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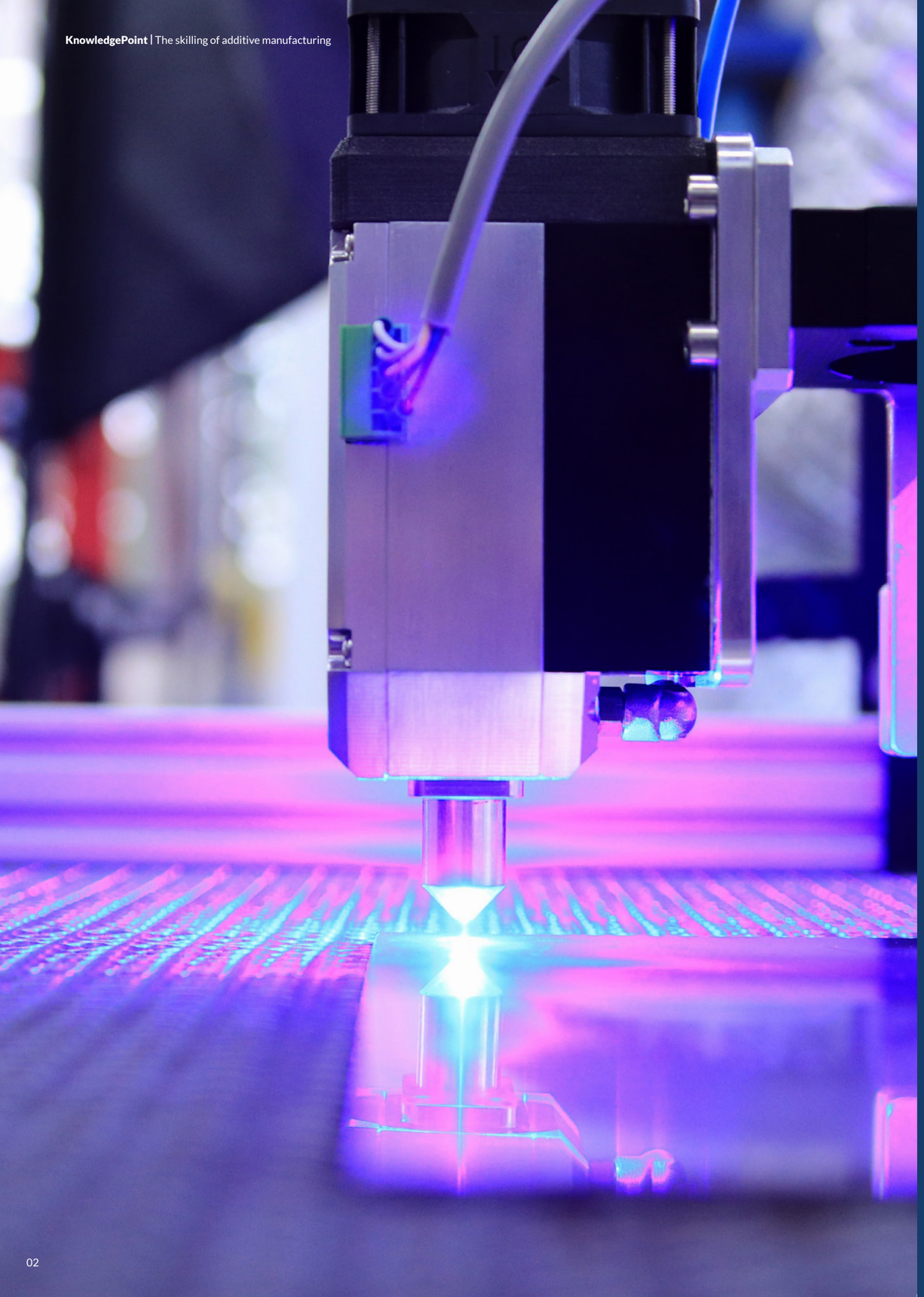
MANUFACTURING INSIGHT

The skilling of additive manufacturing



Summary

Additive manufacturing (AM) – often referred to as 3D printing – has transformed manufacturing forever, but does the sector have the skills needed to keep pace with and to capitalise upon the opportunities afforded by AM?

