UltiMaker whitepaper

The 2024 3D printing guide for military and defense

How 3D printing is becoming the go-to powertool for defense contractors and deployed forces worldwide.

What's inside

UltiMaker 3D printers comply with the TAA and are available on GSA

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EN 07/2024 v1.00

Introduction

The challenges of manufacturing, maintenance, and logistics for a modern military

Today’s global militaries have a heavy reliance on support staff and supply chains. The tooth-to-tail-ratio (TTR) measures the ratio of combat fighters to support personnel. For a little context, in WWI the US Army had a TTR of 1:2. Today, that ratio has grown to 1:10 - meaning the vast majority of personnel play a support role.

Why the change?

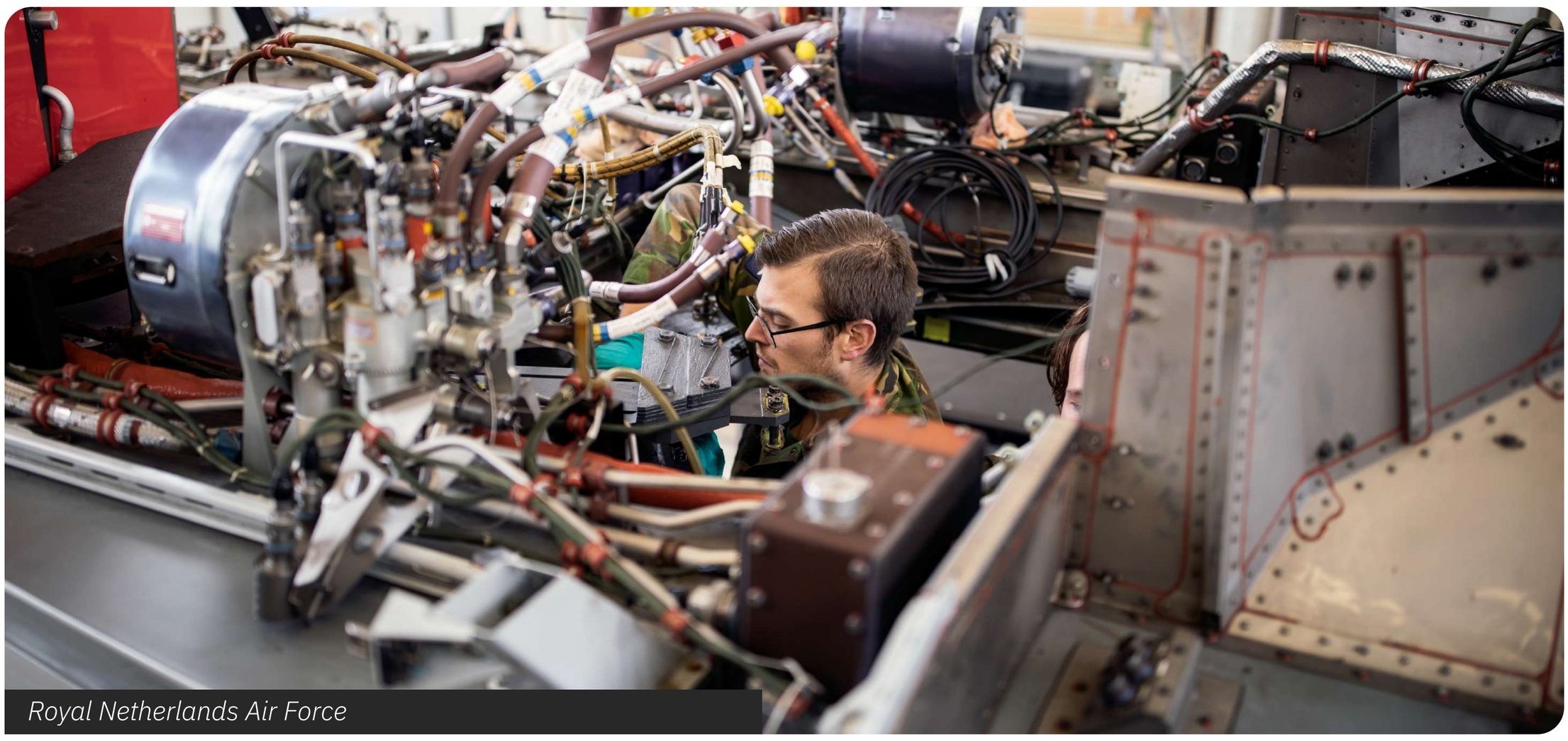
Modern weapon systems and technologies are far more capable than in the past, which means fewer combatants are required to have the same impact.

