

SKILLS WANTED FOR SUSTAINABLE INNOVATIONS

ADDITIVE MANUFACTURING DESIGNER

EBOOK





We're experiencing a global Industry Renaissance today, bringing new ways – real and virtual – of seeing the world, inventing, learning, producing and trading. Tomorrow's game-changers will not be those with the most automated production systems, but those who build a culture of knowledge and know-how to reveal and train the Workforce of the Future, able to solve the challenges of a planet lacking sustainable solutions.

BERNARD CHARLÈS

Vice Chairman of the Board of Directors
and Chief Executive Officer

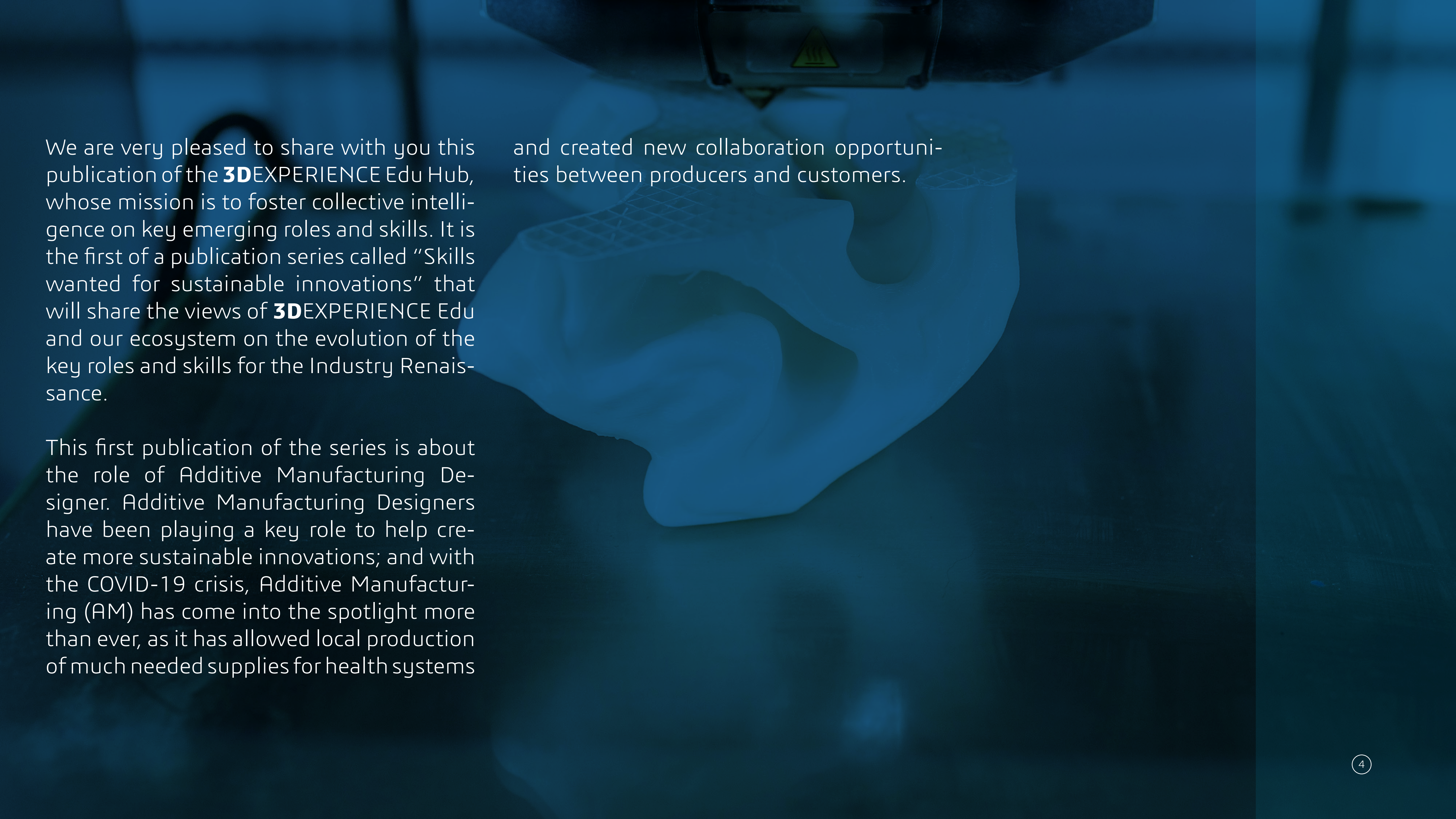
At Dassault Systèmes, we are convinced that the future is about people, that the only progress is human. In order to create a more sustainable world, people need to be empowered with knowledge and know-how.

Technologies are reshaping the world of work. Jobs are being transformed and new jobs requiring new skills are emerging. Dassault Systèmes, as a strategic transformation partner for many Industrial customers, plays a unique role in this jobs transformation.

At Dassault Systèmes, our **3DEXPERIENCE** Edu organization is committed to improve people's skills and foster their employability throughout their lifetime. The value of **3DEXPERIENCE** Edu hinges on the diversi-

ty of its community – students, teachers and professionals, all aiming for the same goal: reinventing the way we learn, teach, make and share to imagine sustainable innovations.





We are very pleased to share with you this publication of the **3DEXPERIENCE** Edu Hub, whose mission is to foster collective intelligence on key emerging roles and skills. It is the first of a publication series called “Skills wanted for sustainable innovations” that will share the views of **3DEXPERIENCE** Edu and our ecosystem on the evolution of the key roles and skills for the Industry Renaissance.

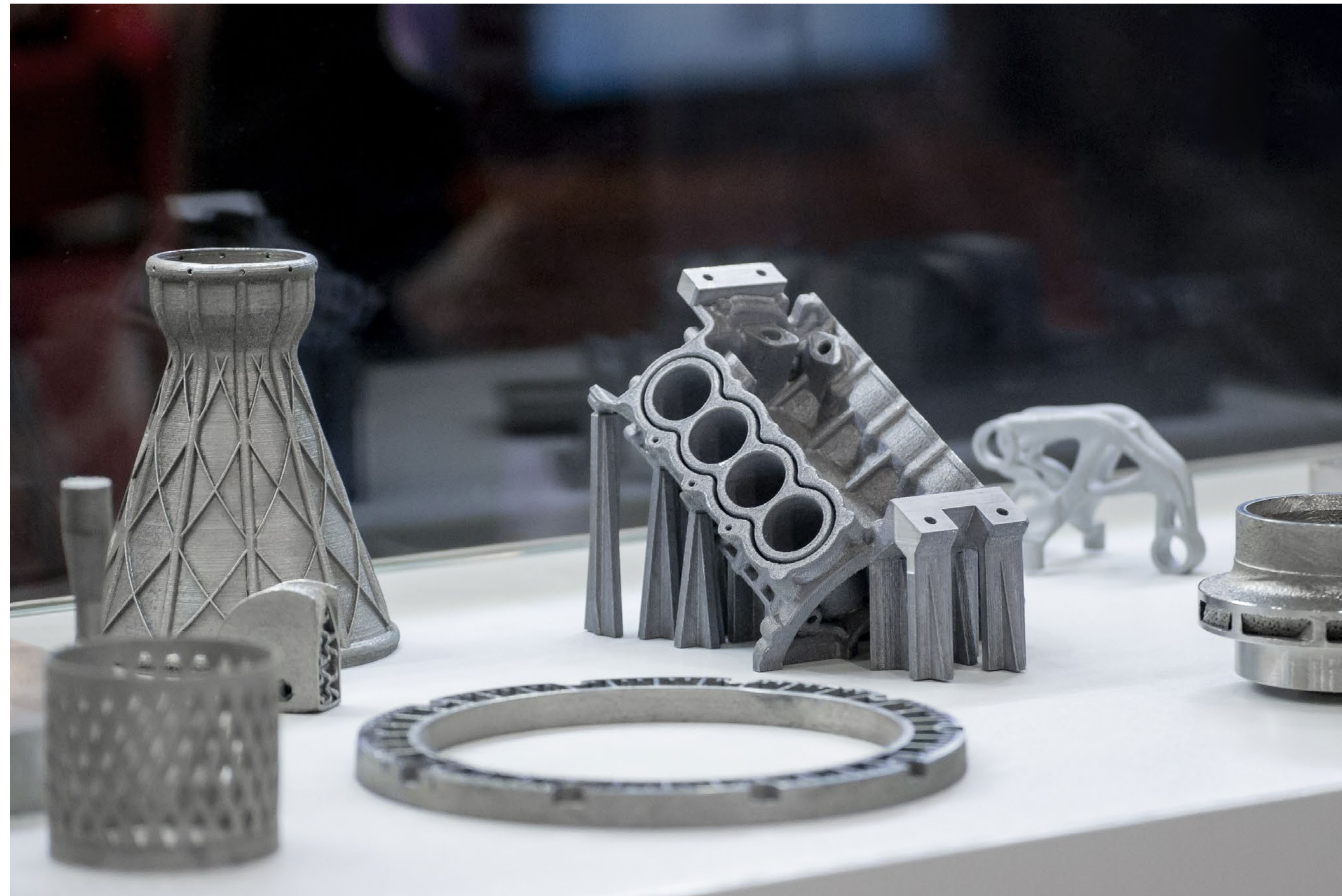
This first publication of the series is about the role of Additive Manufacturing Designer. Additive Manufacturing Designers have been playing a key role to help create more sustainable innovations; and with the COVID-19 crisis, Additive Manufacturing (AM) has come into the spotlight more than ever, as it has allowed local production of much needed supplies for health systems

and created new collaboration opportunities between producers and customers.

