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"The Enemy Below – The Global Diffusion of Submarines and Related Technology"

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"The Enemy Below- The Global Diffusion of Submarines and Related Technology"

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~~Draft~~ **Summary of Discussion**
By Kenneth G.Weiss

Introduction

Roughly 80,000 years ago, our ancestors first crossed out of Africa, and began the process which we now call globalization. (Indeed, even earlier humanoid remains have been found outside Africa as long as 1.75 million years ago). With the diffusion of people around the world came the development of culture and civilization as well as the spread of ideas, goods, technology, and so forth. The process of globalization then is a long standing one, and not an innovation of the late 20th and early 21st centuries. Over the millennia, this process has been an uneven one, and has often caused great disruptions even to the societies that initiated various innovations in culture and civilization, including science and technology. Indeed, many cultures and civilizations have disappeared while some regions failed to advance as rapidly as others, so the process of globalization is not just one of continuing progress.

Globalization in the current era seems to be penetrating the most remote corners of the world at a remarkable rate as a result of advances in science and technology, particularly information technology. The diffusion of science and technology is not necessarily a benign development. It could increase the potential for a global military industrial base that may have an adverse impact on world stability in the future. For example, the diffusion of key military capabilities, like submarines, could have an impact, especially over the longer term, on the US.

***The Center for Global Security Research (CGSR) at Lawrence Livermore National Laboratory (LLNL) has been sponsoring a series of workshops, leading eventually to a conference, focusing on the future of science and technology over the next fifty years, and its potential impact on national security. As part of this project, CGSR sponsored a workshop in cooperation with the U.S. Naval Postgraduate School (NPS) in Monterey, California on 30-31 May 2002 on the diffusion of submarines and related technology as a case study. This workshop was hosted by Dr. Ronald F Lehman II, Director of the Center for Global Security Research, and RADM David R. Ellison, Superintendent of the U.S. Naval Postgraduate School, and organized by Dr. Kenneth G, Weiss, a consultant to CGSR/LLNL, with Professor Clyde Scandrett of the U.S. Naval Postgraduate School, and with the invaluable support of Tami Alberto of CGSR/LLNL with Stephanie Brand of NPS. The format of the workshop was interactive, emphasizing discussion among the invited specialists from the Navy, OSD, various national laboratories, academia, think tanks. Etc., along with some briefings to inspire discussion.**

Thus, the US ability to use its military forces, especially naval forces, to influence events globally in support of peaceful change may decline. Over time, the stresses and strains in the

current international system, largely dominated by the West including Japan, may increase considerably with violent consequences. According to the UN the world's population will increase from 6 billion to 9 billion people by mid-century before leveling off. At the same time, population is declining in the West. Yet the West's life style and culture will continue to be attractive to many in the rest of the world, and thus a source of continuing tension and disruption in more traditional societies, less accustomed to rapid change.

Submarines are ideal for a case study in technology diffusion. The submarine was largely an American invention, although the development of the technology can trace its origins back to Alexander the Great. In 1900, the US Navy bought the first successful submarine, as we know it, from John Holland who then founded the company that is today known as General Dynamics Electric Boat. These submarines quickly spread to the United Kingdom, France, and Russia, while Germany developed the U-Boat based on a competing American design by Simon Lake. Submarines played key roles in both World Wars, and the nuclear submarine, also first developed by the US, spread to the other major nuclear powers during the Cold War. In the post Cold War era, submarines are likely to play even more important roles as the vulnerability of surface ships and associated aircraft increases. As one Chinese PLA officer stated the battleship dominated the seas in World War I, and the aircraft carrier in World War II, while the submarine will be dominant in future wars.

The US response to 9/11/01 in Afghanistan against the Al Qaeda terrorist organization and its Taliban supporters highlighted the US's continuing need to project and sustain power in distant theaters as well as deny sanctuary to its enemies. US naval capabilities are a key factor in the nation's ability to project power in remote regions of the world. In this regard, the US Navy's strategy shifted at the end of the Cold War from open ocean blue water operations to the support of joint operations in littoral waters. This strategic shift increases the threat of conventional foreign submarines (SS) and mines while nuclear submarines will also remain a threat (SSN). The US may be lagging in doctrine, strategy, and tactics in dealing with these capabilities. There is already a problem in countering the current foreign submarine threat, and it could become worse in the future. Moreover, the events of 9/11/01 emphasized the need to "expect the unexpected," and focused US attention on homeland defense. Submarine forces could become instruments of terror in the future. Hostile submarine forces, whether conventional or nuclear, in time could conceivably pose a threat, conventional or WMD, to homeland. As Secretary Rumsfeld has pointed out, the US should not plan to fight this or that country, but examine its vulnerabilities, and how an enemy might exploit them. Thus, the US must take into account a potential enemy's ability to exploit any submarine-related vulnerability.

This summary of the workshop's discussion focuses on three key questions: What do we know or agree on; what don't we know or disagree on; and what requires additional research? In this regard, the following reflects the impressions of the author and no doubt does not adequately mirror the complexity and richness of the views expressed at the meeting.

What Do We Know or Agree On?

