood clot on a surface or freely floating in the blood – in totally-implantable artificial hearts. It turns out that the velocity of the blood, measured with instruments not unlike those used on a grander scale in the Water Tunnel, has a correlation to thrombus development and that the resulting data can be used to study their formation.

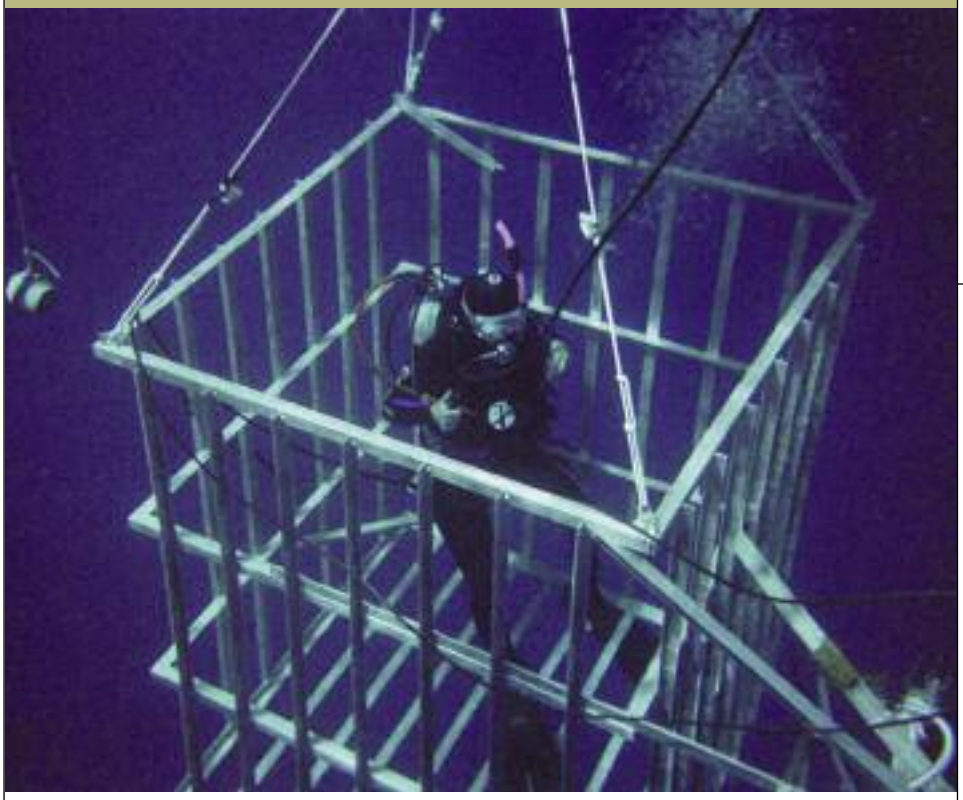
Modern emergency medicine has also benefited from the development of algorithms devised to allow communication among widely-distributed shipboard systems. Janet Johnson worked with her colleagues at ARL to address a similar communication problem among paramedics, fire fighters, and doctors in hospital emergency rooms by writing software for a Palm Pilot. As Johnson noted, "A lot of the information they get is verbal, told to first responders and passed through a nurse before it reaches the doctor. So the doctor is starting from scratch in some cases on what to do for a patient." The software provides an electronic means to transmit information to an ER doctor using touch screens, drop-down menus, and algorithms that allow a quick interface with a desktop computer. In addition to helping to make crucial, life-saving decisions in the field and the emergency room, the software has a collateral benefit. First responders now have the capability to file required reports before they even return to their station. Fewer hours producing piles of paperwork mean more hours freed up for patient care.

From a refrigerator powered by 200-decibel sound to breakthroughs in medical care, many technologies that will be commonplace tomorrow are spinning off from ideas now under development for application in today's submarine fleet. At ARL/Penn State and similar laboratories around the country, scientists are investing substantial effort and taking significant technical risks to equip the silent service with sensors, communications, and weaponry beyond the state-of-the-art. It's gratifying – and a boon to the American taxpayer – to find that this same research and development has significant civilian pay-off as well.

JOC Foutch is a Military Editor for UNDERSEA WARFARE Magazine.

by Dr Jerry Lamb and Joe DiRenzo III

The Naval Submarine Medical Research Laboratory:



Navy Captain Victoria Cassano, serving as a subject for a research dive in the Bahamas, looks at the sound attenuation provided by a standard 7 mm wetsuit hood.

A Little-Known Lab Makes A Big Impact!

The new emphasis on world-wide asymmetric threats, with submarines operating more frequently within the littoral, has created the demand for new ways to address longstanding health and safety issues in today's Submarine Force. Leading the way in examining these concerns is a little known research facility located at SUBASE New London – the Naval Submarine Medical Research Laboratory (NSMRL).

Consider the following scenario: With their nuclear submarine disabled by a collision at sea and one compartment isolated, the boat's crew awaits rescue in shallow littoral waters off a hostile country. Unable either to surface or to operate many key systems, the crew needs to make time-critical decisions that will affect both their endurance and survival. Throughout the submarine, the atmosphere is continually being "scrubbed" of carbon dioxide by hanging "curtains" containing enhanced lithium hydroxide. Meanwhile, the senior person present in each compartment is using a conventional PDA to calculate the time remaining before escape becomes mandatory, with input data from new gas analyzers recently installed onboard. Eventually, the decision is made that escaping from the submarine is unavoidable. Fortunately, this crew will wear the new Submarine Escape Immersion Equipment (SEIE) – full-body survival suits with built-in life rafts – and their chance of making it to the surface and surviving there are better than ever.

All of these items, from the analytical software in the PDA to the new SEIE suits have been developed or evaluated for use by the researchers at NSMRL.

For over 75 years, NSMRL has been the Department of Defense (DOD) Center for Undersea Biomedical Research. Established in the closing days of World War II to conduct mission-critical studies in night vision, sonar sound discrimination, and personnel selection for the Submarine Service, the laboratory's efforts in submarine, diving, and surface biomedical research support its mission to protect the health and enhance the performance of today's warfighters.

Over the years, NSMRL has sponsored an impressive array of high-impact innovations. For example, the laboratory was responsible for the SEALAB underwater habitat, development of the International Orange color for visibility, and the Farnsworth Lantern Color Vision test. In addition, NSMRL scientists, have used the hyperbaric chambers at their facility on SUBASE New London to develop many of the saturation and diving decompression tables in use today. NSMRL also researched many current sonar displays and developed a psychological screening test for prospective submariners.

Today, NSMRL continues to address critical issues for the undersea community, with emphasis on submarine survival and rescue, submarine medicine, diver bio-effects, hearing conservation, and situational awareness. This in-house research is pursued in close association with Submarine Force and fleet elements, such as the newly established Submarine Learning Center, Submarine Development Squadrons 5 and 12, and the Naval Submarine School.

All of the laboratory's efforts are focused on the warfighter. For example, Dr. Ed Cudahy leads a major on-going program studying the bio-effects of underwater sound on the human diver. One of his projects involves the measurement of noise made by underwater tools at working dive sites. His team of scientists and divers descended into history recently when they collected *in situ* data as part of a preservation project for the USS Arizona Memorial in Pearl Harbor, Hawaii. The NSMRL team collaborated with Mobile Diving and Salvage Unit (MDSU) 1 and the National Park Service, making underwater noise measurements of a new hydraulic tool designed to remove samples of the battleship's hull for metallurgical analysis. The research team had to collect underwater noise levels as part of NSMRL's two-year comprehensive in-water noise survey to determine on-site permissible noise-exposure levels for divers. Some members of the research team performed similar work during the recovery of the turret from the USS *Monitor*. As a result of this and similar research, NSMRL has been named the bio-effects lead for DOD's development of diver deterrence systems.