Adoption of AM has been steadily growing since its inception in the 1980s, and has in turn transformed the manufacturing sector. In recent years, there has been significant growth and adoption of this advanced manufacturing process. Each year, new technologies, machines and materials are introduced into the rapidly evolving AM market.

Adoption of AM

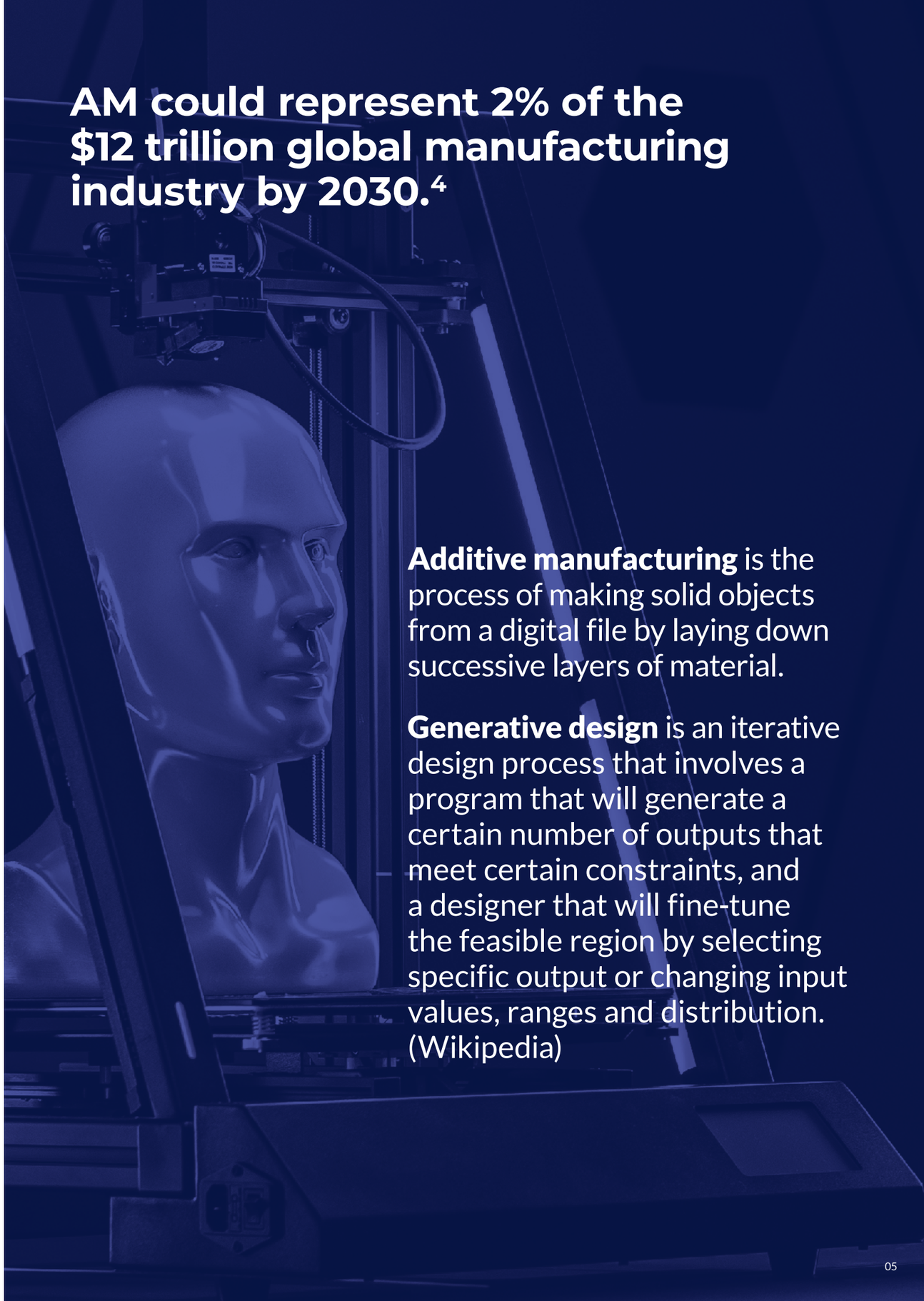
AM is an innovative manufacturing technique used in both prototyping and in the production phase of parts, tools and final products. It is used across a range of sectors, including aerospace, automotive and healthcare, offering companies the potential to produce parts and products rapidly and cheaply – and in remote locations. According to the World Economic Forum, 69 per cent of companies in the manufacturing sector plan to adopt 3D and 4D printing and modelling by 2025[1].

