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Uncrewed Maritime Systems: Navy Should Improve Its Approach to Maximize Early Investments

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Abstract

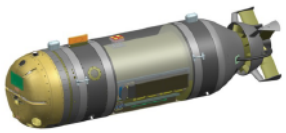
The Navy is in the process of re-examining its maritime strategy to respond to increased competition at sea from nations investing in new weapons and technology specifically designed to disrupt U.S. Naval advantages. In March 2021, the Navy published its Unmanned Campaign Framework which called for the development and fielding of a range of vehicles designed to operate on the surface and undersea without a crew or with a minimal crew to complement the Navy's existing fleet. The Navy's Framework describes a strategy for developing and improving these uncrewed maritime systems by leveraging technology that can be scaled across multiple platforms and domains. The Navy will need to invest significantly in order to develop the technologies necessary to enable these maritime systems to operate autonomously (or semi autonomously), as well as interact with the existing fleet. While the U.S. military has remotely operated uncrewed aerial vehicles for over 2 decades, uncrewed maritime systems are still in their infancy. As a result, the Navy is embarking on a robust effort intended to rapidly develop and field uncrewed system prototypes that can work with existing crewed vessels and solve technical issues prior to acquiring these systems in significant numbers. This paper will assess the extent to which the Navy's (1) strategic planning provide a sufficient basis to invest in uncrewed maritime systems; (2) leadership structure and processes are positioned to achieve its objectives and goals; and (3) prototyping approach is improving its knowledge prior to making purchase decisions.

Background

The Navy plans to introduce a number of uncrewed maritime systems into its fleet over the coming decades.5 While the Navy has previously operated some uncrewed systems including UUVs for missions such as oceanography and mine countermeasures, the Navy is currently developing a number of larger, more complex uncrewed systems. These include USVs—some approaching the size of a frigate or patrol ship—as well as UUVs—some approaching the size of small submarines. In addition to the vehicles, the Navy also needs to develop the software and digital infrastructure capabilities—such as data repositories and modeling and simulation—to operate these systems without a crew on board by developing artificial intelligence capabilities. While some of the software and other pieces will be unique to each vehicle, the Navy is planning for much of the digital infrastructure to be common to all of its major uncrewed maritime efforts.

Uncrewed Maritime Systems

The Navy has six large uncrewed maritime system prototype efforts underway. Four of these were initiated by the Navy's acquisition organization, specifically by the Program Executive Office for Unmanned and Small Combatants' (PEO USC) unmanned maritime system program office. The other two of the Navy's prototypes are being acquired by entities within the DOD's science and technology community, including by the Defense Advanced Research Projects Agency, the Office of the Secretary of Defense Strategic Capabilities Office, and the Office of Naval Research. These efforts have now been transferred to PEO USC. Figure 1 contains information about each of the systems.

Vehicle	Acquired by	Notable demonstrations/events	Prototype quantity	Potential missions
Sea Hunter/Seahawk Medium Displacement Unmanned Surface Vessel  Source: U.S. Navy/Petty Officer 2nd Class Thomas Gooley. | GAO-22-104567	Defense Advanced Research Projects Agency/Office of Naval Research	• June 2018 naval exercise with a reconnaissance payload • September 2020 exercise incorporating advanced autonomy and perception • April 2021 exercise with classified payload	2 delivered 0 planned	• Support MUSV and LUSV development
Overlord Unmanned Surface Vessel  Source: U.S. Navy Institute. | GAO-22-104567	Department of Defense Strategic Capabilities Office /Uncrewed Maritime Systems Program Office	• October 2020 and April 2021 mostly autonomous transits from Gulf Coast to West Coast for both available prototypes • December 2020 naval exercise with electronic warfare payload	2 delivered 2 scheduled for delivery by fiscal year 2023	• Support MUSV and LUSV development
Large Unmanned Surface Vessel (LUSV)  Source: U.S. Navy. | GAO-22-104567	Uncrewed Maritime Systems Program Office	• September 2019, Navy awarded six conceptual design studies worth $42 million • Following fiscal year 2021 budget, the Navy decided to delay procurement	0 delivered Plan to transition program to major capability acquisition	• Surface warfare
Medium Unmanned Surface Vessel (MUSV)  Source: U.S. Navy. | GAO-22-104567	Uncrewed Maritime Systems Program Office	• In July 2019, Navy awarded a $35 million fabrication contract to L3 Harris, with delivery expected in the second quarter of fiscal year 2023	0 delivered 2 planned Up to 7 on contract	• Multi-mission asset due to interchangeable payloads, such as surveillance and electronic warfare
Snakehead Large Displacement Unmanned Undersea Vehicle (LDUUV)  Source: U.S. Navy. | GAO-22-104567	Uncrewed Maritime Systems Program Office	• Initiated in 2012 as an acquisition program, but designated an accelerated research and development effort in 2017 • Government-led prototype to be delivered in fiscal year 2022 • Request for proposal for two industry prototypes issued in 2021	1 under construction 2 planned in short term	• Multi-mission asset due to interchangeable payloads, such as surveillance and electronic warfare • Planned to launch from a submarine
Orca Extra Large Unmanned Undersea Vehicle (XLUUV)  Source: U.S. Navy. | GAO-22-104567	Uncrewed Maritime Systems Program Office	• March 2017, Navy awarded a $274 million contract to Boeing • First XLUUV delivery delayed approximately 21 months until September 2022 due to ongoing production issues	0 delivered 5 under construction Up to 4 on contract Plan to transition program to major capability acquisition	• Modular payloads for seabed warfare

Source: GAO analysis of Navy documents. | GAO-22-104567

Figure 1. Selected Navy Uncrewed Maritime System Prototyping Efforts

Autonomy and Other Digital Infrastructure

The Navy plans to purchase a digital infrastructure that will enable it to operate uncrewed maritime systems autonomously by building its artificial intelligence capabilities over time.6 DOD and Navy officials describe autonomy as artificial intelligence (AI) "in motion," where autonomy is a set of behaviors such as obstacle avoidance that are enabled through the use of multiple capabilities including communications, sensing, and data management, among others. According to Navy officials, to develop an autonomy capability for uncrewed systems, the Navy state will need specialized tools, technologies, and computing infrastructure, such as:

- software models that can be used for simulation,
- software development processes for autonomy and mission planning,
- large data repositories with analytics and machine learning, and
- commercial software and technology that can be quickly purchased and incorporated into Navy systems.

To begin its efforts in this area, the Navy is establishing a set of rules for autonomy software development called the Unmanned Maritime Autonomy Architecture. This architecture is intended to ensure the Navy's software is compatible with other software, vehicles, and payloads provided by multiple contractors. In addition, the Navy is

planning to establish the Rapid Autonomy Integration Lab, which is intended to support the testing and development of contractors' autonomy software. The Navy plans to use the lab, according to the program office, to build software updates quickly and model and simulate uncrewed vehicles prior to testing the software on physical prototypes in the water. According to Navy officials, in fiscal year 2022, the Navy plans to begin integrating the first uncrewed systems—the Overlord USVs—into the Rapid Autonomy Integration Lab software development process.

Prototypes in Acquisition Programs

Over the past 15 years, DOD and Congress have taken steps related to prototyping during the technology development phase of acquisition programs. In 2007, the Office of the Under Secretary of Defense for Acquisitions, Technology, and Logistics issued a memorandum on prototyping and competition expressing concern that DOD's decisions on acquisition programs were largely based on paper proposals that provided inadequate knowledge of technical risk and a weak foundation for estimating development and procurement costs.7 In 2018, DOD developed a guidebook with lessons learned from prototyping, which we refer to as DOD prototyping guidance.

In 2017, we examined several major acquisition programs that used prototyping and identified beneficial practices for prototyping based on information provided by the programs.8 Programs used prototyping to, among other things:

- reduce technical risk,
- investigate integration challenges, and
- validate designs.

We also reported that prototyping has the potential to provide a good return on investment by helping programs better understand key risks, requirements, the feasibility of proposed solutions, and cost. Further, we found that programs that scheduled prototyping efforts to yield results in time to inform key decisions helped to maximize the utility of the prototyping efforts.