Monitoring the internal atmosphere that submariners breathe during long periods of submergence continues to be a focus of the lab. Onboard systems constantly measure critical levels of oxygen and carbon dioxide, but other substances in the atmosphere are potentially damaging to the crew's health. Working with the Naval Sea Systems Command (NAVSEA) and the operational forces, NSMRL conducts the Submarine Atmosphere Health Assessment Program (SAHAP), which investigates new technologies for long-term air quality monitoring. As a result, small, passive air-sampling devices have been placed on many deployed submarines to provide operational commanders with timely information on airborne-contaminant levels while underway.

A U.S. Navy salvage diver pulls himself off the sea bottom onto the stage 20 feet above to make the safe decompression trip back home.

But NSMRL is also concerned with the ability of the crew to conduct their mission – the "human performance" element that is now the focus of the Navy's "revolution in training." Sonar operators aboard the new *Virginia*-class SSNs will be an immediate beneficiary of this research. Although moving the old "sonar shack" into the integrated command center of this highly-automated vessel will significantly improve tactical decision making, the ambient noise level of this high-activity area may mask some sonar signals. Thus, in conjunction with the Bose Corporation, NSMRL's Joe Russotti has developed noise-canceling headphones that more accurately reproduce sonar signals than any unit currently in use. This same technology is also being used in stethoscopes for medical corpsmen and in insertable earplugs for combat troops and Special Operations Forces.

Virginia is also the first submarine whose Operational Requirements Document (ORD) specifically requires improved situational awareness (SA) for the Commanding Officer. Since there is currently no adequate measure of SA in a team-oriented submarine environment, Lieutenant Katie Shobe, MSC, USNR, developed a metric using concepts adapted from fighter-pilot research. Shobe's metric proved out successfully in testing *Virginia*'s combat systems, and additional research is underway to see how the crew's experience level affects SA performance. The results can be applied to training, developing new displays, and drafting operating procedures.

All of these programs are a reality now…but what about the future? Three new advanced technology programs at the laboratory will have immediate impact on tactical capabilities and crew safety.

With funding from the Office of Naval Research, NSMRL's Dr. Tom Santoro is improving detection performance by developing a means to display sonar signals in three-dimensional auditory space. In addition to allowing sonar operators to hear short-duration transients more clearly, their "spatial orientation" within the headphones will indicate the bearing of the source.

NSMRL has been named the bio-effects lead for DOD's development of diver deterrence systems.

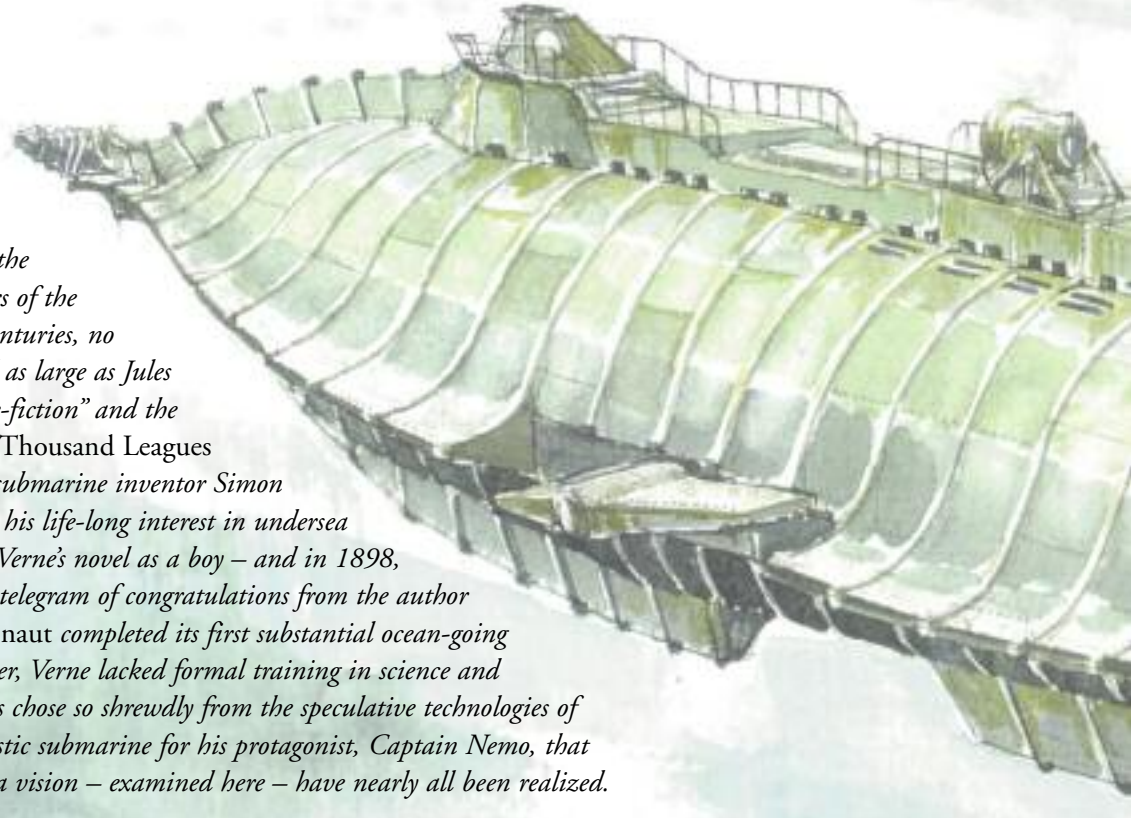
Hearing loss is a national problem now costing two billion dollars in medical compensation annually. At NSMRL, Dr. Lynne Marshall is using sounds generated internally by the inner ear to detect the early onset of hearing loss, so that preventive measures can be taken.

Addressing another safety issue, CDR Wayne Horn, MC, USN, the lead researcher in submarine survival, is studying new technologies for extending crew endurance and making it easier to rescue survivors from the hypothetical sunken-submarine scenario that opened this article.

The Naval Submarine Medical Research Laboratory – a small command… with a huge impact.

Dr. Jerry Lamb is the Technical Director of the Naval Submarine Medical Research Laboratory. He received his Ph.D. from the University of Connecticut and has been in government service for fourteen years. Joe DiRenzo is a retired Coast Guard officer qualified in submarines and a Maritime Homeland Security Technical Director for Anteon Corporation's Center for Security Strategies and Operations.

by Edward C. Whitman



As an inspiration to the submarine pioneers of the late 19th and early 20th centuries, no other literary figure loomed as large as Jules Verne, the "father of science-fiction" and the author in 1870 of Twenty Thousand Leagues Under the Sea. *American submarine inventor Simon Lake, for example, credited his life-long interest in undersea exploration to having read Verne's novel as a boy – and in 1898, he was thrilled to receive a telegram of congratulations from the author himself when his own* Argonaut *completed its first substantial ocean-going voyage. Educated as a lawyer, Verne lacked formal training in science and engineering, but nonetheless chose so shrewdly from the speculative technologies of his day in creating a futuristic submarine for his protagonist, Captain Nemo, that the essentials of his undersea vision – examined here – have nearly all been realized.*

Born in the French port city of Nantes, Jules Verne (1828-1905) was educated for the law and worked as a stockbroker, but his literary and technical interests eventually brought him enormous success as the first real "science fiction" novelist. He wrote *Twenty Thousand Leagues Under the Sea* in 1870.

Paris, the Law, and Literature

Jules-Gabriel Verne was born in 1828 in the French seaport of Nantes, upriver from the Bay of Biscay. Although his younger brother Paul became a naval officer, and Jules attempted to run away to sea in his early teens, his lawyer father intended that he should enter the legal profession and sent him to Paris in 1847 to study law. There, provided an entrée by his uncle, he joined the literary circle of Alexander Dumas, *pere et fils*, and while continuing his legal studies, turned increasingly to writing plays, articles, and stories. In 1849, Verne passed his law degree, but his father grudgingly agreed to his remaining in Paris to pursue a literary career. Over the next several years, he published a series of short stories to no particular acclaim, served as secretary of the Théâtre Lyrique, and collaborated on an operetta libretto. Then, in 1857, having married a young widow from Amiens with two children, he accepted employment as a stockbroker, presumably because it promised a more reliable income.