At the same time, the complexity that comes with highly capable, sophisticated technologies means they often require extensive preventative maintenance from trained technicians to keep them operational and at the ready - even in peacetime.

Beyond defense support personnel, private industry provides an even wider layer of support both in the initial development and manufacturing of weapons and technologies, but also upgrades and maintenance.

With such a major focus on R&D, manufacturing, maintenance, and logistics, it’s not exactly surprising that 3D printers have become critical tools for defense contractors and within defense units themselves.

In this guide, we’ll lay out some of the most common applications for 3D printing in military and defense, cover why 3D printing is a compelling technology within these segments, and touch on how 3D printers are typically procured.



Royal Netherlands Air Force

Part 1

Manufacturing jigs and fixtures for defense supply chain

The US defense industrial base includes private facilities producing defense items, from major contractors to small businesses and innovators. It comprises factories, shipyards, and a skilled workforce, ensuring readiness and adaptability to evolving defense needs, essential for maintaining national security and technological advancement.

While goods can vary widely from clothing to heavy armored vehicles and aircraft, 3D printers offer the flexibility to rapidly improve the manufacturing processes over time. Changes can come in the form of more ergonomic or efficient tools, inspection gauges, organizers, and new jigs and fixtures. 3D printers are becoming critical for the design, production, and replacement of tools – essentially providing tools on demand.

What are 3D-printed manufacturing tools?

Manufacturing tools, in the context of 3D printing, are not the machined molds that will be used to churn out thousands of injection molded parts. Instead, we're referring to very specialized devices that make technicians, engineers, and robots on the line more effective.

Manufacturing engineers generally understand the value of customized tools, jigs, and fixtures. They allow for increased speed and efficiency by making the job of the assembly line workers easier and more repeatable.

They also reduce the risk of defective equipment from being delivered to their frontline customers by reducing the chance of mistakes or inconsistencies during production.

Manufacturing engineers use 3D printers like the (UltiMaker S7) for producing custom jigs and fixtures that can drastically reduce production risk.

Why 3D print manufacturing tools?

In an environment like an assembly plant, manufacturing engineers use a wide range of tools. 3D printers are valuable mini manufacturing plants that can work next to the line and provide unparalleled access to new or replacement tools.

Easy to Access and Easy to Use

3D printers are significantly reduce the physical effort required to create objects. Modern desktop 3D printers are not only powerful but also user-friendly, featuring a compact design that allows them to be conveniently placed where needed. This accessibility makes them ideal for engineers.

Unlike CNC machines, 3D printers are extremely easy to use, enabling almost anyone to produce a part with minimal training. Additionally, they do not need specialized work areas with industrial ventilation, dust collection, or other facilities.

Compared to traditional manufacturing tools like CNC, 3D printers are easy to use and can be placed closer to the assembly line.

Live Process Optimization

Using 3D printers for on-demand manufacturing also allows for rapid iteration and optimization of tools and processes. For example, if you receive feedback from line operators that a certain jig is difficult to use and could benefit from an additional handle for better ergonomics, you can easily address this. Simply open the CAD file, add the handle, and print the revised version, all within a single day. This straightforward process is also applicable to specification changes or new vehicle models, enabling you to set up new production lines quickly and adapt seamlessly to any modifications.

Airbus utilizes UltiMaker 3D printers and Cura software in the local production of tools, jigs and fixtures, and printing lightweight design parts with composite materials at their European manufacturing facilities. (VoxelMatters)

On-Demand Replacements

Maintaining a digital inventory enables an engineer on the plant floor to access an unlimited library of parts without the necessity and costs of a large warehouse. A 3D printer can produce validated parts on demand. For instance, a batch of 20 nozzles for applying window sealant can be printed in a single run. All that is required is a 3D printer, a few spools of filament, and a computer.

Part 2

Maintenance, repair, and overhaul (MRO) with 3D printers

How does modern defense maintenance work?

