REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE *(DD-MM-YYYY)*	2. REPORT TYPE	3. DATES COVERED *(From - To)*
08-05-2023	FINAL	N/A

4. TITLE AND SUBTITLE

The Impact of Artificial Intelligence on Undersea Warfare Tactics

5a. CONTRACT NUMBER N/A

5b. GRANT NUMBER N/A

5c. PROGRAM ELEMENT NUMBER N/A

6. AUTHOR(S)

David Rothwell

5d. PROJECT NUMBER N/A

5e. TASK NUMBER N/A

5f. WORK UNIT NUMBER N/A

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

Writing & Teaching Excellence Center
Naval War College
686 Cushing Road
Newport, RI 02841-1207

8. PERFORMING ORGANIZATION REPORT NUMBER N/A

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

N/A

10. SPONSOR/MONITOR'S ACRONYM(S) N/A

11. SPONSOR/MONITOR'S REPORT NUMBER(S) N/A

12. DISTRIBUTION / AVAILABILITY STATEMENT
Distribution Statement A: Approved for public release; Distribution is unlimited.

13. SUPPLEMENTARY NOTES A paper submitted to the faculty of the NWC in partial satisfaction of the requirements of the curriculum. The contents of this paper reflect my own personal views and are not necessarily endorsed by the NWC or the Department of the Navy.

14. ABSTRACT

This article considers the plausibility of the Commander's Intent 3.0 (2020), a direction from the U.S. submarine commander to subordinate commanders, especially when considered against a near-peer competitor like China. It measures U.S. weaknesses and Chinese capabilities against each other and offers possible solutions to seeming practical impossibilities. It also considers the significance of U.S. shortfalls.

15. SUBJECT TERMS (Key words)
Undersea, autonomous vehicles, submarines, wargaming, manning, doctrine, fleet design

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			Director, Writing Center
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED	N/A		19b. TELEPHONE NUMBER *(include area code)* 401-841-6499

Standard Form 298 (Rev. 8-98)

Question:

How will artificial intelligence (AI) impact the underseas fight against a near-peer competitor?

Date Submitted: 8 May 2023

Word Count: 3580 words

A paper submitted to the Faculty of the United States Naval War College Newport, RI.

Introduction

Some scholars have proposed far-reaching modifications to tactics and strategy because of the introduction of artificial intelligence (A.I.) into warfare. Some even question some major concepts in Wayne Hughes' seminal *Fleet Tactics and Operations.*[1] Due to A.I.'s demonstrated fragility, other scholars predict only minor modifications to tactics and strategy.[2] Wayne Hughes refers to the debate over A.I.'s use in wartime as "health, wide-ranging, and rich with possibilities."[3] Because of the unpredictability of performance and large numbers of vulnerabilities, A.I. and other major 4th industrial revolution technologies seem to have mired the future fight into unprecedented depths of fog and friction. Will AI perform well, or is it too fragile? CNO Admiral Gilday states, "we have a lot to learn" about A.I., especially using AI-enabled unmanned systems.[4] "We need to go slow to go fast," he says, even though China has been moving much faster than the United States in developing AI-enabled capabilities, especially in numbers and varieties of A.I. applications.[5] Commander's Intent 3.0 (2020) is one example of going too slow. In the document, the Commander of the U.S. Submarine Forces guides subordinate commanders to achieve the U.S.'s desired end state in the underseas domain.[6] The U.S. Submarine Forces Commander advises his force on the relative use of manned, unmanned, and sensing undersea platforms and technologies.[7] The force commander makes many predictions about using AI-enabled technology and the ongoing utility of conventional platforms, capabilities, and tactics. Yet the scholarly debate elicits much uncertainty about how AI-enabled technologies will perform in wartime, resulting in diverse and contrary ideas on doctrine, tactics, and strategy. Yet, incorrect decisions about using AI-enabled technologies may impose graver consequences than at any time or war previous given the speed, lethality, accuracy, and range of modern weapons. Therefore, A.I., and other 4IR technologies, must be "the first point to make