- Despite a decline in the numbers of submarine forces in general (458 in 1997, 364 in 2002) following the Cold War, US ability to conduct anti-submarine warfare has declined even more. Allied ASW capabilities have declined as well. Currently, the US has 52 SSNs, 18 SSBNs, and 2 SSAN. The US Navy needs roughly three submarines to keep one forward deployed.

- Over 40 counties have submarines in their naval inventory, over 30 of these are in the Third World. (In this context, Third World means only non-Western nations including Russia and China. It does not necessarily mean economically underdeveloped or technologically inferior. In fact, Russian submarines and related systems are very technologically advanced. Some nations in this category like Singapore are as economically advanced as some Western countries.) There are currently approximately 175 conventional submarines, including midget submarines in the Third World not including Russia and China, who also have roughly 45 nuclear (SSN/SSBN), 8 conventional and 6 nuclear (SSN/SSBN), 58 conventional, respectively. (See Table 1)

- With the Cold War over, the USN has cut back on ASW platforms, surface, air, and subsurface, and related technology, and has curtailed practicing ASW operations. Both Atlantic and Pacific commands are concerned about the decline in US ASW capabilities,

- The very presence of potentially hostile submarines severely complicates US naval operations, and the ability to project power ashore.

-Conventional submarines can be used for coastal defense (ASUW, ASW), merchant shipping interdiction, power projection, offensive and defensive mining, strategic missile platforms, intelligence gathering, special forces etc., although nuclear submarines provide greater range, speed, power, and endurance.

- Submarines/submersibles could be used as unmanned underwater vehicles (UUV), or manned for drugrunning, piracy or terrorism.

- Conventional diesel submarines are difficult to detect because they are quieter than the Soviet nuclear submarines that we hunted in the Cold War, and he who shoots first has the advantage.

-These submarines have/ may become increasingly more sophisticated.
- -Better batteries (snorkel every four days)
- -Air Independent Propulsion (Fuel Cells, Stirling Engine)
- -SSn (Small nuclear plant to generate power for propulsion-has yet to generate much interest)
- -Sophisticated submersibles like unmanned underwater vehicles

-Integrated fire control systems for weapons, sensors, and targeting:
- Advanced weapons, such as wakehoming torpedoes, submarine launched missiles with anti-surface, subsurface, and anti-air capabilities and improved naval mines;
- Advanced passive and active sensors, such as improved microelectronics, hull/bow mounted arrays and flank and towed arrays, and
- Quieting technology, such as hull mounted anechoic tiles, rafted mounted machinery, permanent magnetic motors, improved propellers, etc;
- Improved countermeasures for survival;

- Automated systems requiring fewer personnel for operation, modular construction, etc.

- Even older conventional submarine forces pose a threat. For example, the Chinese deployed a large number of Romeo submarines in a recent exercise, and such deployments are difficult to detect and keep track of.

- The advent of Air Independent Propulsion (AIP), which are as quiet as diesel submarines running on batteries while submerged, may make it even more difficult to detect conventional submarines because they will be able to remain submerged for weeks at a time, instead of days like diesel submarines. (Conventional submarines on batteries can generally run more quietly than nuclear submarines because pumps to cool a submarine's nuclear reactors make noise.)

- Even though many countries are opting largely to develop, acquire, or upgrade conventional submarine capabilities, nuclear submarines are not going away. Although the Russians are retiring or dismantling their older nuclear submarines, they are trying to retain as much of their construction capabilities as possible, and they are continuing to work, however slowly, on newer classes of SSNs and SSBNs. The Russians are also assisting the Chinese in developing a new class of SSNs and SSBNs as well as the Indian nuclear submarine program. The UK has leased its remaining conventional submarines of the *Upholder* class to Canada to concentrate on nuclear submarines. France is also dispensing with its conventional submarines in favor of its nuclear submarine program. However, the French are subsidizing conventional submarine exports to keep open their shipyards.

- Nor can we discount improvements in stealth and other capabilities of foreign nuclear submarine forces, specifically the Russians and the Chinese. The Soviets made significant advances in quieting their nuclear submarines by the end of the Cold War, and the Russians will probably make greater advances in the future. Moreover, Soviet submarines were very capable in speed, diving depth, and weapons array. The Russians are generally willing to sell this technology. With their help, the Chinese new attack submarine under development may have the capabilities of a Victor III, which represented a significant advance in quiet Soviet submarines.

- Submarines and related technology will diffuse over time. Much of the technology can simply be purchased out right or manufactured on co-production and licensing arrangements from Russia, Germany, and France. These three countries also have a significant market for associated systems. For example. Russia, Germany, and France account for 67% of the sales for heavy torpedoes. Indeed, the Russian Shval torpedo or underwater missile available for export has a speed of 200 knots, and has no Western counterpart. Moreover, the Germans guarantee logistic support for their submarines as long the buyer does not go to war against them. They are also helping other countries through sales and technology transfer to improve their own production capabilities like China, India, Pakistan, South Korea, Brazil, etc. (See Table 2)

-Moreover, there are other factors affecting the diffusion of submarines and related technology. For example, as the US and other countries rely more and more on commercial-off-the-shelf technology (COTS) for its weapons systems, other countries will have similar access. Advances in submarine and related technology can also be obtained on an unclassified basis in the US (and probably elsewhere) through conferences, publications, patents, Defense Technology

Information Center (DTIC), National Technical Information System (NTIS), military and technology related websites on the internet, company websites, etc. For example, the Germans have been using modular construction for their submarines based on a US technology patented in the 1960s that the USN is only now utilizing in the new Virginia class of SSNs. European defense/submarine manufacturers seem to be freer with providing technical related information than the US in order to make sales. They are also generally willing to transfer technology through licensing or co-production arrangements. What cannot be bought, or obtained on the internet, can be stolen potentially through espionage or other illicit arrangements, like the manufacturing capability to produce quiet propellers that the Soviets obtained from Toshiba.