INTRODUCTION

In recent years, Additive Manufacturing (AM) has grown exponentially in terms of what can be achieved. No longer just a method to produce nice-looking prototypes, now engineers can create any shape that best meets their need and can manufacture pieces almost anywhere they are needed: under the sea, in deep space, in crisis zones or on the shop floor. Manufacturing leaders across many industries – Aerospace & Defense (A&D), Transportation & Mobility (T&M), Life Sciences (LS), Industrial Equipment (IE) and Energy & Materials (E&M), to name a few – are adopting AM across their enterprises and benefiting from the flexibility that this technology brings to their value chains. In this context, many jobs using AM processes have been emerging over the last few years, and it all starts with design. This ebook will therefore focus on the **Additive**

Manufacturing Designer role, and highlight how that job has evolved, the skills it requires, and how the job will be evolving in the years to come.





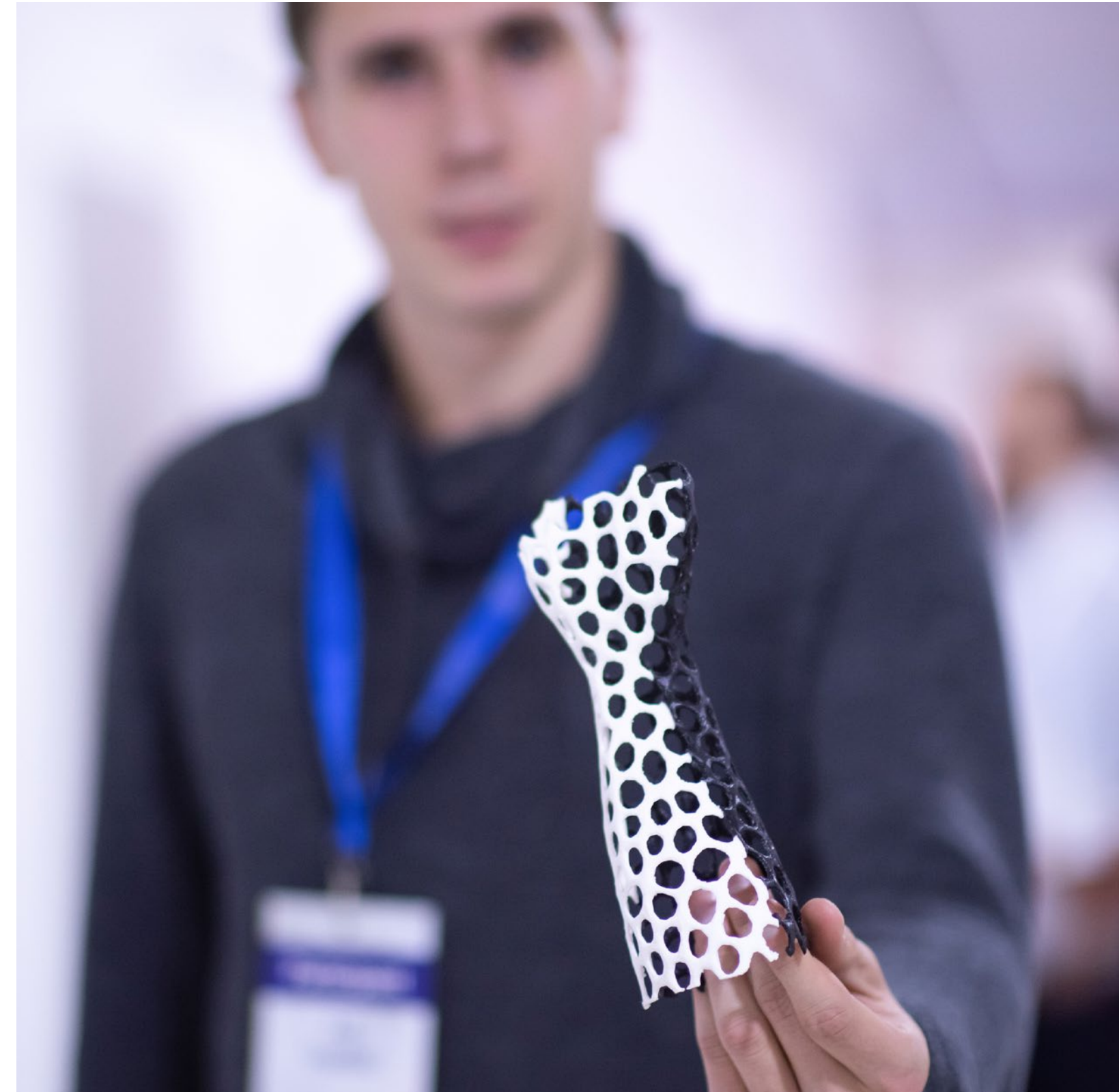
KEY VALUES OF ADDITIVE MANUFACTURING

Before we deep dive into the Additive Manufacturing Designer role, we will provide some context about key values of AM.

AM is a fabrication process used to print 3D objects by continuously adding materials layer by layer. Although AM technologies are nearly 40 years old, the Additive Manufacturing Designer job has been rapidly emerging over the last 5 years. This job comprises the knowledge of that discipline, understanding of materials, AM processes, as well as design methods that are really key elements to being a successful Additive Manufacturing Designer.

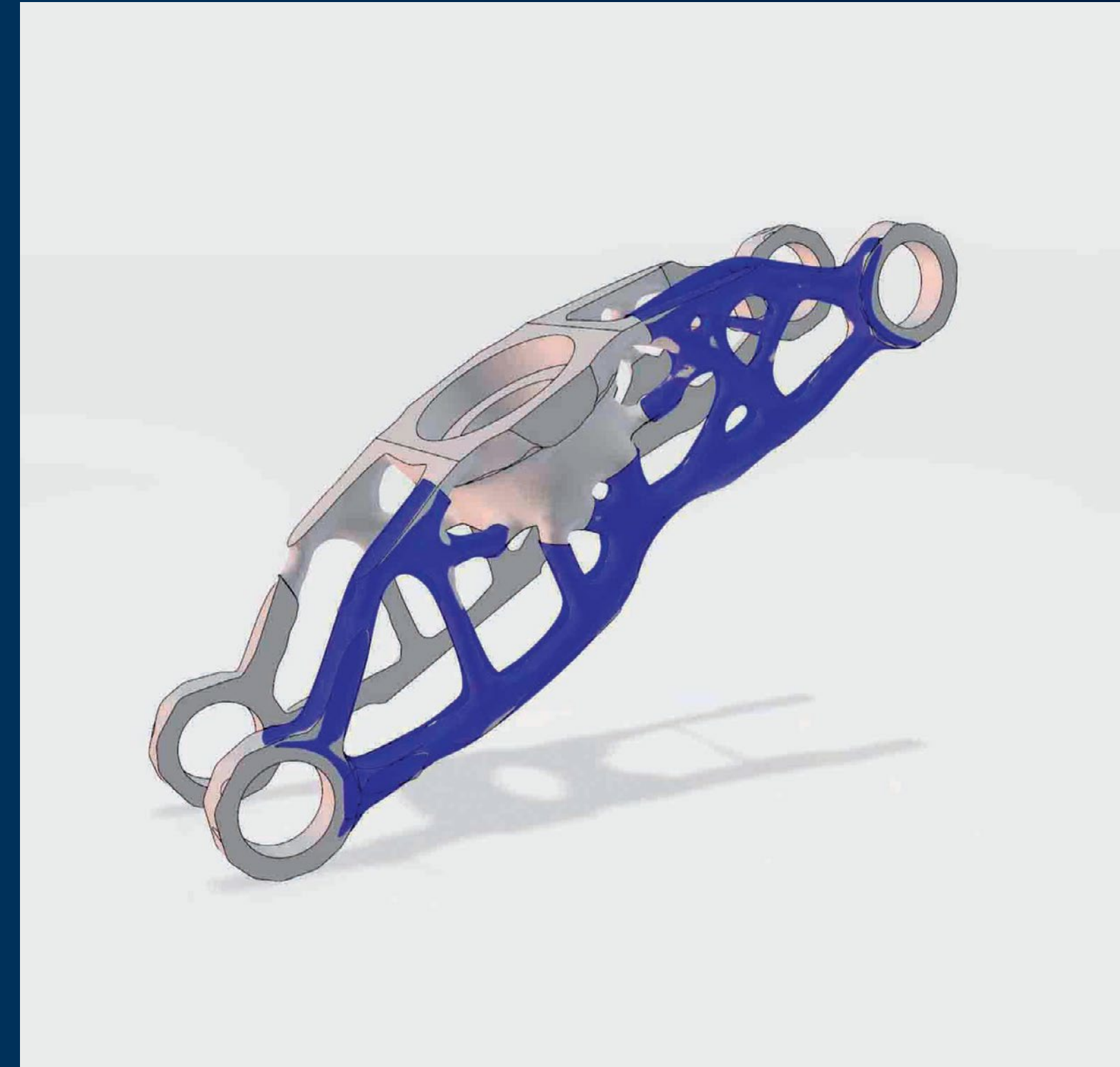
Lightweight Engineering to address environmental needs and sustainability targets

Lightweight Engineering provides designers with expert capabilities to minimize part weight, maximize stiffness, reduce costs and the mass of their components, and optimize material usage. Designers must innovate, by adopting new tools, to come up with multiple design proposals. Lightweight Engineering includes new processes, materials and techniques, such as AM, composites, simulation and hydroforming.