---

[1] Peter Layton. "Artificial Intelligence Battles: Operational Concepts for Future AI-Enabled Wars." Series No. 4. (Canberra, BC: Australian Defense College, 2021), 40.
[2] Artificial Intelligence: Too Fragile to Fight? | Proceedings - February 2022 Vol. 148/2/1,428 (usni.org)
[3] Wayne P. Hughes and Robert Girrier. *Fleet Tactics and Naval Operations.* Third edition (Annapolis, Maryland: Naval Institute Press, 2018), Wayne Hughes, *Fleet Tactics*, 255.
[4] CNO and SECNAV Deliver Remarks at Sea Air Space Navy League Luncheon > United States Navy > display-speeches
[5] Is China Emerging as the Global Leader in AI? (hbr.org)
[6] Commander's Intent 3.0: U.S. Submarine Force and Supporting Organizations, 2020 Edition.
[7] Commander's Intent.

perfectly certain," as Henry Dundas referred to the West Indies in the 1790s.[8] U.S. Submarine Force Commander's Intent 3.0 assumes a manner of AI-enabled underseas operations, which may be incorrect and requires more significant analysis and testing through realistic AI-enabled wargaming in the underseas environment. First, it is uncertain that U.S. underseas vehicles will be able to operate as assumed by Commander's Intent 3.0. Second, the U.S. may be unable to rely upon AI-enabled C2 given its many vulnerabilities, such as cyber-attack, data corruption, or deception. Third, the U.S. has a relatively inferior rate of A.I. development compared to China and must change the status quo, forming a joint plan with partners and allies, lest significant asymmetries develop.

U.S. underseas vehicles may not be able to operate as assumed by Commander's Intent 3.0 in the South China Sea

U.S. submarines may be unable to remain stealthy

Submarines may not be able to operate as predicted by Commander's Intent 3.0 in some waters worldwide, especially those with increased numbers and types of sensors, such as local Chinese waters. China has concentrated maritime ISR assets in the South China Sea.[9] Its robust and interwoven network of sensors yields a plethora of rich data to generate a remarkably accurate picture of the South China Sea.[10] Commander's Intent 3.0 assumes the ability to complete conventional missions against China and Russia.[11] For example, it assumes the ability to use stealthy, hard-to-find submarines to perform assignments like precision strike, anti-submarine and anti-surface ship warfare, seabed warfare, mining, and delivery of special forces.[12] However, U.S. submarines are unlikely to be able to operate in such a fashion since China can obtain continually updated rich data troves through its large constellation of sensors. The data, processed by machine learning, can produce a three-dimensional, constantly updated image of local seas or a local "observable ocean."[13] Finding first may tactically surprise potential

---

[8] Michael Duffy, *Soldiers, Sugar, and Seapower: The British Expeditions to the West Indies and the War Against Revolutionary France* (Oxford: Clarendon Press, 1987), 5.
[9] China's Maritime Intelligence, Surveillance, and Reconnaissance Capability in the South China Sea - Foreign Policy Research Institute (fpri.org)
[10] China's Maritime Intelligence, Surveillance, and Reconnaissance Capability in the South China Sea - Foreign Policy Research Institute (fpri.org)
[11] Commander's Intent, 13.
[12] Commander's Intent, 13.
[13] Layton, "AI Battles," 44.

adversaries like China, enabling the first effective fire.[14] According to Hughes, superior scouting, given sufficient weapon range and accuracy, often determines the opponent who will attack effectively and decisively first.[15] A rich, three-dimensional field of sensors producing vast quantities of data processed with the help of A.I. can rapidly create timely, accurate, objective, relevant, usable, and complete intelligence, all deemed by Vego as essential and valuable in combination.[16] A fire with efficient speed, accuracy, and range may rapidly surprise and destroy an enemy submarine in the wrong water. According to Hughes, to "know tactics, know technology." Unfortunately, we know neither based on the recent statements of Admiral Gilday and computer scientist Edgar Jatho.[17]