-Another reason submarine technology will diffuse over time: Third World countries, including Russia and China, will gain in scientific and technological expertise because they are training many of their students in the West, especially in the United States. In the 1970s, the State Department issued roughly 60,000 student visas; in 2001, the State Department issued 350,000 student visas. Practically all the scientists in the Iraqi WMD programs were trained in the West, especially the US, including the father of the Iraqi nuclear weapons program. Many of these students are from Asia.

- International export controls are weak, making it difficult to control the diffusion of submarine technology. Although the Wasennaar Arrangement replaced COCOM (and even includes Russia in membership) in controlling munitions and dual-use technology to rogue states and regions of instability, Wasennaar controls are extremely weak, and its members' national controls are unreliable. For example, one briefer claimed that Russia is apparently willing to export most weapons technology to China except nuclear weapons and ballistic missiles. The Russians are also assisting the Indian nuclear submarine project (ATV), and helping them to develop missiles for the ATV that the Indians could use for nuclear warheads. Moreover, the Russians little need to forego income earned from weapon sales, and would be very reluctant to agree to restraints on transfers of submarines or related technology. In addition, many Russians resent US claims to naval superiority. China has had a traditional aversion to informal supplier control regimes, seeing them as an effort to retard the development of Third World countries. (Others do not necessarily disagree concerning the difficulties of coming to agreement with other countries concerning supplier restraint, but point out that many believed that there was little chance of success in negotiating supplier regimes like the NSG, MTCR, and Australia Group, and thus efforts to strengthen Wasennaar or make other informal arrangements or requests concerning restraint in specific transfers may be worth exploring.)

- A coordinated ASW effort is necessary. Commonly, a six to one ratio of surface, air, and subsurface platforms is required to deal with a single potentially hostile submarine. There are also promising research and development efforts underway to improve our ability to detect conventional submarines, but they remain in R&D because they have not been given enough priority to move towards the production phase.

- A potential enemy might use its submarines to sink a US SSN if they could, and we might not even know who did it. There are thousands of sailors aboard a single US aircraft carrier, and a submarine-related sinking of a carrier would be the equivalent to the destruction of the World Trade Center towers. US amphibious ships and resupply ships are particularly vulnerable, and

their loss could cripple our ability to project power in a crisis or conflict. Furthermore, in the age of supertankers and giant container ships the impact of a campaign against merchant shipping might be felt more quickly than in World War II.

- Conventional submarines could be used to deliver WMD, nuclear or CBW, against the US homeland or bases overseas. They could also lurk outside a US or overseas base, and attack a US SSN or SSBN as it is entering or exiting port.

- In regard to "expect the unexpected," an effort by terrorists, anti-nuclear activists, or a rogue state's special forces to seize an SSN/SSBN at a US or overseas naval base, with incalculable consequences for US resolve and for the future of the nuclear navy, cannot be wholly discounted.

-US efforts to improve ASW capabilities are not likely to increase in the near future. Some argued that it would not improve until the Navy revived a high level organization dedicated to ASW, More dramatically, others argued that the US would not concentrate on ASW until a US ship was sunk by a foreign submarine.

What We Do Not Know or Disagree On?

- Some argue that the foreign submarine threat is overstated. Not only have the numbers of submarines declined, but some countries are hard pressed to operate the submarines they have. Modern submarine forces, even conventional ones, have become so expensive that many countries have either decided that they cannot afford them or limit the numbers that they buy or build. Yet there was agreement that our ASW capability has also declined. Moreover, others argue submarines that did not appear to be operational have surprised us in the past.

- There has been a consolidation in the number of countries and companies building submarines. In the West, the Germans have all but cornered the market for conventional submarines with the French remaining their only serious competitor. (It is not clear if a US bank's purchase of HDW, the German submarine manufacturer, which also owns the Swedish submarine firm, Kockums, will give the US greater control over German sales. But it probably will not since the Germans have generally resisted US efforts to control the sales of US owned companies in Germany). For example, the Germans and French have been willing to sell submarines in regions of tension, such as South Asia. There was also some disagreement over the numbers of submarines they have sold or will sell. Yet those countries that have had submarine production capabilities like the UK, Italy, Netherlands, etc. seem to be trying to retain some residual capability so that they can ramp up in the future should the international environment or the market change.