Dassault Systèmes' **3DEXPERIENCE** platform offers the best in class solutions in AM Industry. CATIA® Lightweight Engineering solution seamlessly integrates design, simulation and analysis, all the way to manufacturing across all disciplines with the **3DEXPERIENCE** platform. Refine, validate and complete collaboratively and in-context.

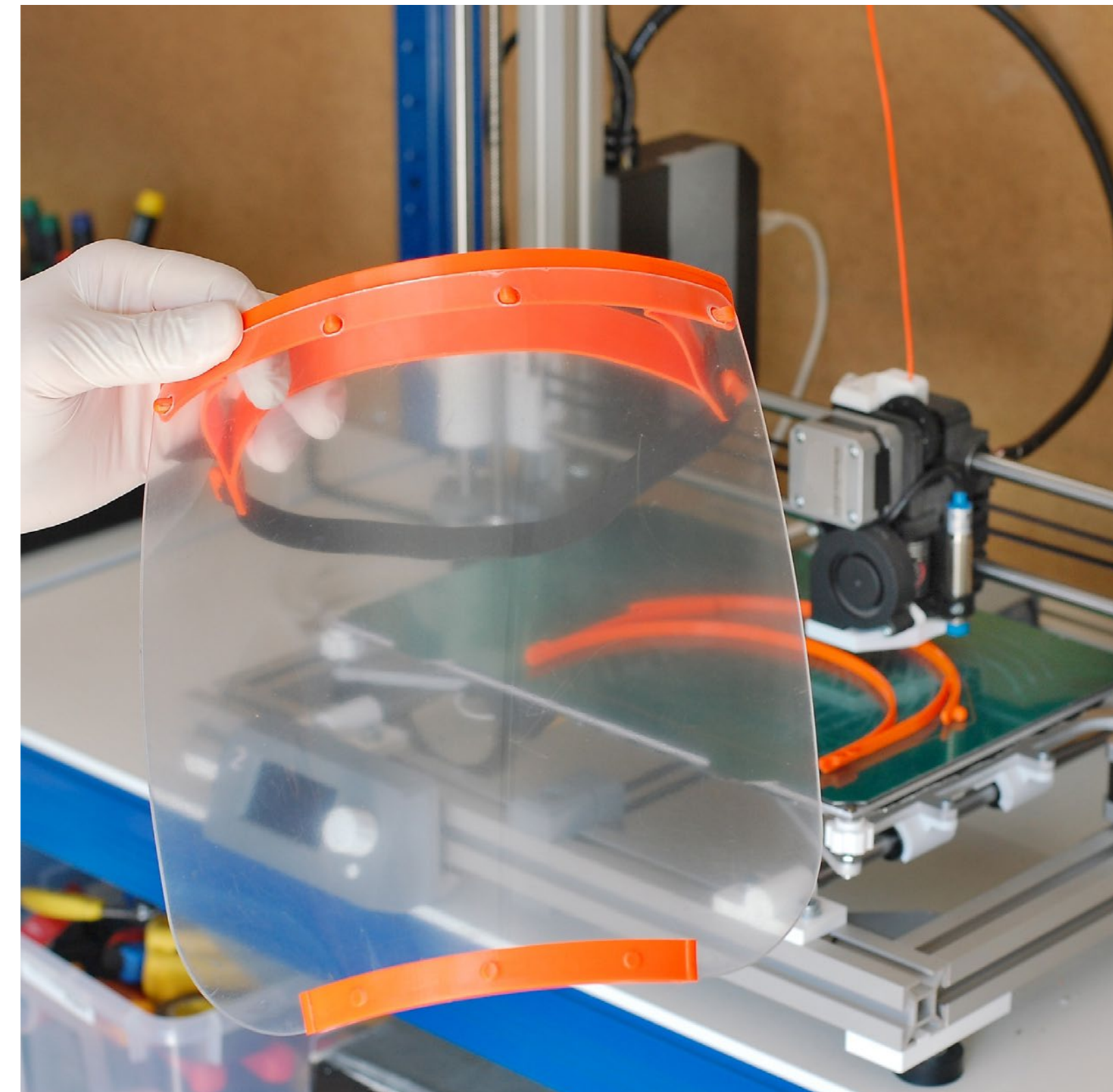
- AM shows great potential in reducing energy and resource needs, and enables more sustainable practices.
- AM helps reduce errors, saving time through a faster production cycle, faster time-to-market, ease of development, reduced overall development cost and less waste.
- Designers and engineers are willing to design products that are beneficial for the environment, society and the economy.
- The rising demand from the aerospace sector and the growing awareness of carbon footprint will significantly contribute towards the development of the AM industry.



Local solutions for global challenges

With the COVID-19 pandemic crippling traditional manufacturing models, Industry has demonstrated how it can adapt and transform existing models. In order to tackle this health crisis, AM has shown itself to be a very innovative discipline that allowed manufacturers to reinvent themselves and offer alternative solutions.

Medical materials, face shields for hospital staff, valves for ventilators and other accessories have become, in a few weeks, very valuable and precious tools that could easily and quickly be 3D printed to meet the very high demands coming from all over the world.





ADDITIVE MANUFACTURING DESIGNER ROLE

Additive Manufacturing Designer is not listed as a job per se in the official Standard Occupational Classification (SOC) systems in Europe and the United States, and Additive Manufacturing is not listed either as a skill; but 3D Printing is referenced as a skill.

O*NET, the United States Occupation Information Network, references "Three Dimensional Printing Machines" as a tool used by Automotive Engineers, Industrial Engineering Technologists, Mechanical Engineering technologists, Model Makers, Metal and Plastic.

If we look at job offers, SpaceX Company, for example, is recruiting an Additive Manufacturing Engineer who is responsible for design, development and testing of all facets of the additive process with a focus on machines,

software, part design and analysis, and additive techniques. APEC, the French Agency for manager's employment, defines the Additive Manufacturing Engineer role as the person who "manages the design, production and diffusion of parts and machines using 3D printing. He/she will work with materials, processes or software related to additive manufacturing."

“

AM pushes the boundary of what is possible to design and manufacture and does so in a more sustainable way.