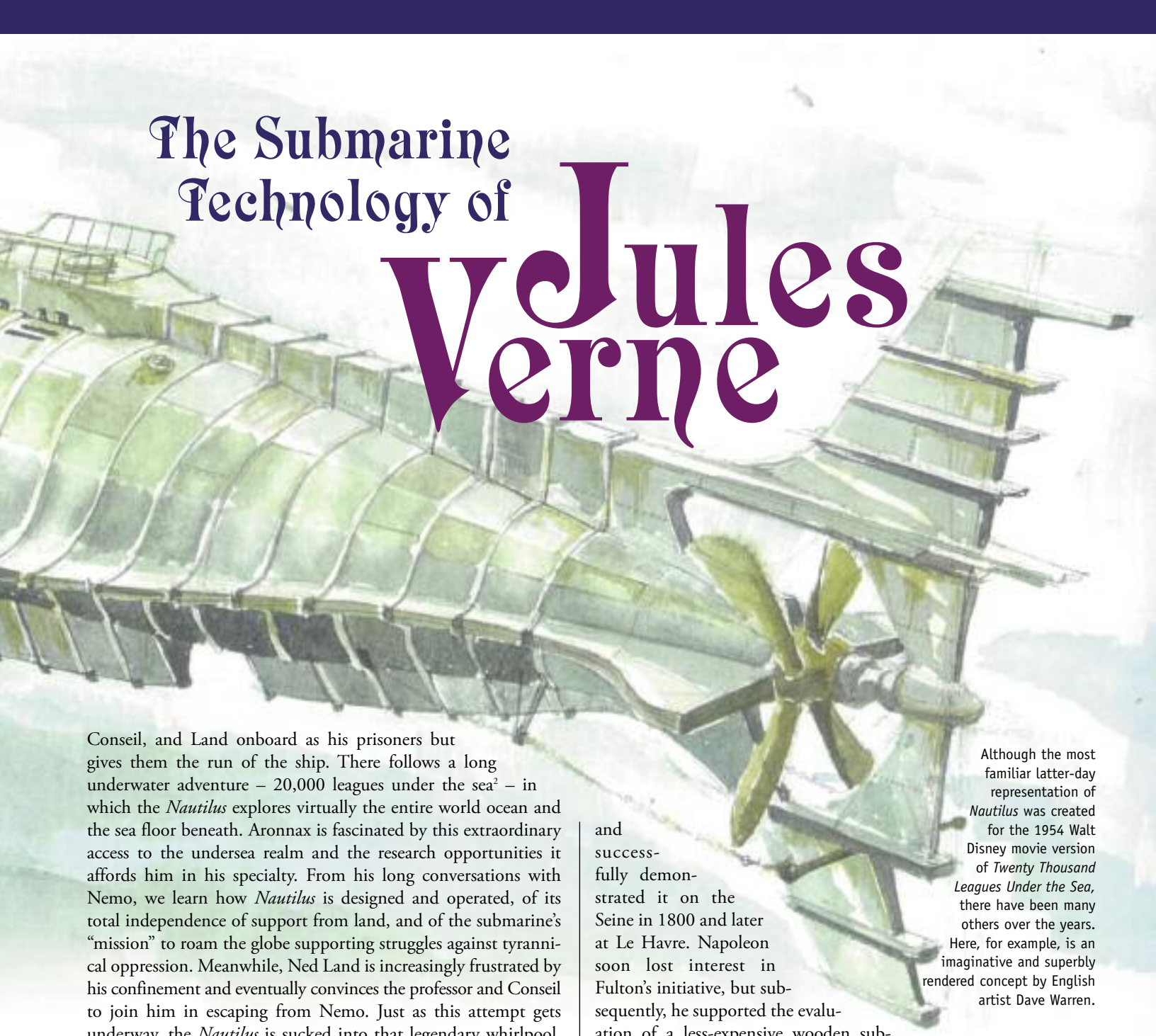
Even so, Verne continued his literary work and simultaneously began indulging a latent interest in natural science and technology by reading assiduously on geology, engineering, and astronomy in the libraries of Paris. The first fruits of this dual avocation were his 1863 novel *Five Weeks in a Balloon*, which achieved immediate success in establishing the new genre of "science fiction." This was followed, with growing acclaim, by *Journey to the Center of the Earth* in 1864, *From the Earth to the Moon* in 1865, and then by *Twenty Thousand Leagues Under the Sea* in 1870.[1] By then, Verne had given up his stockbroker practice and devoted himself entirely to writing.

Verne's Tale of Undersea Adventure

Verne's plot in *Twenty Thousand Leagues* is relatively simple and serves largely as a framework for describing both the wonders of the underwater world and the technologies needed to realize the author's prophetic vision of undersea travel and exploration. The year is 1866, and the maritime community is shaken by sporadic sightings of what appears to be a gigantic sea creature unlike any seen before. When this "cetacean" collides with two merchant ships and nearly sinks them, the U.S. Navy sends the steam frigate *Abraham Lincoln* to hunt the creature down, augmenting her crew with a French naturalist, Professor Pierre Aronnax – who narrates the tale – his servant Conseil, and American master harpooner Ned Land. After fruitlessly searching down the eastern coast of South America and over much of the Pacific, *Lincoln* happens on the "monster" southeast of Japan and attempts to subdue it with both cannon-fire and harpoon. In response, the beast inundates the frigate with jets of water and carries away her rudder in a ramming attack that also throws Aronnax, Conseil, and Land into the sea.

Deserted by *Lincoln*, the three castaways soon find themselves marooned on the "back" of the creature, which is, in fact, an advanced submarine – the *Nautilus* – designed, built, and commanded by the mysterious Captain Nemo, who takes Aronnax,

The Submarine Technology of Jules Verne



Although the most familiar latter-day representation of *Nautilus* was created for the 1954 Walt Disney movie version of *Twenty Thousand Leagues Under the Sea,* there have been many others over the years. Here, for example, is an imaginative and superbly rendered concept by English artist Dave Warren.

Conseil, and Land onboard as his prisoners but gives them the run of the ship. There follows a long underwater adventure – 20,000 leagues under the sea[2] – in which the *Nautilus* explores virtually the entire world ocean and the sea floor beneath. Aronnax is fascinated by this extraordinary access to the undersea realm and the research opportunities it affords him in his specialty. From his long conversations with Nemo, we learn how *Nautilus* is designed and operated, of its total independence of support from land, and of the submarine's "mission" to roam the globe supporting struggles against tyrannical oppression. Meanwhile, Ned Land is increasingly frustrated by his confinement and eventually convinces the professor and Conseil to join him in escaping from Nemo. Just as this attempt gets underway, the *Nautilus* is sucked into that legendary whirlpool, the Maelstrom, off the coast of Norway, and when the resulting violence subsides, presumably only Aronnax, Conseil, and Land have survived to be picked up by a passing ship and tell the story.[3]

