UltiMaker white paper

Rapid readiness: How 3D printing empowers Military & Defense operations

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

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Introduction

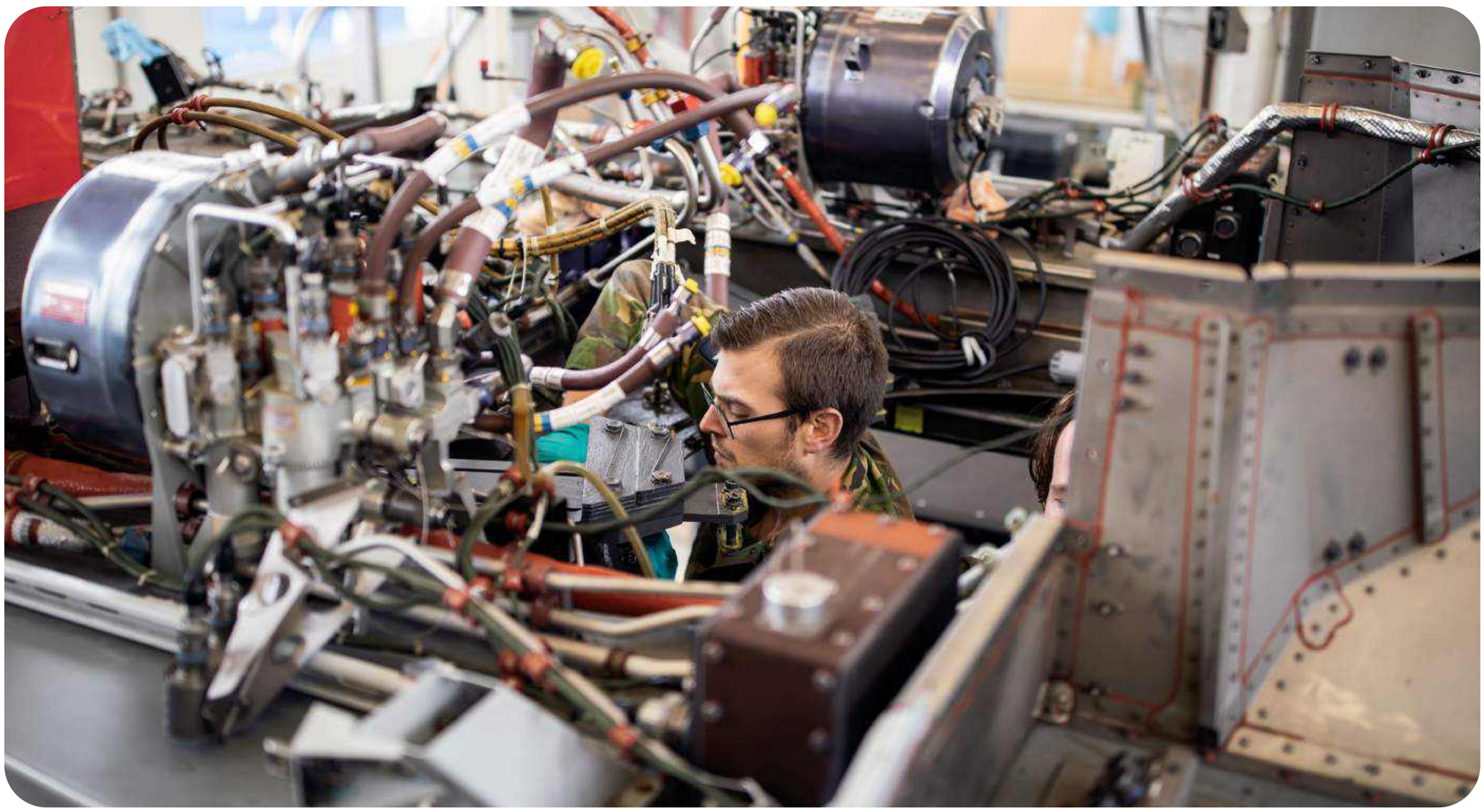
Modern military operational challenges

Today’s global militaries are undergoing a significant transformation, shifting from reliance on long supply chains and external manufacturing to prioritizing shorter, more reliable production capabilities closer to the point of need.

Global events, such as the war in Ukraine and the COVID-19 pandemic, have underscored the critical importance of a secure and resilient supply chain as a cornerstone for operational success on the battlefield.

3D printing is rapidly gaining ground in the Defense sector for its ability to deliver fast, cost-effective, and customizable manufacturing – right where it’s needed, whether in a workshop or on the front lines. This technology helps military organizations simplify logistics, accelerate production, and enhance operational readiness.

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



The Royal Netherlands Air Force

Part 1

Manufacturing jigs and fixtures for Defense supply chain

The US Defense industrial base spans private facilities of all sizes – from major contractors to small businesses – along with shipyards, factories, and a skilled workforce. It's built for readiness and adaptability, supporting national security and driving technological advancement.

