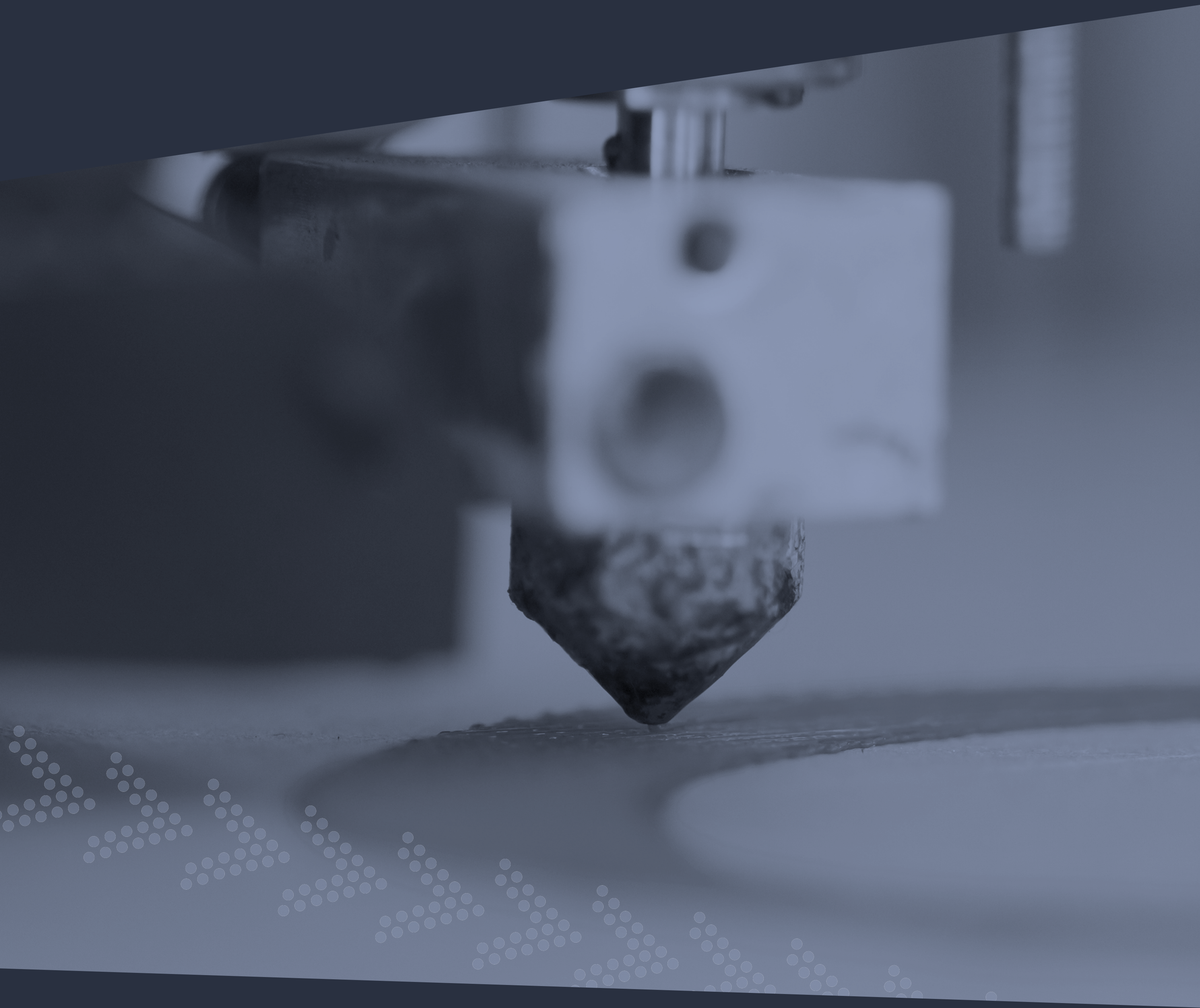
Changing industry norms with Additive Manufacturing