We have also reported on the elements of DOD's prototyping strategies. In March 2013, we found that DOD often documented expectations for developing, demonstrating, delivering, and integrating technologies or stand-alone products.9 We found that, while these documents varied by program and could be tailored, they typically outlined technology and readiness metrics, such as cost, schedule, and performance parameters that the prototype must meet to trigger the end of prototyping and the beginning of the next phase. In addition, we have previously found that clear and objective metrics help sustain a stronger prototype effort by providing a formal way to track progress against requirements.

Portfolio Management

Portfolio management is a disciplined management approach that focuses on evaluating, selecting, prioritizing, and allocating limited resources to programs and projects that collectively best accomplish an organization's strategic objectives. The Project Management Institute, Inc., (PMI) has established standards for project, program, and portfolio management that are generally recognized as leading practices and used worldwide by private companies, nonprofits, and others.11 According to PMI, portfolio management is an approach for making a wide variety of decisions, including capability and funding trade-offs that allow an organization to achieve the optimal mix of capabilities for a given investment, as shown in figure 2.

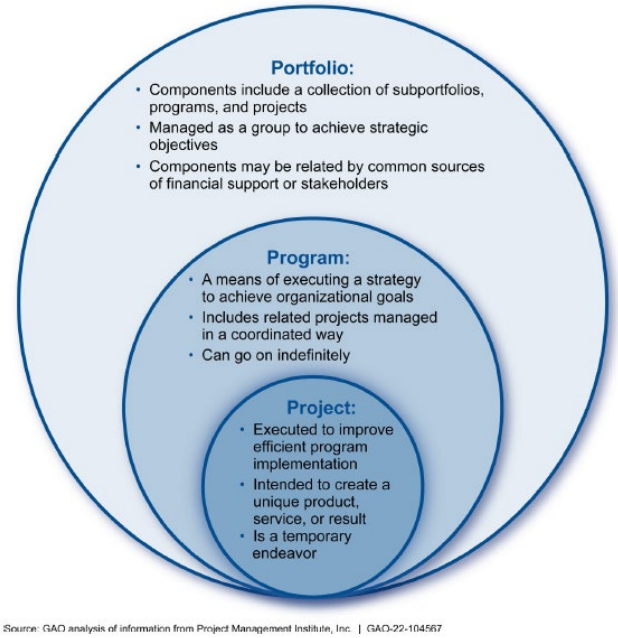


Figure 2. Relationship between a Portfolio, a Program, and a Project, According to Leading Practices

We have previously reported on how large companies manage groups of linked investments and projects using portfolio management.12 In 2007, we reviewed the portfolio management practices of several large companies and found that they follow a disciplined process to assess costs, benefits, and risks of potential product alternatives across a group of linked investments. We also found that successful companies allocate resources to achieve a balanced portfolio that spreads risk across products, aligns with the company's strategic goals and objectives, and maximizes the company's return on investment. To ensure comparability across alternatives, companies require their projects' initial cost, benefit, and risk information to be developed in a transparent manner, to use specific standards, and to report estimates within certain levels of confidence or allowable deviations.

We also found that companies used portfolio management to assess and balance risk to help ensure that they were making investments that were not so risky that they could damage the company if they did not pan out or so conservative that the company could not compete in the marketplace. Companies emphasized that making tough go or no-go decisions, rather than pursuing every investment idea, is critical to keeping a balanced portfolio.

Navy Continues to Assess Effect of Uncrewed Maritime Systems on Shipbuilding Plans but Has Not Estimated All Known Costs

The Navy's strategic planning efforts examined the need for investments in uncrewed maritime systems, but the Navy is only beginning to assess their effects on existing shipbuilding plans. While the Navy has outlined a plan to spend $4.3 billion on uncrewed maritime systems in its shipbuilding plan, we found that this understates the costs associated with these systems because it does not account for all costs—specifically operations and sustainment, and the digital infrastructure necessary to enable them.

Navy Identified a Role for Uncrewed Maritime Systems and Is Currently Assessing Their Role in the Future Fleet

The Navy completed several studies examining the future of its fleet, concluding that uncrewed maritime systems are essential to address current and anticipated threats. In 2020, DOD and the Navy examined different options for modernizing the fleet to counter growing competition from peer adversaries in the maritime environment.13 The Navy brought together fleet operators and the intelligence and acquisition communities to analyze and war-game alternative fleet force structures—including varying levels of uncrewed maritime systems—within prescribed budgetary constraints. Following this study, in March 2021, the Navy published an Unmanned Campaign Framework, which called for the development and fielding of a range of uncrewed vehicles designed to complement the Navy's existing fleet. The Navy's Framework highlights the vital role that uncrewed maritime systems will play in the Navy's future capabilities and describes a strategy for developing and improving these uncrewed maritime systems by using technology that can be applied across multiple air and sea-based systems. In its framework, the Navy highlighted the need for these systems to be affordable.

Through its studies, the Navy determined that uncrewed systems could address capability gaps by enhancing the capabilities of crewed ships or operating independently. For example, the Navy examined the potential utility of LUSVs to meet existing unmet requirements. In doing so, the Navy found that an initial mission for a LUSV system would be to augment the capabilities of crewed surface ships by providing more missile capacity to strike enemy ships. The Navy also studied the use of MUSVs to augment the intelligence, surveillance, reconnaissance, and electronic warfare capabilities of the surface fleet by providing a less expensive, more disposable ship. Figure 3 shows the respective missions of the LUSV and MUSV and a notional control center, which could either be on another Navy ship or ashore. While uncrewed maritime systems may eventually have the potential to address a wide range of different missions, the Navy focused on meeting initial requirements for identified missions with as little technology development as possible.

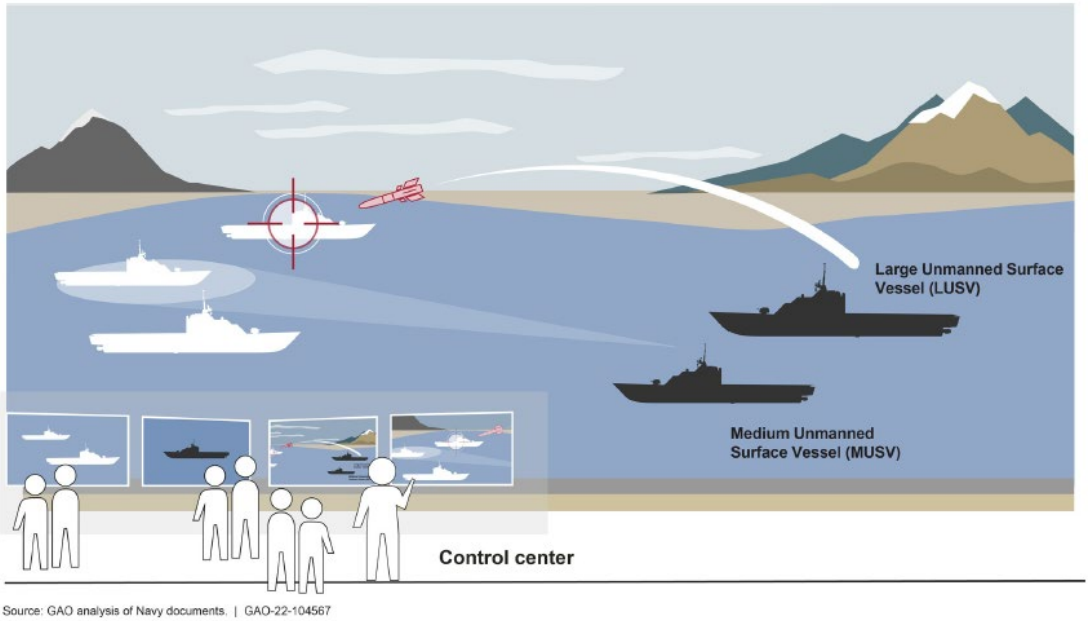


Figure 3. Notional Uncrewed Surface Vessel Operational View

In its studies, the Navy also examined the potential role of an XLUUV to fulfill existing unmet requirements. As such, the Navy plans for the initial XLUUV to be an autonomous, long endurance, pier-launched UUV for delivering payloads—such as mines—as shown in figure 4. According to Navy officials, using a UUV for this mission reduces the risk to crewed submarines.