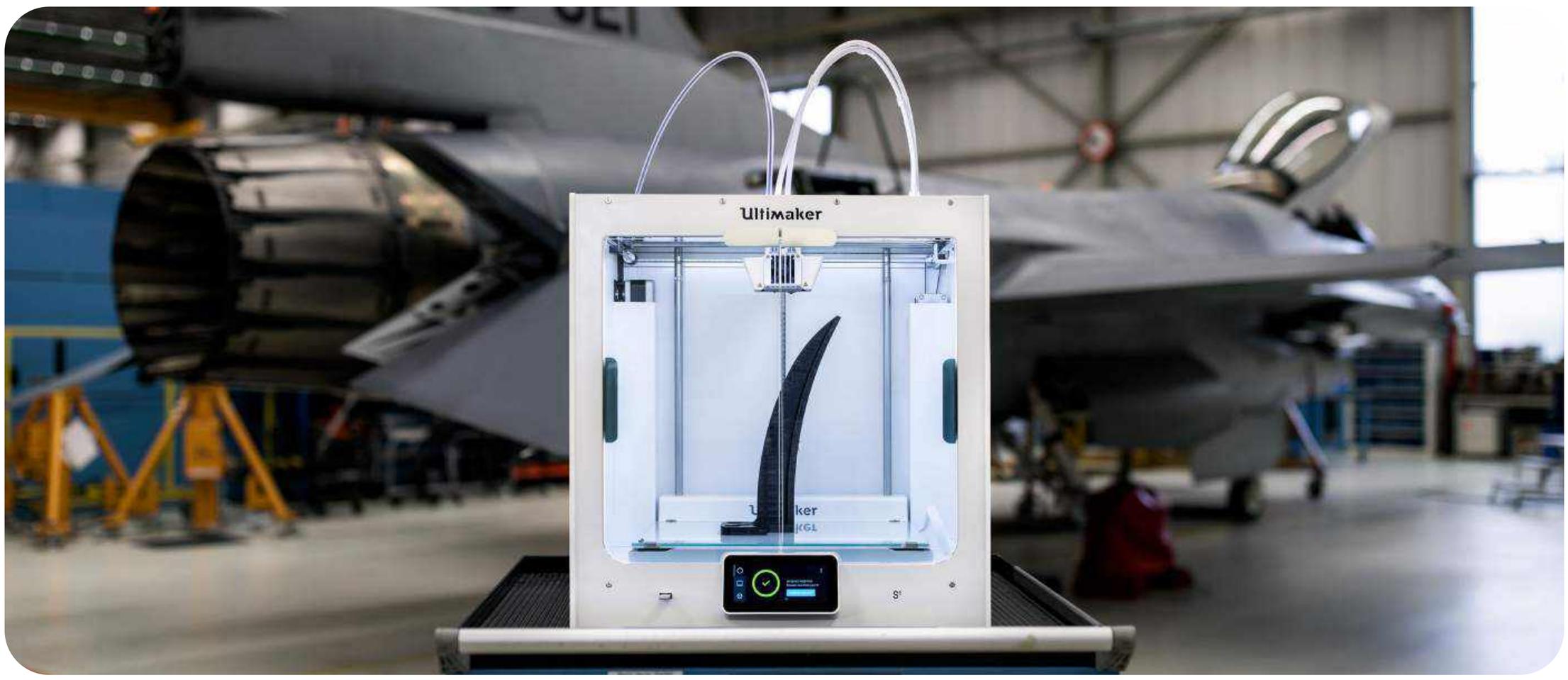
While the range of goods produced is broad, from uniforms to armored vehicles and aircraft – 3D printing offers a flexible way to enhance manufacturing efficiency. With this technology, production no longer needs to happen exclusively in military facilities; it can be deployed in the field or remote locations. From ergonomic tools and inspection gauges to custom jigs and fixtures, 3D printers enable on-demand design, production, and replacement of essential parts and tools.

3D printed tools for Defense

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.

In the Defense sector, military and logistical operators and engineers generally understand the value of customized 3D printed tools, jigs, and fixtures. They allow for increased speed and efficiency by moving the production to on-demand instead of relying on third-party suppliers.

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.



Defense engineers use 3D printers like the for producing custom jigs, fixtures, and tools that can drastically reduce production risk.

Why 3D print tools?

3D printed tools give Defense organizations the flexibility to produce tools in a variety of materials depending on the requirements. With on-demand printing, teams always have tools and spare parts at hand.

Easy to deploy and operate in the field

3D printers have significantly reduced the logistical and operational barriers to producing mission-critical parts. Compact, rugged, and user-friendly, today's desktop 3D printers can be deployed directly in forward operating bases, maintenance units, or mobile workshops.

Unlike CNC machines, they require minimal training to operate and do not rely on specialized infrastructure such as industrial ventilation or dust collection. This makes them ideal for Defense personnel who need rapid, on-demand part production in diverse and often harsh environments.

Compared to traditional manufacturing tools like CNC machines, 3D printers are easier to operate and can be deployed closer to the point of need.