In the shoes of Steven, a designer for AM



STEVEN
Additive Manufacturing designer
working for the Aerospace industry

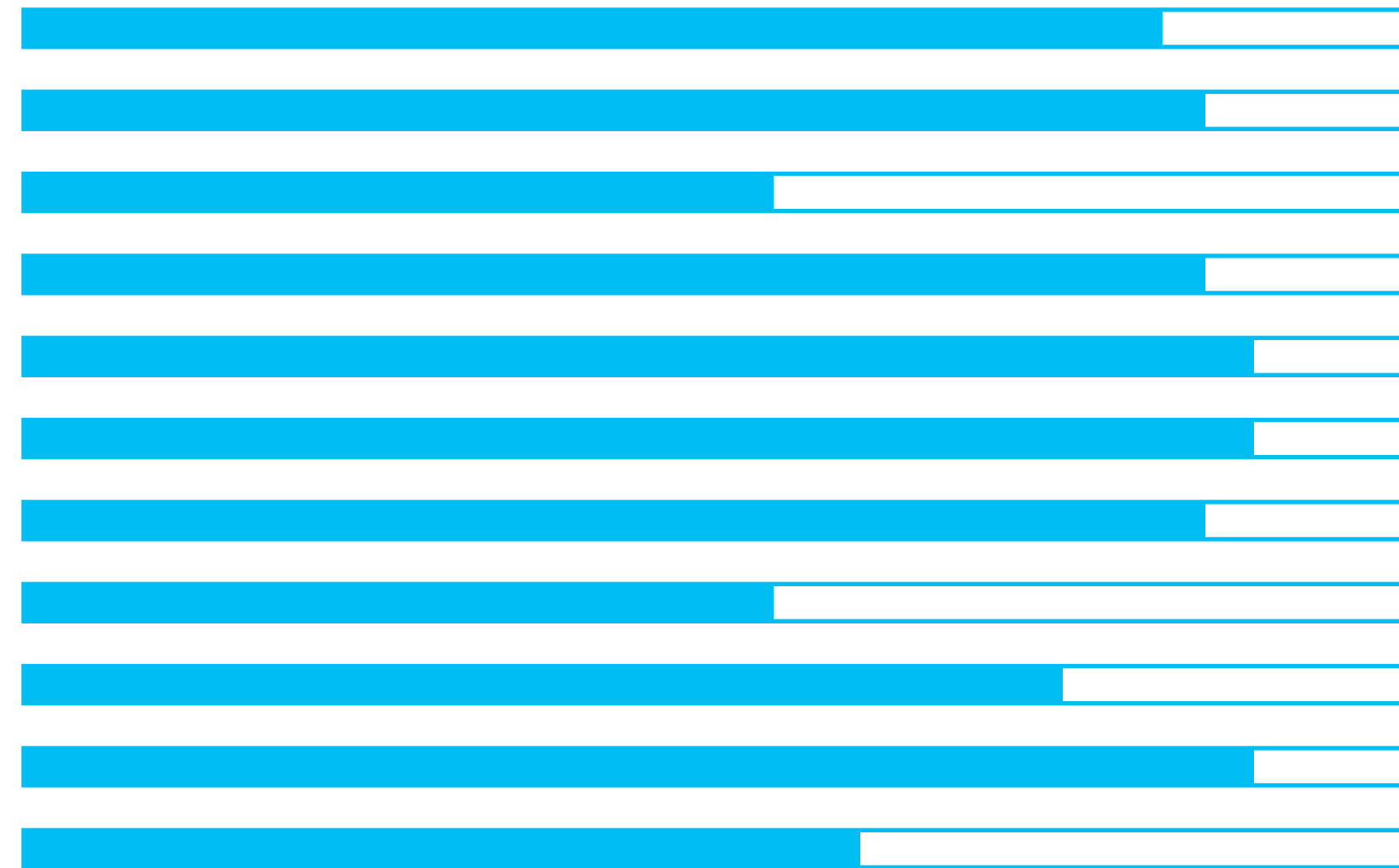
Steven's missions

Steven is responsible for designing and developing all steps of the additive processes for air system equipment, and serves as a technical lead for AM product development.

- He designs aeronautic air system equipment that is made with additive manufacturing.
- He optimized parts.
- He has a high expertise in Material properties.
- He writes and validates technical product requirements.
- He performs conceptual and detailed design using CAD principles.
- He participates in simulating the selected manufacturing processes.
- He promotes additive manufacturing externally (to customers and at conferences).

Steven's skills

- Design for Additive Manufacturing (DfAM)
- FEA and Topology optimization
- 3D Modeling
- Material Properties
- Mechanical Engineering
- 3D Printing
- **3DEXPERIENCE**
- Digital Prototyping
- Analytics skills
- Complex problem solving
- Best-practices & strategic deployment



Steven's background and experience

Steven has a Master's degree from Penn State University in the US, with a major in Mechanical Engineering.

In 2019, Steven completed the "Be an Additive Manufacturing Designer" learning path from Dassault Systèmes and received the related professional certification "3DEXPERIENCE Function Driven Generative Designer".

Thanks to the challenges he has tackled before with his company, Steven has gained experience in:

- Topology optimization software
- Product process qualification
- Additive Manufacturing production line
- Design and build of mechanical components

- Additive simulation software
- Material Fatigue
- Reverse Engineering tools through CAD software

He can demonstrate high technical knowledge, great accountability and natural skills for working with teams, and now continues developing his skills and know-how through a network of peers in the Aerospace industry.

“

Soft skills are most important for an AM designer, because in this job, you need to act with agility, solve complex problems capitalize on what you have learnt from other projects and actors.

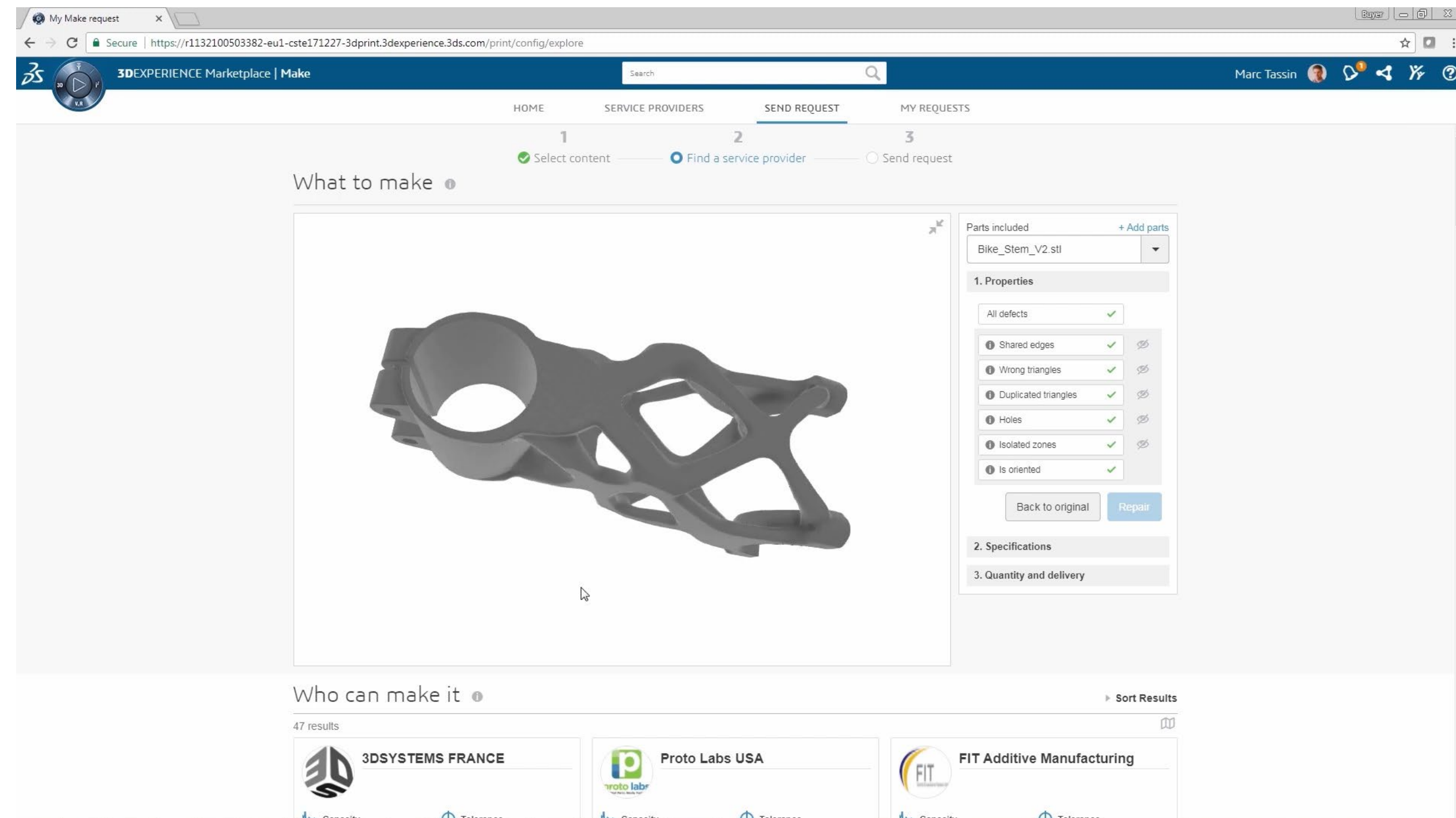
STEVEN
Additive Manufacturing designer
working for the Aerospace industry



Steven often uses **3DEXPERIENCE** MarketPlace | Make to print parts if the equipment or materials he needs are not available at his office, and connects directly with industrial manufacturing service providers that have proven track records in printing parts and prototyping.

What is 3DEXPERIENCE MarketPlace | Make?

It is an online, on-demand manufacturing platform operated by Dassault Systèmes. It connects the industrial ecosystem of Designers, Engineers, Buyers and Production Planners with industrial manufacturing service providers so that you can be confident to find the best partner based on your project requirements.



To learn more, visit
3DEXPERIENCE MarketPlace

<https://make.3dexperience.3ds.com/welcome>

JOB OUTLOOK

1. Market Size

According to an article from Reports and Data, overall revenue generated by the AM Industry reached a total of US\$10 billion in 2019, for the first time since its introduction 40 years ago. That number is expected to grow and reach US\$32 billion by 2023, and reach more than US\$50 billion in 2026 according to Fortune Business Insights. This data includes the overall revenue from AM, from equipment to materials used in AM, plus its services, as well as all types of materials (metals, plastics, composites and ceramics).

In terms of adoption rate of AM, North America is leading the market. Europe is not too far behind in the competition, while the Asia Pacific region is expected to show the highest growth. Indeed, International Data Cor-

poration (IDC) estimates that China will be the fastest growing country in the AM market over the next five years, with an annual growth rate of 21.6%.

In 2020, the top three countries in terms of generated revenue from AM are Germany, United States and China. France ranks fourth with more than EUR 490 million of revenues generated, according to an article from Primantes 3D website, dated January 2020.

This would therefore lead to many new jobs opportunities in all the above regions and countries. According to a report from Wanted Analytics, a loss of jobs related in the manufacturing sector has been observed in the United States. Despite this loss, 2 million of manufacturing jobs could remain vacant by 2025.

2. Talent skills

Those people are mainly manufacturing engineers (85% of them) and most are employed in the Aerospace or Automotive Industry according to an article from L'Usine Nouvelle.