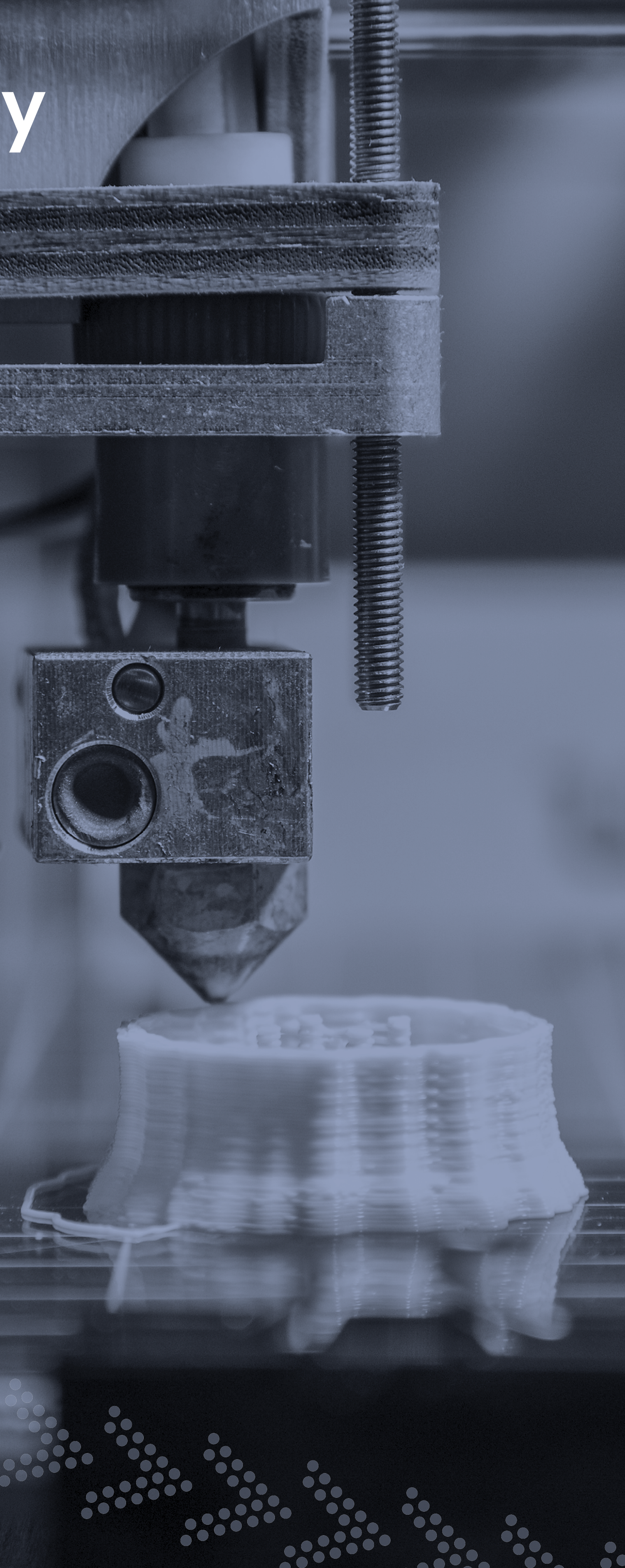
euautomation

You wouldn't be blamed for thinking Additive Manufacturing (AM) was a novel technology that only dates back a few years. In fact, am's roots can be traced back to the 1980s, when engineering physician chuck hull invented the process of stereolithography. This first additive manufacturing technology was used to produce models, prototypes and patterns by curing a photo-reactive resin with a uv laser.

Considering the technology has been around for a while, it's surprising that its primary use hasn't changed. To this day, additive manufacturing is mainly used for prototyping products. In fact, global automotive company Ford is currently using the process to make large selections of its car parts for testing. However, over the past decade we've seen glimpses of just how AM technology will make its mark in the traditional manufacturing industry.

In this industry report, obsolete automation parts supplier EU Automation discusses the changes that additive manufacturing will bring to industry and whether it will ever be able to replace traditional manufacturing techniques.