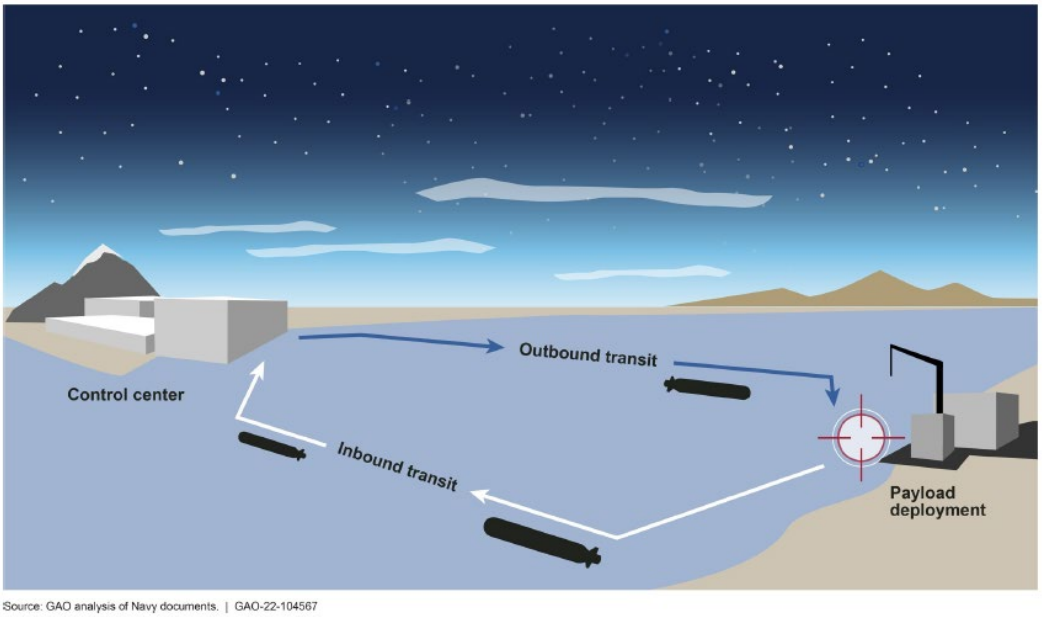


Figure 4. Notional Extra-Large Unmanned Undersea Vehicle Operational View

In addition, the Navy intends for LDUUV to be a long-endurance, multi- mission UUV that uses modular and reconfigurable payloads to increase the situational awareness of the crewed submarine that the Navy plans to launch it from, as shown in figure 5.

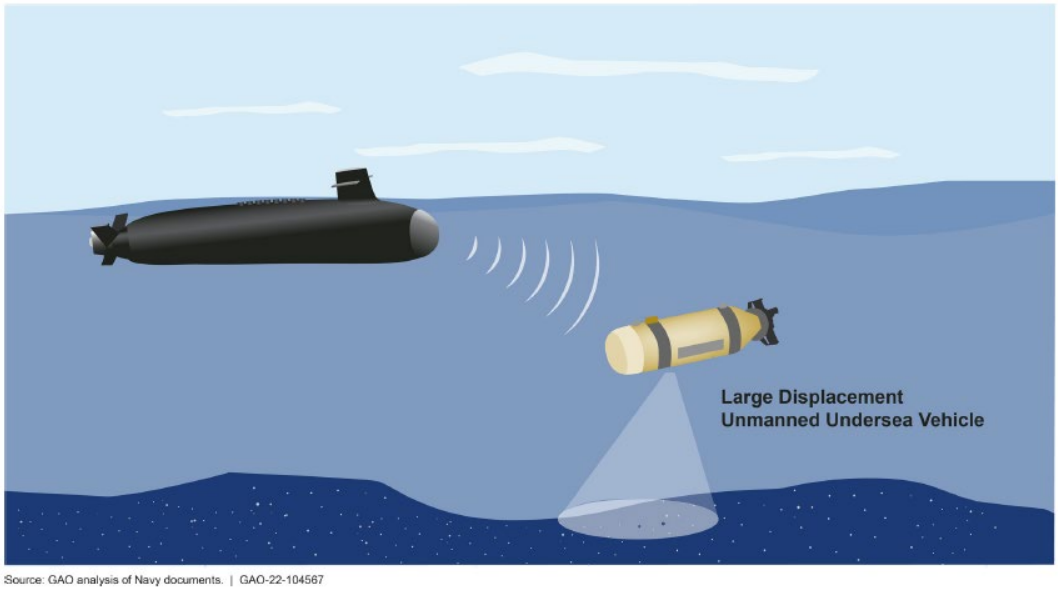


Figure 5. Notional Large Displacement Unmanned Undersea Vehicle Operational View

The Navy has a series of further analyses planned, which could address the effectiveness of uncrewed maritime systems in meeting identified missions to inform future tradeoffs. For example, the Navy initiated an Offensive Surface Fires Analysis of Alternatives to inform the LUSV effort after it was mandated to do so in the William M. (Mac) Thornberry National Defense Authorization Act for Fiscal Year 2021.14 This analysis will look at a variety of solutions—including uncrewed maritime systems— to provide a naval surface strike capability.

According to Navy officials, the Navy has yet to initiate any analyses to assess the effect that added capabilities of the XLUUV and LDUUV systems could have on the submarine fleet. However, after the Navy takes delivery of the XLUUV prototypes, it intends to complete a military utility assessment in 2024 to determine the effectiveness of XLUUV, which could inform other trade-offs. Finally, the Navy and DOD's Office of Cost Assessment and Program Evaluation are working on a number of efforts to assess the composition of the future fleet including continuing to assess options, as a part of the Navy's force structure review, which can inform the fiscal year 2024 shipbuilding plan. In doing so, a senior Navy official told us that the Navy remains committed to actively testing potential operational concepts for the uncrewed maritime systems.

Navy Is Budgeting for Uncrewed Maritime Systems but Has Yet to Estimate All Costs

The Navy is planning to spend billions of dollars on uncrewed maritime vehicles over the next 5 years. In December 2020, the Navy released a 30-year shipbuilding plan outlining a goal of acquiring 143 uncrewed maritime vessels and vehicles by 2045, as shown in figure 6.

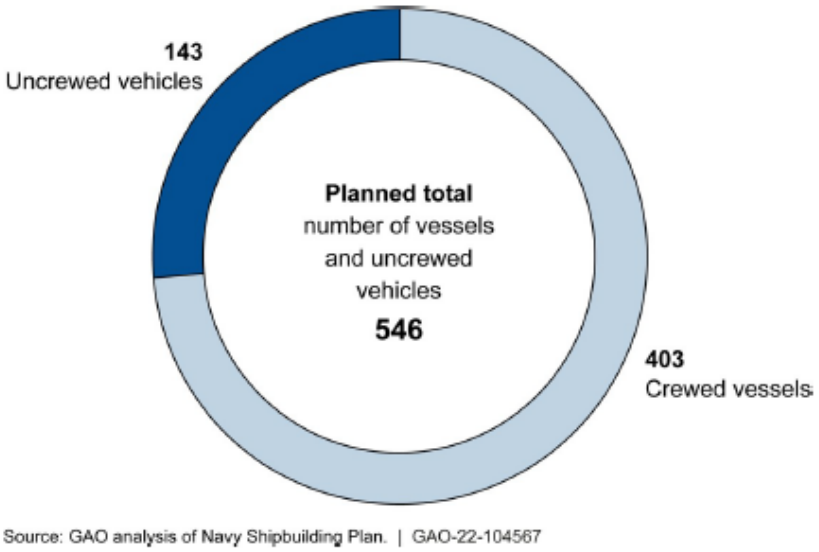


Figure 6. Total Vehicles and Vessels (Crewed and Uncrewed) in December 2020 Shipbuilding Plan

According to the December 2020 shipbuilding plan, the Navy plans to spend $4.3 billion over the next 5 years for 21 uncrewed vehicles, including $581 million planned in fiscal year 2022. According to the Congressional Budget Office's analysis of this plan, the Navy plans to spend an average of $1.2 billion per year for 30 years in fiscal year 2021 dollars, about 4 percent of the planned shipbuilding budget, on uncrewed maritime vehicles, as shown in figure 7.