Suppose submarines cannot operate as predicted in some regions of the world. In that case, U.S. military leadership should re-evaluate its joint strategy, tactics, and doctrine, as submarines have become increasingly integral to joint actions. If submarines cannot procure their predicted capabilities, the U.S. must find another means to fill its critical capabilities. Although war plans frequently must change during combat, knowingly promulgating wrong-headed doctrine is foolhardy. The sailors reliant on the doctrine for training may have the basis in theory and wisdom to navigate successfully despite failed doctrine. Still, it will create increased vulnerability and decrease their time for decision-making as they seek to rebuild optimized tactics in the sinews of ill-conceived doctrine. Errant doctrine may destroy the submarine force and even the joint force if the U.S. faces a near-peer adversary, given modern weapons' speed, lethality, accuracy, and range.

U.S. autonomous vehicles may not operate as predicted

Like submarines, autonomous vehicles may not operate as predicted in Commander's Intent 3.0. In some sea areas, these vehicles must also contend with large arrays of undersea sensors. The U.S. also may encounter large numbers of underseas vehicles of the adversary.

---

[14] Hughes, *Fleet Tactics*, 212.
[15] Hughes, *Fleet Tactics*, 200.
[16] Vego, Milan N. *Joint Operational Warfare : Theory and Practice.* (Newport, RI: Naval War College, 2007), VIII-26.
[17] Artificial Intelligence: Too Fragile to Fight? | Proceedings - February 2022 Vol. 148/2/1,428 (usni.org)

China has grown a large and capable fleet of underseas autonomous vehicles.[18] It has produced large, medium, and small underseas unmanned, autonomous undersea vehicles.[19] China now has several high-producing shipbuilding conglomerates to support its navy's development and several universities involved in underseas autonomous vehicle (AUV) production research.[20] It also has built a significantly interwoven public-private partnership. Two major Chinese corporations are building AUVs and associated equipment.[21] The net result is a large fleet of capable Chinese AUVs for surveillance, mine warfare, counter-mine warfare, underseas cable inspection, marine survey, and anti-submarine warfare.[22] Further, autonomous and semi-autonomous vehicles are susceptible to cyber-warfare and communications disruptions, such as the cloud. Hughes predicted that A.I. and unmanned vehicles would radically change tactics and strategy.[23] He explained that Rear-Admirals Sims, Fiske, and Moffett were great admirals and visionaries because they studied, knew, and leveraged technology to their advantage.[24] Doctrine, the basis of training, can hardly be formed without tactics, and tactics without knowing technology and how it will perform in a fight.[25] If "sailors matter most," as suggested by Hughes, then a paucity of realistic training based on carefully worked out doctrine will substantially and irreversibly disrupt both one's forces' morale and ability to win.[26] As Clausewitz suggested, one must first determine how one will conduct a war before starting it.[27] Sun Tzu said that one wins a victory before fighting at the preparation stage.[28]

---

[18] Leviathan Wakes: China's Growing Fleet of Autonomous Undersea Vehicles - Center for Security and Emerging Technology (georgetown.edu)

[19] Leviathan Wakes: China's Growing Fleet of Autonomous Undersea Vehicles - Center for Security and Emerging Technology (georgetown.edu)

[20] Leviathan Wakes: China's Growing Fleet of Autonomous Undersea Vehicles - Center for Security and Emerging Technology (georgetown.edu)

[21] Leviathan Wakes: China's Growing Fleet of Autonomous Undersea Vehicles - Center for Security and Emerging Technology (georgetown.edu)

[22] Leviathan Wakes: China's Growing Fleet of Autonomous Undersea Vehicles - Center for Security and Emerging Technology (georgetown.edu)

HYPERLINK "about:blank"Leviatha
n Wakes: China's Growing Fleet of A
utonomous Undersea Vehicles - Cente
r for Security and Emerging Technolo
gy (georgetown.edu)

l, Michael Eliot Howard, Peter Paret, and Carl von Clausewitz. *On War.* Edited by Michael Eliot Howard and Peter Paret. (Princeton shorts ed. Princeton, NJ: Princeton University Press, 2008), 579. https://doi.org/10.1515/9781400837403.