In the last decade, the US Army, Air Force, and Marines have adopted a leaner approach to equipment maintenance called two-level maintenance. This approach enables greater efficiency through the use of technologies such as advanced sensors, diagnostics, and modular designs - allowing for more effective reactive and preventative maintenance to occur in the field rather than at the depot or factory level.

The US Navy's traditional rule of thirds with their vessels (⅓ deployed, ⅓ in drydock, ⅓ in replenishment) means that most vessels are not actively used. Similarly to the other armed forces, there is a push to improve preventative maintenance in the field to reduce downtime by leveraging modern technologies.

Royal Netherlands Air Force

Why 3D printers in defense maintenance?

While modular components are already enabling better field maintenance and reducing the need for massive in-theater depots and long supply lines with transport vehicles, there is still a lot of room for improvement. Defense logistics and maintenance officers are starting to realize the potential of 3D printers in field and sustainment maintenance.

Replacement Part Production

Traditional defense maintenance supply chains require in-theater storage of replacement parts which means large space requirements and replenishment via transport. By leveraging 3D printing, planners can create catalogs of 3D printable parts that can be stored digitally. Then when a modular component needs to be replaced, the unit's technicians can download the file and print the necessary components. Thanks to the evolution of 3D printing technology, high performance materials such as carbon fiber composites and even metals can be leveraged.

The Royal Dutch Navy proves the material performance of a 3D printed winch link by lifting a 12-ton M113 armored personnel carrier. The link was printed in carbon fiber composite using the UltiMaker S5 3D printer. (UltiMaker)

On-Demand Tool Sourcing

Much like replacement parts, tools for maintenance require extensive storage. In some cases the right tool for the job may break, be in short supply, or not exist at all. This is where the versatility of 3D printing comes in. Digital catalogs of tools can be made available to print on-demand, so if the tool you need is constantly being used by another tech, just print another one. In the case that a mechanic needs a specific fixture or tool that they don't have, they can even step into CAD with the specs and design and print that tool in the span of 24 hours.

The Royal Netherlands Air Force utilizes UltiMaker 3D printers to produce custom tools for the maintenance of their Chinook, Apache, NH90, and F16 aircraft. (UltiMaker)

Portability and Accessibility

Part output is one factor, but if the tool or process is too cumbersome, then it won't be useful in the field. 3D printers come in a wide range of shapes and sizes. The professional desktop models specifically can pack a major punch, while being compact and portable all-in-one manufacturing stations. They can be deployed in forward areas with quick setup and are relatively easy to use. There are even examples of 3D printers being used within all-terrain heavy-trucks - serving as automated manufacturing workstations within mobile workshops.

