AM is critical to naval innovation, opening new design possibilities as shipbuilding programs ramp to meet aggressive production targets and enhance fleet readiness.

ADDITIVE MANUFACTURING GAINING MOMENTUM ACROSS THE ARMED FORCES

Qualification advancements are paving the way for expanded adoption.

By **Anthony Basenese & Ross Brown**

The Navy, NASA, and aerospace agencies all want safe, repeatable, and efficient additive manufacturing (AM) processes. Aligning on the "what's necessary" vs. "what's nice to have" in terms of standards is the key to unlocking cross-sector AM adoption. And it's already starting to happen, as demonstrated by a few key AM projects in naval applications.

AM is about much more than merely replacing traditional manufacturing methods. It enables unprecedented design innovations, including intricate geometries, lattice structures, and part consolidation. A proactive approach is required to best adapt to the shift to AM. This means embracing new design options, sharing information fostering collaboration among defense sectors, and keeping critical suppliers well-positioned to meet the Navy's increasing demand for high-performance parts in future shipbuilding programs.

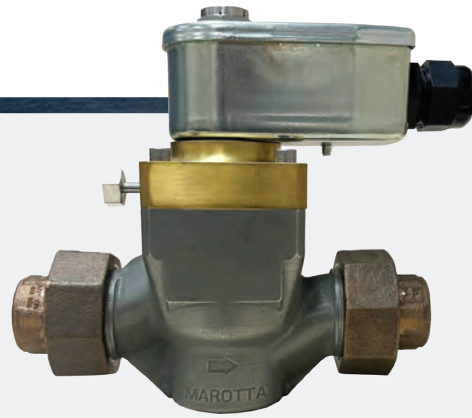
Aligning qualification across defense sectors

In 2020, Naval Sea Systems Command (NAVSEA) released its first set of AM Technical Publications, built with input from industry partners, representing a major step forward in creating a clear path for AM in naval applications. Today, there are ongoing talks to align standards across military and space sectors to streamline the AM qualification process. The Navy, NASA, and aerospace leaders in AM are working to find common ground so qualified parts can be used across programs without repeating the entire process. These efforts would simplify part approvals and make it easier to scale AM across different branches and suppliers.

The advancement of AM across military and space segments reflects a shared interest and need for high-performance, reliable, and certifiable parts – although each sector has slightly different

PHOTOS COURTESY OF MAROTTA CONTROLS INC. UNLESS OTHERWISE NOTED

A multi-year research program with America Makes fostered development of a lattice-integrated manifold, Marotta's RMQ11-3. Lattice structures are only possible with AM and can be used to improve mechanical and acoustic performance in manifolds while reducing component weight. In this design, part mass was reduced by 38% while still meeting critical functional requirements such as proof pressure and high-impact shock testing.



By using AM techniques, Marotta produced a direct replacement of a chilled water valve with delta qualification which previously had a 29-week lead time for its traditional sand-cast brass body. Marotta's engineering team replaced the brass valve body with a requalified version produced via Laser Powder Bed Fusion (LPBF) using Inconel 625, a corrosion-resistant nickel superalloy.

priorities. Both would greatly benefit from a reliable metal AM supply line, particularly for providing low-quantity spare parts to maintain equipment supporting the warfighter. As such, there's generally a push to develop universal material specifications for defense. Agreeing upon standardized material specs (e.g., feedstock powder, process controls, mechanical properties) would allow manufacturers to produce parts meeting baseline performance requirements across agencies. Universal standards also benefit the suppliers of AM components, who would then be able to provide their services to various industries without the burden of a high-cost qualification protocol. For example, a titanium alloy used in both a satellite bracket and a submarine valve could be qualified under the same spec and produced by the same subcontractor, assuming material strength, fatigue life, and corrosion resistance are mutually acceptable.

AM in both sectors must follow strict documentation and process controls, from machine calibration to environmental monitoring. Developing a common set of process validation criteria (such as certification requirements, inspection methods, and material testing) would allow for cross-sector certification of parts.

Creating AM-specific methods of nondestructive testing (NDT), such as computed tomography (CT) scanning protocols or ultrasonic testing techniques for lattices, is critical as well. With acceptance across agencies, these protocols would reduce redundancy and ensure consistent part quality with universally recognized inspection processes.

Both sectors need access to validated performance data to support qualification. Shared databases (possibly through consortia such as America Makes) could reduce redundant testing and speed up certification for common part families. Shared design principles and digital model standards could also help streamline collaboration between suppliers and end users.

Critically, the same unified approach can be applied to qualification pathways. Rather than qualifying individual parts, both sectors would benefit from category- or function-based qualification (e.g., all pressure-retaining parts made with powder bed fusion using X material). Time and cost are minimized while safety and performance remain priorities.