Live process optimization

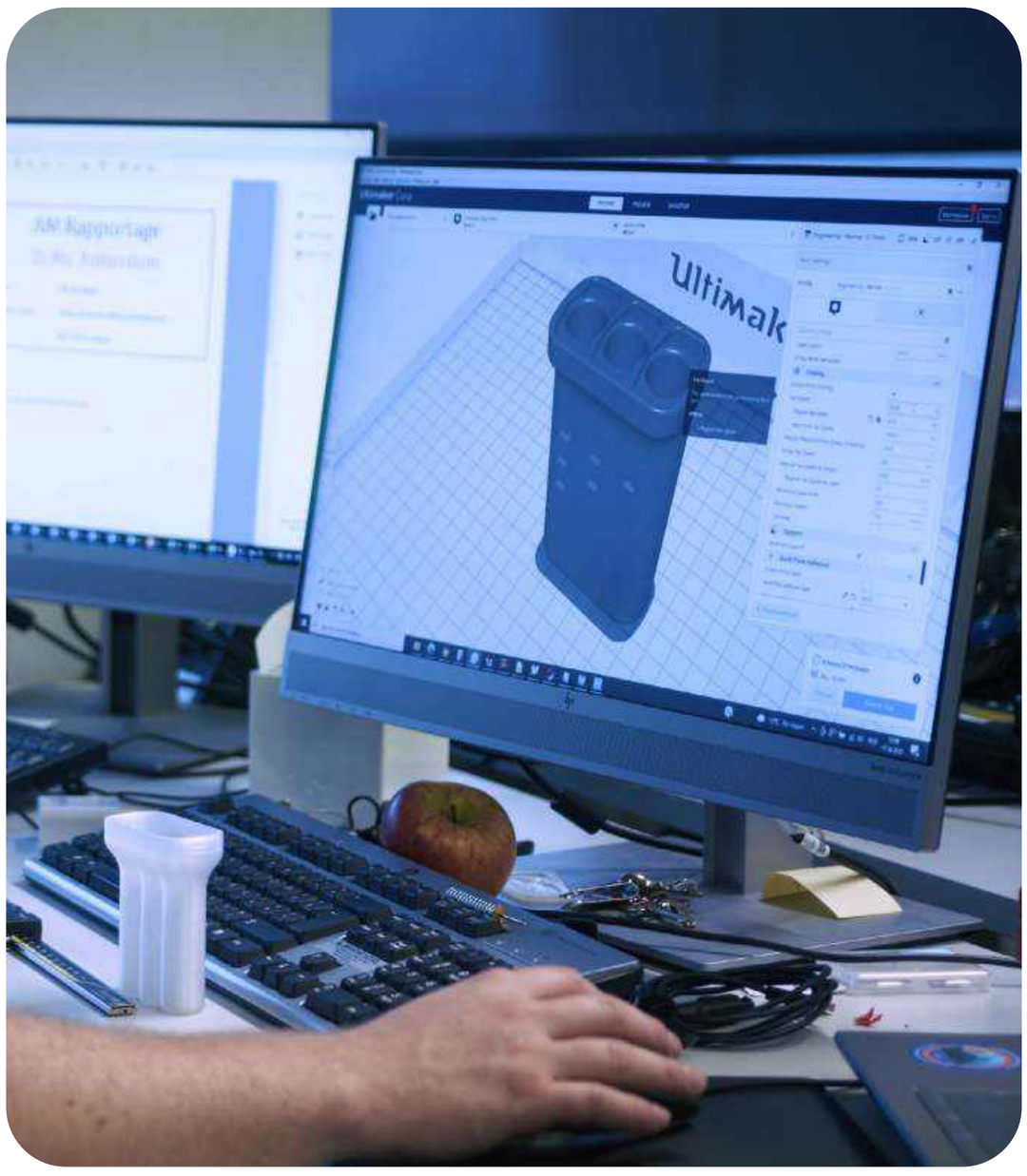
On-demand 3D printing enables rapid iteration and optimization of tools, components, and support equipment. For instance, if personnel in the field report that a particular tool or fixture is difficult to handle or needs ergonomic improvements, adjustments can be made immediately.

With a simple update to the CAD file, the modified version can be printed and deployed, often within the same day. This flexibility is especially valuable in Defense operations, where quick adaptation to evolving mission requirements, equipment upgrades, or new vehicle configurations is essential for maintaining operational effectiveness.

CAD files can be easily modified and quickly 3D printed directly on Navy vessels, enabling fast validation and verification on board.

On-demand replacements

Maintaining a digital inventory allows operators and military engineers to access an extensive library of tools and spare parts without the need for physical storage. For example, a naval vessel can carry a few 3D printers instead of dedicating space to a stockpile of replacement parts that may never be used. This approach significantly reduces onboard weight and storage requirements while ensuring immediate access to any tool or part as needed.



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 advan ced 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.

Due to maintenance, upkeep, or NATO deployment rotations, most vessels belonging to the Royal Netherlands Navy are not actively used. Similar to the other forces around the globe, there is a push to improve preventative maintenance in the field to reduce downtime by leveraging modern technologies, for example,

Royal Netherlands Air Force

Real-life case study

How The Royal Netherlands Air Force speeds up maintenance with 3D printed tools

The Royal Netherlands Air Force is modernizing how it maintains its aircraft by embracing 3D printing. With a diverse fleet of helicopters, jets, and cargo planes, custom-made tools are essential for efficient repairs. UltiMaker 3D printers now play a key role in creating those tools on demand.

The problem

Maintaining aircraft with complex and often one-of-a-kind components poses major challenges. Off-the-shelf tools don't always fit, and ordering custom parts is costly and slow – delays that can impact readiness and operations. For instance, even simple parts like protective caps for jet engines can take weeks to arrive and cost more than they should.