Traditionally, physical parts were machined down from solid billets or sheets of materials in a process known as subtractive machining. Although subtractive machining has evolved to very sophisticated levels it has some limitations, especially in the complexity of the parts that can be made. This has led to the use of more material than is needed, increasing the cost and weight of the final products. It has also become apparent that some of the complex designs that CAD (computer aided design) can create (and especially products resulting from generative design) cannot be made using subtractive machining.

Manufacturers are increasingly turning to technologies such as AM and generative design to realise benefits including reduced waste, reduced time to market or lighter products. One example in the automotive sector is the need to build lighter vehicles which get more range out of their batteries. Research suggests automotive leads the way in use of AM and accounted for more than 20 per cent share of the global revenue in 2021[2].

McKinsey talks about how, when compared with traditional production approaches, AM technologies offer four potential sources of value[3]:

1. Their ability to generate almost any 3D shape allows designers the freedom to create parts that perform better or cost less than conventional alternatives
2. With no need for moulds or fixed tooling, every part produced by a machine can be unique, paving the way for mass-scale customisation
3. Eliminating time-consuming toolmaking and fabrication operations accelerates both product development and production, reducing time to market
4. They can simplify the maintenance and support of products in the field, reducing the need for spare-parts inventories by enabling on-demand production of items from digital files



AM could represent 2% of the $12 trillion global manufacturing industry by 2030.[4]

Additive manufacturing is the process of making solid objects from a digital file by laying down successive layers of material.

Generative design is an iterative design process that involves a program that will generate a certain number of outputs that meet certain constraints, and a designer that will fine-tune the feasible region by selecting specific output or changing input values, ranges and distribution. (Wikipedia)

Implications for the workplace and workforce

A well-trained and competent workforce is critical to maximising the opportunities afforded by AM technologies. Innovations in AM materials and technologies demand different skills and capabilities to those previously required in the manufacturing sector.

It has been suggested that many innovations have outpaced the ability of the broader manufacturing workforce to adapt. According to research by Brandon Hall in 2013, around 88 per cent of manufacturers were struggling to find the skilled workers needed – a shortage that was impacting production, quality, innovation and growth[5].

A decade later, is the sector still chasing its talent tail?

AM technologies not only have an impact on product design, they also influence how a manufacturer structures and manages the design process itself. AM also has implications for the skills and capabilities needed from the workforce, and how these teams work, engage and collaborate. A range of roles are involved in use of the technology including technicians, engineers, CAD designers and software engineers.

Deloitte highlights how "the rise of AM will likely drive heightened demand for cross-functional technical and managerial competencies. Engineers must learn and implement new design processes and technologies, adapt to new design programs, and gain familiarity with new materials beyond their traditional training and professional experience. Moreover, design engineers will have to work side by side with manufacturing engineers on the factory floor, and both will need to think about fabrication and modelling more imaginatively than they have historically."[6]

"In a conventional development process, designers and engineers iterate repeatedly to achieve the best design, creating a design, then testing and adjusting it. Generative design software saves valuable time by building manufacturability into the design options that are generated. It also gives the design team the ability to come up with valid concepts faster and evaluate the full design space, something that is virtually impossible with a manual design process."[7]

As design and manufacturing converge, companies need to invest in capability to make the most of design software. Software and tools which brings together design, engineering, simulation, additive manufacturing and factory floor management. Competence in these tools will enable more agile work among engineering teams and empowering manufacturers to become more competitive.

> Without a well-trained workforce capable of adapting to – and adopting – the applications and uses of AM, organisations may fail in their ability to integrate and implement AM processes effectively. These new design, development, and production processes require agile workforce allocation and management practices.[6]
>
> **Deloitte**

Skills are a barrier to growth

Sculpteo's research into the 3D printing market highlights how training and education are key concerns which could affect the uptake of these new technologies[8]. Future generations working with these new technologies need to gain practical experience, experiencing first-hand the interplay between design technologies and production processes.

There is significant potential for AM around the world, opening up opportunities in markets not traditionally known for manufacturing prowess. In the Middle East, the UAE is striving to establish itself as a centre of excellence through its Dubai 3D Printing Strategy.