The technology



The key to understanding additive manufacturing lies in the name. Traditional techniques start off with a block of material and subtract material until the desired part is obtained. Additive manufacturing, on the other hand, uses powerful lasers to melt very thin layers of material together and produce the desired part – it adds material rather than subtracting it.

In 2010, the American Society for Testing and Materials (ASTM) group formulated a set of standards that classify the range of additive manufacturing processes into seven categories; VAT photopolymerisation, material jetting, binder jetting, material extrusion, powder bed fusion, sheet lamination and directed energy deposition.

Categorisations mainly depend on the materials used. For example, in VAT photopolymerisation, liquid photopolymer resin is used to construct the model layer by layer. Because this process uses liquid to form objects, there's no structural support from the materials during the build, so support structures are often used to counteract this.

Material jetting is the most similar method to standard ink jet printing. Material is jetted onto a build platform using a drop on demand approach. The material then solidifies and the model is built.

Two materials are used in the binder jetting process; a powder based material and a binder. The binder acts as an adhesive between powder layers, while the print head deposits alternating layers of binder and powder. With this method, binding is not always suitable for structural parts and, despite the relative speed of printing, the additional process of removing unbound powder can extend the overall process.

During material extrusion, material is drawn through a nozzle where it is heated and is then deposited layer by layer. This technique is commonly used to produce inexpensive and domestic items.

Powder bed fusion is the most common method of additive manufacturing, with techniques such as laser melting, laser sintering and beam melting falling into this category. Powder bed fusion either uses a laser or electron beam to melt and fuse material powder together. This method involves spreading the powder material over previous layers, using either a roller or a blade.

Processes that fall into the sheet lamination category include ultrasonic additive manufacturing (UAM) and laminated object manufacturing (LOM). UAM bounds together sheets or ribbons of metal using ultrasonic welding, while LOM uses paper as an adhesive instead of welding. Because the metal isn't melted, the process can be carried out at a low temperature, bonding materials with little energy.

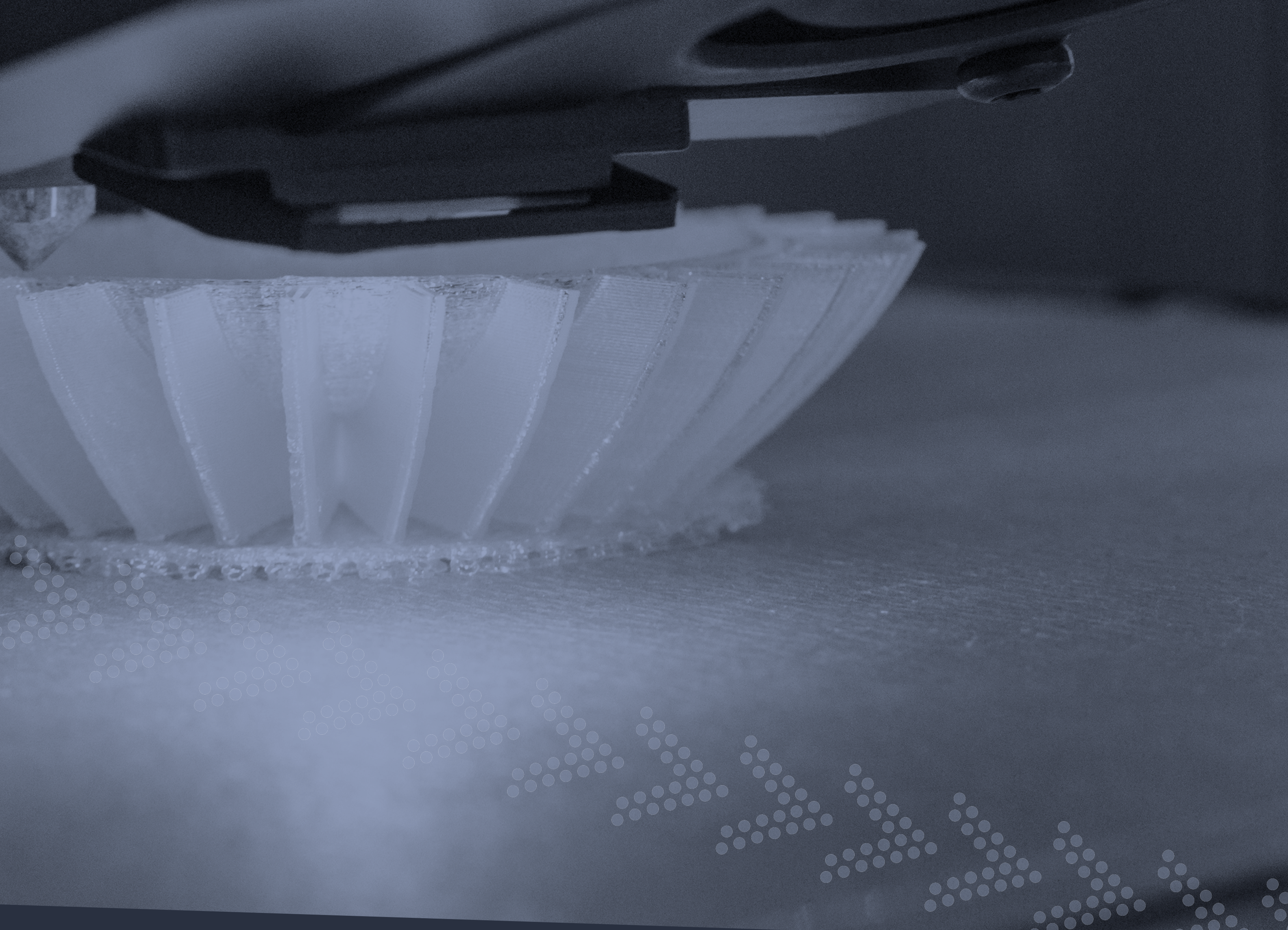
Directed energy deposition is a more complex process, commonly used to add material to existing components. The process is similar to material extrusion, as they both use a nozzle to distribute material. However, in directed energy deposition the nozzle can move in multiple directions rather than being fixed to a specific axis.