Additionally, maintenance tasks often require highly specialized fixtures or adapters, particularly for helicopters and jets. Traditional methods like CNC machining are time-consuming and expensive for prototyping, and outsourcing isn't always practical. These bottlenecks slow down maintenance and increase operational costs.

The solution

To overcome these obstacles, the Royal Netherlands Air Force has adopted Ultimaker 3D printers across its operations – starting with the MakAIRsJop workshop at the Woensdrecht Air Base. Here, engineers and even non-technical personnel receive basic 3D printing training and quickly begin developing custom tools to speed up maintenance tasks. In just a few hours, they can produce fit-for-purpose parts, significantly reducing downtime and costs.

The team uses 3D printing to create everything from simple engine caps to specialized adjustment tools for helicopters. They also prototype and test parts before metal machining, ensuring better accuracy and fewer errors. With the addition of the Ultimaker S5, the Air Force has expanded its capabilities to larger parts and advanced materials – empowering maintenance teams to innovate, iterate, and take control of their own solutions, all from within their base.

Rotinor turbine wrench
Not only does this not damage the transportation system, it also visually tracks abrasion: When the white walls become worn, the black material begins to show through, making it clear when the wrench needs to be replaced.

	External suppliers	UltiMaker 3D printers
Material	Steel	PA CF10 Igus® iglidur® i150
Time	12 weeks	13 hours
Cost	€ 1,100	€ 24 (98% savings)

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 the 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.

On-demand tools for successful maintenance

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.

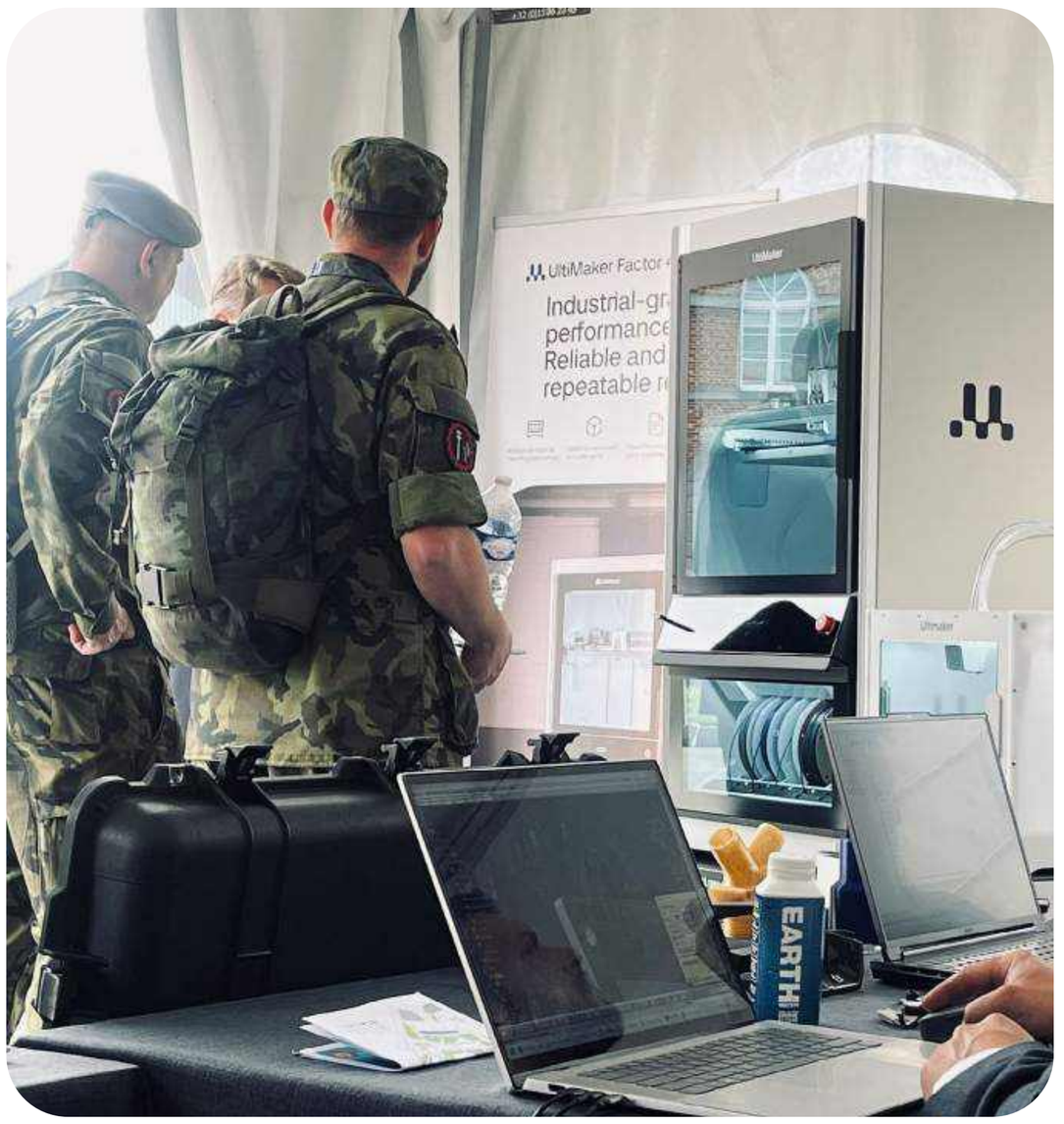
This is where the versatility of 3D printing comes in. Digital catalogs of tools can be made available to print on-demand, so if the tool you need is constantly being used by another tech, just print another one. In the case that a mechanic needs a specific fixture or tool that they don't have, they can even step into CAD with the specs and design and print that tool in the span of 24 hours.

