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Analysis of a Lightly Manned Autonomous Combat Capability (LMAAC) Concept

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NPS NRP Executive Summary
Analysis of a Lightly Manned Autonomous Combat Capability (LMAAC) Concept
Report Date: 10/13/2020 | Project Number: NPS-19-N168-A
Naval Postgraduate School | Graduate School of Operations and Information Sciences

EXECUTIVE SUMMARY

Project Summary
As the technology of the "third offset" (artificial and autonomous capabilities) matures, the United States Navy (USN) is embracing some aspects of the capability, including experimentation with the test vessel Sea Hunter. However, ambiguity of its missions has stemmed from tightly intertwined concept of operations (CONOPS)for fleet operations, which have been absorbed and trained for every deploying ship. In addition, trust in an autonomous ship, negative reactions to arming an unmanned vessel, security, and command and control (C2) are all part of the culture of incremental acceptance and change. Combined with the geopolitical situation, particularly in the Pacific, what emerges is an evolutionary "bridge" in which small, fast, lightly manned combatants are called for to provide autonomy with onboard human oversight, and tactical employment of weapons systems. This report details the needs of such a vessel (which we call *Sea Fighter* in this report), combined with unmanned autonomous vessels (e.g., *Sea Hunter)* as sensors, within a sensor grid and truly distributed capabilities. CONOPS are discussed, which are the result of the form and function of this class of warship, while costs and means of acquiring this capability quickly are also examined.

Keywords: *Autonomy, Artificial Intelligence, Force Structure, Human and Machine Teaming, Great Power Competition and Strategy in the Pacific Rim*

Background
Defense Advanced Research Projects Agency (DARPA) largely built the Autonomous Continuous Trail Unmanned Vessel (ACTUV)—later to become MDUSV, then MUSV, and now synonymous with Sea Hunter—as an experiment in autonomy. Since that time, many years have been spent determining what its mission set should be, At least two conferences were held, one at Navy Warfare Development Command, and another at Naval Postgraduate School. The discussions were at the "what if" level of thinking, mostly void of tactical needs. There are many problems with "potential" and "possible" as determinants of capability—mainly in that they don't exist. and there is a bridge to cross between fully manned (present) and fully unmanned (future), especially when autonomy is also armed. While we test run at these hurdles, a middle ground sea-control means is needed for the United States' response to the near peer nations and possible domination of the sea lines of communication in the Pacific.

Lightly Manned Autonomous Combat Capability (LMACC) turns "what if " thinking on its head. It is designed to meet a CONOP and strategic mission *now*, rather than built and then refined in a concept of operations. The LMACC has one primary mission: deliver missiles to targets ashore and afloat within the first island chain, while the "leviathan navy" waits out the first round of missile exchanges, to become the second or third round of mission-capable delivery ,in a joint operation with long range aircraft and carrier-based fighters. The cruisers, guided-missile destroyers, and aircraft carriers with will not survive the first round of long-range surface to surface missiles inside the second island chain.

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Speaking to the concept of building large ships, as can be afforded by the national economy and shipbuilding funding:

> "*In a major war at sea, we may find that our cost-effective peacetime strategy of concentrating on economies of scale has created a situation of "too many eggs in one basket." The loss of a DDG while conducting an independent offensive surface action becomes a loss of missile and air defense, antisubmarine warfare (ASW), and escort capacity to the fleet—as well as a highly skilled crew.*" (Kline, J.E.)

> In a truly distributed maritime operations, each of these LMACC vessels has the primary mission above and a secondary warfare mission unique to that platform. Anti-submarine warfare (ASW) vessels, anti-air warfare vessels, and surface warfare vessels, for example, would be distributed among the Sea Fighter, and in company with Sea Hunter vessels as sensors. A "pack" might consist of four Sea Fighters and six Sea Hunters. Three packs would be employed forward and relieved on station by another three packs. This equates to 12 Sea Fighters and 18 Sea Hunters. The manned vessels would include a crew of 15 weapons and tactics specialists, commanded by an 03 or 04. The ship would be built around the current state of autonomy, which looks after the ship's well-being and navigates according to the rules of the road. As artificial intelligence and machine learning become more realistic for combat, these can be integrated into the LMACC. Trust in these systems will be generated by exercising capabilities in realistic contexts. Eventually it is possible that fully intelligent unmanned combat vessels may be ready, however that day is far off. The best perceptual and intuitive capability that exists is still a human brain. It can know when a vessel has exceeded the third level of control described at the beginning of this report, and adjust to bring the system back to steady state.