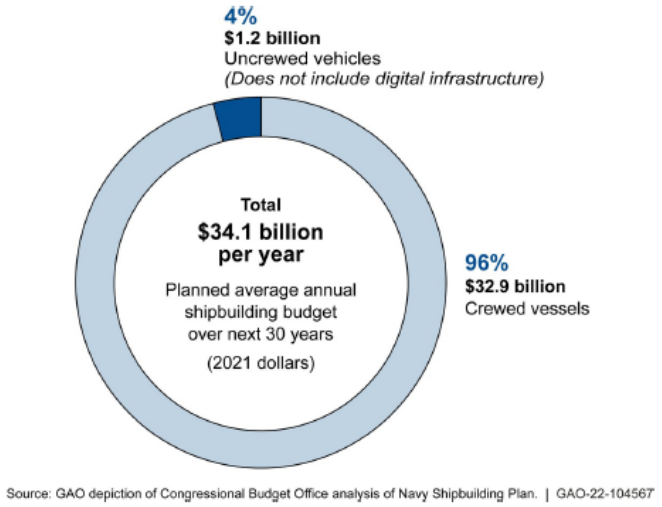


Figure 7. Navy's Planned Investment in Uncrewed Maritime Vessels and Vehicles

Overall, the Navy's December 2020 shipbuilding plan—including both crewed and uncrewed vessels—would require up to 50 percent more resources for shipbuilding than what the Navy has been receiving on average for the past 5 years, according to the Congressional Budget Office. Therefore, funding uncrewed maritime systems could come under pressure from the Navy's competing shipbuilding demands. The Navy subsequently published a shipbuilding plan in June 2021 to accompany its fiscal year 2022 budget request, but this plan only covered fiscal year 2022 rather than a 30-year forecast. While it did not include a future-year forecast for uncrewed maritime systems, it was consistent with the Navy's December 2020 plan in highlighting the importance of uncrewed maritime systems for the future fleet. Thus, we used figures reported in the December 2020 plan for this review as the best indication of the Navy's planned long-term level of investment for uncrewed maritime systems.

Based on our analysis of the Navy's December 2020 shipbuilding plan, we found that the Navy is underestimating the resources needed to acquire its uncrewed maritime systems. Specifically, the estimate does not encompass costs for: (1) operations and sustainment or (2) the digital infrastructure needed to enable and support these systems.

The December 2020 shipbuilding plan only includes operations and sustainment costs for the crewed fleet, and the June 2021 shipbuilding plan does not include operations and sustainment costs at all. According to Title 10, Section 231 of the U.S. Code, the annual shipbuilding plan must include estimated operations and sustainment costs for each vessel.15 In the December 2020 plan, the Navy stated that uncrewed maritime systems do not have a sufficient level of maturity and fidelity that would allow them to model operations and sustainment costs. We have previously reported that operations and sustainment costs for ship programs are a significant portion of a program's total cost.16 Given that operations and sustainment costs are such a large portion of a shipbuilding program's total cost, the Navy cannot fully assess the affordability of uncrewed maritime systems without an understanding of operations and sustainment costs, even if an estimate of these costs needs to be refined over time as more knowledge is gained through prototyping.

Further, while the removal of a crew onboard may present the opportunity for some operations and sustainment cost savings, these systems still require some crew to operate them either at onshore facilities or on board a crewed ship or submarine. The

Navy has yet to determine how many sailors will be required to operate uncrewed maritime systems in these roles, and according to Navy officials, is using prototyping to inform these crew requirements.

However, previous attempts by the Navy to reduce crew size by increasing automation did not go as planned. For example, in 2017 and 2021, we reported that the Navy's attempts to reduce crew sizes on crewed ships through increased automation, called optimal manning, resulted in large increases to maintenance costs when the automated systems failed to work as intended, ultimately leading the Navy to assigning additional crew to its ships.17 Given this trend, the Navy cannot fully assess the affordability of uncrewed maritime systems without understanding the extent to which the replacement of a crew on board with automated systems affects operations and sustainment costs.

The Navy's $4.3 billion estimate also does not include the costs associated with the digital infrastructure necessary to enable the uncrewed maritime systems to function without a crew on board. According to the Navy's initial prototyping plans, developing the digital infrastructure, including the Rapid Autonomy Integration Lab needed to enable uncrewed maritime systems, will require a significantly larger software development effort than is typical for shipbuilding programs. A senior Navy official in the Navy's Research, Development, and Acquisition office told us this digital infrastructure is still under development and the full extent of costs remain unknown, although they expect costs just for the digital infrastructure to run into the billions of dollars. However, the Navy did not include an estimate of the costs for developing the digital infrastructure in either the December 2020 or June 2021 shipbuilding plans, even as the Navy budgeted $293 million for digital infrastructure. Despite its criticality, Navy officials told us that developing this software capability has thus far not been as high of a priority as fielding vehicle prototypes. However, Navy officials also noted that the forthcoming fiscal year 2023 budget submission is expected to provide more funding for digital infrastructure.

The Navy attributes the incomplete cost estimates for uncrewed maritime systems to the unique nature of these efforts, as well as being prototyping efforts that are not typically included in shipbuilding plans. For example, Navy officials noted that the Navy does not produce program life-cycle cost estimates for prototyping efforts. However, the Navy often includes early estimates for ships that do not yet have program life-cycle costs, including the Light Amphibious Warship.

While there are some uncertainties with regard to uncrewed maritime systems, our cost estimating leading practices account for uncertainty in program costs. These practices state that, while programs tend to start with rough order of magnitude estimates, these estimates should be refined over time as more is understood about a program and as funding levels are expected to increase.18 Despite initial uncertainty, it is important to document planned costs as early as possible because initial cost estimates help to inform trade-off decisions among cost, schedule, and requirements, which increase a program's probability of success.19 Once completed, the Navy would benefit from updating these estimates as the uncrewed efforts gain knowledge over time in accordance with our cost estimating best practices.

The Navy highlights affordability as a significant reason for developing and acquiring uncrewed maritime systems in its Unmanned Campaign Framework. However, without even a rough cost estimate covering the full known scope of investment to acquire, operate, and sustain these systems, it cannot be certain that uncrewed maritime systems are the affordable solution for providing the capability that the Navy desires. A

cost estimate, beginning with rough order costs that is refined over time, forms the basis for establishing and defending informed investment decisions and is integral to determining and communicating a realistic view of likely cost and schedule outcomes.21 By highlighting the affordability of these systems without analysis that accounts for all estimated costs, the Navy could potentially communicate unrealistic cost estimates and expectations for its uncrewed maritime systems. If uncrewed maritime systems turn out to be more expensive than anticipated, the Navy may not be able to buy as many ships—whether crewed or uncrewed—as currently planned, which could jeopardize its future force plans.

Navy Is Missing Opportunities to Better Manage Efforts to Achieve Its Uncrewed Maritime System Objectives

The Navy is not managing its individual uncrewed maritime system efforts and capabilities as a portfolio and, as a result, is missing opportunities to more efficiently achieve its strategic objectives and maximize its investments. Specifically, the Navy has not initiated key practices for its group of related investments on uncrewed maritime systems and capabilities:

1. clearly defining a portfolio that is linked to strategic objectives,
2. establishing clear metrics for judging the portfolio,
3. defining and appropriately empowering governance roles for the portfolio, and
4. identifying stakeholders and a stakeholder engagement plan for the portfolio.

By not establishing a portfolio and initiating these key steps, the Navy is reducing the likelihood that it will achieve its strategic objectives for uncrewed maritime systems.