[28] The Art of War (utoledo.edu), 34.

As semi-autonomous and autonomous vehicles become a larger and larger proportion of the U.S. underseas fleet, they gain greater and greater importance. Tactical and doctrinal errors become more significant. As numerical advantage may prove essential for tactical and operational flexibility, the speed and quality of industrial production capabilities may also be critical. War games have shown a greater willingness to use autonomous and semi-autonomous vehicles to perform high-risk missions rather than using manned assets. Thus, as autonomous and semi-autonomous vehicles provide for an increasing proportion of high-risk operations, relative advantage against potential adversaries in this regard will become increasingly important. The U.S. must carefully safeguard its comparative advantage in the present and industrial productive capacity for competitive advantage in protracted conflict.

The unpredictability and vulnerability of AI-enabled C2 may critically threaten all US AI-enabled wartime decision-making

The fragility of A.I. data and systems threatens AI-enabled C2 reliability

Commander's Intent 3.0 at once assumes the use of AI-enabled C2 in the integration and analysis of vast amounts of data from the U.S.'s array of ocean sensors and through the deployment of large numbers of autonomous vehicles. Nevertheless, A.I., including AI-enabled C2, is notoriously fragile. It depreciates without maintenance and is susceptible to corruption and damage.[29] Machine-learning AI, which comprises the bulk of military-use A.I., relies on large amounts of corruptible data. Highly-skilled data scientists must carefully tag and laboriously process the data to train a machine to make the right decisions properly.[30] Steps depend on imperfect humans who are subject to error. They must avoid leaving outdated, incomplete, or corrupt data.[31] Many steps in A.I. production further increase the chances of a data vulnerability, including steps to normalize, verify, standardize, enrich, and clean.[32] Bad actors may also corrupt data and machine-learning algorithms through internal individual threats, cyber-attack, or electronic countermeasures.[33] If AI-enabled C2 is compromised or disabled, it can lead to disastrous outcomes. For example, autonomous AI-enabled fires shot down 2 U.S. and allied

[29] Layton, "AI Battles," 16.
[30] Layton, "AI Battles," 16-17.
[31] Layton, "AI Battles," 16-17.
[32] Layton, "AI Battles," 16-17.
[33] Layton, "AI Battles," 16.

military pilots in 2003, causing their deaths.[34] According to Vego, C2 is one area of warfare where the advantage is extremely important and valuable. Time is an irreplaceable and extremely precious asset, sometimes determining victory or defeat by its relation to the culminating point.[35] Effective C2W against vulnerable AI-enabled systems obscure a fair estimate of the situation and results in less effective decision-making.[36] Adversaries have traditionally attacked C2 through physical destruction or electronic warfare.[37] AI-enabled C2 is vulnerable at many additional points, given its long process of development, maintenance, and through a cyberattack. The loss of C2 reduces one's ability to act and increases one's reactiveness, whereas relatively better C2 protection means superior and more rapid decision-making.[38] At the same time, failure to use AI-enabled C2 can place one at a significant disadvantage, given the speed at which well-trained machines can retrieve, organize, and analyze vast quantities of data. Commander's Intent proposes continued human-centric decision-making in submarines; inferiority in the speed and quality of human decision-making may lead to destruction and defeat. One can trade time and space; thus, decision-making timeliness is crucial.[39]

A warring state's speed and quality of C2 have become more significant given the volume of sensor data and the need for organization, analysis, communication, and rapid decision-making to fire delivery. The speed and range of weapons and the rich distribution of underseas sensors increasingly position human-based C2 data synthesis, intelligence construction, and communication and decision-making as the rate-limiting step. Thus, defensible AI-enabled C2 has become paramount, and securing and overcoming the many threats to the A.I. integrity in construction and delivery is extremely important. Though one should always back up AI-enabled C2 with human capability, given its fragility, the U.S. should protect AI-enabled C2 and seek to stay ahead of adversaries since it has the potential to be a rate-limiting step and the most significant area where time is lost. As the most likely rate-limiting step, time saved by assuring AI-enabled C2 superiority can quickly become a powerful, decisive advantage.