Rapid prototyping

Rapid prototyping is used to fabricate a scale model of a physical part or assembly using three-dimensional computer aided design (CAD) data. Construction of the part or assembly is usually done using additive manufacturing technology.

In addition to being a relatively fast and inexpensive way of manufacturing digitally rendered items, rapid prototyping can be used to test the efficiency of a part or product design before it is manufactured in larger quantities. Testing may have more to do with the design or size of a part rather than its strength or durability, as the prototype may not be made of the same material as the final product.

The reasons many manufacturers are choosing to implement rapid prototyping into their production line are mainly centred on cost. Rapid prototyping decreases development time by allowing corrections to a product to be made early in the process. By giving engineering, manufacturing, marketing and purchasing a look at the product early in the design process, mistakes can be corrected and changes can be made while they are still inexpensive.



Medical devices and implants

AM is now being used in a diverse set of industries, including aerospace and defence, automotive and medical devices. While much of the technology's history has been focused on rapid prototyping and tooling, these industries are now looking to use AM to improve standard manufacturing processes.

The medical applications of additive manufacturing are continuously increasing. By relying on medical scanning and imaging technologies, such as CT, MRI and ultrasound for scans, this new approach to healthcare offers more affordable and effective solutions for the medical industry.

Some medical end-user applications have already been manufactured are now in use. These include generic hip, knee and shoulder implants, unique bespoke items such as hearing aids and dental stones, and patterns used in downstream processes to fabricate dental crowns and aligners.

Additively manufactured implants have become increasingly common over the last few years and the market continues to grow. The biocompatible metal powders used in AM allow surgeons to obtain surfaces that generate expected responses from neighbouring cells and tissues. In short, this means additively manufactured parts are less likely to be rejected by the human body once implanted.

Compared to traditional manufacturing of customised implants, which is particularly time consuming and expensive, AM is a flexible process allowing for individual customisation. Personalised products provide superior comfort that leads to a faster recovery. Custom shapes optimise the distribution of stress on bones and provide better adaptability. This eliminates the need for manual handling performed by surgeons in the midst of an operation. Failure risks are reduced, as are surgical time and overall costs.