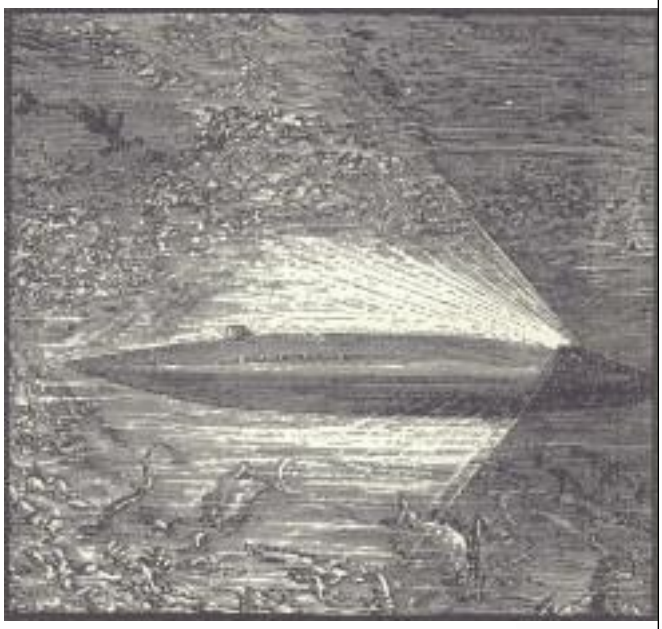
Nemo's Submarine Precursors

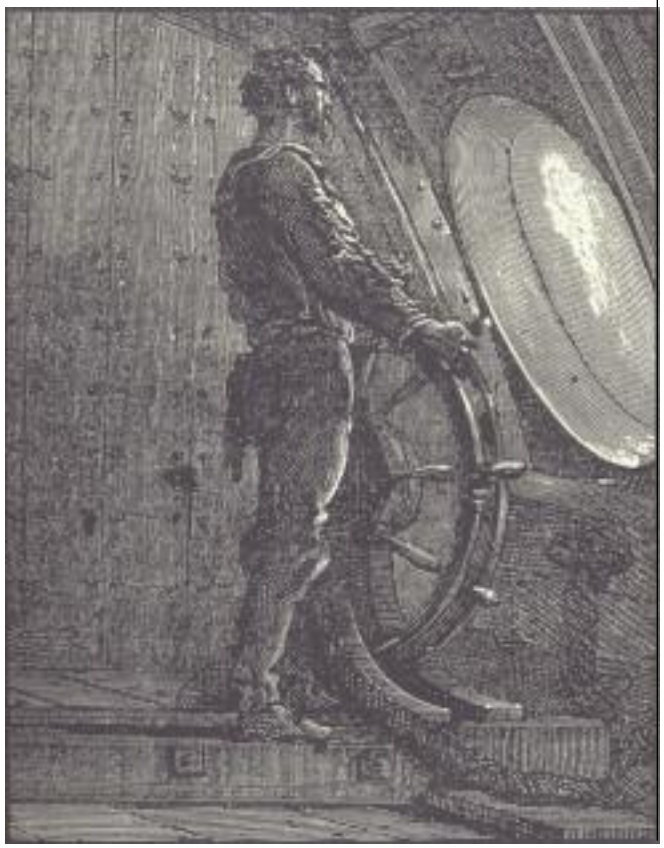
Although very early submarine experimenters such as Cornelius van Drebbel in early 17th-century London and David Bushnell in the American Revolution had demonstrated occasional successes, it was only in the early and mid-19th century that the problems of underwater navigation were attacked in earnest. In France, for instance, the American Robert Fulton – later renowned as the "inventor" of the steamboat – attempted to win the support of the government of First Consul Napoleon Bonaparte for an undersea craft capable of breaking the British blockade. Awarded a contract for building a man-powered submersible of his own design, Fulton christened his boat *Nautilus* – the same name chosen by Jules Verne 70 years later – and successfully demonstrated it on the Seine in 1800 and later at Le Havre. Napoleon soon lost interest in Fulton's initiative, but subsequently, he supported the evaluation of a less-expensive wooden submersible built at Le Havre by two brothers named Coessin. Their prototype achieved some limited success, but then nothing more was heard of it.

In the 1830s and 1840s, several other French inventors – DeMontgery, Petit, Villeroi, and Payerne – offered other submersible concepts, and some were actually built. But it was only when the French Navy became interested in a design by Captain Simon Bourgeois and naval constructor Charles Brun that significant progress was made. In 1863, Bourgeois and Brun launched *Le Plongeur* ("the Diver") at Rochefort and experimented with the boat for three years. Powered by a reciprocating engine driven by stored compressed air, the 140-foot long *Le Plongeur* managed to average five knots submerged but suffered from inadequate longitudinal stability and was eventually abandoned. At the same time, other European countries were pursuing their own submarine programs, and on the far side of the Atlantic, the American Civil War had stimulated more immediate interest in submersible

(top) Reproduced from the original 1871 French edition published by J. Hetzel et Cie in Paris, this engraving shows Captain Nemo's *Nautilus* underway as Verne himself must have envisioned it. In this view, the craft is moving from right to left, the course ahead illuminated by a powerful electric searchlight mounted abaft the pilothouse.

(bottom) In another first-edition engraving, Captain Nemo is portrayed at *Nautilus*'s wheel behind the "bi-convex" windows of the small pilothouse. Nemo's cloudy origins are only fully revealed in Jules Verne's 1875 novel, *The Mysterious Island*, where it emerges that he was born an Indian prince and educated in Europe, before his overthrow by the British led him to build *Nautilus* as a weapon against tyranny and oppression worldwide.





combatants, particularly in the Confederacy, where raising the Union economic blockade was a primary objective. There, the most spectacular success was achieved by the hand-cranked submersible CSS *Hunley*, which in February 1864 sank the USS *Housatonic* in Charleston Harbor – the first-ever sinking of a warship by a submarine. In light of his voracious reading and exhaustive reportage of the Civil War by the European press, Jules Verne would certainly have known of these events at the time he embarked on writing *Twenty Thousand Leagues Under the Sea*.

For the submarine community, *Twenty Thousand Leagues Under the Sea* raises fascinating questions: Just how prophetic was Verne in exploiting technologies nascent in 1870 to create Captain Nemo's *Nautilus*? How accurately did he predict the actual evolution of the modern submarine? And how many of the undersea innovations he envisioned 130 years ago have actually been realized?

Designing and Building Nautilus

According to Verne's tale, Captain Nemo and his men built *Nautilus* on a desert island in total secrecy by ordering components and materials from disparate sources and arranging their delivery to a variety of covert addresses. The design was entirely Nemo's, based on the engineering knowledge he had gained from extensive study in London, Paris, and New York during an earlier part of his life. The steel double hull is spindle-shaped and 70 meters (230 feet) long, with a maximum diameter of 8 meters (just over 26 feet). As Captain Nemo describes it,

…Nautilus *has two hulls, one interior, one exterior, and they are joined by iron T-bars, which gives the boat a terrific rigidity. Because of this cellular arrangement, it has the resistance of a solid block. The plating can't yield; it's self-adhering and not dependent on rivets; and the homogeneity of its construction, due to the perfect union of the materials involved, permits it to defy the most violent of seas.*[4]

Submerged, the submarine displaces 1,507 metric tons (roughly 1,670 short tons) and surfaced, with only one-tenth of the hull above the water, it displaces 1,356 metric tons (1,495 short tons) – Verne is quite precise about this.[5]

Nautilus is controlled from a small, retractable pilothouse set into the top of the hull about a quarter of the way back from the bow. Several large bi-convex glass windows – 21 centimeters thick at the center – provide an all-around view, augmented by illumination from a separate electric searchlight mounted in an external pod abaft the pilothouse. There is no periscope – these would not come into general use for more than three decades. For use while surfaced, a small, flat deck fitted with removable manropes is apparently installed just behind the pilothouse, and this can be accessed by a hatch from below. Nemo and his first mate frequently use this platform for celestial navigation in conjunction with a pit log read out by electrical telemetry. The only other protuberance topside is a low "dry-deck shelter" faired into the hull for housing a metal dinghy that can be entered and launched from within, even while underwater.

Electricity – A "Powerful Agent"

With its imaginative technology, Nemo's engineering plant for *Nautilus* is certainly the most extraordinary aspect of his design. On behalf of his nautical protagonist, Verne conceived what was essentially an "all-electric" ship at a time when the first practical

applications of electricity were only a few decades old and a century before building any such ships became feasible. In Captain Nemo's oft-quoted words,

There is a powerful agent, obedient, rapid, facile, which can be put to any use and reigns supreme on board my ship. It does everything. It illuminates our ship, it warms us, it is the soul of our mechanical apparatus. This agent is – electricity.

And indeed, *Nautilus* uses electricity for cooking, lighting, distilling fresh water, running pumps and other auxiliaries, instrumentation, and, of course, main propulsion. The ship is fitted with a conventional four-bladed propeller at the stern, six meters (20 feet) in diameter and coaxial with the centerline of the hull. Consistent with the relative diameters of the hull and propeller and the freeboard prescribed by Captain Nemo, Aronnax observes that when surfaced, the propeller blades occasionally rise above the waves, "beating the water with mathematical precision." Verne has Nemo claiming a speed of 50 knots at 120 revolutions per second – probably in error. 120 revolutions per *minute* makes much more engineering sense for a propeller that size, particularly in view of the type of engine that powers the submarine.