Despite substantial growth opportunities for 3D printing in the Middle East and Africa, the AFMG's 2020 report highlights barriers to faster adoption, including a lack of 3D printing expertise. It suggests that "overcoming these issues, for example by providing training and establishing AM programmes at local universities, will be instrumental in driving greater use of the technology in both regions".[9]

€12.6bn

Estimated value of the worldwide market for 3D printing products and services in 2020[10]

€76.16bn

Revenue forecast in 2030[11]

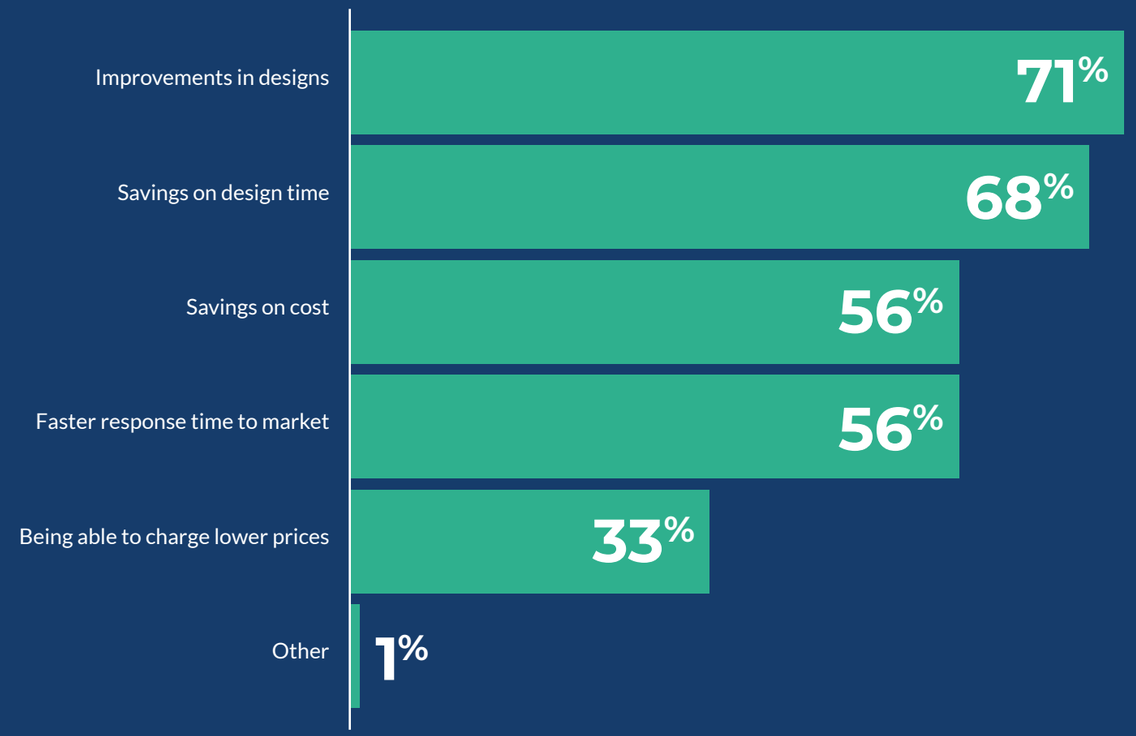
€13.4bn

Industry with a 22 per cent annual growth rate. Value of additive manufacturing in 2020[3]

20.8%

Growth rate: CAGR of 20.8% from 2022 to 2030[11]

Benefits and productivity changes[12]



> After decades as a bit player, additive manufacturing is on the cusp of stardom. Faster machines, better materials, and smarter software are helping to make AM a realistic solution for many real-world production applications. As the technical barriers fall, the onus is on manufacturers to improve their understanding of these rapidly evolving technologies, building the skills, processes, and business models needed to make additive manufacturing shine in the industrial world.[3]
>
> **McKinsey & Company**

Learning from experience: **university and training provider collaboration**

Academia and employers alike need to play a role in increasing familiarity with the tools and technologies in use in modern manufacturing, supporting students and employees to gain the skills they need to be productive.

One such example is a recent collaboration between Generative CAD Services and the Faculty of Engineering at Lagos State University saw a number of lecturers being equipped with the necessary skills to navigate today's dynamic engineering curriculum. With the need to not just up-skill but to also future-skill, the project combined academic knowledge and industry applications.