Parts for aerospace

A good example of the reliability of AM technology is its use in the FAST project, which sees Constellium, STELIA and the CT INGENIERIE team exploring the topological optimisation of aerospace structures with additive manufacturing. The aim of the project is to examine the possibility of using AM to produce large scale aerospace structures and parts, including aeroplane fuselages themselves. Because of the current size, cost, and efficiency constraints of traditional technologies, the partners believe that AM could serve as a cost-effective alternative.

FAST is only in its early stages, but the companies involved hope to apply a holistic approach to additively manufacturing large scale structures. Constellium is the material supplier in the project, with STELIA guiding the design and production process and CT INGENIERIE optimising the design.

For some time now, AM technology has been used in the manufacturing of defence aircrafts. The industry has steadily grown its ability to innovate and produce replacement components more quickly and efficiently, using the latest AM technology. The technology is already being used to streamline product innovation for new aircrafts, while bringing added value benefits by making precision-engineered parts that are lighter and boost fuel efficiency.

The aerospace industry has undertaken some major developments over the last few years, from the plane that's being flown with 1,000 additively manufactured parts, to a huge 3D printed turbine. Using additively manufactured parts in aerospace is a particularly significant step because new lightweight materials can now be used and produced to airline safety standards. Stratasys, whose machines were used to make the parts for the Airbus A350 XWB, said the technology had reduced production time and costs.

The 1,000 parts were printed from Stratasys' ULTEMTM 9085 material, which met the aerospace requirements set by Airbus. At the same time, the components were strong and lightweight due to the fused deposition modelling (FDM) technology used. They also met the flame, smoke, and toxicity regulations needed to be used inside an aircraft.

Automotive parts

In September 2015, it was announced that several parts of the Bloodhound super-sonic racing car, including the titanium nose tip and steering wheel would be manufactured using AM techniques. The shape of the steering wheel is completely unique, contouring precisely to match the hands of the driver. Machining the original scan of the driver's hands is a complex process, but additive manufacturing allows rapid prototyping to finalise the product in four days.

The titanium nose tip will experience huge aerodynamic loads as the car hurtles across its desert racetrack, so it's important that the structure is solid. Manufacturers will use a powerful laser to fuse micron-scale particles together, creating the tip layer by layer.

However, it isn't just automotive and aerospace that AM is making its mark. One of the largest suppliers to the oil and gas sector, GE, is working on introducing the technology to offshore installations, and has said it is set to revolutionise maintenance work in the sector.

Such breakthroughs have the potential to change the mobilisation of components and resupply, allowing users to assess the condition of equipment and additively manufacture a replacement component, making the process of deploying offshore tools much more efficient. GE believes that the offshore printing of small spare parts, such as gaskets, will start within five years, but that larger parts and tools will take longer.

