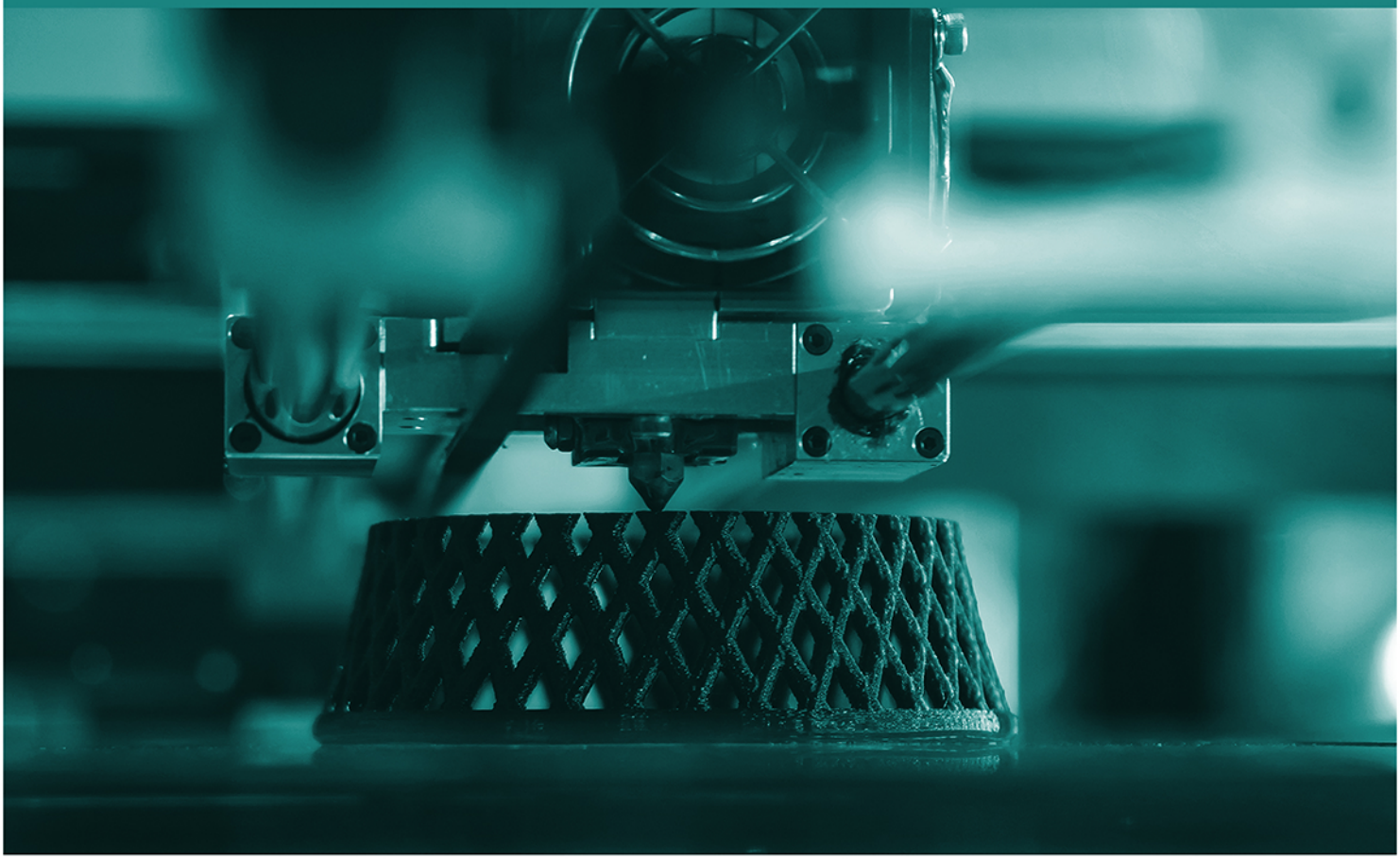
SECTOR SKILLS STRATEGY IN ADDITIVE MANUFACTURING

Project No. 601217-EPP-1-2018-1-BE-EPPKA2-SSA-B

Additive Manufacturing Foresight Report

Executive Summary



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The **Sector Skills Strategy in Additive Manufacturing** (SAM) ERASMUS+ project is a strategic approach to skills in Additive Manufacturing (AM), which is developing a dynamic forecast methodology focused on skills gaps, shortages and mismatches identification, anticipation, and validation, in order to develop and/or revise qualifications and profiles in AM with the engagement of relevant stakeholders within the European and National landscapes.

The project's outcomes has already shown that implementing Additive Manufacturing (AM)/3D printing requires investment in workers' skills and know-how at an unprecedented scale, in such a way as to allow the current workforce to reskill and adjust to the new reality.

The work conducted by the SAM consortium is of crucial importance to ensure that the European AM sector expands and grows relying on a highly trained and knowledgeable workforce.