Navy Has Not Established Uncrewed Investments as a Portfolio, Though It Identified Strategic Objectives

The Navy has not identified uncrewed maritime systems as a portfolio.22 A portfolio is a collection of projects, programs, subsidiary portfolios, and operations that should be managed as a group to achieve strategic objectives.23 According to PMI, a portfolio management approach creates a process for an organization to implement strategic objectives. Through portfolio management, organizations can make a wide variety of decisions—including capability and funding trade-offs—to achieve the optimal mix of capabilities for a given investment. According to PMI and our prior work, managing a group of linked investments as a portfolio is typically more effective than overseeing each effort individually because it, among other things, allows an organization to:

- ensure that investments match the organization's objectives,
- provide active and decisive leadership,
- clearly identify stakeholders and creates a stakeholder engagement plan, and
- improve risk management.

According to PMI's portfolio management standard, there are four phases in a portfolio life cycle: initiation, planning, execution, and optimization.24 The first of these phases—initiation—occurs when an organization establishes the approach and processes that define how it will manage the portfolio. See appendix II for a list of PMI's leading practices throughout the full life cycle of a portfolio.

Even though it has not established uncrewed efforts as a portfolio, the Navy published a collective set of strategic objectives for these individual efforts, which are highlighted in the March 2021 Unmanned Campaign Framework. These are:

- advance crewed and uncrewed teaming within the full range of Naval and joint operations,
- build a digital infrastructure that integrates and adopts uncrewed systems at speed and scale,
- incentivize rapid incremental development and testing cycles for uncrewed systems,
- disaggregate common problems, solve them once, and scale solutions across platforms and domains, and
- create a capability-centric and sustainable approach for uncrewed contributions to the Navy.

These strategic objectives for the Navy's uncrewed efforts illustrate the linkage between the various investments that share funding and expertise to solve similar issues—key criteria for a portfolio.

Instead of managing the various uncrewed maritime systems as a portfolio, senior Navy officials told us that the Navy divides its efforts between three different offices within the Office of the Chief of Naval Operations—surface, undersea, and warfare integration. These offices prioritize and allocate funding across the Navy's investments, which typically do not overlap. While this structure works for investing in individual surface and undersea vehicles, it does not facilitate collective efforts that span these areas, such as the digital infrastructure. Senior Navy officials told us that they opted for this approach to uncrewed maritime systems because they prefer having experts make trade-off decisions within their respective surface and submarine domains. However, without establishing a portfolio, the Navy does not have a mechanism by which it can collectively work together on shared aspects of its uncrewed maritime system efforts to optimize its ability to achieve its objectives.

Navy Does Not Have Clear Metrics That Link Uncrewed Maritime Efforts to Strategic Objectives

The Navy has also not established metrics that enable it to measure its progress towards achieving the strategic objectives established in its Framework. According to PMI, once an organization establishes a portfolio, it should develop objectives and metrics that allow it to track progress. While the Navy has established strategic objectives, it has not defined key terms to allow for measurement. For example, the Navy is currently:

- conducting naval exercises to better understand teaming between crewed ships and uncrewed maritime systems. However, the Navy has not established metrics that better define its goal of uncrewed teaming within the full range of naval operations, according to several senior Navy officials and the program office. Thus, the Navy cannot be sure it is on track to achieve its stated objective even as it conducts some initial teaming efforts at sea.
- planning to build the digital infrastructure needed to operate these systems. However, according to the program office, the Navy has not established metrics for building the digital infrastructure, such as measures to define speed and scale, and is not tracking its progress toward achieving this objective. However, establishing clear metrics— and refining them as more is learned—is a critical early step when the portfolio is initiated.

Navy program officials told us that it is too early in the program to measure progress against its objectives. However, PMI states that organizations should measure

progress at the beginning stages of an effort. Without establishing metrics, the Navy cannot ensure that its progress is aligned with its strategic objectives.

Navy Has Not Established Governance with Authority for Uncrewed Maritime Systems

The Project Management Institute and our best practices state that organizations should have governance structures that appropriately empower leadership for its projects and portfolios.25 Further, effective portfolio management provides the space for organizations to responsibly innovate while also helping to ensure that the organization is setup to meet future goals and outpace competition by effectively balancing and prioritizing projects, as discussed by PMI and our prior work.26 However, the Navy does not have a governance structure with an empowered leader who has an understanding of the full uncrewed maritime system effort and can reprioritize the Navy's investments in this area as needed. Navy officials agreed that there is no senior leader with the responsibility for the collective decision-making process that determines how Navy investments in uncrewed maritime system efforts are oriented toward achieving its stated objectives.

The Navy attempted to build a common governance structure for uncrewed maritime systems, but its efforts were unsuccessful. In 2015, the Navy established a Deputy Assistant Secretary of the Navy for Unmanned Systems, but, according to officials who were in this office, it was disbanded in April 2018 in favor of managing uncrewed vehicles through the existing groups within the Office of the Chief of Naval Operations. According to officials in the Office of the Secretary of the Navy for Research, Development, and Acquisition, the Deputy Assistant Secretary of the Navy for Unmanned Vessels did not have the responsibility and authority needed to make research and investment decisions across the Navy's full uncrewed maritime system effort.

Senior Navy officials told us that they also established an office in 2015 within the Office of the Chief of Naval Operations focused on uncrewed systems including air, sea, and undersea. Both the office of the Deputy Assistant Secretary of the Navy for Unmanned Vessels and the uncrewed office within the Office of the Chief of Naval Operations were disbanded in fiscal year 2018. This was due to a lack of support from senior leadership for an organizational structure separate from its traditional warfare areas with its own resources, according to these officials.

Several organizations have also recognized the Navy's lack of governance of its uncrewed efforts. A provision of the William M. (Mac) Thornberry National Defense Authorization Act for Fiscal Year 2021 required the Navy to designate an existing program executive officer as the lead official for acquiring and sustaining autonomous capabilities by February 2022. A program executive office can share some similarities with a portfolio management approach, in that these offices oversee the execution of a group of linked investments. However, the designation requirement addresses the acquisition of autonomous capabilities and not the entire uncrewed maritime system enterprise, including research, acquisition, and operations. A portfolio manager, as defined by PMI, would oversee all of these areas. As of December 2021, Navy officials told us that they are working on implementing this National Defense Authorization Act provision but have yet to decide on an approach.27

In addition, in 2021 the Center for Strategic and Budgetary Assessments recommended the Navy establish an Autonomy Project Office within the Navy with sufficient authority to coordinate resourcing and management of all of the Navy's uncrewed efforts across all domains. The Center for Strategic and Budgetary Assessments also recognized that the Navy does not have a governance structure that

can unify various parts of the Navy who are working on autonomy-based projects. Further, while the Navy already has an autonomy program division within its research and development community, Navy officials said that they hope to formalize collaboration between the Office of Naval Research Autonomy office and the program executive office that is assigned responsibility for autonomy.

However, as of December 2021, Navy officials stated they had yet to complete their efforts to establish formal relationships between these offices. Without formalizing unified leadership for a single portfolio for uncrewed maritime systems, the Navy could have multiple leadership positions responsible for autonomy. This could, among other things, result in inefficient investments and multiple autonomy-based projects attempting to solve similar problems without coordinating their efforts.

Senior Navy officials confirmed that it is difficult to gain support for investments in developing the digital infrastructure compared to purchasing vehicle prototypes because digital infrastructure is not a tangible deliverable like a ship. Further, Navy officials did not identify an appropriately empowered Navy official who has the responsibility for leading the digital infrastructure through the Navy's investment process. In line with one of its objectives and how Navy governance is setup, the Navy program office and offices with the Chief of Naval Operations have been prioritizing purchasing uncrewed maritime vehicle prototypes and getting them to the fleet as quickly as possible to prove that the uncrewed concept can work in the field.