The Royal 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.

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

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.



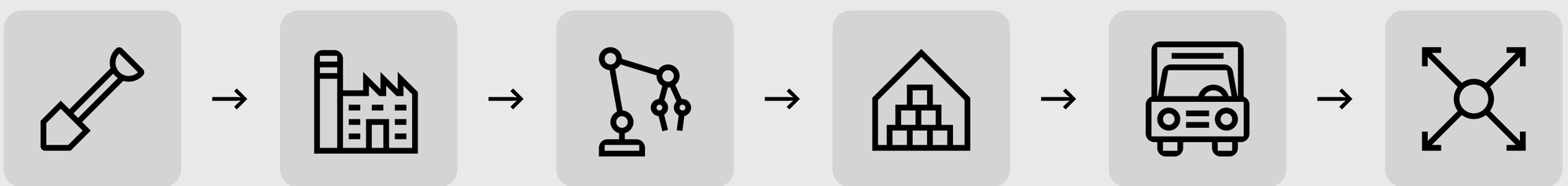
Part 3

Supplementing the supply chain with 3D printers

What is the traditional Defense resupply chain?

Traditional manufacturing

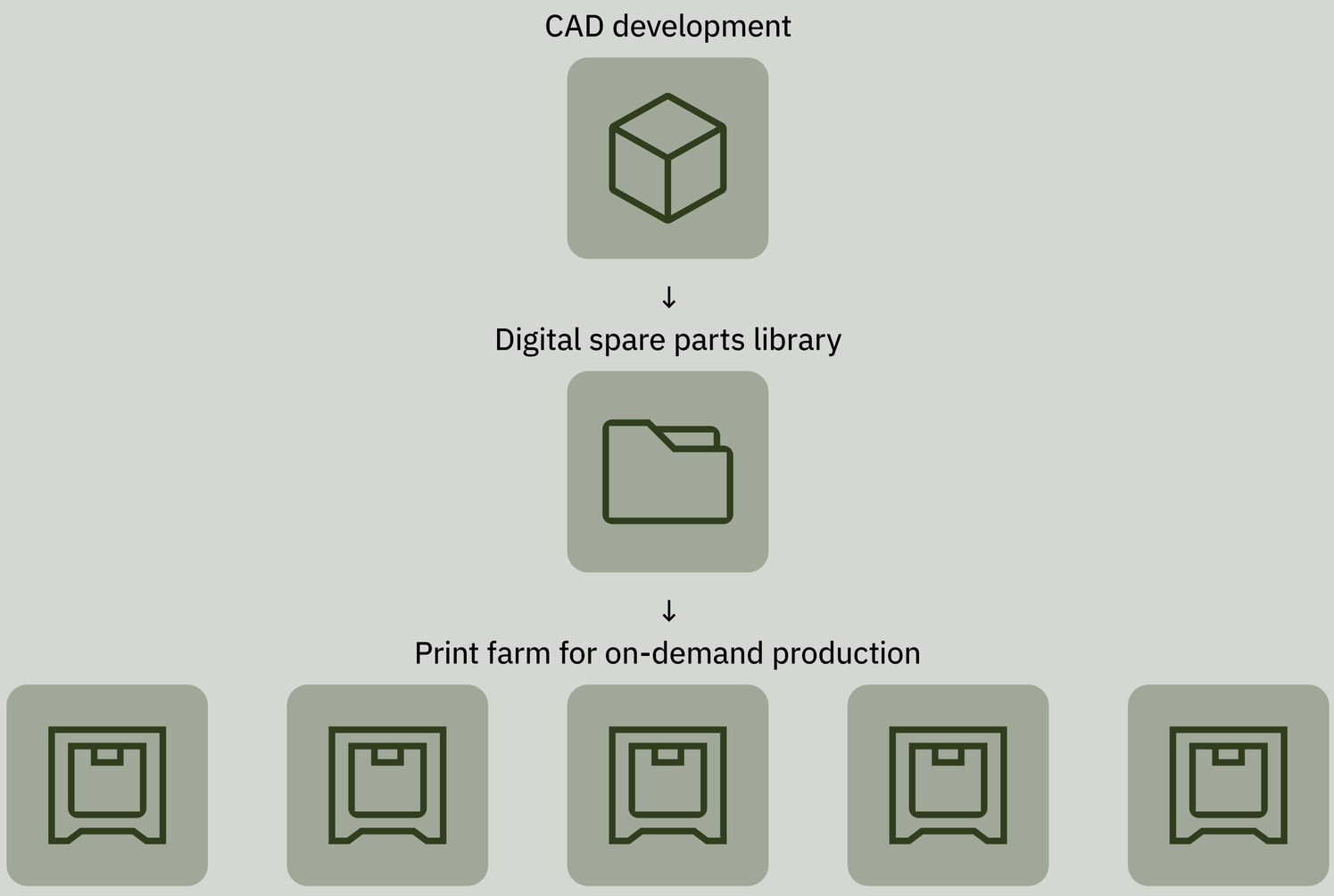
Historically, militaries got their supplies in three ways – (1) in the field, (2) carried with them, or (3) shipping them in from the rear. In today's modern militaries, supply chains focus on carrying and shipping supplies utilizing large convoys, cargo aircraft, and even tactical pack robots.