In addition, based on a review of LinkedIn profiles, more than 335,000 people worldwide have declared that they have either AM and/or 3DPrinting skills.

Should you, as an individual or a company want to manufacture or design parts internally, but you do not have the skills? No worries! Dassault Systèmes offers you engineering services through its **3DEXPERIENCE** Engineering Marketplace for on demand engineering across all disciplines.



More than 75% of people occupying this job are Male.

Gender Diversity

Job postings

2,800

job postings from around the world that have either Additive Manufacturing or 3D Printing in their description (recap based on LinkedIn, May 2020).

Most of the job postings were located in the US. Germany also had a very high demand. In France, a report from JobLift (Career platform) highlights that those positions take a bit longer to recruit compared to other profiles.

This demonstrates the challenges in recruiting such professionals. A report from Katalyse (Business strategic consulting company) estimates that by 2025, new job creations for AM could reach almost four times the number it was in 2018 (a total of 380 versus 100). In addition, the same report says that the number of postings linked to AM had grown 100% in 2017, reached 6,000 positions in 2018, and overall increased by 12% weekly. AM is growing 25 times faster than the overall job market. Many recent reports highlight that this in-

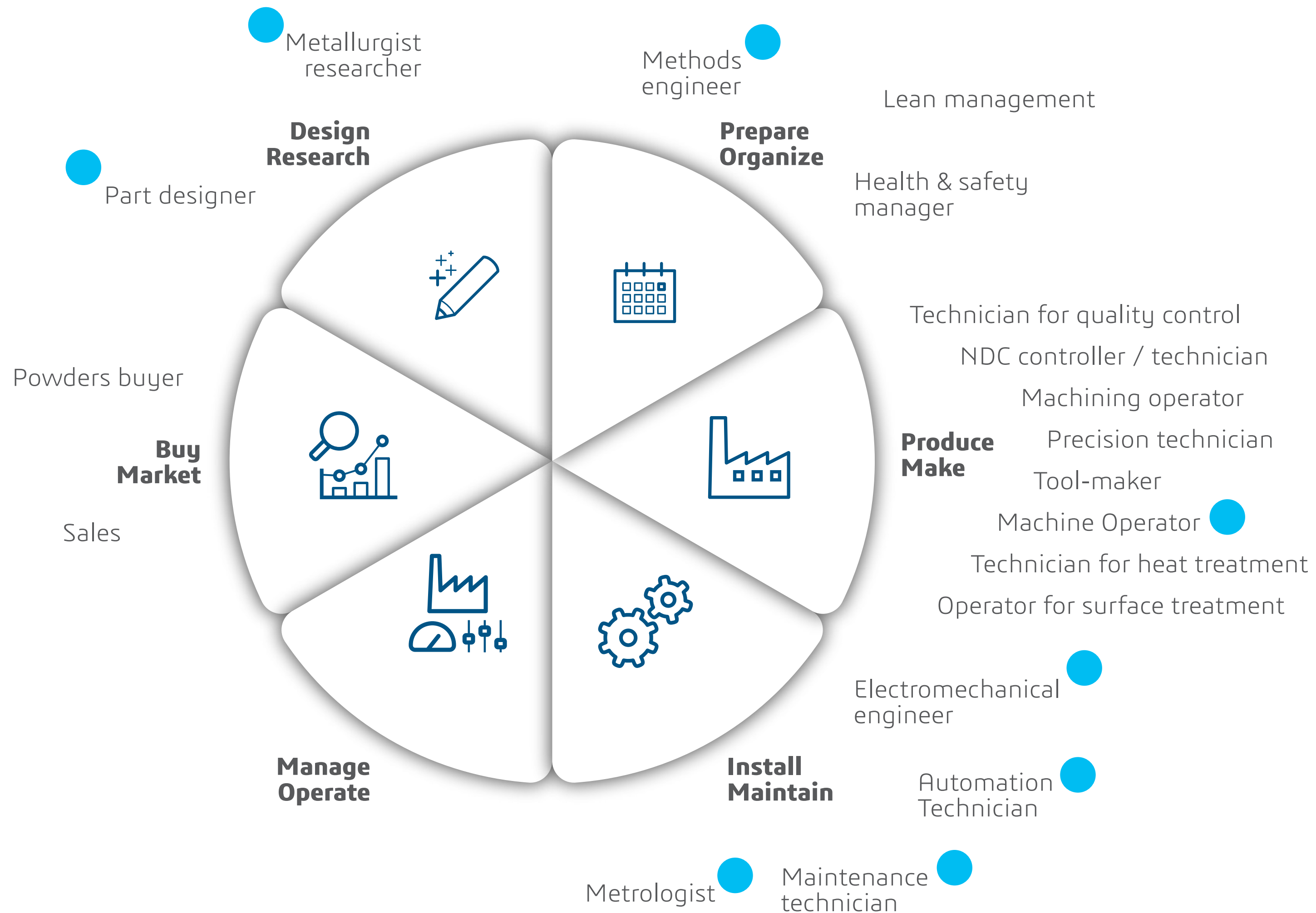
dustry is having some difficulties in recruiting because the market has been growing more quickly than the number of graduate profiles. Most notably, this trend is expected to continue in the coming years with higher salary levels.

Discover job opportunities connected to your Dassault Systèmes skills and get inspired with success stories from power users. Visit the 3DS Academy Job Place.

To see jobs related to Additive Manufacturing in your region

<https://edu.3ds.com/en/job-place>

Jobs impacted by Metal Additive Manufacturing

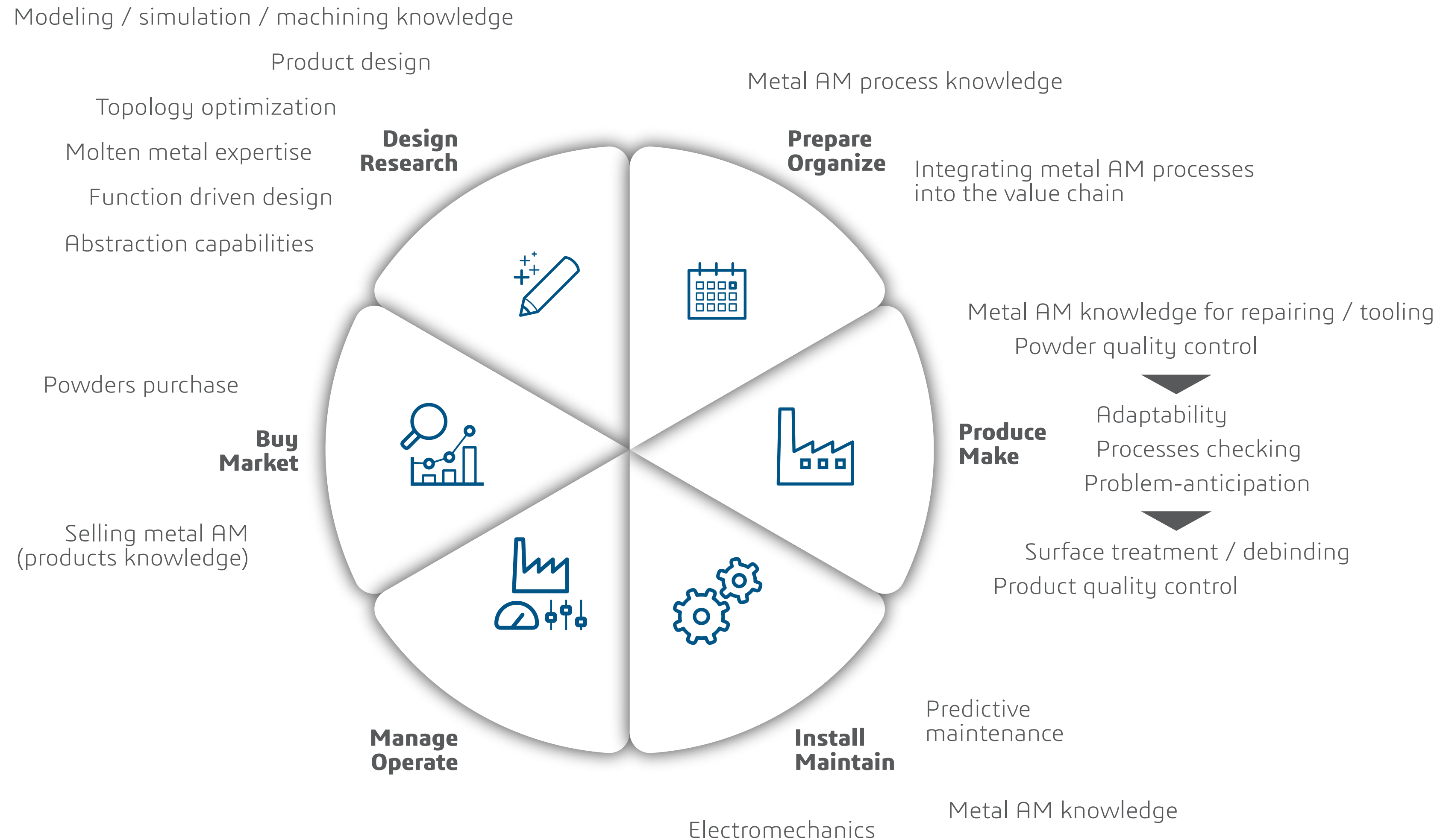


● Mostly impacted jobs

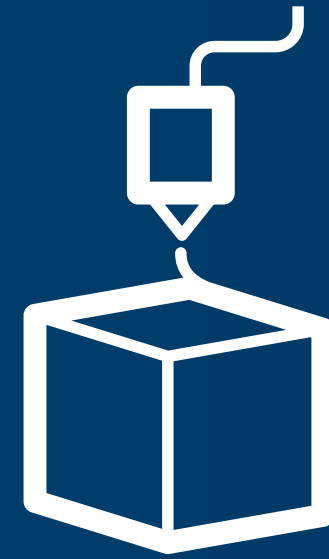
French metallurgy observatory (*Observatoire paritaire, prospectif et analytique des métiers et qualifications de la Métallurgie*)