- Outside the West, the Russians are the only serious player with the possibility of China and India in the future. There was disagreement on how successful the Russians have been in making sales. The Russians have been working on AIP since the 1970s, and they envision equipping the *Amur-class* submarines, the follow-on class to the *Kilo*, with a fuel cell based AIP system. However, the first submarines of the class will rely on diesel engines and batteries for propulsion. The Russians hope to sell the *Amur* to the India and China. Some believe that the Russians have had difficulty in developing an AIP system, and may have a hard time selling the *Amur*. The Chinese are also very interested in acquiring or developing an AIP submarine

capability as well as improving their indigenous conventional submarine manufacturing capabilities, while acquiring *Kilo*-class-submarines from Russia. There are reports that the Chinese may be developing an AIP system for their *Ming*-class submarines. Nevertheless, some point out that the Chinese have been experiencing significant difficulties developing their new *Song*-class of conventional submarines.

- Although other countries in the Third World, such as Argentina, Brazil, Chile, South Korea, etc, have some capability to construct submarines, they remain dependent on countries like Germany to complete them. However, others argue that these countries have ambitions to eventually develop independent capabilities of their own, and they could become sources for submarines and related technology to rogue state or regions of tension. For example, Germany and France have been willing to sell to India and Pakistan, and these countries could become sources for submarines and associated capabilities in the future.

- Some countries have decided to upgrade existing platforms or buy older submarines from other countries. However, even modernizing old platforms can be very expensive. For example, there was some disagreement on how likely Third World submarine forces will buy wake homing torpedoes from the Russians.

- AIP is not cheap, and can add as much as 15-20% to the cost of a submarine. Some argued that AIP may not prove to be attractive as some think, and that diesel submarines may remain sufficient for most roles and missions. On the other hand AIP is still experimental, and costs could go down as production increases. Also more capable AIP platforms may reduce the need for larger numbers of diesel submarines for most roles and missions. Moreover, the Germans and French are constructing their boats so AIP can be added if buyer should desire that option after purchasing the boats. For example. Pakistan, a poor country, has ordered three *Agosta*-class submarines from the French. The third boat is to be equipped for AIP, but the other two can be retrofitted for AIP in the future. However French technical help was suspended temporarily after French technicians became victims of a terrorist attack.

- There was disagreement over the spread of nuclear-powered submarines globally. The development or acquisition of nuclear submarines is extremely costly, and thus are not likely to spread beyond a few countries. Nevertheless, India has a current effort to build nuclear submarines, called the Advanced Technology Vehicle program (ATV). Indeed India leased a *Charlie*-class nuclear submarine in the late 1980s from the Soviet Union, and has apparently been interested in acquiring an *Akula* II from Russia, but the cost may be prohibitive. Brazil and Argentina have had such ambitions in the past.

- There was disagreement over how far Brazil's on again/off again program progressed with some arguing that the Brazilians succeeded in developing a prototype naval nuclear propulsion plant for a boat of about 2800 tons. Neither the Nuclear Nonproliferation Treaty (NPT), nor its Latin American equivalent, the Treaty of Tlatelolco, provide a legal barrier to its signatories for the development of nuclear-powered submarines. The NPT does not prohibit the development of nuclear submarines. For example, the Canadians would never have violated their NPT obligations by developing 10-12 nuclear submarines as they seriously considered in the late 1980s. The Treaty of Tlatelolco, specifically permits the development of nuclear propulsion, and, in this

regard, the Brazilians have maintained that nuclear submarines provide "transportation," and are not weapons per se. Indeed, the Brazilians retained their right to develop nuclear-powered submarines in joining these treaty organizations.

- Conventional submarines can be used as nuclear weapons platforms. The Russians developed the *Golf*-SSB for this purpose, The Chinese still have a *Golf*-class submarine which has been used as a SLBM test bed. Some argued that the Israelis may be acquiring the *Dolphin*-class diesel submarine from Germany for this purpose, and the advent of AIP may make conventional submarines more attractive as a deterrent platform. Pakistan tried to buy a *Han*-class SSN from China in the 1980s, and has stated that it would equip their conventional submarine with nuclear weapons to offset any Indian capability. Some doubted that the Pakistanis have the scientific and technical capability to adapt their French submarines, with a possible AIP capability, for WMD purposes. However, a nuclear device does not necessarily have to be delivered by torpedo or missile from a submarine to destroy a hostile port.

- Some argue that a country needs an overall defense budget of at least $20 billion to be able to afford a submarine program, and that expense severely limits submarine program whether conventional or nuclear. Others point out that economic growth rates in many Third world countries may make submarine programs, even nuclear, more affordable in the future. For example, even Russia which had negative growth rates for most of the 1990s, posted a growth rate of 1.5% in 1999 and 6.7% in 2000. High oil prices over time will do wonders for the Russian economy. China has been scoring high growth rates since the advent of the Open Door policy in the late 1970s and even India seems to have broken through the Hindu growth rate of 4% to post above 5% and 6% growth rates in recent years. All three of these countries also have significant and growing scientific and technological capabilities. For example, economic development in the ASEAN countries have enabled many of them to purchase or consider acquiring submarines like Singapore, Thailand, and Malaysia. Economic clout gives Taiwan the ability to acquire or develop a submarine program if the Taiwans can find someone willing to help them. Another one of the little dragons, South Korea, has been acquiring and developing submarines with the help of Germany despite US efforts to discourage Seoul in doing so. The South Koreans are even planning on acquiring AIP-equipped submarines from Germany. The Japanese are also interested in improving their submarine capabilities with AIP-equipped boats. Finally, even relatively poor countries, like Iran and Pakistan, will buy submarines to satisfy perceived military requirements.