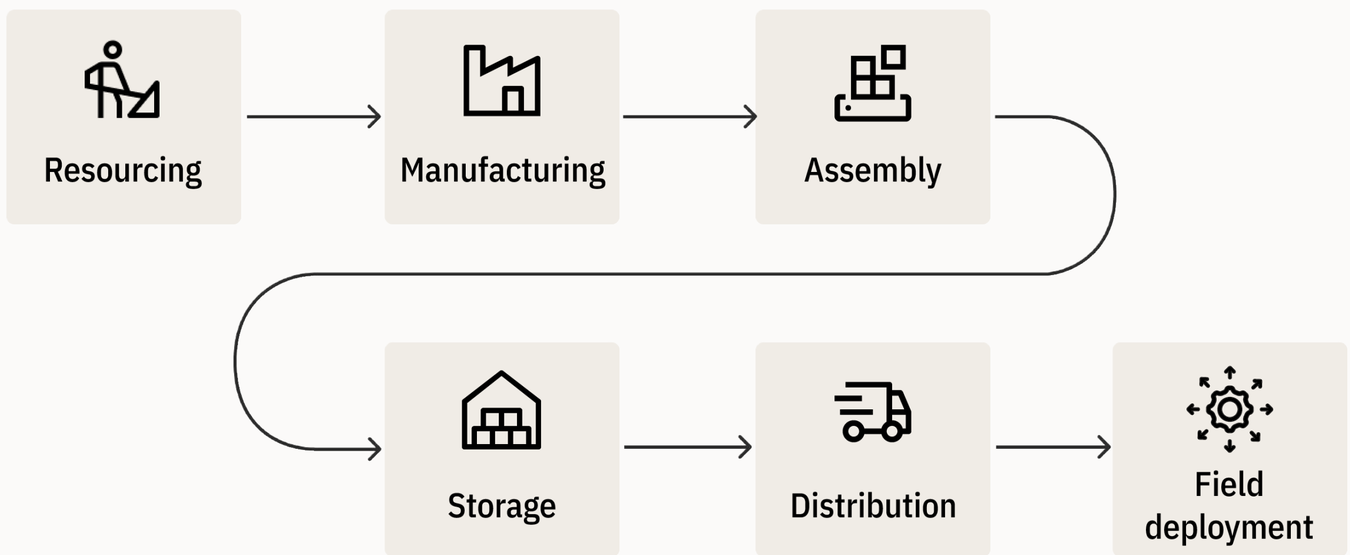
Part 3

Supplementing the supply chain with 3D printers

What is the traditional defense resupply chain?

Traditional manufacturing

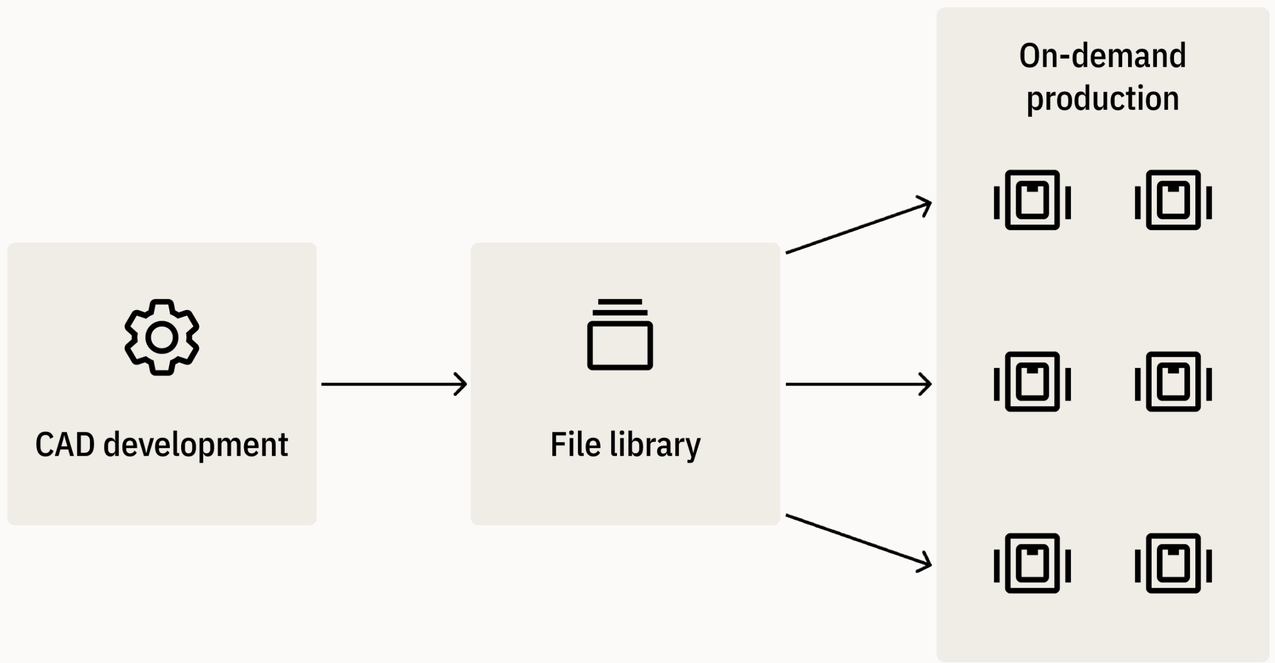
Historically, militaries got their supplies in three ways - (1) in the field, (2) carried with them, or (3) shipping them in from the rear. In today's modern militaries, supply chains focus on carrying and shipping supplies utilizing large convoys, cargo aircraft, and even tactical pack robots.



It's important to remember that these supplies are not limited to tactical gear, but include food, water, lights, generators, and other critical on-base supplies. This is true both on land and at sea.