New or evolving skills requirements on Metal Additive Manufacturing



3. Key figures



+35%

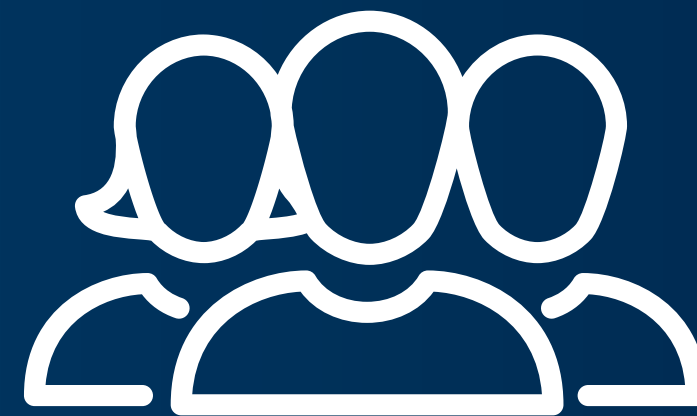
job offers for AM for Health and +15% for AM for Manufacturing Industries

+28%

job offers for AM Engineers profiles and +7% Designers profiles in France

US\$ **52** Billion

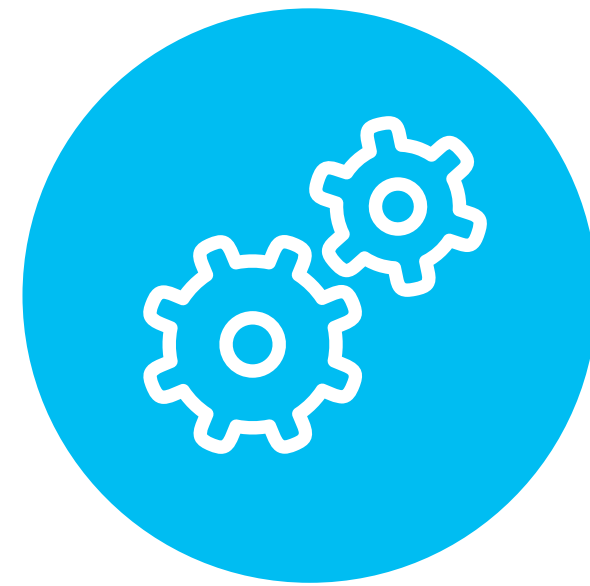
expected Additive Manufacturing Worldwide Market Size by 2026



335,000

people have either Additive Manufacturing and/or 3D Printing listed in their LinkedIn profile

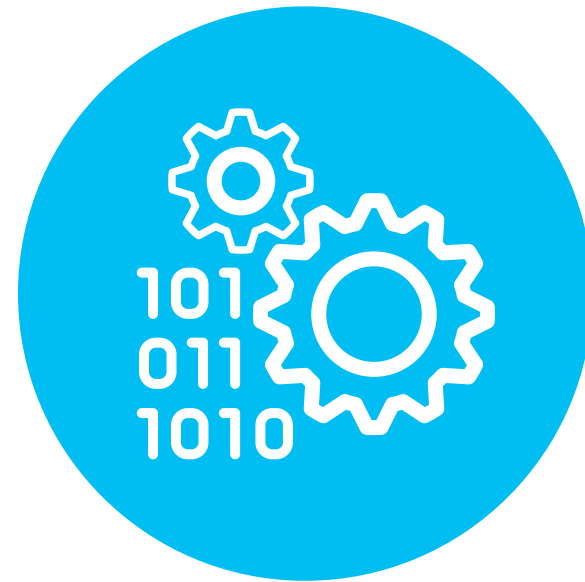
4. Related jobs using AM principles



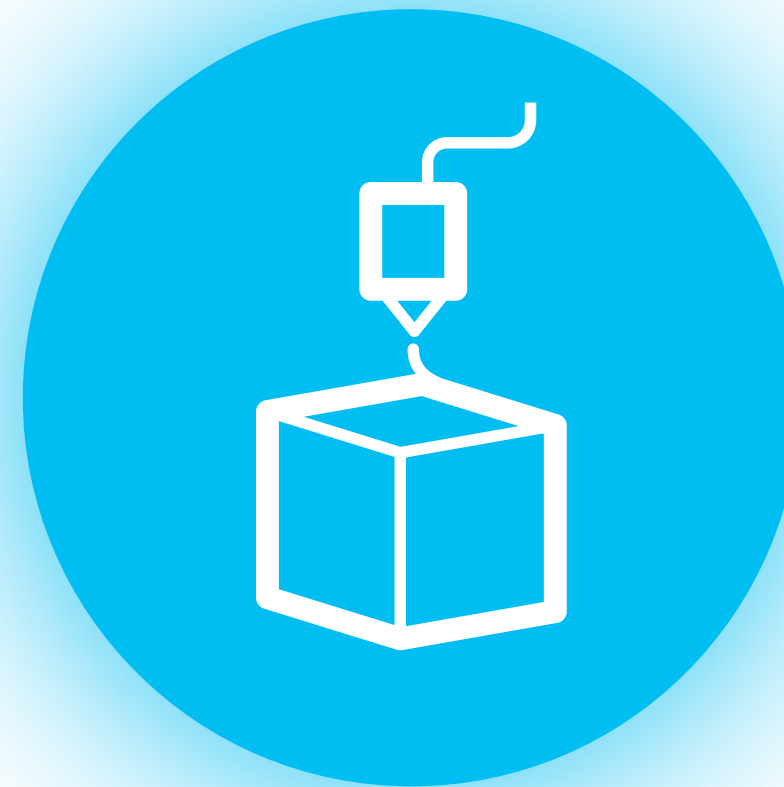
Mechanical Design Engineer



Design Engineer



AM Programmer



Industrial Engineer



AM Technician

5. A growing training offer for Additive Manufacturing

The organization America Makes supports the transformation of manufacturing in the United States through innovative, coordinated AM and 3D Printing Technology Development and Transition, and Workforce and Educational Development.

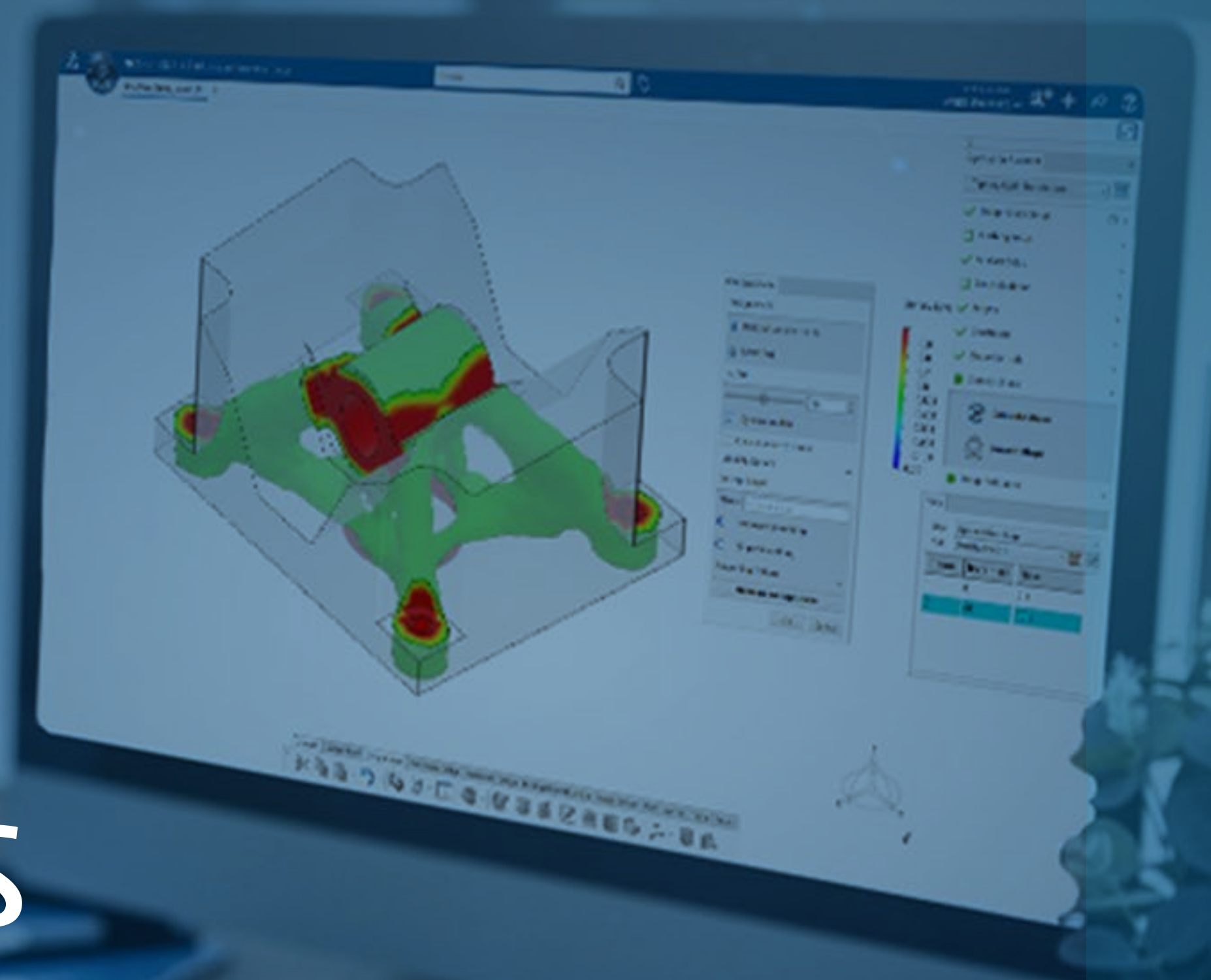
Josh Cramer from America Makes confirmed “the growth in the need to train and develop talents in the AM industry”. Additive Manufacturing is a great ‘enabler’ to introduce students, of any age, to advanced manufacturing in general as well as the new concepts of Industry 4.0.