- There was some disagreement on how well some of these countries can operate these submarines. Ecuador, for example, does not operate them very well at all. However, friendly foreign submarines have succeeded in penetrating US carrier screens in recent exercises. The Indians believe that the Pakistanis are very capable submariners, and they themselves practice with the US in mind. It was not clear how well Iranian Kilos are manned and operated. However, it was argued that if we were really concerned we should simply mine Bandar Abbas, so they either could not exit or reenter after they left. Others pointed out that it was unlikely even in a crisis situation that the rules of engagement would permit mining Iranian harbors. In the past, Chinese submarine exercises have not ventured far from the coast, and they usually returned to port at the end of the day. However, the Chinese navy is moving towards more lengthy exercises in blue ocean waters. Some have argued that five of six Chinese nuclear submarines have not been

active, or were non-operational, while others pointed out that this was not the case for the *Xia* SSBN at least.

-It was not clear there was any agreement on the impact of submarine programs on regional stability. However. India's effort to develop or acquire a nuclear submarine capability has prompted Pakistan to seek some offsetting capability in the past. Moreover, the Indians seem to be acquiring nuclear submarines as a way of projecting power in the seas around China. Such regional tensions should be a concern to the US since conflict between or among nuclear powers is a serious threat to global stability even though India's nuclear and conventional submarine programs may not be aimed at the US. Indeed, India cannot rule out that the US might "lean" towards Pakistan as Washington did in the Indo-Pakistani War of 1971. In that crisis, the US deployed the *Enterprise* carrier task force to the Indian Ocean as a warning to New Delhi not to occupy territory in West Pakistan. Thus, Indian submarine operations are conducted with the US in mind as well as Pakistan. Moreover, it probably is no accident that all the little dragons who could afford them are now acquiring or trying to acquire submarine capabilities. Of them, only Taiwan seems to have a reasonably clear reason for doing so unless the others are also concerned about Chinese intentions in the region. Even so, it seems that if one ASEAN state acquires a military capability the others want a similar one.

What Other Questions or Issues Need Further Research?

-Exactly how great has been the decline in US ASW capabilities, and what do we need to do about them? What about our allies?

-We need further research identifying diesel and/or AIP submarine vulnerabilities, and new technologies that could help locate conventional submarines. Are there new technologies that would enhance a US SSN ability to detect conventional as well as nuclear submarines?

- We need further research into submarine-related military doctrine, strategy, tactics, operations., training and exercises of Third World submarine forces.

-How will general developments in science and technology affect submarine warfare in the future? For example, the development of the diesel engine for railroad use before World War II provided US submarines with greater speed and range. Among others, how will the exponential development of computing power in the future affect submarine technology, and how will submarines and ASW be integrated with "netcentric warfare?"

- What implications does the spread of submarines have for research in computers/software/ algorithms, data management, materials sciences and engineering, weapons effects, MEMs technology, artificial intelligence, etc.?

- In the future, are there any potential breakthroughs in ASW that could render the US deterrent force vulnerable to attack? Is the export of ASW-related dual use technologies making our SSN/SSBN force potentially more vulnerable? For example, the export of detection equipment for seabed oil drilling, and the use of SOSUS technology for academic related oceanographic research.

- How vulnerable are our SSN/SSBN submarines to a terrorist attack or takeover? What about nuclear submarines of other countries?

- Could Al Qaeda or some other terrorist organization acquire submarines from Iran, North Korea, or some future fundamentalist government in Pakistan, Algeria, Malaysia, etc. to launch a WMD attack on the US homeland, US bases overseas, or elsewhere?

- Could another country such as Iran use a conventional submarine, including midget submarines, to launch a sneak attack on a US port without us detecting their approach or even identifying the attacker afterwards?

- What is the likelihood the submarines could be used for drug smuggling or piracy or other criminal activities?

- What is the likelihood that other countries besides Israel may use conventional submarines as deterrent platforms? Can they develop the requisite nuclear or WMD capabilities or missile or torpedo launched WMD? Do they need to or could they just lay a WMD device in a port like a mine or place a device aboard a midget submarine or UUV? Have CBW capable-warheads been developed for submarines?

- There is also need further research on the probability of additional countries acquiring nuclear submarines, and the hazards they may pose to nuclear proliferation, safety and the environment, regional stability, and US naval operations. There is also a need to explore the interrelationship between US national security, proliferation, environmental safety, and Russian nuclear submarine dismantlement.

- What are the implications of the spread of submarines for arms control, nonproliferation, and export control arrangements?

-We should look more closely at how Third World submarine forces affect our ability to influence crises through naval diplomacy, especially between nuclear powers like India, Pakistan, and China, as well as over a continuum of scenarios from peacetime operations to terrorism to confrontation or crisis to local war to conventional war to nuclear war.

- Although this workshop concentrated on discussing the current submarine threat, there is a need for further research on how the threat may evolve over the longer term, especially with the advent of a multipolar world.