Curiously, the main propulsion engine on *Nautilus* is not a rotating electric motor. English scientist Michael Faraday (1791-1867) had established the principle of the rotating motor by 1825, and an American blacksmith, Thomas Davenport, had patented a direct-current (DC) motor with all its essentials – rotating coils, a commutator, and brushes – in 1837. Yet, despite the fact that several motor-driven electric vehicles had been demonstrated in both Europe and America by mid-century, Verne's notional design for the prime mover on *Nautilus* emerges as the electrical analog of a reciprocating steam engine, "where large electromagnets actuate a system of levers and gears that transmit the power to the propeller shaft." In other words, the main engine seems to be mechanically equivalent to a steam engine with "large electromagnets" replacing conventional pistons – a choice that seems strangely backward-looking in light of Verne's technical sophistication.

In contrast, the "breakthrough" that enables Nemo to generate virtually unlimited electrical power extrapolates electrical science so far into the future that only "the willing suspension of disbelief" keeps technically-astute readers onboard. Although some hasty writers have wrongly portrayed *Nautilus* as "nuclear-powered," the actual source for her vast reserves of electricity is described as a hugely scaled-up elaboration of a well-known 19th-century primary battery, the Bunsen cell. Invented in 1841 by German physicist Robert Bunsen (1811-1899) – better known for devising the "Bunsen burner" – the Bunsen cell uses a carbon cathode in nitric acid and a zinc anode in dilute sulfuric acid, with a porous separator between the liquids. The device generates a potential of 1.89 volts, and later versions added potassium dichromate as a depolarizer.[6] Let Captain Nemo describe his fundamental modification:

Mixed with mercury, sodium forms an amalgam that takes the place of zinc in Bunsen batteries. The mercury is never consumed, only the sodium is used up, and the sea resupplies me with that. Moreover, I can tell you, sodium batteries are more powerful. Their electric motive [sic] force is twice that of zinc batteries.

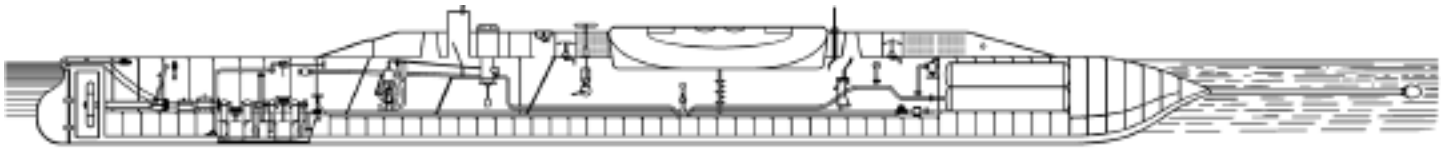
Had this actually been tried, the reaction of metallic sodium with sulfuric acid would have been exciting to behold.

Despite some ambiguity in Verne's description, it also appears that the relatively low voltage of the Bunsen cells is stepped up to a more useful level using a double-wound variant of the induction (i.e., "spark") coil invented in Paris by another German, Heinrich Ruhmkorff (1803-1877), around 1850.[7] This same combination of a sodium-based Bunsen cell, probably some kind of periodic interrupter, and a Ruhmkorff coil is described later in the novel as a high-voltage power source for portable undersea lights. Ultimately, Nemo replenishes his sodium supply by distilling seawater and separating out its mineral components at a secret operating base located inside the crater of a volcanic island near the Canary Islands. The energy for this process is derived by burning sea coal, which he and his men mine from the ocean bottom.

Submerging, Surfacing, and Life Onboard

Similar to the approach adopted by subsequent submarine pioneers Simon Lake and Thorsten Nordenfeldt, the basic technique described for submerging *Nautilus* and maintaining a desired operating depth is to flood ballast tanks to establish net neutral buoyancy at the corresponding water density. The main ballast tanks are sized to bring the boat just under the surface when completely filled. For deeper submergence, additional water is introduced into supplementary tanks, which can increase the weight of the submarine by as much as 100 metric tons to match the increasing weight of its displacement with depth. As John Holland later established in his first successful submarine designs, a much more efficient depth-control technique is to establish slightly positive buoyancy and maintain depth using the dynamic forces generated by the boat's forward speed. In fact, "with a view to saving [his] engines," Captain Nemo also exploits dynamic forces, but only when he wants to take *Nautilus* below 2,000 meters. Then, two horizontal hydroplanes mounted at the center of flotation (that is, amidships) are used to angle the boat downward in response to the thrust of the propeller. Within a few decades of the appearance of *Twenty Thousand Leagues Under the Sea*, it had also been realized that stern planes are much more efficient for controlling depth dynamically, but *Nautilus* has no stern planes. In any event, Verne claims extreme depth capabilities for *Nautilus* – Aronnax reports reaching a depth of 16,000

Nautilus is powered entirely with electricity produced from the sodium found in seawater by scaled-up and modified "Bunsen cells." This original engraving of Captain Nemo and Professor Aronnax inspecting the engine room seems to show large Bunsen cells to the right and a huge "Ruhmkorff coil" for stepping up the voltage overhead.



The most advanced French submersible built prior to the publication of *Twenty Thousand Leagues Under the Sea* was Bourgeois and Brun's *Le Plongeur*, launched in 1863. Powered by stored compressed air, the 140-foot craft achieved five knots submerged, but inadequate longitudinal stability forced its abandonment by the French Navy after three years of experiments.

meters (52,500 feet) in the South Atlantic – reflecting a time when it was not yet known that the world ocean reaches a maximum depth of nearly 36,000 feet in the Challenger Deep.

To regain the surface, the ballast tanks are emptied – not by compressed air, but rather by using powerful electric pumps, supposedly capable of working against even the highest back-pressure. Aronnax even describes what we would call today an "emergency surface blow":

The Nautilus *rose with terrific speed, like a balloon shooting into the sky. Vibrating sonorously, it knifed up through those waters. We could see nothing at all. In four minutes we traveled those four leagues between the bottom and the surface.*[8] *After emerging into the air like a flying fish, the* Nautilus *fell back into the water, making it leap like a fountain to a prodigious height.*

In his novel, Verne describes bottom excursions from Nautilus with passengers and crew clad in diving suits that accurately prefigure today's SCUBA gear. Sustained by stored compressed air, assisted by powerful electric torches, and protected by air-powered small arms firing electric "bullets," Verne's undersea explorers opened the beauty and mystery of the deep to millions of armchair readers.

Although Nemo acknowledges that he has the scientific acumen to "manufacture" air for ventilating the submarine underwater, he opts instead to use electrically-driven compressors to store breathing air in special tanks, with periodic visits to the surface to replenish his supply. However, when *Nautilus* becomes wedged beneath an ice cap near the South Pole – another geographical misapprehension – this dependence on surface air puts the crew *in extremis* until they devise a clever way to free the boat by melting the surrounding ice – using electricity, of course.

Nemo's crew are a strange, largely silent lot, and it's never clear how many there are. The most Aronnax ever sees on deck at one time are about 20, but there are likely more below. However, the crew's berthing compartment on *Nautilus* is only 5 meters (16 feet) long, so unless the berths are stacked like cordwood – or there's a lot of hot-bunking going on – it seems unlikely that there could be more than 40. On the other hand, Captain Nemo's quarters are quite lavish, consisting of a 5-meter bedroom, a 5-meter private dining room, a library of about the same size, and a 10-meter salon – 25 meters out of a total hull length of 70 meters. Moreover, the salon contains a priceless collection of European art, a small museum of unique biological specimens, and most famously, a pipe organ. Large observation windows, concealed by movable panels, are fitted into the outboard bulkheads, providing a close-up view of the passing underwater scene to both sides, illuminated as necessary by the external searchlight.