Sea Fighter is currently being designed at Naval Postgraduate School, employing many innovative designs. For example, large ships have largely given up on maneuver as an element of defense against missiles. We are exploring the realm of "hyper maneuvering" tactics that are combined with kinetic, electronic and other forms of defense. For propulsion, diesel electric hybrid technology would be employed, potentially with water jet or screws that can leave one in trail for battery charging and energy cultivated from the movement of the ship in higher sea states. Weapons that have been proven rather than creating anew (until something better comes along) intelligent sensors sensors, and C2 capabilities that allow it to communicate over the horizon in a satellite degraded/denied environment. Many tactics are taken from the aviation community, human systems integration, and the field of human-machine teaming.

Funding for this project was initiated under Navy Research Project funding, with N96 as its sponsor. To build this vessel (prototype) will take a stretch of the acquisition system, employing funding such as Joint Capability Technology Demonstrations (JCTDs), Congressional plus-up, and Other Transaction

Authority (OTA) procurement. Nontraditional shipyards could be employed for this 1,000-ton, fully loaded vessel of less than 200 feet.

Our first design was based on an extension of the Cyclone coastal patrol (PC) class that could be refit using current autonomous seakeeping and mission behavior capabilities. Eventually the project employed a newly designed vessel, detailed in the project technical report.

This partially manned vessel would perform most of its mission-state behaviors (e.g., sea keeping, maneuvering, systems maintenance) and mission behaviors (e.g., surface intelligence, surveillance, and reconnaissance; patrol of sea lanes; and intelligence gathering) autonomously, while the limited crew would perform oversight, man-in-the-loop and man-on-the-loop functions, as well as providing security. This would be an experimental but also CONOP developing system, one that could point the way to future ship/human teaming designs.

Findings and Conclusions

In our analysis, we have determined that the LMACC is a deterrent that can be effectively employed in denying our adversary a *fait accompli* from which the U.S. may not recover. LMACC is a forward deployed first island chain asset that includes human machine teaming onboard LMACC and between LMACC and accompanying Sea Hunter sensors.

The ability to create true distributed maritime operations is possible by having a primary mission across all vessels (long range surface to surface strike against terrestrial and surface targets) while distributing a secondary mission to each LMACC and Sea Hunters. A "pack" of this capability is 5 LMACC and 6 Sea Hunter. Deployment times of 60 days is anticipated, with a relief pack on station and the third pack undergoing maintenance. The cost of this entire capability of 15 LMACC and 18 Sea Hunter is less than the cost of a single guided missile destroyer (DDG),

We also determined that CONOPS are feasible with the current capabilities, and most of the design features have already been incorporated into the current version of a prototype vessel for testing with Surface Development Squadron and Sea Hunter. However, additional work will be needed to create a more robust capability as the state of autonomy for said vessels is in infancy. Further development centers on mostly avoiding traffic in sea lanes. It also remains unlikely that autonomous vessels will possess striking capabilities.

In addition, this research produced several additional articles and theses content. One is a book chapter abstract which has been accepted but not yet published, on the principle of "emergence." This explores the unanticipated actions of autonomy as real-world context changes (Gallup, S.P.) A second article investigates the funding costs and comparison with an *Arleigh Burke* class DDG. A third article by Mr. Ben DiDonato, and this PI was published in the Center for International Maritime Security. Fourth, an Acquisition Research paper was published.

There are also several related student theses in progress as well, particularly addressing communications to LMACC in an anti-access, area denial communications degraded environment.

Recommendations for Further Research

Our research shows that this vessel is completely within the capability of the United States military as we possess shipyards equipped for final development, and construction plans for the vessel are now being compiled. Future research should be focused on fully developing human machine teaming and human systems integration, and brought to bear on a final design. In addition, war games at the Global and PACFLT level need to incorporate the Lightly Manned Autonomous Combat Capability (LMACC) as a technical inject.

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Acronyms

CONOPS	Concept of Operations
DDG	guided missile destroyer
HMT	Human-Machine Teaming
LMACC	Lightly Manned Autonomous Combat Capability