Comment and Conclusion

The end of the Cold War seemed to create a more peaceful international environment. September 11 reminded us of the dangers of complacency. Indeed, even before September 11 US forces had intervened in a number of wars and crises, including Panama, the Persian Gulf War, Somalia, Rwanda, Bosnia, Kosovo, several Taiwan Straits crises, the North Korea nuclear weapons crisis, and most recently Afghanistan. US ability to intervene in remote areas of the world is often

dependent on the Navy's ability to project power ashore. As a result, US ability to influence events in crisis situations, especially between or among nuclear powers, may become more difficult along with our ability to conduct littoral warfare.

Although the numbers of potentially hostile submarines have declined with the end of the Cold War, US anti-submarine warfare capabilities have also declined. Moreover, foreign submarines and related technologies are likely to diffuse globally. New technologies like AIP, improved weapons and sensors will make conventional submarines more dangerous, and the spread of nuclear submarines even to a few more countries raise political, military, environmental, and safety concerns. Submarines are one of the key weapon systems used alone or in combination with other weapon systems such as coastal defense missiles, aircraft, and other sea-based missile platforms to deny US ability to project power ashore, Thus, other countries who wish to deny the US the ability to interfere with their regional or even global ambitions may emphasize the acquisition and/or development of submarines.

As the world become more multipolar over the longer term, as the Chinese believe it will, countries such as Russia, China. etc., may be able to acquire the submarine capabilities to challenge us not just regionally, but in blue waters. To the extent that our alliance relationships require US naval access or superiority to sustain them, then our erstwhile friends/allies such as Japan, South Korea, ASEAN states, Taiwan, etc., may seek their own arrangements with other powers for their protection or seek WMD capabilities to offset the former reliance on the US. In addition to a loss of unchallenged regional access, the US may have to devote greater resources for protecting its homeland, and perhaps its sea-based deterrent, from hostile submarine forces.

List of Terms

AAW - anti-air warfare

AG -Australia Group - international supplier regime to control Chemical/Biological/Warfare - related precursors and technology.

AIP - Air Independent Propulsion (Stirling engine, Fuel Cells): conventional submarines that do not rely on using a snorkel to obtain air to run the diesel engines to recharge their batteries while submerged.

ATV - Advanced Technology Vehicle: India's nuclear submarine program.

ASW - Anti-submarine Warfare

ASUW - Anti-surface Warfare

COCOM - Coordinating Committee for Multilateral Export Controls: the Cold War international organization which controlled munitions, dual-use, and nuclear related technology to the Communist bloc.

CVN - Nuclear-powered aircraft carrier

MTCR -- Missile Technology Control Regime: international supplier regime to control missile-related technology.

NSG - Nuclear Suppliers Group - international Supplier regime to control nuclear weapons related technology.

R&D - Research and Development

SLBM -- Submarine launched ballistic missile

SS - Conventional submarine

SSAN - Auxiliary nuclear submarine

SSB -- ballistic missile conventional Submarine

SSN - Nuclear-powered attack submarine

SSn -- small nuclear plant to generate power for propulsion, Which has yet to generate much interest.

SSBN - Nuclear-powered ballistic missile submarine

SSGN - Nuclear-powered cruise missile submarine

Third World - Non-Western Countries, including Russia and China. Third World does not necessarily mean underdeveloped, There are some very economically advanced countries in the Third World, especially in East and Southeast Asia. Nor does it necessarily mean poor since the oil rich countries are in the Third Word. Finally, it does not necessarily mean technologically backward. For example, Russia produces state-of-the art submarines and associated weapon systems and other related technologies.

UN - United Nations

UUV - Unmanned Underwater Vehicle

Wasennaar Regime: international supplier regime to control conventional weapons related technology including both conventional and nuclear submarines and related technology. However, controls in the Wasennaar Regime are considerably weaker than in the NSG, MTCR, and AG.

TABLE 1: **CURRENT FOREIGN OPERATIONAL SUBMARINES***

	1997	**2002**
Estimates	458 Total	364 Total
Russia	120 (77 nuclear, 43 diesel)	53 (45 nuclear, 8 conventional)
China	70 (6 nuclear, 64 diesel)	66 (6 nuclear, 58 diesel)
North Korea	40	44
India	18	17
Germany	17	14
France	17 (11 nuclear, 6 diesel)	10 (all nuclear)
Turkey	16	13
Japan	16	17
United Kingdom	14 (all nuclear)	16 (all nuclear)
Norway	12	6
Sweden	9	5
Italy	9	7
Greece	8	8
Spain	8	8
South Korea	8	9
Pakistan	6	7
Peru	6	6
Denmark	5	1
Brazil	5	4
Netherlands	4	4
Egypt	4	4
Argentina	4	3
Chile	4	3
Taiwan	4	4
Australia	3	5
Yugoslavia	3	1
Canada	3	2
Israel	3	3
Iran	3	3
Poland	3	2
Portugal	3	2
South Africa	3	2
Bulgaria	2	0
Albania	2	0
Columbia	2	2
Ecuador	2	2
Indonesia	2	2
Venezuela	2	2