One can fool A.I. in the underseas domain, and this may change naval warfare strategy

---

[34] The Devil You Know: Trust in Military Applications of Artificial Intelligence - War on the Rocks
[35] Vego, *Joint Operational Warfare*, III-20.
[36] Vego, *Joint Operational Warfare*, VIII-48.
[37] Vego, *Joint Operational Warfare*, VIII-48.
[38] Vego, *Joint Operational Warfare*, VIII-53-54.
[39] Vego, *Joint Operational Warfare*, III-19.

Commander's Intent assumes the effectiveness of AI-enabled sensors and weapons. While excellent at finding the adversary, one can fool AI-enabled systems and may do so using other AI-enabled assets.[40] For example, warring adversaries may find ways to deceive detection sensors through camouflage, false electronic or auditory signals, and the induction of physical environmental changes.[41] This feature of AI-enabled vehicles and systems has created the possibility for an entirely new level of salience for the defense at sea, including within the undersea environment.[42] Layton suggests the rise of defense-in-depth strategies for the surface warfare environment.[43] An enormous data trove for machine learning will reduce the likelihood of deception of A.I. technologies while increasing the chances of finding the adversary.[44] Local data superiority gives China a significant advantage in its seas. Effective defense may determine a future war's victor, as it may change the war's first effective fires and procure benefits represented in the Lanchester equation. In the equation, the side to fire effectively first creates an enduring and expanding advantage, with all other things starting equal since that side will create a more significant force with the first effective salvo.[45] According to Hughes, effective defense saves time for a warring partner, making time for effective offensive fires.[46] Prolonging the adversary's expected endpoint of war can increase the likelihood of success by decreasing the adversary's morale and shaking political will as costs accumulate.[47]

Given the susceptibility of AI-enabled weapons and sensors to deception, the U.S. should consider the possibility that defense will become much more important in a future fight. Force protection means greater force available, increasing the likelihood of capturing more space in a decreased timeframe. Effective defense can mean a change in the balance of forces. As discussed in the Lanchester equation, effective defense can mean the difference between victory and failure at tactical, operational, or even strategic levels. Given most naval assets' fragility and high cost, the U.S. must consider the increasing possibilities for effective defense. The U.S. must also

---

[40] Layton, "AI Battles," 31.
[41] Layton, "AI Battles," 31.
[42] Layton, "AI Battles," 14.
[43] Layton, "AI Battles," 45-46, 62.
[44] Layton, "AI Battles," 23.
[45] Hughes, *Fleet Tactics*, 30.
[46] Hughes, *Fleet Tactics*, 212.
[47] Vego, *Joint Operational Warfare*, III-60.

consider China's and other potential adversaries' capabilities for AI-enabled defense and develop tactics and strategies to overcome their defenses.

The rising primacy of cyber-warfare

A warring state may decrease AI-enabled sensors, weapons, or C2 effectiveness through cyber-attack. An effective attack may occur anywhere along the process of A.I. utilization, from manufacturing to delivery. With machine learning's dependence on significant and sensitive data sets, A.I.'s susceptibility to cyber-attack raises cyber warfare to new prominence.[48] A warring partner may introduce cyber-attacks at any point along the kill chain: at the time of machine learning, during sensing, at the time of C2, or at the time of weapons fires or targeting since all AI-enabled ML systems depend on data.[49] Combat and weapons systems may be damaged or immobilized.[50] Cyber-attacks may even eliminate an adversary's ability to control its military platforms, weapons, and fires, even turning fires against friendly forces.[51] A.I. may be employed to create sophisticated cyberattacks or promote cyber defense.[52] Andrew Lohn states that A.I. is "rife with vulnerabilities"; hackers can exploit A.I. data and algorithms by enabling mistakes and malfunctions.[53] According to Milan Vego, C2W will significantly increase in importance; cyberwarfare may be integral to impacting AI-enabled C2.[54]