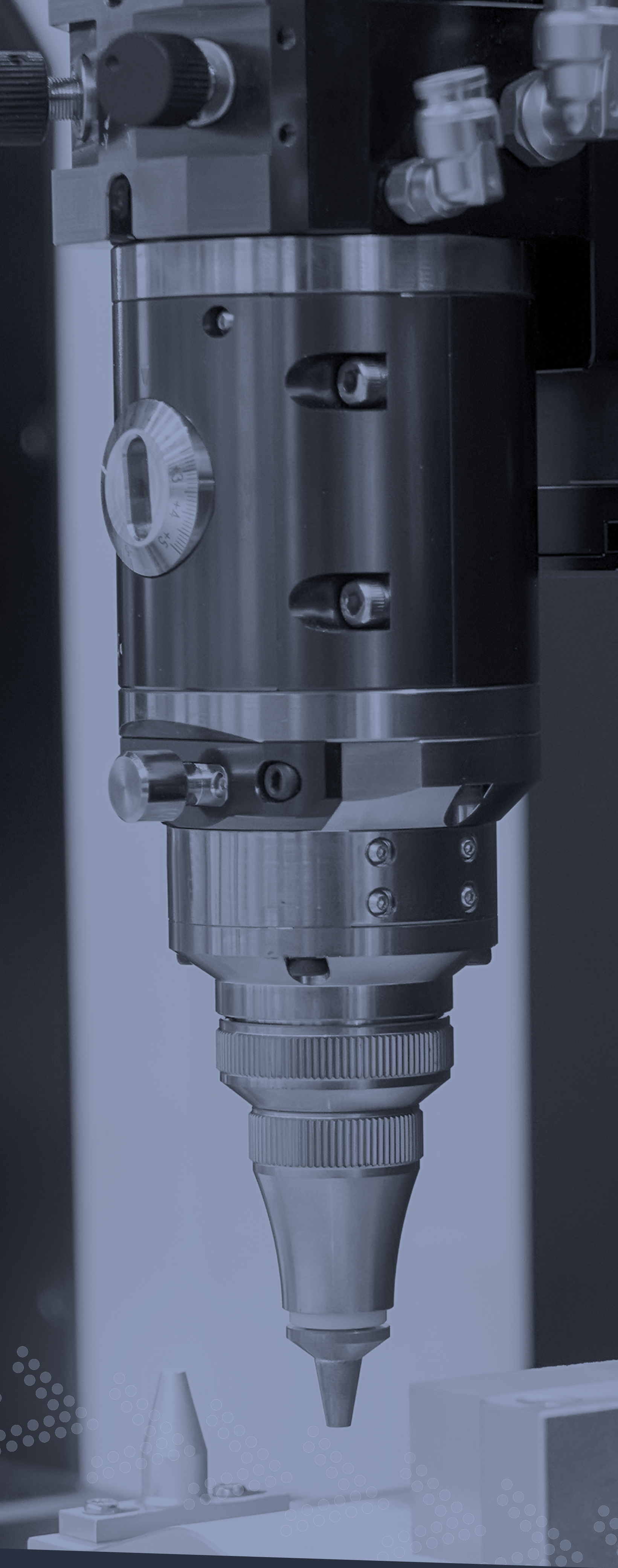
More to learn

In 2013, analysts estimated additive manufacturing's overall market size to be 3.1 billion US dollars, with an annualised growth rate of 35 per cent. The increase in AM's popularity, along with general fascination with the technology, has sparked a demand for education and training for current and future engineers and designers.

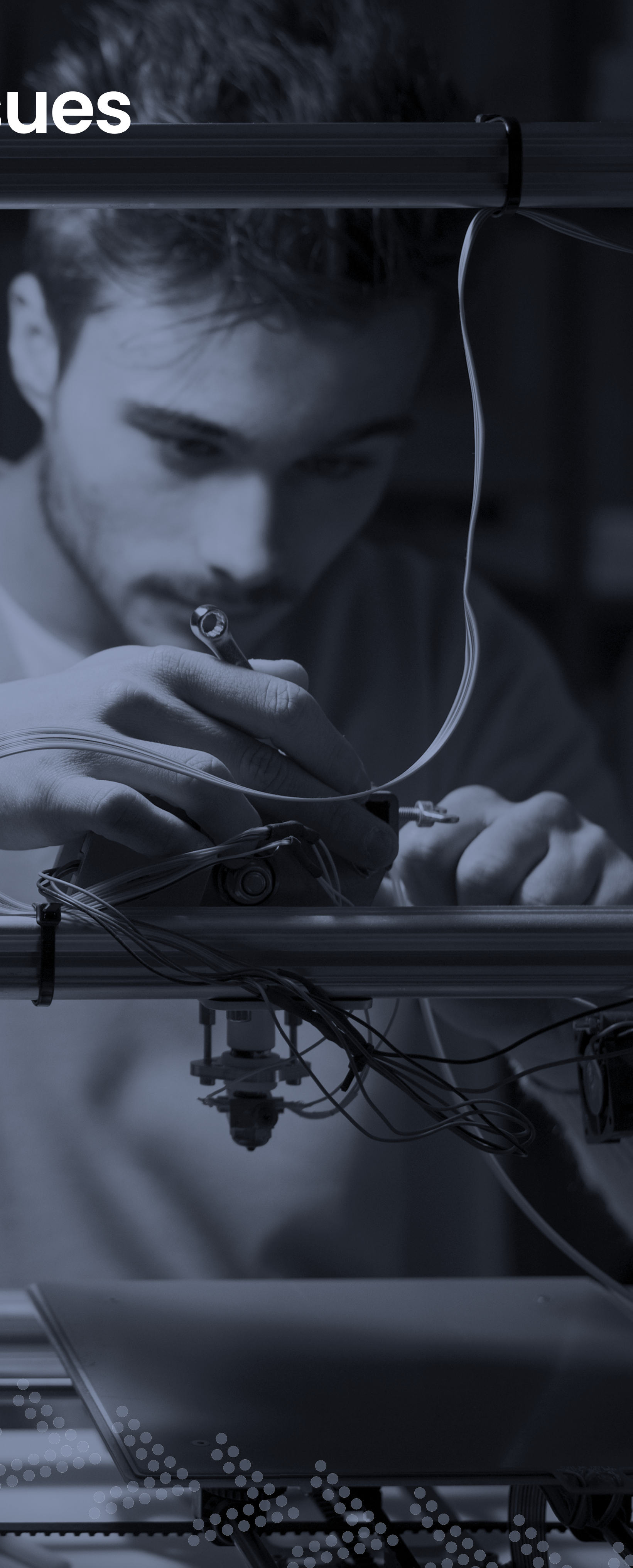
Recently, desktop 3D printers were introduced in schools for the first time, with 21 UK state schools taking part in a pilot project. 3D printing and additive manufacturing design skills were introduced into the curriculum and, after proving a success, the scheme was rolled out across the UK. For the first time, thousands of teachers are being trained to use the technology, ensuring in turn that pupils are familiar with it by the time they finish their studies.