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 an 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 and 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. Improvisation in the field 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.

Real-life case study

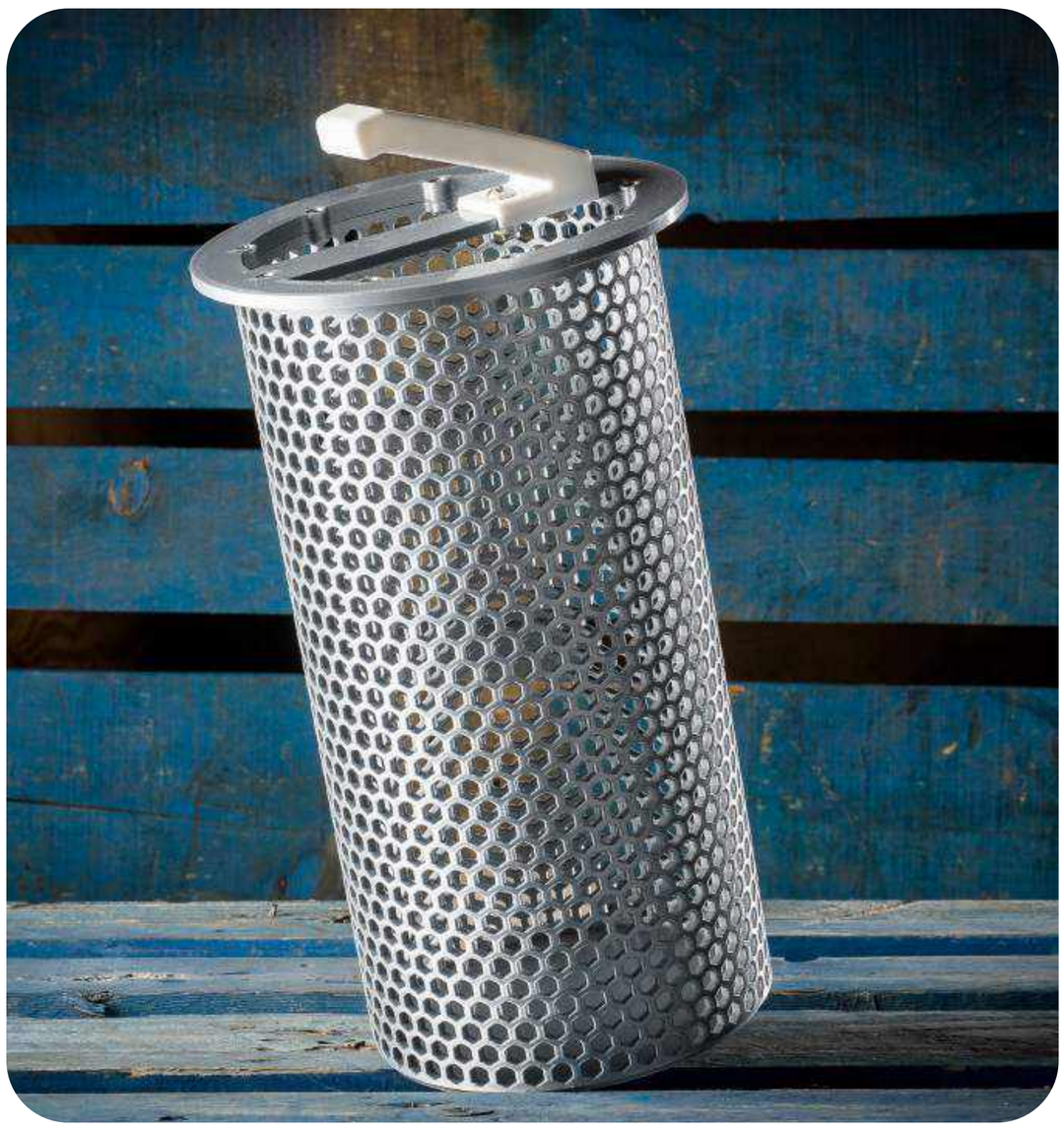
How The Royal Netherlands Navy solves spare parts logistics with onboard on-demand printing

The Royal Netherlands Navy combines centuries of maritime tradition with cutting-edge innovation. As a global force operating across oceans, they face constant challenges in maintaining their fleet. To stay mission-ready at all times, they've turned to advanced technologies like 3D printing.

The problem

Maintaining a global fleet of ships and submarines presents a complex logistical challenge. Spare parts are often needed at remote locations, but transporting them – especially by air – is expensive, time-consuming, and sometimes not feasible. Stockpiling spares on board adds unnecessary weight, consumes valuable storage space, and drives up costs.

Some essential components become unavailable when suppliers halt production. This creates operational risks, especially when mission-critical parts fail or need replacement during extended deployments far from supply lines.



The solution

To solve these challenges, the Royal Netherlands Navy has deployed UltiMaker 3D printers across its fleet. These printers, combined with a secure digital catalog of pre-approved parts, allow crew members to print spare components on-demand, directly on board. This reduces reliance on external logistics and ensures rapid availability of mission-critical parts.