Algeria	2	2
Vietnam	0	2
Romania	1	0 (1 non-operational)
Singapore	1	3
Malaysia/Thailand	0	0 (acquiring submarines)

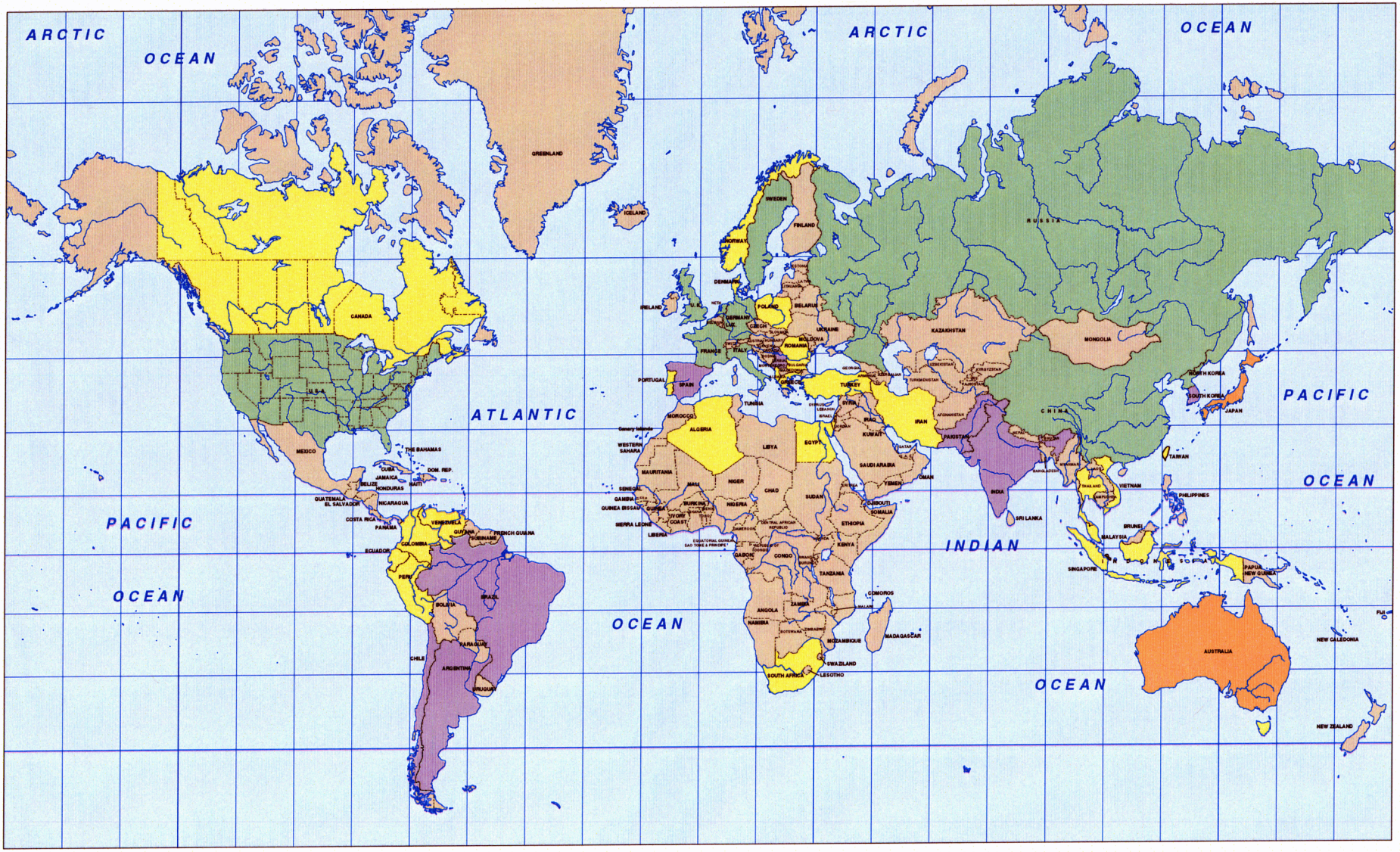
*There will probably be discrepancies in the figures. Numbers for 2002 are taken from "The Submarine Census, May 2002," by A.D. Baker III, 15 May 2002, Numbers for 1997 are taken from a table in *Technology for the United States Navy and Marine Corps 2000-2035: Becoming a 21st-Century Force, Volume 7 Undersea Warfare*, by the Naval Studies Board, National Research Council, National Academy Press, Washington, D.C., 1997, p.91. There was some dispute in the workshop on the inactive /non-operational status of China's nuclear submarines. So all 6 of China's nuclear submarines (1 Xia SSBN, 5 Han SSN) are listed as operational, although only one Han SSN is listed as operational in "The Submarine Census."