Cyberwarfare may become essential for both the attack and defense of AI-enabled systems. The U.S. must carefully develop and maintain its advantages in cyber-attack and defense, as U.S. adversaries may disrupt A.I. data and algorithms, crippling its AI-enabled weapons and systems. Superior cyber capabilities, therefore, offer potentially decisive advantages. In the underseas domain, superior U.S. cyber defenses may render sensors, submarines, mines, and autonomous vehicles decisively effective. On the other hand, the U.S. may render the adversaries' sensors, submarines, mines, and autonomous vehicles ineffective through superior cyber offenses. Excellent U.S. offensive capabilities may slow, disable, or destroy various adversary assets. Similarly, U.S. cyber-attack or defense may substantially

---

[48] Hacking AI - Center for Security and Emerging Technology (georgetown.edu)
[49] Hacking AI - Center for Security and Emerging Technology (georgetown.edu)
[50] Layton, "AI Battles,"65.
[51] Layton, "AI Battles," 26.
[52] Preparing for AI-enabled cyberattacks | MIT Technology Review
[53] Hacking AI - Center for Security and Emerging Technology (georgetown.edu)
[54] Vego, *Joint Operational Warfare*, XIV-13.

impact C2, impacting the adversaries' communication, maneuver, initiative, and timeliness. Cyberwarfare's impacts on underseas assets or C2 are potentially decisive in the underseas environment.

The uncertainty of producing a superior relative rate in the development of A.I. and AI-enabled technologies, and the involvement of humans in tactics and strategy

The slow rate of technology development

Commander's Intent assumes the ability to maintain a credible deterrence force, gain underseas domain mastery, and to grow subsea/seabed superiority. Unfortunately, these goals do not seem to match up with practical realities. In recent years Pentagon-controlled technological development has been extremely slow. Given the absence of near-peer adversaries for decades, the slow rate of U.S. technological development was not a problem. Now, with credible threats and a new near-peer competitor in China, top officials at the Pentagon regularly complain about the languid movement on technological development and employment.[55] The Vice Chairman of the Joint Chiefs of Staff Hyten noted the rapid speed at which China modernized its military and developed its nuclear arsenal.[56] By contrast, Hyten said, the U.S. was "unbelievably slow" due to bureaucracy and risk aversion.[57] Without mitigation, the U.S.'s slow technological improvement and employment rate may become a decisive factor hastening its loss in a hypothetical war against China, including in the undersea domain. According to former President Bill Clinton, U.S. technological superiority allowed it to defeat or deter any military adversary.[58] Too significant a technological disadvantage can present an insurmountable hurdle preventing victory and blunting deterrence despite force morale or strategy. According to Sun Tzu, an individual must count the cost before fighting; technological lethargy will create unacceptable costs for war, enabling a U.S. adversary can force its will.[59] Wayne Hughes stated that new weapons and scouting capabilities could produce an outsized outcome in a war, especially if accompanied by

[55] Hyten Says Pentagon is Moving "Unbelievably Slow" in Defense Modernization (nationaldefensemagazine.org)
[56] Hyten Says Pentagon is Moving "Unbelievably Slow" in Defense Modernization (nationaldefensemagazine.org)
[57] Hyten Says Pentagon is Moving "Unbelievably Slow" in Defense Modernization (nationaldefensemagazine.org)
[58] Maintaining Military Advantage Through Science & Technology Investment (archives.gov)
[59] The Art of War (utoledo.edu), 25.

updated doctrine and tactics.[60] Secretly developed weapons and systems can have even more critical consequences since one can catch the enemy unprepared to defend effectively.[61]

The U.S. must address its increasing loss of technological competitiveness with China and other potential adversaries; otherwise, it can find itself unable to resist adversary efforts to mold and force its will. A.I. can hasten the U.S. adversaries' abilities to force U.S. will, while U.S. superiority in A.I. can slow its growing technological inferiority since A.I. enables so many other technologies. A.I. influences the factor of time, and since the U.S. can trade time for space, A.I. may significantly impact the ability of the U.S. to produce the first effective fire. However, if the U.S. loses technological competitiveness, the U.S. will lose its ability to compete with China and other potential adversaries, including in the critical, enabling technology A.I. Too great a measure of technological inferiority will force the U.S. to submit to China's or another adversary's political will.