Using UltiMaker's Cura and Digital Factory software, the Navy can manage production securely and efficiently, even with large distributed teams. A wide selection of materials, including PETG and carbon fiber composites, enables the printing of durable, high-performance parts tailored to extreme maritime conditions – like a water filter resistant to saltwater or a lightweight antenna bracket for landing boats.

Navy cold water filter

What began as a temporary 3D printed replacement has now become the Navy's new standard part. Made from PLA and TPU and is printable in 1 day using their onboard UltiMakers.

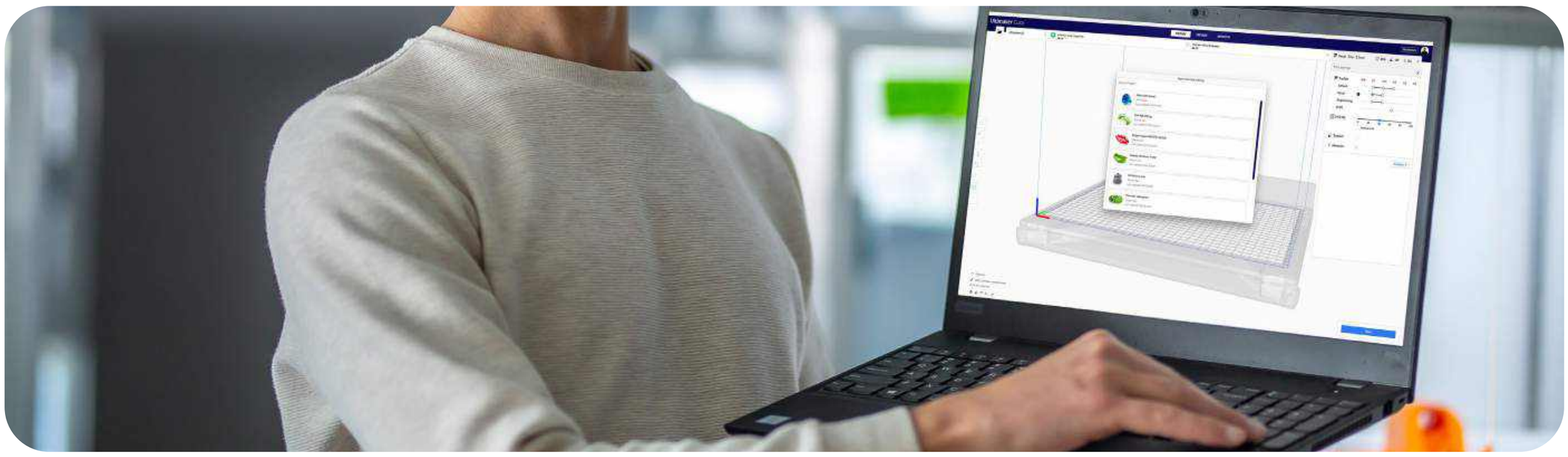
	External suppliers	UltiMaker 3D printers
Material	Inconel	UltiMaker PLA UltiMaker TPU 95A
Time	2 months	1 day
Cost	€ 1,600	€ 30 (98% savings)

Part 4

Locked-in security: End-to-end 3D printing workflows for Defense readiness

In the defense and military fields, secure 3D printing software is critical to protecting sensitive data, design files, and workflows. Without proper safeguards, vulnerabilities can lead to unauthorized access or compromised parts. While having secure hardware is important, with secure software, defense organizations can ensure data confidentiality, control user access, prevent tampering, and maintain the integrity of mission-critical production workflows.

Key features to consider when choosing a 3D printing ecosystem for Defense



1. Design file protection

The 3D printing process begins with the creation and handling of highly sensitive design files. In defense applications, protecting these files from unauthorized access or leaks is crucial. UltiMaker addresses this by aligning its security practices with international standards.

Key features

- Compliant with ISO/IEC 27011
- Compliant with GDPR
- Frequent software updates

2. Secure slicing and preparation

Before a part is printed, it must be sliced using software such as Cura Enterprise. These tools apply strict access controls during slicing to avoid unauthorized file manipulation.

Key features

- Role-based access control (PoLP)
- Enterprise-level management controls
- Long-term support for secure deployment

3. Encrypted data transmission

Print files are often sent over networks to printers, making encryption essential. UltiMaker secures this step with modern encryption protocols that protect data in transit.

Key features

- TLS 1.3 encryption between Cura, Digital Factory, and UltiMaker 3D printers
- Firewall authentication tools available

4. Access control and user management

To prevent internal threats or operational errors, access to 3D printing systems must be tightly controlled. UltiMaker's tools let defense teams manage who can view, modify, or execute jobs.

Key features

- User roles (admin, member, guest) across Digital Factory
- Secure cloud platform built on Google Cloud infrastructure
- Enterprise-level privacy controls

5. Verified printing and firmware integrity

Maintaining the reliability of printed parts means preventing tampering at the firmware level. UltiMaker printers run signed firmware updates that are rigorously verified.