However, the digital infrastructure to support uncrewed systems has not kept pace with vehicle investment. Of the approximately $1.9 billion in total funding that the Navy has spent on uncrewed maritime systems since 2015, the Navy only requested a fraction of this amount, $293 million, to develop the digital infrastructure, even though the vehicles will be much less effective without it. In addition, the Navy's Seahawk, Sea Hunter, Overlord and XLUUV efforts do not conform to the planned Unmanned Maritime Autonomy Architecture for digital infrastructure, which could result in costly retrofits. Senior scientists within the Office of Naval Research told us that building the digital infrastructure to develop and test capabilities before building whole vehicles is the preferred way to rapidly develop and execute uncrewed maritime system efforts. Further, AI experts from DOD and external organizations agree that DOD must have the necessary digital infrastructure in place to develop, acquire, and scale AI effectively for weapon systems.

As a result, the Navy risks purchasing vehicles and software that cannot be easily updated, reconfigured, or maintained, which would result in assets that will not meet the Navy's needs. Without defining a portfolio with a governance structure and assigning leadership, the Navy is missing opportunities to more effectively manage its uncrewed maritime system efforts. Less effective management could result in the Navy suboptimally utilizing investment dollars, which would delay its achievement of uncrewed maritime capabilities.

Navy Has Not Identified Roles and Responsibilities for Key Stakeholders

The Navy has not clearly defined the roles and responsibilities of the numerous stakeholders that have some responsibility for developing and acquiring uncrewed maritime systems. There are many key stakeholders for these efforts from two large communities within the Navy—the science and technology community within the Office of the Chief of Naval Operations, and the acquisition community within the Assistant Secretary of the Navy for Research, Development, and Acquisition. In 2015, we highlighted what happens when these two stakeholder communities do not actively

collaborate with one another on transitioning technologies into acquisition programs and solving problems.28 Specifically, in 2015, we reported that the scientific community often does not develop technologies to a level of maturity that provides substantially less risk to the acquisition program. This report looked at 10 case studies and found that, in all five cases where a successful technology transition occurred, active collaboration between science and technology research and acquisition efforts was crucial to success.29

The Navy's uncrewed maritime efforts have, so far, resembled a hand-off from the science and technology community to the acquisition offices, rather than a collaborative effort. For example, according to Office of Naval Research scientists, even after years of development by the Office of Naval Research and others, uncrewed maritime undersea vehicles require additional development by the acquisition program office to achieve necessary endurance capabilities. In 2013, we found a range of management tools used by transition programs to support communication and collaboration among stakeholders, such as informal agreements, which can help organizations work together to solve technical problems during uncrewed system development. Specifically, we found that "good faith" agreements that document the expectations for developing, demonstrating, delivering, and integrating technologies helped to formalize collaborative prototyping efforts.30 However, according to DOD science and technology officials we spoke with, the scientific community does not have these or similar agreements for the uncrewed maritime system prototypes.

Lastly, Navy acquisition officials told us that they are working closely with subject matter experts in the science and technology community to facilitate the continued development of uncrewed maritime systems. However, we found that the roles and responsibilities of each group going forward on this effort are largely informally defined. Accordingly, Navy scientists, engineers, and program managers, among others, have to self- organize and coordinate across organizational boundaries to solve problems or move programs forward.

The Navy is considering a number of organizational changes to help manage its uncrewed maritime efforts, but these changes do not yet address the core organizational issues that are preventing more formal collaboration between the science and technology and acquisition communities. For example, the Navy stood up a task force on uncrewed maritime systems in 2021 with stakeholders from across the Navy to help coordinate day-to-day management of its uncrewed maritime systems. Navy officials told us they also recently began discussing efforts to stand up an Unmanned Campaign Council to coordinate strategic decision making, including the resourcing of uncrewed maritime systems, but the roles and responsibilities of this organization have yet to be established.

According to Navy officials, this organization would potentially coordinate the efforts of the surface and undersea warfare resource sponsors for uncrewed maritime systems, including the necessary digital infrastructure. However, senior Navy officials told us that this group will primarily be charged with identifying existing commercial technologies that the Navy can potentially use to provide needed capabilities instead of developing new technologies. As of January 2022, senior Navy officials told us that the Navy had yet to document the roles and responsibilities of this group. Specifically, the Navy has yet to define whether these new organizational bodies will coordinate between Navy stakeholders, including the science and technology and acquisition communities. Since portfolios often cross organizational boundaries, according to PMI's guidance, organizations should formally identify stakeholders and develop a plan for how they should coordinate when a portfolio is initiated. Without defined roles and responsibilities for key stakeholders, the Navy's process for problem solving through prototyping and

incorporating these lessons into future acquisitions is ad hoc and relies on the unofficial and voluntary collaboration of officials working across bureaucratic divisions.

Current Prototype Approach Does Not Ensure That the Navy Is Building Knowledge Prior to Making Decisions

The Navy's prototyping plan for uncrewed maritime systems has the potential to reduce risk before significant investments are made, but it lacks several key strategies for successfully transitioning the efforts to acquisition programs that are highlighted in DOD guidance and our prior work.31 Specifically, the Navy has not:

- documented clear evaluation criteria to inform readiness of prototyping efforts to transition to acquisition programs;
- developed prototyping schedules to help ensure that knowledge is gained in time to inform key decisions; or
- detailed the technology maturation process and other development milestones, such as the achievement of safety certifications in prototyping plans.

Without incorporating these strategies into its prototype planning, the Navy will not maximize its significant investments in prototyping these systems.

Navy Does Not Have Measurable Criteria for Evaluating Prototyping Efforts

We reviewed all of the Navy's available prototyping documents, including test strategies and prototyping plans, and found that the Navy does not have evaluation criteria to determine the readiness of each prototype to move to the next phase. DOD prototyping guidance states that an example of a best practice is to establish evaluation criteria that specifically outlines milestones and metrics that describe when a prototype is ready to move to the next phase.32 The guidance also states that the purpose of prototyping is to reduce technical risk to support the next phase of the effort. Tailored evaluation criteria is important because each prototyping effort is designed to meet a different set of missions.

Navy officials responsible for the uncrewed maritime prototypes told us that it is too early to establish measurable evaluation criteria for the Navy's prototypes. Project officials also said that further assessment of the progress and status of the Navy's prototypes will determine if the prototypes receive additional funding. As of January 2022, the Navy has yet to complete more detailed capability descriptions. However, DOD prototyping guidance recommends that transition planning should begin in the first year of the prototyping effort. The Navy's prototyping efforts for MUSV, XLUUV, and LDUUV have each been underway for almost 3 years. Further, even though the Navy has delayed the LUSV prototyping effort, it has received two Overlord USV prototypes from DOD's Strategic Capabilities Office and ordered two more without developing evaluation criteria. In addition, the Navy has also been operating the Sea Hawk and Seahunter to inform the MUSV program since fiscal year 2020 without evaluation criteria.

Without metrics and milestones to evaluate the prototypes, the Navy will not know when it has achieved its objective of lowering the risk of acquiring these systems before committing to significant investments. As a result, the Navy may transition these programs into the acquisition process before they are ready, potentially leading to concurrency between the technology maturation, design, and building stages of the program. As we have previously reported on multiple Navy shipbuilding programs over the last 10 years, concurrency often results in cost growth, schedule delays, and performance issues.

Navy Has Yet to Develop Schedules for Aligning Uncrewed Maritime System Efforts

The Navy has yet to develop schedules that align its uncrewed maritime vehicle prototypes and the related digital infrastructure to help ensure that its prototyping milestones align with key investment decisions. We requested an integrated schedule for the uncrewed maritime system prototyping efforts, but the most detailed schedules that the Navy provided to us only included a limited number of events illustrated on a single briefing slide for each prototyping effort. Therefore, we could not determine if knowledge from prototyping events would be available when the Navy plans to make investment decisions, such as buying additional vehicles. Further, as of January 2022, the Navy was unable to provide schedules for the digital infrastructure development efforts and did not have a schedule that integrated these efforts with its vehicle prototypes. The most recent schedules, which accompanied the Navy's fiscal year 2022 budget request, provided limited future information rather than a long-term schedule, and the schedules did not demonstrate how the Navy plans to gain knowledge prior to making decisions or how all of the efforts are integrated.