Nautilus as a Warship

In its role as a combatant, *Nautilus* functions primarily as a high-speed ram, and for this purpose, its bow narrows finely to a reinforced steel point, triangular in cross section. In one harrowing chapter, Professor Aronnax describes its effectiveness in destroying a warship – presumably British – from initial detection and sparring for position; through "clearing for action" by retracting the pilothouse and searchlight to produce a smooth, projectile-like shape; diving the boat; running up to speed on a broadside collision course; and passing right through the victim "like a sailmaker's needle through canvas!" There are no survivors.

From its encounter with *Abraham Lincoln*, we can also deduce that the submarine's powerful ballast pumps can also be used as water cannon when "non-lethal force" is called for, but except for a substantial arsenal of unique small arms, *Nautilus* carries no other weapons. Nemo and his crew use highly advanced air rifles for hunting and self-defense both on land and underwater. These versatile guns are charged from portable compressed air tanks but instead of shooting conventional solid bullets, they launch small glass capsules,

…which are sheathed in steel and weighted with lead. They are veritable little Leyden jars charged with high-voltage electricity. At the slightest impact they discharge, and the animal, no matter how large or strong, falls dead.

Unfortunately, this novel technique of shooting what amounts to charged capacitors as bullets falls short in *Nautilus*'s celebrated encounter with a school of giant squid, because the projectiles pass right through the animals' soft bodies without activating. Thus, Nemo's crew and their "passengers" are reduced to hand-to-hand combat with the monsters, but that only makes for a more exciting story in which Ned Land can exhibit his prowess with the harpoon.

Captain Nemo as Scientist and Explorer

For underwater exploration, treasure-hunting, and gathering food from the ocean bottom, Captain Nemo has provided *Nautilus* with an integrated airlock and a suite of sophisticated diving equipment, which includes diving suits with a self-contained underwater breathing capability clearly recognizable in today's SCUBA gear. Nemo credits the Rouquayrol-Denayrouze diving apparatus – a "demand-valve" system invented in France in 1864 – as the basis for his version, which uses back-packed tanks of highly-compressed air capable of sustaining underwater excursions ten hours long. For undersea illumination, spiral gas-discharge tubes – actually invented earlier in the century – are used as lanterns, with excitation by the high-voltage output of a portable version of the Bunsen-Ruhmkorff system described above.[9] Outfitted in this way, Professor Aronnax, Conseil, and Ned Land

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JOB TASK ANALYSIS:
Speeding the Blade of the Revolution in Training

by William Kenny, Submarine Learning Center Public Affairs

For future training to better benefit Sailors, the Submarine Force, and the Navy, the submarine community needs an assessment of how individual training is conducted now – examining the "when," "where," and "how" of the business so that we can begin making required changes. The Revolution in Training provides a roadmap, and Job Task Analysis (JTA) is a primary tool for plotting a course for each Sailor's life-long learning.

CWO4 James Brink, a Submarine Learning Center (SLC) JTA Assessment Team member, offered a quick definition of the concept. "Simply put," Brink explained, "JTA is a procedure for each rating that breaks down all the *J*obs and *T*asks required for normal performance and then *A*nalyzes these to determine complexity, difficulty, training requirements, safety hazards, and relative time demands.

"JTA is an important tool for future submarine training," he said. "Navy leaders need to analyze the overall health of a rating's professional development vector, schedule training when it is needed – or delete it if unnecessary – assess training gaps, and evaluate what Sailors are 'trained on.' At the same time, they should be finding ways to document proven skills and provide Sailors with civilian equivalency certificates."

For Submarine Force training, JTA is not a priority but *the* priority, said Brink. "All submarine ratings for which the Submarine Learning Center is responsible have completed the initial phase of the JTA process. We need to identify every job or task a Sailor performs to fully validate the ones identified in fleet surveys and also to support the training specialists who define corresponding Skill Objects (SOs)." By definition, Skill Objects are a grouping of like tasks. These tasks are trained together, performed together, evaluated together, dependent upon one another. They also require similar knowledges, skills abilities, and tools (KSATs).

As FTCM(SS) Somales pointed out, a big JTA challenge was just getting the process started. "Our Job Task Analysis began by reviewing all documents that describe Sailor tasks, including PMS, qualifications, courses of instruction, technical manuals, input from subject matter experts, and numerous other sources. This data was then placed on a professional development continuum in accordance with fleet surveys that told us what Sailors were actually doing."

"You start at the beginning, and you don't stop identifying tasks until they are all accounted for," Brink added. "This is the 'dirty work' of studying the professional development vector. Once the jobs and tasks are laid out, additional analysis shows how the required knowledge, skills, abilities, and tools (KSATs) are supposed to be provided. If the necessary KSATs are not being supplied, the Navy needs to provide them. If appropriate KSATs have been provided, but Sailors aren't retaining the information, the corresponding training may then need to be scheduled just before it's needed – a just-in-time scenario."

In the submarine community, the fire control technicians (FTs) went through JTA first, and FTCM Somales recalls an associated pitfall. "We found ourselves at times being too specific in some areas and actually in danger of losing the overall concept," he said. This was due mostly to 'over-exuberance,' as I call it, since we made sure that we did the job right the first time and captured every task a Sailor might do, no matter how minute. We improved throughout, getting better as we went along.

"I'm hopeful we'll complete the initial phase of JTA during the early summer."

CWO4 Brink echoed Somales on both the direct and indirect value of JTA. "Without intending to be dramatic," he noted, "JTA is the foundation of the Revolution in Training. Without JTA, a submarine would never leave the pier. For the Sailor, it results in improved retention, because he can sense when his skills are at their peak, and he'll be more likely to enjoy his job because he's better at it. The JTA process reduces the time a Sailor spends in the schoolhouse learning KSATs he may not need until long after he's onboard his ship. And by then, those KSATs may be obsolete from lack of need!"

> "Job Task Analysis ensures that Sailors are given the knowledge, skills, and abilities they need to perform their jobs and assure success."

Master Chief Somales added that for a community with a heritage in technological innovation, driving the Revolution in Training with JTA was not only logical, but also inevitable. "Our training system has served us well but doesn't fully capture the potential of new technology to provide training to our Sailors. With these new developments, we can provide not only training that's relevant and timely – we'll be able to update and provide that training much more rapidly. And we'll also provide each Sailor the capability to see exactly where he is along his career path and to set goals and make changes based upon his progress.

Changes Of Command

USS Los Angeles (SSN-688)
CDR Thomas P. Stanley relieved
CDR Christopher B. Thomas

USS La Jolla (SSN-701)
CDR Brian T. Howes relieved
CDR Phil Sawyer

USS Pennsylvania (SSBN-735)(B)
CDR Michael J. Dobbs relieved
CDR Timothy N. Daseler

USS Alabama (SSBN-731)(G)
CDR Melvin E. Lee relieved
CDR Jonathan A. Dowell

USS Helena (SSN-725)
CDR Douglas E. Wright relieved
CDR Timothy C. Bertch

Qualified For Command

LCDR James Belz
USS Kentucky (SSBN-737)(G)

LCDR Brien Dickson
USS Ohio (SSGN-726)

LCDR Richard Dubnansky
USS Key West (SSN-722)

LCDR Jeffrey Heydon
USS Henry M. Jackson (SSBN-730)(G)

LCDR Trevor Tyler
USS Alabama (SSBN-732)(G)

Limited Duty Officer Qualified In Submarines

ENS Thomas Layne
COMSUBRON-7

Supply Corps Officer Qualified In Submarines

LTJG Jason Hoftiezer
USS Alabama (SSBN-731)(B)

LTJG Llahn Mcghie
USS Houston (SSN-713)

LT Glenn Wright
USS Nevada (SSBN-733)(G)

Technology of Jules Verne

continued from page 28

join Nemo and his men for a series of vividly-depicted underwater expeditions, where they get to experience both the wonders and dangers of the deep.