Additive manufacturing

3D printing has revolutionized supply chains by offering unprecedented flexibility and efficiency. 3D printers can be stationed anywhere in the world and produce parts on demand, allowing for localized manufacturing that reduces shipping times and inventory costs while meeting specific, immediate needs.



How do 3D printers fill gaps in the defense supply chain?

Unlike the traditional supply chain that relies on heavy transport vehicles moving provisions from manufacturing or storage facilities to bases or near the front lines, 3D printers can be positioned to manufacture goods on location. This means they can fill supply chain gaps due to unexpected rise in demand, bad weather, or even adversarial denial. While the major equipment required on the battlefield is unlikely to be fully 3D printed, there are countless examples of applications where 3D printing makes a lot of sense.

Base / Shipboard Infrastructure

Forward operating bases are hubs for deployments and are often built from the ground up to be self-sufficient. Similarly, naval ships can be deployed for months on end in locations where resupply can be challenging. Having 3D printers on-location enable immediate manufacturing of a wide range of goods such as hooks, handles, valves, switches, gears, clips, and more. The ability to print these types of parts can cut wait time from weeks to days, and reduce the number of resupply missions.

UltiMaker 3D printers were deployed at US Navy and Marine bases globally with the award of a $5 Million IDIQ contract. (3D Printing Industry)

Medical and Health Care

Robust medical and health care is critical to a successful military deployment. 3D printers are already a normal sight in the dental community, and medical applications are becoming more common. Aside from custom surgical implants that are based on CT Scan data from the patient's own anatomy, more basic applications like anatomical splints and braces and replacement ambulatory equipment can be 3D printed on-demand without the need for resupply.

Epipen protective holster 3D printed on a UltiMaker 3D printer

Mission-Specific Customizations

Standard operating procedures don't always work as planned. Battlefield improvisation can play a critical role in certain mission situations. 3D printers can deliver customized solutions that can help units achieve their mission. These one-off tools can be prototyped, but also used in the field and modified based on feedback for maximum impact. Designs can then be shared back to defense contractors for mass production where it makes sense.

Part of the Dragontech platform incorporates the LIDAR, Multi-Spectral Spectral Sensors, and a controller attached to an enterprise drone via mounts 3D printed on the MakerBot METHOD X using Nylon Carbon Fiber.

Part 4

FAQs

When procuring a 3D printer for defense

1. Do you have a viable 3D printable part / application?

Whether it’s one of the applications we discussed in this guide, or something different, you’ll want to identify at least one use case that will utilize a 3D printer regularly.

2. What properties / materials do you need?

Depending on your part requirements, you should identify the properties that you need, from impact-resistance, to stiffness, flame retardance, rubber-like flexibility, or even metal. 3D printing materials run the gamut of properties so do some research.

3. What should you look for in a 3D printer for defense?

That really depends on your application, but there are a few common needs. Having a secure system from a connectivity standpoint or simply having an online / offline mode is essential. Is it manufactured in a trusted country that will be able to provide support both now and in the future? Does it have compliance and certifications within the manufacturing process?

4. Who else needs access to 3D printing?

You may have a single use in mind that requires a single 3D printer, but communicate with your teams to identify additional needs and users. It’s not uncommon for numerous requests to surface once a 3D printer arrives and suddenly you’re at full capacity with a backlog. At this point, you’d need multiple printers to keep up.