In France, considering the great potential that AM offers, Safran is creating Safran

Additive Manufacturing Campus dedicated to improve AM Workforce skills inside the group. The intention is to deploy new knowledge, as well as new skills, related to design and printing lines management.

These organizational initiatives show the major interest in improving the skillset of more and more people in the discipline, and developing new knowledge for an emerging market area.

DASSAULT SYSTÈMES LEARNING EXPERIENCES FOR ADDITIVE MANUFACTURING



In 2020, Dassault Systèmes started to develop a new portfolio of Learning Experiences that combines domain knowledge and know-how in key Domains of Excellence, to empower the workforce of the future. To learn more about our Learning Experiences Portfolio dedicated to Additive Manufacturing, "Be an Additive Manufacturing Engineer", including industry recognized experts' lectures, visit Dassault Systèmes Training website.

To learn more about our Learning Experiences Portfolio

<https://www.3ds.com/training/learning-offer-in-domains-of-excellence/>

Be an Additive Manufacturing Engineer is a learning path that provides a learn-by-doing approach about the concepts of the Design for Additive Manufacturing. It covers the domain knowledge from industry experts and applications of additive manufacturing.

It also covers the know-how of designing lightweights parts, using a topological optimization process and finding the design that best meets requirements.

Upon completion, you will understand the end-to-end process of Additive Manufacturing, including materials, design, safety considerations and market needs. You will be able to implement methodologies, design and validate parts for Additive Manufacturing.

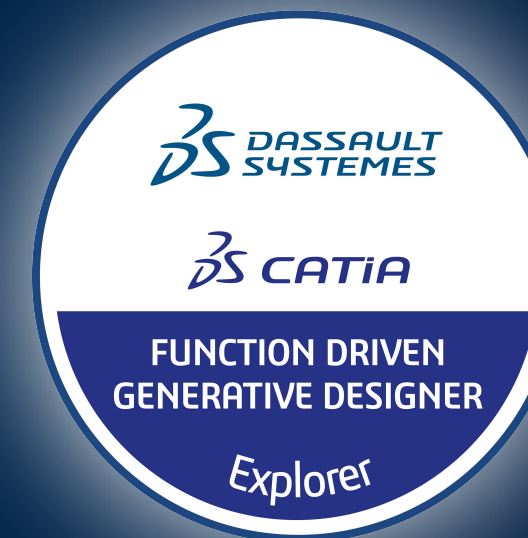
This learning Experience has been developed in collaboration with **AddUp**, leader in Metal 3D Printing machines and Additive Solutions.



Now, prepare to earn your own certificates and digital badges from Dassault Systèmes!

To know more about our Certification Program

<https://www.3ds.com/training/certification-program/>



TESTIMONIALS

Our experts share their views about the disciplines, how they envision the evolution of the Additive Manufacturing Designer job, and the skills needed today and required in the future.

Jeswin Joseph Chankaramangalam

Program Manager | Research Manager, Emerging Technologies & CAD/CAM at National Institute for Aviation Research (NIAR), Wichita State University

NIAR has recently observed a growing interest for AM. Jeswin stated they are in the process of developing WSU AM-focused trainings. People attending this training will be developing the following skills: “Design for AM, Optimization, Material Properties, Process development, What can and cannot be printed, Different types of AM technologies”. According to him, “AM designers are going to be expected to know how to model AM parts and Materials & Processes engineers will be expected to understand material properties and their specific applications. Finally, Stress engineers are going to need to know how AM can be analyzed for part integration”. “AM can handle a variety of applications, from parts to molds. But the lack of AM knowledge creates the assumption that AM can replace traditional machining completely, which is not true!”, Jeswin concluded.



AM designers are going to be expected to know how to model AM parts.

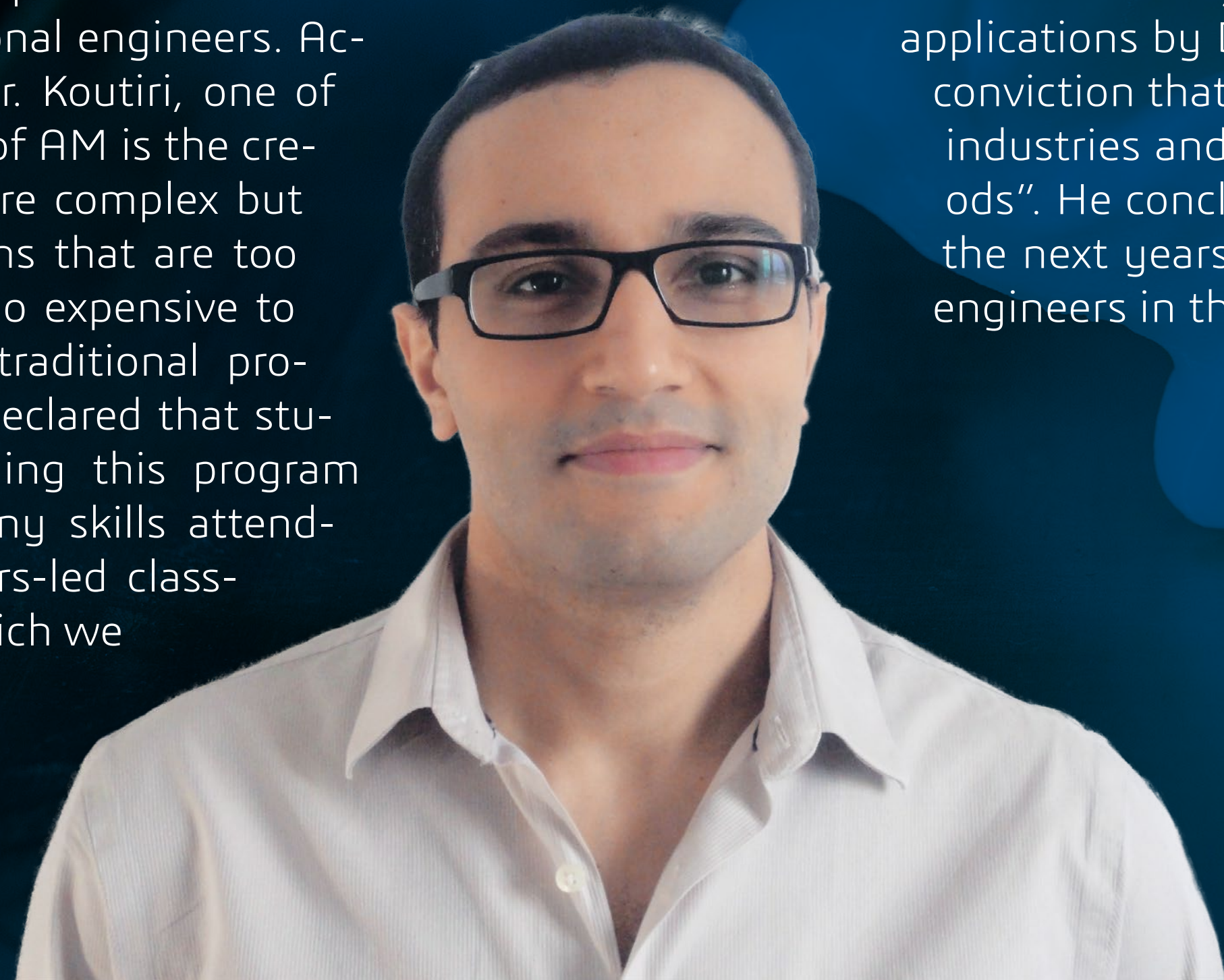


Imade KOUTIRI

Assistant Professor in charge of Materials and Additive Manufacturing (MADMAN) curricula at ENSAM (Ecole Nationale Supérieure d'Arts et Métiers)

Imade Koutiri who was interviewed during the COVID-19 lockdown shared with us a few key highlights of the AM market and gave some details about curricula dedicated to materials and Additive Manufacturing (MADCAM) that ENSAM introduced in 2015. This program is a 150-hour curriculum, and is open to their students and professional engineers. According to Mr. Koutiri, one of the benefits of AM is the creation of "more complex but lighter designs that are too difficult or too expensive to build using traditional processes". He declared that students attending this program "develop many skills attending instructors-led classrooms, in which we

give them some knowledge about the processes and materials. Our students are very interested in this new technology because it is fun and it allows developing their creativity". Their students practice, test their products and use the materials in lab sessions. He added they could also practice "numerical exercises using the **3DEXPERIENCE** platform applications by Dassault Systèmes. We have the conviction that AM brings a new philosophy to industries and can change the working methods". He concluded that "they are sure that in the next years, the request for the number of engineers in this discipline will increase."





