The Printer is Mightier than the Sword

3-D printing set to become the ultimate weapon in defense/aerospace

credit - Stefano Tinti _ Shutterstock

Imagine instantly constructing a hard-to-find replacement part for an old aircraft—and doing it at lower cost and higher quality than the original component. Imagine building a complete unmanned aerial vehicle (UAV) from scratch in a remote theater of operations, simply using a CAD file sent from headquarters over the Internet. Imagine leapfrogging rival military powers by seamlessly transforming an exciting concept into a revolutionary weapon, all in a matter of days or even hours.

This is the promise—and the reality—of 3-D printing, a technology that stands to transform the commercial and military aerospace sectors, according to IHS Technology.

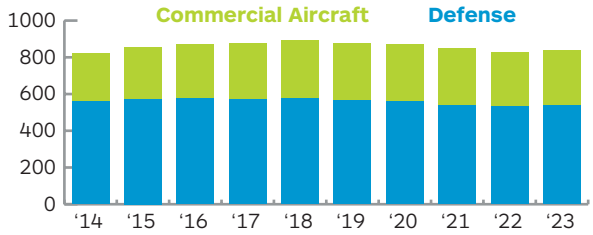
Militaries and contractors that harness the power of 3-D printing are opening up new horizons of innovation and problem solving that deliver decisive competitive advantages. Those that fail to capitalize on this revolution in design, manufacturing, logistics and invention risk losing in what could be the next major technology and arms race.

Beyond the strategic implications of 3-D printing in defense and aerospace, the financial impacts are massive. The technology has wide applicability across the commercial aerospace and defense equipment sectors, which are expected to expand to a combined $891.5 billion worldwide in 2018, up from $821.6 billion this year, according to IHS Aerospace, Defense and Security (AD&S).

The next Industrial Revolution—now in 3-D

The technology of 3-D printing is expected to have a revolutionary impact on the entire manufacturing sector during the next decade.

Worldwide Spending on Defense and Commercial Aerospace Equipment (in Billions of U.S. Dollars)



Source: IHS

Also called additive manufacturing, 3-D printing adds materials to create products, rather than subtracting them as in traditional industrial processes such as machine tooling. The additive approach delivers significant potential cost savings. Furthermore, with 3-D printing, products are designed using sophisticated computer software platforms and are then printed layer by layer, allowing for complex features that are not possible with traditional manufacturing techniques.

Although the technology has existed since the 1980s, 3-D Printing has gone mainstream during the last three years, with widespread usage in consumer, medical and industrial applications. Products made with 3-D printers include shoes, toys, tools, electronics and artificial body parts. In one high-profile example, more than 1 million consumers have used Invisalign dental aligners, which are custom-made by 3-D printers to fit individual patients' mouths.

Stratasys, the market leader in terms of the installed base of 3-D printers, estimates the market opportunity for the technology at more than $35 billion. Although IHS is still formulating its 3-D printing market size estimate, we regard Stratasys' estimate as conservative. To put it into perspective, if the technology can capture even 1 percent of the more than $10 trillion global manufacturing sector, the market size will be measured in hundreds of billions of dollars.

The embargo eliminator

A recent event illustrated how 3-D printing can reshape supply chains in the defense/aerospace industry by overcoming procurement obstacles.

Amid rising tensions in Ukraine, the Russian government placed an embargo on its RD-180 rocket engines for use by the U.S. military. The United States is dependent on the RD-180 for its launch vehicles, including those that serve the International Space Station (ISS).

In the past, such a major supply disruption could have been a showstopper, potentially halting operations at the ISS.

However, U.S. company SpaceX now has emerged as a viable alternative to the Russian supplier, with its Dragon V2 launch vehicle and its SuperDraco engine. In order to meet NASA's demanding cost and time requirements, SpaceX employs 3-D printing technology to manufacture a key component in the SuperDraco. The SuperDraco's combustion chamber is created by a process called direct metal laser sintering that works with an extremely strong material known as Inconel, suitable for the high temperatures and pressures generated by rockets.

Moving into the next dimension

As remarkable as this development is, it only hints at the full potential of 3-D printing in aerospace and defense. With the complexity and technologically groundbreaking nature of defense and aerospace systems, 3-D printing is a natural fit for these areas.

Recognizing the vast potential of 3-D printing, government agencies and contractors now are rapidly mobilizing their resources to get ahead of the curve. With much of this work done in secret, it's difficult to estimate the size of the market for 3-D printing in the aerospace and defense area.

However, IHS believes the United States currently leads in this area, largely because of early investment by the federal government. President Obama in 2012 called for the creation of the National Network for Manufacturing Innovation (NNMI), an initiative designed to accelerate the development of advanced manufacturing. NNMI included the National Additive Manufacturing Innovation Institute (NAMII)—later renamed "America Makes"—which focuses on additive manufacturing.

Four benefits of 3-D printing

The benefits of 3-D printing add up to improved design, speed, cost and personalization.