In the absence of an integrated schedule from the Navy, we analyzed the information provided to us and developed a depiction of the schedule for all of the Navy's uncrewed system prototypes, including when the Navy plans to transition them to acquisition programs. Figure 8 depicts the schedule information that we could determine from analyzing available documents.

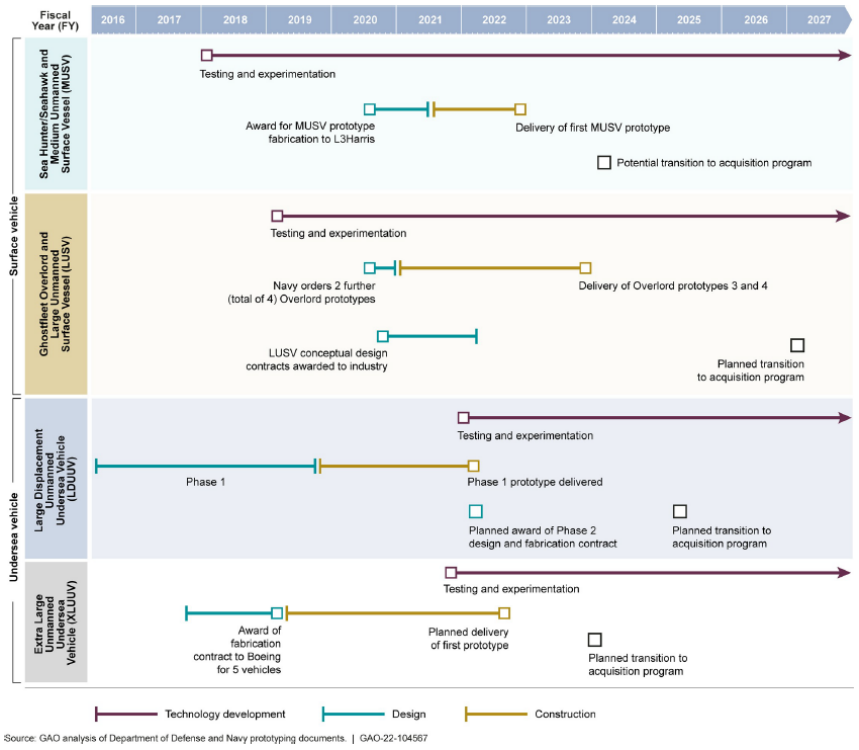


Figure 8. GAO Depiction of Uncrewed Maritime System Prototype Schedule

We found that there is potentially significant overlap between ongoing prototyping efforts of uncrewed surface vehicles and the Navy's plan to acquire follow-on prototype vehicles. For example, the Office of Naval Research recently provided the Navy with two medium uncrewed vessel prototypes—Sea Hunter and Seahawk—that the Navy is beginning to use for experiments. The Navy's schedules do not clearly outline when the

Navy plans to gain knowledge from its prototypes and how the timing of this knowledge aligns with when the Navy needs to make decisions about forthcoming investments. Although the Navy delayed the LUSV effort by 5 years, its schedule is not detailed enough to understand when the Navy plans to gain knowledge from prototyping Overlord—the precursor to the LUSV. Thus, without an integrated schedule, the Navy cannot demonstrate how Overlord prototyping aligns with LUSV design, requirements, and transition to acquisition or how this effort supports planned investments for the MUSV and digital infrastructure.

The Navy is pursuing common elements for all of the prototyping efforts—especially between USVs and UUVs—such as information technology standards, autonomy and endurance capabilities, and other key technologies and certifications for the uncrewed systems. For example, the Navy expects that endurance improvements for an undersea prototype like the XLUUV are applicable to the LDUUV. The same concept applies to the surface prototypes, where reliability improvements, such as an automated lube oil system, contributes to both the LUSV and MUSV. There are also interdependencies between the information technology and autonomy portions of the systems. For instance, the standards that the Navy is developing to guide autonomy (Unmanned Maritime Autonomy Architecture) are common across all four efforts, as is the planned Rapid Autonomy Integration Laboratory. Without a schedule that states how the Navy plans to align the development of these common efforts, the Navy risks inefficient and out-of-sequence work as it tries to develop uncrewed maritime capabilities.

GAO's scheduling best practices state that a master schedule should identify interdependencies between subprograms, which help programs manage risk and can be tailored to the maturity level of the program.34 In addition, in 2017, we found that prototyping efforts should be structured so that they can be completed in time to inform key decisions.35 Further, the Project Management Institute states that one advantage of portfolio management is that organizations can gain a better understanding of the schedule interdependencies between its efforts, which improves the organization's ability to manage and invest in these efforts.

However, project officials told us that they do not have schedules because their prototype efforts are early and have already been subject to numerous schedule changes based on changes to their budget and other delays. While the Navy's efforts are early, our scheduling best practices state that even a basic integrated schedule of key milestones provides a time sequence for the duration of a program's activities and helps stakeholders understand both the dates for major milestones and the activities that drive the schedule.36 If the Navy does not develop schedules that account for interdependencies between prototype efforts and update the schedules as progress is made, the Navy cannot manage these efforts to ensure that knowledge gained from prototyping will inform future purchasing decisions and designs.

Navy Prototyping Documents Provide Little Detail on Technology and Certification Development

The Navy has yet to document: 1) how it plans to develop technologies to achieve its uncrewed maritime system requirements and 2) how it will use prototyping to advance systems towards developing certification standards prior to making investment decisions.

Prototyping Documents Lack Detail on Technology Development Process

Each of the Navy's uncrewed maritime system efforts has prototyping documents for the current phase of each effort. However, these documents contain little information about how the Navy plans to use the prototypes to achieve its top level requirements. The

Navy has established top level requirements for each of its uncrewed maritime system prototypes that specify, among other things, the range, endurance, and speed the Navy believes it must achieve for the systems to be militarily useful. However, the Navy's current prototyping plans generally focus on how it will execute experimentation with prototype vehicles, instead of how technology development milestones link to top level requirements.

Specifically, none of the Navy's prototyping documents that we reviewed identify the technologies and planned technology development milestones necessary for progressing the prototypes to a point where they meet the top-level requirements. For example:

- In spring 2019, the Navy declared the MUSV to be a rapid prototyping project and created a prototyping plan. The prototyping plan identifies several requirements related to endurance, reliability, and autonomy. However, the plan does not include key details on the current status of the technologies needed to achieve these requirements and the process for maturing these technologies through prototyping.
- In December 2016, the XLUUV prototyping document identified performance risks associated with endurance, autonomy, and reliability. In addition, the XLUUV used a technology assessment completed by a similar program to identify current technology readiness levels. However, the technology maturation plan in XLUUV prototyping documents does not identify actions that are planned for maturing the technologies through prototyping. The XLUUV plan states that project officials will track technology development in industry and the scientific community, but we found that technologies matured by the Navy scientific community differ from technologies used in the XLUUV.

DOD's prototyping guidebook states that one of the main purposes of prototyping is to reduce technical risk prior to beginning the next phase of the effort. Also, in 2017, we found that successful prototyping efforts gathered information on technology maturity, potential costs, and the achievability of planned performance requirements.37 Lastly, our technology readiness assessment guide states that early technology development efforts should identify what technologies a project aims to mature and the associated milestones and risks.38

Navy program officials acknowledged that they need to revise their plans to document the steps necessary to progress the prototypes towards meeting top-level requirements but have yet to take action. Without documenting the key milestones it plans to achieve during the prototype experimentation process, the Navy cannot be certain that it is on track to reduce technical risk prior to transitioning the effort to an acquisition program.

Prototyping Documents Lack Detail on Certification Development

The Navy has yet to document in its prototyping plans how it will develop safety and proficiency standards for uncrewed maritime systems, called certifications. Certifications generally establish the basic functional standards for safe operation of a Navy vessel and can vary widely depending on the type of ship. For example, the certification for safe operations differ significantly between a diesel-powered frigate and a nuclear-powered submarine because of where these vessels operate and how they are powered, among other differences. Critical systems, the crew, and the flight deck (among many other things)—have an associated certification process that a person or system must pass for the vessel to be approved for operational use by the fleet. According to

Navy guidance, the Navy uses certification as a tool to help ensure that ships and sailors are ready to safely and effectively operate vessels.