Recruiting experts in AM is difficult but this lack is compensated by young profiles that are very attracted by this exciting technology.

DfAM is definitively the Top1 skill to be successful on AM, but soft skills are also key to understand and anticipate other actors' challenges.

We are training our customers and internals on AM in an innovated manner: We are introducing serious games that are very adapted to the AM discipline!



FRÉDÉRIC PARISOT
AM Training Engineer, AddUp

Mr. Frédéric Parisot, working at AddUp, leader in AM solutions, shared with us his expertise as a training engineer in AM. According to him, the AM discipline is not yet much covered at universities or in engineering schools. Consequently, the AM skill remains rare on the market, and soft skills are key to be able to adapt to this new and complex technology.

Mr. Parisot said that a designer should rethink the way he designs objects, integrate new free shapes and constraints that are all interconnected, within multidisciplinary teams. Indeed, all actors involved in an AM project must collaborate altogether from the start so each team integrates its own constraints. This is where the AM processes really differ from the traditional techniques.

In terms of trainings, Mr. Parisot said AddUp proposes a serious games offer to their customers and employees as traditional trainings are not adapted to AM technology, though it is important to innovate and propose new training formats that are more fun.

It's definitely a promising technology!

“

A designer is required to design, innovate and bring new ideas to the reality.

We are entering in an era where the new parts are developed with AM in the mindset. Thus the job has evolved and it's more fun!

Rhushik is head of AM division at Yamaichi Special Steel, a Japanese company that specializes in Steel manufacturing and post processing. He gives “freedom to his designers to create the most eccentric designs which still follow the manufacturing rules”.

In terms of recruitment, he declared “it is difficult to recruit experienced profiles, but his company focuses on trying to recruit fresh graduates not yet limited by conventional manufacturing”.

According to Rhushik, different skillsets are required, such as a strong “Mechanical and Mathematical knowledge is required in AM to push the design limits”. He added that “Engineers and designers are also required to know the basic of operation of 3D printing, thus they know better the limits of the technologies”. The AM designer job did evolve, but now enters a new era: until now, it aimed at “adapting the conventionally designed parts to make them manufacturable”.



RHUSHIK MATROJA
Head of AM division,
Yamaichi Special Steel

“

Do not wait, and go ahead, the journey is very promising!

The 3DEXPERIENCE platform not only brings together all the needed pieces of software, but it also makes real-time collaboration possible.



DANIEL PYZAK
CATIA Mechanical Worldwide
Technical Director, Dassault
Systèmes

According to Daniel, a good AM engineer needs multiple skills: CAD modeling, some FEA know-how (topology optimization is based on FEA) and a good understanding of the advantages but also the constraints of the technology. A plus could be some knowledge on metallurgy (metal AM is like welding: you start from solid stated (powder), it melts (liquid state) and it solidifies).

He also added that the **3DEXPERIENCE** platform influences the evolution of the job! “It does not only bring together all the needed pieces of software but it also makes real-time collaboration possible, reducing the risk of errors, reducing the lead time and allowing to harvest collective intelligence: the AM operator can, for example, give some feedbacks to the designer to optimize even further the design.”

Daniel finally gave some inputs to the companies about the deployment of the technology: first step would be “to print parts designed traditionally, then to print topology-optimized parts and the ultimate goal to create completely new designs that take all the benefits of the technology”.

CONCLUSION

You got it now! Additive Manufacturing opens new horizons as part of multiple technological innovations for the Future of the Industry.

AM is presented as an answer to one of the challenges that today's engineers are facing: innovate more, with more agility, in a more sustainable way. Designers and engineers have the capability to design and imagine products that are beneficial for the environment, society and the economy.

Thus, AM offers new evolution perspectives to designers that want to specialize themselves and innovate more. Thanks to a growing training offer for AM, Engineering students will be having more possibilities to learn the basics and deep dive into that discipline and professionals to improve

their skillset and new ways to collaborate, through multi. More and more jobs using AM techniques are going to be introduced in this emerging market.

Additive Manufacturing really opens doors for the future!



BIBLIOGRAPHY & CONTRIBUTORS

Bibliography

Ceramic 3D printing, a market in full growth, October 2018, Michelle S, <https://www.3dnatives.com/en/ceramic-3d-printing-market-growth-101020184/>

Reports and Data 3D Printing (Additive Manufacturing) Market Size, Share & Trends Analysis Report by Technology, by Manufacturing, by End-User, by Region, Competitive Strategies and Segment Forecasts', 2016-2026, August 2019

COVID-19 and 3D Printing by Steve Banker, April 13, 2020, Forbes, <https://www.forbes.com/sites/stevebanker/2020/04/13/covid-19-and-3d-printing/#2ede21303f7a>

Safran Additive Manufacturing Campus : un nouveau site dédié à la fabrication additive, <https://www.safran-group.com/fr/media/safran-additive-manufacturing-campus-un-nouveau-site-dedie-la-fabrication-additive-20200312>

La fabrication additive métallique : Marché et métiers', Etude Nationale, Feb 2019, <https://www.observatoire-metallurgie.fr/analyses-previsions/la-fabrication-additive-metallique-marche-et-metiers>

LinkedIn website, <https://www.linkedin.com>

Fortune Business Insights infographics, <http://www.fortunebusinessinsights.com>

What is Additive Manufacturing?, <https://www.3dnatives.com/en/3d-technologies/>

Le marché mondial de l'impression 3D atteint les 9,3 milliards de dollars en 2018, Alexandre Moussion, Dec 2018, <http://www.primante3d.com/chiffres-fabrication-additive-14122018/>

Le marché de l'impression 3D en France en 7 chiffres clef', Jan 2020, <http://www.primante3d.com/impression-3d-emploi-22032018/>

Impression 3D : Zoom sur le métier de responsable de production', July 2017, <http://www.primante3d.com/donnees-francaises-31012020/>

Additive Manufacturing Market To Reach USD 23.33 Billion By 2026, March 2018, Reports and Data at <https://www.globenewswire.com/news-release/2019/03/18/1756526/0/en/Additive-Manufacturing-Market-To-Reach-USD-23-33-Billion-By-2026.html>

From Additive Manufacturing to 3D/4D Printing 1: From Concepts to Achievements', Jean-Claude André, Oct 2017

ESCO website, <https://ec.europa.eu/esco/portal/occupation>

Usine du futur, bâtiment du futur, 12 métiers en émergence – revue de tendances 2019, publication CESI & APEC, <https://www.defi-metiers.fr/sites/default/files/users/229/cesi-apec-2019.pdf>

Fabrication additive : Préparer l'industrie de demain, Industrie 4.0, May 2018, <https://www.usinenouvelle.com/article/fabrication-additive-preparer-l-industrie-de-demain.N699384>

Dassault Systèmes website, <http://www.3ds.com>

Contributors & Authors

Jeswin J. Chankaramangalam, Program Manager | Research Manager, Emerging Technologies & CAD/CAM at National Institute for Aviation Research (NIAR), Wichita State University

Imade Koutiri, Professor at ENSAM, Ecole Nationale Supérieure d'Arts et Métiers

Rhushik Matroja, Head of Additive Manufacturing division, Yamaichi Special Steel

Frédéric Parisot, AM Training Engineer at AddUp

Josh Cramer, Education and Workforce Development Director, America Makes

Daniel Pyzak, CATIA Mechanical Worldwide Technical Director, Dassault Systèmes

Terrence Drula, Senior Communication Manager / Copywriting - Corporate Publishing, Dassault Systèmes

Valérie Ferret, **3DEXPERIENCE** Edu Vice President, Dassault Systèmes

Natacha Bécard, **3DEXPERIENCE** Edu Hub Senior Manager, Dassault Systèmes

Anne-Laure Vaudoit, **3DEXPERIENCE** Edu Hub Specialist, Dassault Systèmes



The **3DEXPERIENCE**[®] Company