Inadequate navy recruiting

Commander's Intent assumes that a submarine C.O. will train his or her crew rigorously and "maintain the highest standards of individual mastery and team performance."[62] Unfortunately, it's hard to see this objective becoming a reality because the U.S. Navy increasingly fails to meet its recruiting requirements among officers and enlisted. Experts predict that the problem will become only worse.[63] Not only will the number of crew members decrease, but their ability to retain talent remains questionable.[64] Yet, training and experience add to sailors' value and importance. Wayne Hughes underscores the value of talent, passion, will, and morale in his chapter on the value of sailors.[65] Humans are the innovative driver behind A.I., machine, and new weapon development. They contribute a level of creativity and thinking that machines have not yet achieved; general AI, reflective of the entire breadth of human thought, remains a far-off aspiration.[66]

---

[60] Hughes, *Fleet Tactics*, 226.
[61] Hughes, *Fleet Tactics*, 226.
[62] Commander's Intent, 18.
[63] Navy Predicts Challenging Future Recruiting Environment, On Target to Hit Retention Goals - USNI News
[64] The Navy Still Punishes Talented Risk-Takers | Proceedings - May 2022 Vol. 148/5/1,431 (usni.org)
[65] Hughes, *Fleet Tactics*, 18.
[66] The Future Of Artificial General Intelligence (forbes.com)

Sailors provide more capabilities than A.I. in some respects. Humans can perform some tasks for which A.I. is ill-equipped and may be necessary to drive warfighting as A.I. is increasingly disabled throughout a war. Also, many autonomous undersea vehicles work better when paired with human-directed ships and submarines. Humans are also essential and will continue to be necessary in a supporting role as data scientists, programmers, and in other functions which support A.I. data, programming, and maintenance.

Conclusion

The U.S. cannot afford to make decisions about the operability or inoperability of conventional or autonomous undersea vehicles without thorough confirmation or testing. Preparation is often the key to success, including technological, tactical, doctrinal preparation, and optimal human resources planning and training. Therefore, the U.S. must seek every way possible to mitigate war's ever-increasing fog and friction. As the U.S. continues to fall behind China due to its superior pace of technological development, it must optimize resource utilization better than at any point in recent history. The U.S. must gather its allies in times of danger, as suggested by Sun Tzu. The U.S. must retain allies through economic investment, countering Chinese Belt and Road and international economic investment.[67] As "sailors matter most," the U.S. should coalesce the human resources of services, allies, and partners to increase its chances to match or exceed Chinese advances in A.I. and 4IR technologies.[68] Engaging all services, allies, and partners also enables the coalition to divide labor to create experts in various areas of A.I. and 4IR capability. U.S. military leaders should continue to try to fix a broken Pentagon and work with politicians and the public to mitigate volumes of bureaucratic red tape and roadblocks. In areas of bureaucratic challenge, the U.S. should outsource to allies and partners to step around impossibilities. Due to high numbers of variables and unknowns, the U.S. should pursue realistic wargaming with actual, miniaturized vehicles, with real weapons driven by A.I. and remote control, to produce the most realistic, warlike scenarios. For the underseas force and the navy, the U.S. may consider conducting wargames in areas such as inland lakes, which are easier to shield from outside observation. At a massively lower cost than full-sized vehicles and weapons

[67] The Art of War (utoledo.edu), 49.
[68] Hughes, *Fleet Tactics*, 18.

in actual war, these games could drive several vital advances in strategy, tactics, and doctrine. They can move the agenda for DARPA and budget appropriation. The U.S. will then be able to "know one's enemy" and "know oneself" regarding evolving technology, doctrine, and tactics.[69] Frequent wargames and continual improvement will sharply improve confidence and morale among the coalition, joint force, and politicians, enabling a strong force that can compete with emerging near-peer competitors.

[69] The Art of War (utoledo.edu), 32.