TABLE 2: SUBMARINE SUPPLIERS

PRODUCER	BUYER
China	North Korea (22 Romeo/Project 033 with most produced in NK Egypt, (4 Romeo/Type 033 which have been later modernized). Produces a number of classes -of nuclear and conventional submarines. Negotiated with Pakistan to provide Han SSN in late 1980s.
France (Spain)	Chile (2 Scorpene 2004-2005), India (6-12 Scorpene on order) , Malaysia (2 Scorpene/l Agosta on order), Pakistan (1 Agosta-90, 2 more building in country, 2 Agosta, 4 Daphne), Portugal (2 Daphne), Spain (4 Agosta, 4 Daphne, producing Scorpene with France), South Africa (2 Daphne). Also produces SSNISSBN for France, and offered to transfer submarines and technology for constructing Rubis-class SSNs to Canada in the late 1980s.
Germany	Argentina (2 TR-1 700, 1 Type 20911200), Brazil (4 Type 209/1400, 1 Improved tbd,) Chile (2 Type 209/1300). Columbia (2 Type 209/1200), Denmark (3 Type 207), Ecuador (2 Type 209/1300), Greece (Type 214 AIR tbd, 4 Type 20911200, 4 Type 20911100), India (4 Type 20911500 with India), Indonesia (2 Type 209/1300), Israel (Dolphin/IKL-800), Italy (2-4 Type 212A AIP with Italy), South Korea (3 Type 214 Al P on order, 9 Type 20911200), Norway (6 Ula/Type 210), Peru (6 Type 209/1200), Poland (1-3 Type 207 from Norway), South Africa (3 Type 209/1400, tbd), Thailand (2 IKL-500 from Israel in negotiations), Turkey (4-8 Type 209/1400 with Turkey, 6 Type 209/1200 with Turkey), Venezuela (2 Type 209/1300)
Italy	Columbia (2 midget COS,M-O.S.SX-506), South Korea (3 midget COS.M.O.S, SX756W), Pakistan (2 midget COS.M,O,S. MG-110),- Teaming with Germany to produce Type 212A AIP; retains residual submarine manufacturing capability as well.
Netherlands	Egypt (Moray 1400 with USA in negotiations), Taiwan (2 Hai Lung)
North Korea	Vietnam (2 Sang-o coastal submarines)
Russia (USSR)	Algeria (2 Kilo), China 2 Kilo/Project 636 with 1 on order? 2 Kilo/Project 877 EKM) Iran (3 Kilo/Project 877/EKM), India

	(2 Amur/Project 677E with 6 built in India may be ordered. 10 Kilo/Project 877EKM, 2 Foxtrot/Prolect 641 M, 1 Foxtrot Project 641K), Poland (1 Kilo 877E), Romania (1 Kilo/Project 877E-non-operational) , Ukraine (1 Kilo/Project 877E-non operational). Russia produces both nuclear and conventional submarines. Has leased 1 Charlie-class SSGN to India, 1988 1991: India and Russia have -had discussions on in transferring Akula 11 to India, but may be too expensive.
Sweden (Germany)	Denmark (I Nacken AIP), Singapore (3 Sjoormen with 1 tbd). Germany's HDW now owns Kockums, the Swedish submarine manufacturer.
United Kingdom	Leasing 4 Upholder-class SS to Canada; retains some residual conventional submarine manufacturing capability. Produces SSNs/SSBNs: offered to transfer Trafalgar-class SSNs to Canada in late 1980s.
United States	Egypt (Moray 1400 with Netherlands), Taiwan (2 Guppy-11A\ For training; seeking partner to produce conventional submarines for Taiwan). No longer produces conventional submarines, but US shipyards interested in teaming with others to manufacture submarines for Egypt/Taiwan. Produces nuclear submarines for own use, but does not generally export nuclear submarines/ technology.
Other Producers	Australia (5 Collins/Type 471, 1 fitting out) Japan (4 Oyashio (4 building, 2 planned), 6 Harushio, 5 Yushio, 1 Harushio AIP in trials and training, 1 Yushio training; Japan does not export armaments as a matter of national policy.)
Some Production Capacity	Argentina (some production capabilities/ambitions), Brazil (Type 209s with Germany; latent ambitions to produce nuclear submarines). Chile (some production capabilities/ambitions). India (Type 209s with Germany. developing AT, V SSGN: has produced Foxtrots in past), Pakistan (Agosta-90s with France), South, Korea (Type 214 AIP and Type 209 with Germany, 3 midget Dolgorae), Spain (produces Scorpene with France), Yugoslavia? (1 Sava,midget Una. 1 midget Una modified in Croatia).

Source: "The Submarine Census. May 2002." By A.D. Baker III. 15 May 2002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INDONESIA
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AUSTRALIA
NEW CALEDONIA
NEW ZEALAND
FIJI
WESTERN SAHARA
SENEGAL
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GUINEA BISSAU
GUINEA
SIERRA LEONE
LIBERIA
IVORY COAST
BURKINA FASO
MALI
NIGER
NIGERIA
CHAD
SUDAN
ETHIOPIA
DJIBOUTI
SOMALIA
ERITREA
KENYA
UGANDA
RWANDA
BURUNDI
TANZANIA
CONGO
GABON
EQUATORIAL GUINEA
SAO TOME & PRINCIPE
CAMEROON
CENTRAL AFRICAN REPUBLIC
ANGOLA
ZAMBIA
NAMIBIA
BOTSWANA
ZIMBABWE
MOZAMBIQUE
MADAGASCAR
COMOROS
MALAWI
SWAZILAND
SOUTH AFRICA
LESOTHO
Producer
Other producers
Some production

Current foreign operational submarines