A key effort for uncrewed maritime systems is converting certifications previously completed by the crew into certifications that are executed by software before the vehicles can be used for military operations, according to Naval engineers. Navy officials told us that there is ongoing work to develop certifications for uncrewed maritime systems, but it will take several years to complete these efforts. While Navy officials told us that they are working to develop the certifications, they added that gathering data from the operation of current prototypes is necessary to inform this process.

However, we found that the prototyping plans for the systems do not include the level of detail needed to inform this process. For instance, in the MUSV prototyping plan, the Navy describes the various certifications the system will need, such as transportation, safety, and information assurance, among others. Yet, the plan provides no additional detail on how the Navy will use the prototypes to work toward developing these certifications. Similarly, in a LDUUV prototyping document completed April 2021, the Navy stated that it will leverage certification expertise gleaned from similar programs and projects, but this document does not identify any specific milestones related to certification development. In addition, the prototype document recognizes the need for certifications related to cybersecurity and safe integration with a submarine but does not identify how the Navy will develop the identified certifications or other components for the LDUUV related to autonomy. Without an understanding of all needed certifications or how the Navy plans to use the LDUUV prototypes towards meeting and developing certifications, there could be a delay in progressing the LDUUV because of unplanned work.

By reflecting additional details on safe and effective prototype operations in the prototyping plans for the uncrewed maritime systems, the Navy can better understand how prototyping can inform certification development and better ensure that it will have the knowledge it needs before making design and fabrication decisions that rely on these details. For example, if Navy engineers must make changes to a system to meet a certification requirement after fabrication is complete, these changes could delay uncrewed maritime systems' availability to the fleet. Further, if the Navy does not know what safety standards it needs to meet, it will not be able to use valuable prototyping time to work toward achieving these developmental milestones.

Conclusion

The Navy has identified uncrewed maritime systems as an important affordable capability for future warfare. However, the Navy has yet to develop a basic cost estimate for these capabilities and, therefore, does not know how these efforts fit in with future ship planning. This is critical as the Navy is likely to face continued budget pressure as it attempts to build up its fleet. Portfolio management offers the Navy an approach to optimize its uncrewed maritime systems by balancing resources across multiple efforts and linking its efforts to its strategic objectives. However, if the Navy maintains its current approach of managing these systems through its divided portfolios that were not intended to share resources, it will likely continue to make investment decisions that minimize the importance of the digital infrastructure necessary to operate these vehicles. This divided approach is also unlikely to help the Navy achieve the collective objectives it set for its uncrewed maritime system efforts.

Moreover, the Navy is unlikely to fully realize the benefits of prototyping because it has yet to develop: (1) evaluation criteria to measure the readiness of prototypes to enter

into acquisition, (2) schedules that demonstrate how prototype efforts align with key investment decisions, and (3) prototype plans that illustrate how the Navy intends to mature technology and achieve certifications. If the Navy does not implement these practices, it may not get the most of the billions of dollars it is investing in these prototypes and would also likely begin future uncrewed acquisitions with more risk than planned.

Recommendations for Executive Action

We are making the following seven recommendations to the Department of the Navy:

- The Secretary of the Navy should provide Congress with a cost estimate that includes the full scope of known costs to develop and operate uncrewed maritime systems—including estimated costs for operations and sustainment as well as the digital infrastructure—and develop an approach to refine this estimate over time as part of its next shipbuilding plan. (Recommendation 1)
- As the Secretary of the Navy considers potential reorganization of the management of uncrewed maritime systems as required by law, it should establish an uncrewed maritime systems portfolio and assign an entity with the responsibility for overseeing this portfolio in line with portfolio management best practices and define the role of key stakeholders. (Recommendation 2)
- The Secretary of the Navy should provide details about how it intends to achieve its uncrewed maritime system strategic objectives. Such information should include measures and metrics, as well as a planned process to assess the Navy's progress toward achieving its stated objectives in line with portfolio management best practices. (Recommendation 3)
- The Secretary of the Navy should develop evaluation criteria for assessing each uncrewed prototype effort's readiness to transition to an acquisition program. (Recommendation 4)
- The Secretary of the Navy should develop a master planning schedule to include each uncrewed maritime system effort. This schedule should establish when the Navy plans to purchase and prototype each vehicle as well as when it plans to achieve desired capabilities, including the digital infrastructure. (Recommendation 5)
- The Secretary of the Navy should revise the prototyping plans for each uncrewed maritime system to incorporate how it plans to use its prototyping efforts to mature technologies to achieve top level requirements. (Recommendation 6)
- The Secretary of the Navy should revise its prototyping plans for each uncrewed maritime system to incorporate how it plans to use information gained from prototyping to develop certifications that apply to uncrewed maritime systems prior to investment decisions. (Recommendation 7)

Agency Comments and Our Evaluation

We provided a draft of our report to the Navy for comment. The Navy's written comments are reprinted in Appendix III of this report. The Navy generally concurred with all seven recommendations, but some of the actions that it plans to take in response to three recommendations would not fully address the issues that we discuss in this report. GAO maintains that fully implementing all recommendations is warranted.

In response to our first recommendation, the Navy agreed to develop a full cost estimate. Further, the Navy stated that uncrewed maritime systems should not be included in the battle force inventory of ships.

We interpret the Navy's response to mean that it does not plan to provide an estimate of the full costs of uncrewed maritime systems in shipbuilding plans. As the Navy's response states, it does not plan to complete a cost estimate until it is required to do so by acquisition policy. As such, the cost of the Navy's uncrewed maritime portfolio will remain unaccounted for in shipbuilding plans in the near term because the Navy has yet to establish a timeline for transitioning these efforts to acquisition programs. Regardless of whether uncrewed ships are a part of the battle force inventory, the Navy's shipbuilding plan is required to have an estimate of the operations and sustainment costs, among other costs, for the ships that will be delivered under the plan. Given that operations and sustainment costs are such a large portion of a shipbuilding program's total cost, the Navy cannot fully assess the affordability of uncrewed maritime systems without an estimate of these costs.

In response to our second recommendation, the Navy stated that it has designated the Unmanned and Small Combatant program executive office as the executive agent responsible for the acquisition of autonomy, as required.

However, the Navy's response does not address gaps in the governance of the entire uncrewed maritime system enterprise, including research, acquisition, and operations, as discussed in the report. Specifically, the Navy's uncrewed maritime programs remain divided across the surface, undersea, and warfare integration offices within the Office of the Chief of Naval Operations—since these are the offices that determine how the Navy allocates resources. Further, the Navy did not address how the Unmanned and Small Combatant Program Executive Office will improve collaboration with the science and technology community. As we discuss in the report, an essential element of portfolio management is empowering a governance structure that is responsible for the collective decision-making process and can direct Navy investments in uncrewed maritime system efforts to ensure that they achieve their collective objectives. The Unmanned and Small Combatant office, even as the executive agent for autonomy, still will not have the ability to make decisions and direct investments for the entire portfolio of uncrewed maritime efforts.

In response to our third recommendation, the Navy requested that we remove the recommendation because, stating that it overlaps with our fourth through seventh recommendations.

We disagree with the Navy's response because the third recommendation focuses on the Navy's strategic objectives, as outlined in its Unmanned Campaign Framework. The Navy's proposed actions are focused on each separate effort rather than the collective whole. As we discuss in the report, a key element of managing a portfolio is establishing strategic objectives and measuring progress towards achieving them for the entire uncrewed maritime effort. Without measuring its progress towards its strategic objectives, the Navy will likely continue to miss opportunities to manage risk and allocate resources across its uncrewed maritime portfolio.

The Navy agreed with our fourth through seventh recommendations.

DOD and the Navy also provided technical comments that we incorporated as appropriate.

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