Key features

- Firmware integrity checks for unauthorized updates
- Offline printing capabilities support secure, air-gapped environments

Why hardware security matters in Defense 3D printing

Hardware security plays a critical role in ensuring the reliability and safety of 3D printing in defense applications. Compromised printers can serve as access points into broader networks or become tools for producing altered or defective parts – posing serious risks to mission success and operational safety. In critical environments, it's essential that 3D printers are built with secure firmware, integrity verification, and the ability to operate independently from insecure networks.

UltiMaker's hardware is designed and manufactured in the Netherlands, ensuring full compliance with the EU's strict regulations for both production and data handling. UltiMaker is ISO 9001 and 14001 certified. This means that UltiMaker is recognized for consistency and repeatability at the highest level, and showing a commitment to sustainable manufacturing practices – ensuring that security measures are integrated without compromising environmental responsibility.

With UltiMaker, you have the option to choose where your data is hosted. Choose between the US or EU for peace of mind.

By combining reliable hardware with verified firmware updates and offline capabilities, UltiMaker provides defense users with the physical and digital safeguards needed to print confidently, even in sensitive or classified contexts.

bsi ISO 9001 Quality Management Systems CERTIFIED
ISO 14001 Environmental Management

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

GSA

Part 5

FAQ

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 is the best material for Defense applications?
   Depending on the application and environment, different materials may be more suitable. For instance, TPU is ideal for jigs and fixtures that require flexibility, while carbon fiber composites like PET CF are better suited for harsher environments.

3. What should you look for in a 3D printer for Defense?
   That 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. How can I get more information about 3D printing for Defense?
   If you want to learn more about how your military department can utilize 3D printing, talk to one of our experts at UltiMaker.

Secure and deployable 3D printers from the factory to the frontlines

Discover how the UltiMaker ecosystem can bridge your logistic gaps and deliver the quality results you need.

S6 →

S8 Pro Bundle →

Factor 4 →

Why professionals choose UltiMaker

Engineers and designers need to move fast – without sacrificing quality. But clunky tools and slow processes often stand in the way of great ideas. That's why UltiMaker offers a complete 3D printing solution – printers, software, and materials that just work. With the fastest printers on the market and easy-to-use software like Cura, we help professionals turn ideas into parts – every single day. Since 2011, our global team has helped thousands of innovators shift to local, digital manufacturing.

Ready to print smarter? Discover the UltiMaker ecosystem.

Choose the right 3D printing ecosystem for your business needs

Discover how the UltiMaker ecosystem can bridge your logistic gaps and deliver the quality results you need.

3D printers fit for every application

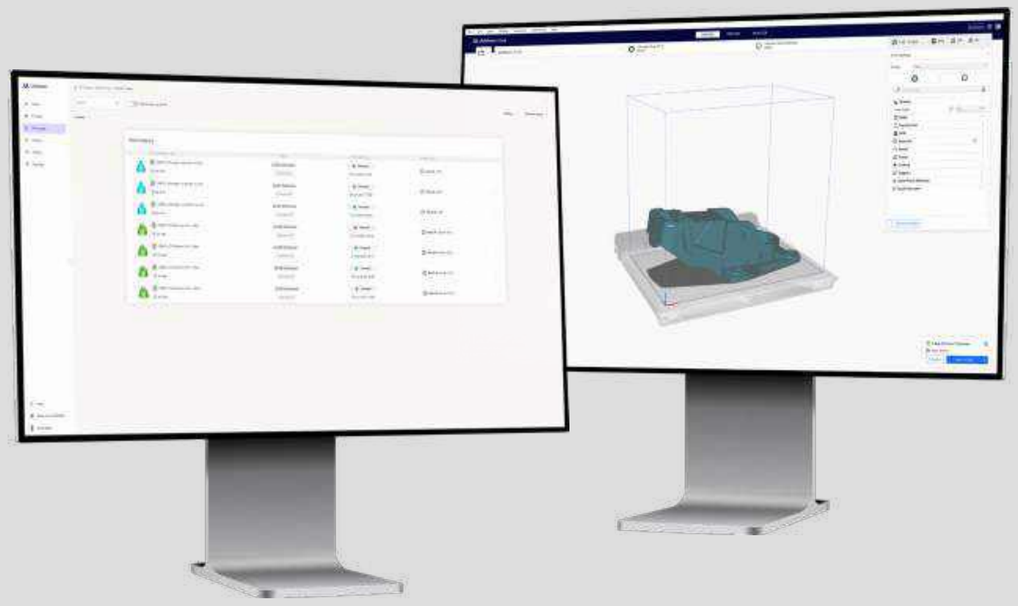
A comprehensive lineup of professional 3D printers designed to meet the needs of everything from design studios to factory floors. All our machines share the same UltiMaker DNA: reliability, quality and ease of use, while excelling in different applications.

One click print with over 240 materials

The widest range of materials on the market, enabling innovative and complex applications. Our high-performance materials are tested for reliability and accuracy, while the broad selection of certified options expands possibilities for various applications.

Secure cloud software for easy remote printing

A secure and streamlined platform for preparing, organizing and monitoring your 3D printing operations. 3D printing software trusted by millions of users. Fine-tune your 3D model with 400+ settings for the best slicing and printing results.



Support dedicated to your success

The expertise of hundreds of people with over 10 years of experience ready to help you. Our dedicated customer support and application engineer teams multiply the value of UltiMaker products with their knowledge.