Despite Nemo's obsessive, vengeance-driven dark side, Verne credits him with unparalleled accomplishments as an underwater scientist and explorer. Among his many discoveries are the lost continent of Atlantis, a subterranean passage between the Red Sea and the Mediterranean (i.e., a subaqueous Suez Canal), countless new species of undersea life, and new findings in oceanography. He maps the ocean bottom, measures thermal profiles, and observes that in all the deeps of the world, the water temperature approaches the same limiting value of 4.5 degrees Centigrade. He skillfully conns *Nautilus* through the Strait of Gibraltar by taking advantage of the same deep-lying, outward-flowing current layer exploited by savvy submariners in two world wars decades later. In the wonderful world of *Twenty Thousand Leagues*, there is seemingly nothing that Captain Nemo cannot do.

The Undersea Legacy of Jules Verne

Accelerating progress in fielding undersea vehicles in the late 19th century – and rapid advances in both natural science and engineering technology – created the milieu within which Verne launched his "submarine novel." For a non-specialist, Verne was unusually well-informed about recent progress in the science and technology of his times. Consequently, his reputation as a futurist rests not only on his imaginative predictions of things to come, but also on his uncanny skill in crafting convincing extrapolations of the technologies of his era to achieve those visions. Flying continental distances, journeying to the moon, penetrating to the center of the earth, exploring the depths of the ocean at will – all these had been thought of by other men. But it was Jules Verne who first popularized notional solutions to these challenges and created a sense of possibility that had been absent before.

So alive does Nemo become for us in *Twenty Thousand Leagues Under the Sea* that generations of readers have been tempted to credit *him* with creating *Nautilus* and stimulating our subsequent fascination with the undersea world. But it is really the broad erudition – and extraordinary imagination – of Jules Verne that illuminate these pages, much as Nemo's Ruhmkorff lights illuminated the treasures of the deep. Verne died in 1905, just as the first generation of modern submarines reached fruition and less than a decade before they achieved their first lethal successes in undersea warfare. In foreseeing the possibilities inherent in the submarine 35 years before, he had been right about some things and wrong about others, but the likelihood of fulfilling all the essentials of his vision is now little doubted.

Authors note: *The best modern translation of* Twenty Thousand Leagues Under the Sea *is that of Walter James Miller and Frederick Paul Walter (Naval Institute Press, Annapolis, 1993). This version restores all of the French text customarily deleted in earlier English translations, and it includes many helpful annotations. Another useful source of information on the technical details of Nautilus, as well as a fascinating survey of past and present representations, is the website of Michael and Karen Crisafulli,* ***http://home.att.net/~karen.crisafulli/nautilus.html.***

Notes

1 That same year, the Franco-Prussian War broke out – much to France's ultimate disadvantage – and Verne served briefly as commanding officer of a small coast guard vessel at Le Crotoy near the mouth of the Somme. Reportedly, during that period he wrote the drafts of four novels!

2 By Verne's reckoning, 20,000 leagues is about 43,000 nautical miles.

3 In a subsequent Jules Verne novel, *The Mysterious Island* (1875), Captain Nemo reappears near the end of his life, he and *Nautilus* having survived their encounter with the Maelstrom to continue their underwater quest. It emerges that Nemo was born Prince Dakkar, an Indian rajah's son of extraordinary intellect, who was provided a comprehensive education in Europe, where he developed unparalleled artistic and scientific capabilities. After he returned to India, Prince Dakkar became a leader of the gathering independence movement that erupted in the "Great Indian Mutiny" of 1857, which was brutally suppressed by the British. Although Dakkar's family was massacred in the upheaval, he himself escaped, gathered an international band of what might be called today "freedom fighters," and built *Nautilus* in secret as an instrument of vengeance against oppression world-wide – and particularly against the British.

4 Professor Aronnax contradicts himself in describing *Nautilus*'s hull plating. When first stranded on top, he notes, "That blackish back on which I was sitting was glossy and smooth, with nothing like overlapping scales." Some days later, he says, "I noticed that its iron plates, slightly overlapping each other, resembled the scales covering the bodies of large terrestrial reptiles." Moreover, the hull is described as iron in one passage and steel in another.

5 In size and shape, *Nautilus* is similar to the former experimental submarine USS *Albacore* (AGSS-569) launched in 1953: 203 feet long, 1,242 tons surfaced, 1,847 submerged. However, in comparing the ratio of surface to underwater displacement, *Nautilus* more closely approximates subsequent nuclear-powered attack submarines, such as the USS *Los Angeles* (SSN-688) class.

6 Interestingly, an electric boat powered by a Bunsen-cell pile was apparently demonstrated in Paris in 1871.

7 At one point, Verne refers to "Ruhmkorff cells," but this is probably an error.

8 Covering four vertical leagues in four minutes corresponds to an average rate of rise of 130 knots – hardly likely!

9 An inconsistency appears in Captain Nemo's description of his portable light source. There he speaks of "a Bunsen battery that I activate not with potassium dichromate but with sodium." Previously, he described replacing the Bunsen cell's zinc elements with sodium. Interestingly, Verne had already prognosticated such "Ruhmkorff lights" in *Journey to the Center of the Earth* and *From the Earth to the Moon*.

From Humble Origins

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hostilities do break out, the American submarine force will undoubtedly be in the thick of the fight.

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Floating Drydock Resolute Ends 58-year Career

by JOC(SW/AW) Mark O. Piggott, COMNAVSUBFOR Public Affairs

After 58 years of service to the U. S. Navy, the Medium Auxiliary Floating Drydock *Resolute* (AFDM-10) was inactivated at a ceremony at Naval Station Norfolk on November 7, 2003. *Resolute* was one of a kind, the last of her class serving submarines on the East Coast.

"*Resolute* is an engineering marvel," said CAPT Bruce E. Grooms, Commodore, Submarine Squadron 6. "Her 139 safe and accident-free drydockings are the direct result of hard-working, dedicated crews. I salute you and your superb efforts," he continued, "to make *Resolute* one of the finest drydocks the Navy has ever known."

Resolute was built by the Chicago Bridge and Iron Works in Newburg, New York in 1944 and entered active service as YFD-67 the next year. Designed to forward-deploy with the fleet and keep ships battle ready, *Resolute* joined the war effort just before the end of the Pacific conflict.

"*Resolute*, born of the fighting spirit that made and keeps our nation strong, has had a varied and at times indeterminate history," said CDR Douglas J. Holderman, her Commanding Officer. "Yet it is not her steel skin alone that bestows that spirit, but rather her crew…" he added, "…and the devotion to duty and loyalty to country that goes into keeping this rather large chunk of steel active for 58 years, ready to serve."

Since arriving in Norfolk, *Resolute* has safely docked 139 submarines, and completed 55 Selected Restricted Availabilities (SRA) without incident. *Resolute* has been awarded seven Battle "E" Efficiency ribbons, two Meritorious Unit Commendations, two National Defense Service medals and was awarded the Chief of Naval Operations Safety Award in 2001 for outstanding contributions to fleet readiness.