The next generation of engineers and designers are likely to find themselves interacting with AM technology at some point, as it is set to be used in so many different sectors. Bringing 3D printers into schools gives students an opportunity to learn valuable technology skills that will help them if they pursue a career in creative, digital, engineering or medical sectors.

For the older technophiles who want to improve their AM or design skills, there are other options available. Whether you're a designer branching out into AM or you're considering buying a 3D printer for your home, there are online training courses available that teach you all you need to know about the new technology.



Regulatory issues



Despite the hype and excitement, the rise of additive manufacturing comes with a new set of regulatory challenges. As additive manufacturing takes off, issues surrounding material standards, safety and intellectual property may increase.

Similarly to problems experienced in the music industry with the Napster and SoundCloud platforms, issues will arise when design files are uploaded to online software that potentially infringes patents and design rights.

Looking at similar technological advances in the past can help us predict what could happen going forward. In 1984, many were worried that the VCR would lead to copyright infringement because people at home could potentially copy television shows and display them. However, The Supreme Court determined that the VCR was useful for substantial non-infringing purposes.

The problem with the VCR is that the issue wasn't raised until the technology was being used regularly by a large number of households in the developed world. It's encouraging that reports like the government-funded Hargreaves Review have already flagged the need to investigate the additive manufacturing industry further. Hargreaves highlights that the industry is still under development, so now is the time to launch a review on what should be done surrounding copyright issues. Copyright issues associated with AM need to be addressed before it becomes a widely-used technology. If not, intellectual property law will inhibit, rather than enable the technology's potential growth.

Another surprising fact about additive manufacturing is that you can print in a wide range of materials, which certainly asks the question, is there anything that can't be 3D printed? Over the last year alone, we've seen houses, clothing, jewellery and food produced using additive manufacturing, but the question is which sectors are simply getting excited about the hype and which ones truly get added value from the technology.

It's likely that additive manufacturing will start appearing more and more in production environments, but the reality is that the technology will probably never replace traditional manufacturing techniques like tooling, machining or vacuum casting. What AM might do is become a useful complementary technology for some manufacturers It took the additive manufacturing sector 20 years to reach a market value of one billion Euros, but only five years to reach the second billion. Analysts are now predicting that the sector could grow at least fourfold over the next ten years and, based on these figures, it looks like the predictions may come true.