On the design front, 3-D printing increases innovation, allowing the creation of new structures and shapes that otherwise would be impossible to make with conventional manufacturing techniques. Additive manufacturing also improves the design process and allows new combinations of materials.

In terms of speed, 3-D printing dramatically cuts the amount of time it takes to move from design to prototype, with samples potentially generated in a matter of hours, instead of weeks as with traditional methods.

As for cost, 3-D printing reduces development expenses and waste by using fewer materials.

Finally, 3-D printing enables customization and personalization of products, without incurring more cost.

These improvements result in other benefits, such as producing products that are simpler, lower in weight and of more durability than components made using traditional means.

Take the LEAP

General Electric's Leading Edge Aviation Propulsion (LEAP) jet engine for commercial aircraft exemplifies many of these benefits.

The fuel-injection nozzles in the LEAP are made using 3-D printing technology. Each LEAP engine will have 19 of these fuel-injection nozzles, and GE plans to produce 100,000 units by 2020.

The 3-D printed nozzles are 25 percent lighter than nozzles made using conventional manufacturing. They also are simpler, consisting of a single part, down from 18. The new nozzles have enhanced designs, with more intricate cooling pathways and support ligaments that will result in five times higher durability vs. conventional production.

Breaking the supply chain

As the Russian embargo showed, 3-D printing can help resolve supply chain disruptions. Both the defense and commercial aerospace industries face the less dramatic but equally vexing problem of obtaining obsolete parts for old systems, a supply-chain challenge that can derail an entire aircraft or weapon.

Take, for instance, the issue of finding replacement parts for the B-52 bomber, which made its first flight in 1952, and is set to end its service in 2040, nearly 90 years later. Finding parts for such an old system represents a massive and growing challenge—one that can be addressed with 3-D printing.

In an example of how 3-D printing can address such challenges, Airbus has developed a replacement hinge for its A310 narrow-body aircraft, which first entered service in 1983. The new hinge not only serves as a substitute for an older part, but it also is thinner, lighter, stronger and uses less raw material than the part it replaces.

In the near future, 3-D printing could play a major role in filling the obsolete parts gap.

Bomb, bullets, bayonets and beyond

The potential of 3-D printing in military and aerospace was evoked in a recent announcement from China.

China's media—citing the Chinese military—reported in late 2013 the ongoing development of the new J-25 Ghost Bird stealthy fighter jet, claiming that the incorporation of 3-D printing in production will mean the plane will have superior specifications than the U.S. F-22 Raptor, now largely regarded as the world's most advanced combat aircraft in service. The reporting about both the existence of the aircraft and the sophistication of its capabilities is apocryphal. However, it is notable for its framing of 3D printing as an accelerator of disruptive innovation that will allow

fast prototyping and production of components—and even complete weapons— and enable nations to overturn technological advantages very rapidly.

The UAV is in the mail

A more demonstrable example of the technology's potential comes in the form of the 3-D printed UAV. Researchers at Sheffield University in the United Kingdom this year said they printed a complete working UAV in less than one day.

The researchers said the plastic UAV could lead to the printing of disposable 3-D unmanned aircraft that are used for one-way flights. Furthermore, such UAVs could be produced in the same regions where they will be used, speeding deployment and eliminating the logistical challenges involved in shipping the vehicles to far-away locations. In the near future, the latest design for a UAV could be e-mailed from headquarters to a regional hot-spot, where the vehicle would be printed and sent out onto the battlefield the next day.

The opportunity in UAVs is massive, with the global market expanding to $10.9 billion in 2023, up from $6.7 billion in 2014, according to IHS AD&S. Additive printing technology could account for a significant portion of this market during the next few years.

However, this approach could be used for a broad range of systems beyond UAVs. The U.S. military now is developing its own 3-D printers for deployment on the front line, which will enable soldiers to quickly and cheaply produce spare parts for weapons and equipment. Such a capability could change the way militaries mobilize and equip, allowing them to produce weapons right at their theater of operations that are customized for the specific needs of the battlefield.

The perils of printing

While 3-D printing holds great promise, it also carries significant risks and challenges. These include intellectual property concerns, environmental impact, prohibitive costs for raw materials, speed and size limitations, and required certifications for medical/aerospace usage.

However, IHS expects most of these issues to be resolved over time as more companies enter the 3-D printing market, and as companies and militaries gain experience with the technology.

Printing the future

Although the market for 3-D printing in aerospace/defense is still in its infancy, the technology has already had a major impact. In the future, 3-D printing could turn out to have a transformative impact—on the order of the invention of gunpowder or the advent of military electronics and avionics. For military organizations and contractors, the time is now to invest in 3-D technology and expertise.

Alex Chausovsky is Associate Director & Principal Analyst – Industrial Automation & 3-D Printing at IHS Technology. Regan Chambers is Senior Manager, C4ISR/Systems, for IHS AD&S.

Connect with Alex on LinkedIn:
http://bit.ly/Achausovsky

Connect with Regan on LinkedIn:
http://bit.ly/Rchambers

For more information visit ihs.com/defenseinnovation

6175_0814PB