SAM's data collection and feedback phases allowed for the identification of gathered skills gaps and demands of the AM gaps and shortages were framed according to different scenarios:

- **Scenario 1:** Real case, in which extent skills need to be addressed in less than 1 year.

- **Scenario 2:** Short-term, how relevant skills / trends need to be addressed in the less than 3 years.

- **Scenario 3:** Foresight scenarios, how relevant skills / trends need be addressed in the future, within the next 10 years.

The current summary focus on with evaluating and forecasting the skills, trends, and developments related to AM until 2030. Findings are based on data from multiple rounds of activities, including an initial skill forecast workshop with AM experts, and two rounds of follow-up surveys (i.e., Delphi method) with AM experts experts from industry, academic institutions, research, and technological centres. The participants were from various sectors, including aerospace, construction, defence, energy, industrial equipment, and tooling.

Some of the key findings from the foresight analyses revealed that:

1. The main AM materials that will be used in the next 10 years are **Aluminium, Copper, Inconel** (i.e., nickel-chromium-based superalloys) and **Titanium**.

2. The new AM materials that will be developed in the next 10 years include **composites, functionally graded materials**, and **metal alloys**.

3. The main AM processes that will be used in the next 10 years are **AM processes for bioprinting, Directed Energy Deposition (DED), Metal Binder Jetting (MBJ)** and **Powder bed fusion (PBF)**.

4. The major sectors/industries that will be heavily affected by AM in the next 10 years are the **aerospace**, **automotive** and **health sectors**.

5. For the aerospace sector, the main parts that will be produced with AM are **fuel nozzles** and **systems**, **guide vanes** and **turbine blades**. For the automotive sector, the main parts that will be produced with AM are **spare parts**, **low volume interior parts** and **engine components**. For the medical sector, **implants, prosthetics,** and **surgical models**.

6. The main occupations in AM in the next 10 years will be **AM designers, process experts** and **R&D experts**.

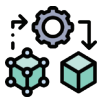
7. The main expected developments and technological trends in AM in the 10 years include **the establishment of AM in series production**, availability of more public standards available in different areas (design, feedstock, processes, personnel, machine, etc.), **development of new materials**, **cost reduction** and more reliable simulation techniques for most AM technologies.

8. The major implications of the developments/trends on the AM labour market will lead to more **digital experts** (data managers, niche experts for processes and algorithms, etc.), **reskilling people** from the "conventional" processes to AM technology and more **robust simulation techniques**.

9. The main AM areas that will foresee a reduction of costs in the next 10 years are **AM machines** and **equipment**, **AM materials** and **feedstock** and **AM post-processing stages**.

10. The major AM areas that will require the development of professional standards are **AM materials**, **AM processes**, **AM design** and **modelling**, and **AM equipment** and **software**.

AM value chain and trends for the next 10 years (2021 - 2030)

AM value chain	Expected developments and technological trends	Impact on skills and occupations
Modelling & Design 	• Availability of more public standards for modelling & design • More reliable simulation techniques for most AM technologies	• More training qualifications and public standards to ensure the widespread application of AM technologies. • Increased need for more **AM supervisors, digital experts, data managers and specialists** to develop new AM processes and algorithms. • Training for diferent roles, such as **AM supervisor, AM engineer, AM designer** to become qualified. • Predicted occupations include **process experts, data manager / miners, AM designers** and **AM operators**. • Increased need for AM workers to know the overall AM process suply chain. • Occupations that will benefit the **reskilling** from "conventional" processes to AM technology include **welding inspectors, coordinators, operators** and **designers**. • Higher uptake of AM across more industries and sectors.
Materials 	• Cost reduction across AM materials and feedstock • Main materials will include **aluminium, copper, Inconel** (i.e. nickel-chromium-basedsuperalloys) and **titanium** and emerging materials will include **hybrid materilas, composites, functionally graded materials** and **metal alloys** • Availability of more public standards for materials	
Processes 	• Main processes will include **bioprinting, directed energy deposition, metal binder jetting** and **powder bed fusion** • Cost reduction across AM machines and equipment • Workflow simplification, increased automation and establishment of AM in series production • Combination of multiple AM processes for efficient manufacturing • Availability of more public standards for AM equipment and software	
Post-Processes 	• Cost reduction for post-processing • Availability of more public standards for post-processing stages	
Products 	• Am products with larger dimensions • Cost reduction and development of standards for AM products • The major sectors will be the **aerospace, automotive** and **medical sectors** • For aerospace, the main AM parts will be fuel nozzles and systems, guide vanes and turbine blades • For automotive, the main AM parts will be spare parts, low volume interior parts and engine components • For medical, the main AM parts will be implants, prosthetics and surgical models	
End-of-Life 	• Availabilty of established processes and more public standards for end-of-life processing • Cheaper end-of-life processing options	

Full report is available in ***SAM website*** (http://www.skills4am.eu/results.html)

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