Prof Elkanah Oyetunji, Dean Faculty of Engineering, Lagos State University, Nigeria said: "From understanding the critical components of the future of work to the thinking process of how modern products are made (design intent, manufacturability, sustainability, usability, scalability, etc.), to creating high fidelity digital designs that are manufacturable to actual digital manufacturing (3D printing); it was a comprehensive product development training with a focus on real-world applications.

"…the Faculty is in the process of adopting and implementing Autodesk Fusion 360 into our learning curriculum to facilitate product design and digital manufacturing for our students."

> Students typically get trained on using 3D modelling tools to design but they are not given any experience of how you manufacture these designs. This is a huge skills gap that impacts the ability to successfully operate in the manufacturing space. A designer/ engineer needs to understand how to translate their design into efficient manufacturing processes of physical products.
>
> **Chukwubuikem Felix Amaefule, Generative CAD Services, Nigeria**

Image: Generative CAD Services

Learning from experience: **boosting employability**

NET-INFO in Tunisia developed and delivered a series of training sessions encompassing Additive Manufacturing and 3D printing, 3D Jewellery Design & Printing and Building Information Management (BIM) as part of the D-CLIC program.

Organised in collaboration with the International Organization of Francophonie (OIF), the program aims to strengthen the technical and professional digital skills of Tunisian young people. The D-CLIC "train yourself in the digital" program is a response to gaps in the labour market, and supports the development of digital skills to improve employability.

Samia Chelbi from NET-INFO says: "Tunisia has experienced high unemployment over the past years, particularly among graduates. There are a number of reasons for this including a mismatch between what employers need and the skills of Tunisian job seekers, particularly technical and digital skills.

"This need has been recognised by the government and other organisations. There's a significant push across the country to support companies in transforming towards Industry 4.0, helping them to build digital solutions into their operations. Our work with OIF supports these efforts."

NET-INFO engaged about 140 students across 14 educational institutions in Tunis and Nabeul. Six-hundred training hours were delivered in total, helping participants to apply the use of Autodesk solutions, including Fusion 360, in real-life scenarios. The Additive Manufacturing and 3D Printing course was targeted at young people with or without a diploma in crafts and cultural heritage, mechanical engineering and industrial manufacturing and product design.

Participants were overwhelmingly positive about the benefits: "This training is the link between the theoretical that we learnt from our studies and the professional world."

Collaboration with other partners and knowledge transfer with other educational institutions are key to the success of the program. Leith Aouni, additive manufacturing & industrial modelling trainer/3D jewellery modelling and luxury product visualisation trainer says: "This experience allowed me to transfer my knowledge, and develop exchanges with students. It develops my skills and enriches my pedagogical skills."

What are the barriers to expanding the use of 3D printing at your company?[8]

14.5%
Recruitment (finding qualified candidates)

14%
Lack of training

What factors will limit the adoption of 3D printing?[8]

51.9%
Knowledge gap

What does the 3D printing industry need to grow?[8]

40.7%
More training/education

Developing skills needed to maximise the AM opportunity

1.

Map your talent needs: get ahead of your talent needs before they become a problem. Assess which roles will play a part in the adoption of AM, and make sure you have a plan for acquiring the capacity and capabilities you need to make it a success!

2.

Add to your skills pipeline: support your employees to develop understanding and expertise in AM and generative design, and get certified along the way. Professional courses are industry-specific learning and are vital to closing the skills gap.

3.

Seek collaborative learning opportunities: develop partnerships involving industry, expert training partners and academia to stay abreast of developments in the rapidly evolving AM sector. Many software providers have partner programmes that provide subsidised and affordable access to their platforms, products, resources, and certification exams.

For further information about KnowledgePoint and our role as the Autodesk Learning Partner Distributor for the EMEAR territory, or to find out about training local to you, visit:

knowledgepoint.com/autodesk

Additive manufacturing was first used to develop prototypes in the 1980s — these objects were not usually functional. This process was known as rapid prototyping because it allowed people to create a scale model of the final object quickly, without the typical setup process and costs involved in creating a prototype. As additive manufacturing improved, its uses expanded to rapid tooling, which was used to create moulds for final products. By the early 2000s, additive manufacturing was being used to create functional products.[13]

MIT Sloan

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