Line Officer Qualified In Submarines:

LTJG John Bacholzky
USS Olympia (SSN-717)

LTJG Robert Bogan
USS Michigan (SSBN-727)(B)

LTJG Nicholas Borman
USS Olympia (SSN-717)

LTJG Benjamin Britt
USS Pennsylvania (SSBN-735)(B)

LTJG Scott Brockman
USS Pennsylvania (SSBN-735)(B)

LTJG Samuel C. Gray
USS Tennessee (SSBN-734)(B)

LTJG Philip Castellano
USS Asheville (SSN-758)

LTJG Michael Garner
USS Michigan (SSBN-727)

LTJG Robert Gautier
USS Parche (SSN-683)

LTJG David George
USS Portsmouth (SSN-707)

LTJG Marcus Gioe
USS Chicago (SSN-721)

LTJG Heath Heist
USS San Francisco (SSN-711)

LTJG George Howell
USS Henry M. Jackson (SSBN-730)(B)

LTJG Nicholas J. Hill
USS Nebraska (SSBN-739)

LT Quintin James
USS City Of Corpus Christi (SSN-705)

LTJG Gregory Johnson
USS Pennsylvania (SSBN-735)(B)

LTJG Pratik Joshi
USS La Jolla (SSN-701)

LTJG Horacio Larios
USS Greeneville (SSN-772)

LTJG Bruce M. Reilly
USS Montpelier (SSN-765)

LT Jeffrey Mills
USS Columbus (SSN-762)

LTJG Hoang N. Tran
USS Montpelier (SSN-765)

LTJG August Negele
USS Michigan (SSBN-727)

LTJG Trent Neville
USS Henry M. Jackson (SSBN-730)(B)

LTJG Thomas Niebel
USS La Jolla (SSN-701)

LTJG Randal P. Shaffer
USS Maine (SSBN-741)(B)

LT Jeremy Pelstring
USS Michigan (SSBN-727)

LTJG Jason Pepin
USS Nevada (SSBN-733)(G)

LTJG Weylin Piegorsch
USS Olympia (SSN-717)

LTJG Craig Prost
USS Pasadena (SSN-752)

LTJG Thomas Resig
USS Alaska (SSBN-732)(B)

LTJG Matthew Rivera
USS Nevada (SSBN-733)(G)

LTJG Kenneth Rogers
USS Alaska (SSBN-732)(G)

LT Joseph Root
USS Columbia (SSN-771)

LTJG Jonathan Ross
USS Alabama (SSBN-731)(B)

LTJG Chad Roum
USS Alabama (SSBN-731)(B)

LTJG Aaron Running
USS Nevada (SSBN-733)(B)

LTJG Logan Schulze
USS Los Angeles (SSN-688)

LTJG Raj Singaraju
USS Buffalo (SSN-715)

LTJG Michael Stodick
USS Portsmouth (SSN-707)

LTJG Corbyn Thorsen
USS Alaska (SSBN-732)(B)

LTJG Jon Vorachek
USS Henry M. Jackson (SSBN-730)(B)

LTJG Robert Yovich
USS Olympia (SSN-717)

SUBRON 3 Senior Chief on Target

by JO3 Corwin Colbert, USN

With extreme patience, he slowly pulls the trigger and, with a bang, another near-perfect shot pierces the target silhouette.

Electronics Technician Senior Chief Greg Silvey, Submarine Squadron 3, shoots with determination and precision, which is why he sports a unique badge on the left shoulder of his khaki uniform. It is the President's Hundred badge, given to those ranked among the top 100 competitors in service pistol shooting. Silvey ranked 51st in the President's Hundred, 3rd in the Expert Service pistol match, 9th in the National Trophy individual match, and 1st on the U.S. Navy Pistol shooting team. He has been in the U.S. Navy for 21 years and has been firing small arms for even longer.

According to Silvey, his fascination with shooting started when he was quite young. "The first gun I fired was when I was 10 years old with my father on my grandparent's ranch in Santa Paula, California. It was an M-14 rifle. We were shooting cans and bottles near a riverbed we used for practice," said Silvey.

Silvey has a variety of firearms and remembers when he purchased his first weapon. "The first gun I ever bought was a .357 Magnum. I felt comfortable with it, and that's why I bought it. It got it for self-defense, because one day, when I was helping a friend build a log cabin back in Georgia in my spare time, we got shot at by poachers. The local sheriff told us it would be in our best interest to own a firearm for protection. I started being interested in competing when I took that .357 Magnum out to the range."

In his free time, Silvey shoots at Koko Head public shooting range, where he also competes as part of the local Chinese Gun Club. Lester Higa, a Honolulu native, is a Chinese Gun Club teammate.

"Greg and I are a part of the Chinese Gun Club. I met him through another one of our bullseye shooters. To be a bullseye shooter takes a lot of practice and patience," said Higa. "Greg is very dedicated to the sport. He comes out to practice, not to socialize. I think he sets a really good example of what a bullseye shooter should be doing at a practice session," said Higa. "During a match, Greg has a tremendous amount of concentration. When he has 10 minutes he takes the full 10 minutes. Sometimes it is a little frustrating because we are all finished shooting and we are waiting on Greg," Higa chuckles. "It will be nine minutes and 45 seconds and he will shoot the last shot. His ability is improving every day, provided he gets the practice time in, and he is able to make the matches. Unfortunately, he lost some momentum due to his service duties, but he has been gaining it back," concluded Higa.

"I have been to three nationals, and I will be there for 2004," said Silvey. "The national championship is held at Fort Perry in Clinton, Ohio. It's interesting to meet people at the competitions and find out what they do and how they got into competing. You make friends there, and they're friends for life. It's a big social event."

Silvey hopes some day to break former Navy service member Donald L. Hamilton's record. "Not only just to break the record, but to keep it Navy as well," remarked Silvey. "Hamilton's score was 2,688 out of 2,700. The best I've done is 2,636 out of 2,700, but I've been breaking 2,600 for a while, and I think I have a chance."

Qualified Nuclear Engineer Officer

LT Stephen Fisher
USS Nevada (SSBN-733)(B)

LTJG Ismial Aljihad
USS Alabama (SSBN-731)(B)

LTJG Joseph Bobrowski
USS Michigan (SSBN-727)(B)

LTJG Robert Bogan
USS Michigan (SSBN-727)(B)

LT Tullio Celano III
USS Jefferson City (SSN-759)

LT David Edgerton
USS Honolulu (SSN-718)

LTJG Steven Everhart
USS Ohio (SSBN-726)(B)

LTJG Maurice Greer
USS Los Angeles (SSN-688)

LTJG Daniel Hogan
USS Pennsylvania (SSBN-735)(G)

LTJG Matthew Holland
USS Salt Lake City (SSN-716)

LTJG James Hough
USS San Francisco (SSN-711)

LTJG Stephen Korupp
USS City Of Corpus Christi (SSN-705)

LTJG Bradley Lambert
USS Pennsylvania (SSBN-735)(G)

LTJG Ramon Martinez
USS Kentucky (SSBN-737)(B)

LTJG Nathan Mills
USS La Jolla (SSN-701)

LT Andrew Omeara
USS Jefferson City (SSN-759)

LTJG Kyle Partridge
USS Alaska (SSBN-732)(G)

LT Jon Phillips
USS Greeneville (SSN-772)

LTJG Andrew Platten
USS Columbia (SSN-771)

LTJG William Swanbeck
USS Asheville (SSN-758)

LTJG Jon Uyboco
USS Louisville (SSN-724)

LTJG Chimi Zacot
USS Tucson (SSN-770)

Honolulu Surfaces at the North Pole

The *Los Angeles*-class *fast-attack* submarine USS *Honolulu* (SSN-718) surfaced in an open water area approximately 280 miles from the North Pole in October 2003. While conducting otherwise classified operations in the Arctic, *Honolulu* collected scientific data and water samples for U.S. and Canadian universities as part of an agreement with the Artic Submarine Laboratory (ASL) and the National Science Foundation (NSF). Commanded by CDR Charles Harris, *Honolulu* is the 24th *Los Angeles*-class submarine, to visit the North Pole region. *Honolulu* is assigned to COMSUBPAC, Submarine Squadron 3, Pearl Harbor, Hawaii. Pictured right, three polar bears approach *Honolulu*'s starboard bow. Sighted by a lookout from the sail of the submarine, the bears investigated the boat for almost two hours before leaving.

Photos by YNC Alphonso Braggs.

On The Back

"The Submarine 'Nautilus' in dry-dock 371 nautical miles NNE of Vanikoro" by Dave Warren. According to Verne's Captain Nemo, *Nautilus* was built in secret on a deserted island in the Pacific Ocean using components ordered under various *pretexts* from all over the industrialized world. This is English artist Dave Warren's conception of the submarine nearing completion but still on the stocks. Mr. Warren has been a film industry art director for 10 years, but he created his Nautilus drawings largely as an avocation. He lives near London. See the "Submarine Technology of Jules Verne" on page 24.

“The Submarine ‘Nautilus’ in dry-dock 371 nautical miles NNE of Vanikoro”

by Dave Warren