5. How does purchasing work?

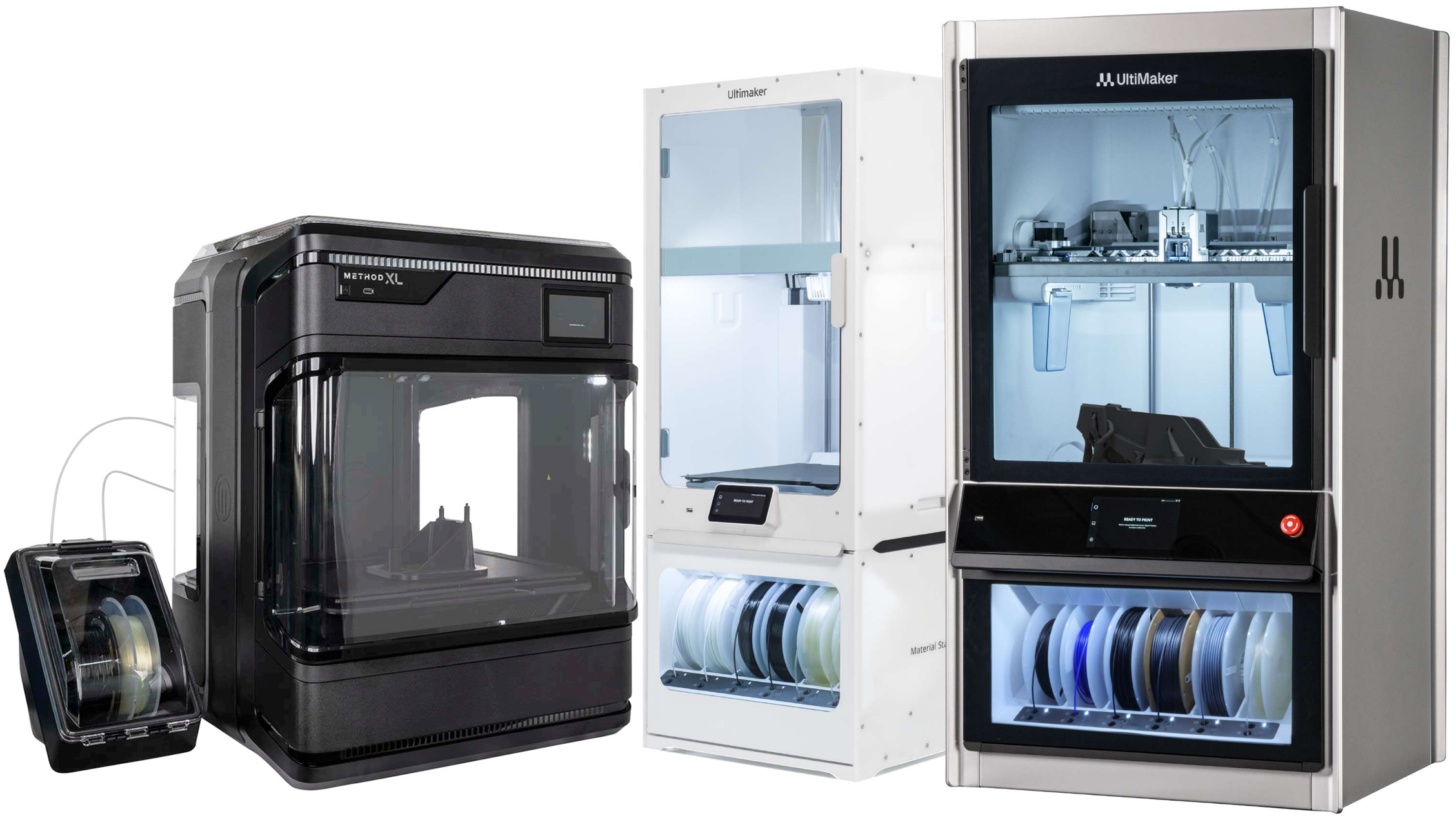
Defense contractors typically have departmental budgets, but may need to plan ahead to get these purchases approved - making a case through ROI. Defense personnel may be able to draw from logistics budgets. The US DOD has a few programs for requisitioning - (1) Program Office Items and the Table of Allowances, (2) Tactical - Ad-HOC, and (3) TLS Program, among others, but every country’s military branches will have their own requisition processes.

6. Should you talk to a sales professional?

Sales professionals directly from the manufacturer or from an authorized reseller can help you narrow down the type(s) of 3D printer(s) you need, materials that will work for your application, efficiencies for your workflow, or even identify if 3D printing will be a good solution for your needs. They usually work on teams with applications engineers who can draw from a pool of experience and knowledge based on customers both public and private.

Battle Tested 3D Printers from the Factory to the Frontlines

Learn how UltiMaker 3D printers can bridge your logistics gaps.



Method XL >

S7 Pro Bundle >

Factor 4 >

What does our unique platform include?

Field-deployable 3D printers

Print with strong and rugged materials

Secure software for easy direct printing

Global access to expert support and learning

Learn more at ultimaker.com

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