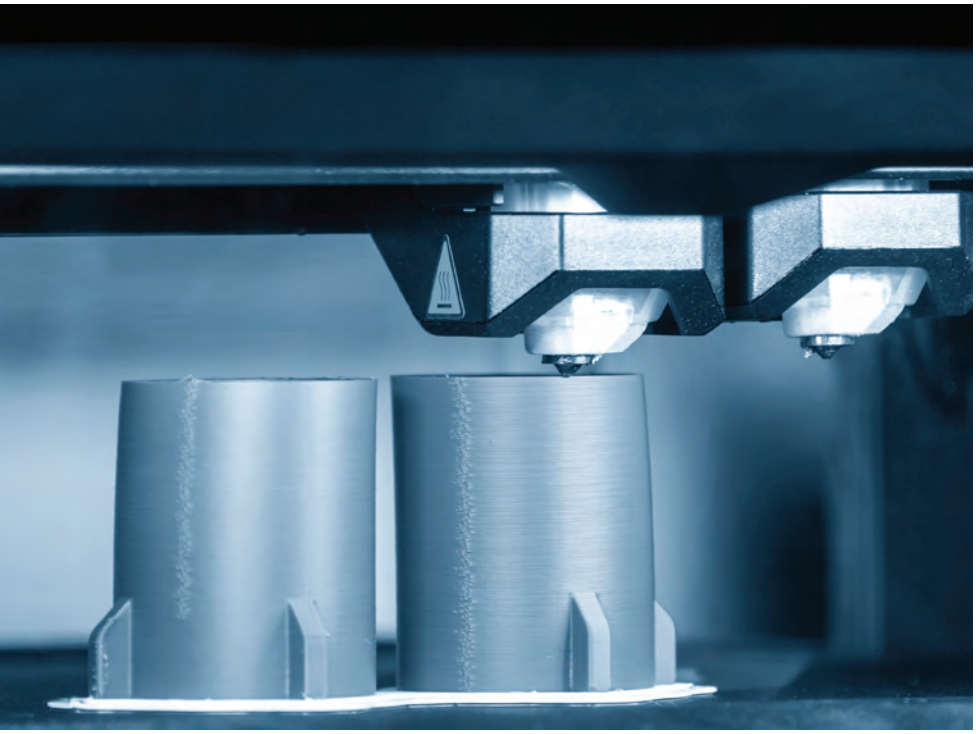
AM design innovation in context

Unlike traditional manufacturing processes, designs produced via AM aren't restricted by tool accessibility. Further, component complexity doesn't necessarily correlate to cost increases. With AM, it's now possible and economical to design parts with intricate internal structures or channels, lattice structures, and functionally graded materials.

The unlocked design capabilities offer numerous benefits with the potential to impact every industry where trained engineers embrace AM. In manufacturing, internal cooling channels can create more efficient dies and molds. In professional sports, lattice structures can reduce the force of impact on athletes. In healthcare, patients can benefit from customized orthopedic implants fitting properly to their unique bodies. And the U.S. Navy can make its submarine fleet quieter.

In one project, a specialized flow device was designed to address the extreme valve performance requirements for submarines. Traditional manufacturing couldn't produce a design with the necessary flow control features, so AM was explored. It became the first AM part with a NAVSEA-approved qualification plan for any metal submarine application, setting a precedent. The part underwent a multi-year qualification process with Marotta Controls, prime contractors, and NAVSEA personnel essentially co-writing the qualification standard, leading to the initial development of NAVSEA Technical Publication S9074-A2-GIB-010/AM-PBF in 2020. Small quantities of these flow elements are now installed with many more actively in production.

In a project funded by the Maritime Sustainment Technology and Innovation Consortium (MSTIC), an Other Transaction Authority (OTA) supporting Navy



innovation and guided by NAVSEA, a cast valve body was redesigned and requalified to be produced via AM. Casting is a traditional manufacturing method becoming more difficult to source due to supplier decline and long lead times. Marotta redesigned the valve for AM, resulting in a simplified supply chain, improvement in part quality, and a 70% shorter lead time. After full qualification, including high-impact shock and shipboard vibration testing, the valve was approved for shipboard use on U.S. Navy destroyers and has provided a touchstone example of using AM to solve a legacy supply chain challenge.

In another example, a multi-year research program with America Makes fostered development of a lattice-integrated manifold. The project's goal was to explore how lattice structures only possible with AM can be used to improve mechanical and acoustic performance in manifolds while reducing component weight. The design and development team reduced part mass by 38% while still meeting the critical functional requirements such as proof pressure and high-impact shock testing. Further development of this manifold concept may lead to acoustic and structural noise improvements as well.

These projects show how collaboration between private industry, Navy stakeholders, and public R&D initiatives (such as America Makes and MSTIC) is critical to advancing AM in naval systems. Each project delivers immediate solutions and contributes to the development of standards and frameworks needed to support wider AM adoption across the fleet and other defense sectors. This offers a fresh sandbox for design innovation and alternate supply lines expediting maintenance and repair cycles. DM

About the authors: Anthony Basenese is the engineering manager in the Naval Systems Business Unit at Marotta Controls for Additive Manufacturing initiatives. Connect with Anthony at Abasenese@marotta.com; Ross Brown is a senior engineer specializing in Additive Manufacturing at Marotta Controls. Connect with Ross at rbrown@marotta.com or linkedin.com/in/wrossbrown.

Marotta Controls Inc.
https://marotta.com

CREDIT: ISTOCK-1339305659