SECTOR SKILLS STRATEGY
IN ADDITIVE MANUFACTURING

2.3 Short Term Scenarios' Kit M34

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Table of Contents

1. Introduction

The current kit is produced in the framework of WP2, which covers SAM's forecast methodology: assessment of current and future skills in AM. SAM's Forecast Methodology is structured into three scenarios sequenced in time f The kit reported here relates to the identification of short term skills requirements (Scenario 2 I.e to be addressed within a timeframe of three years). Different tools will be used for data collection, such as the surveys which are included in this kit. They will be used to identify the professional profiles and general core activities to be undertaken within each profession.

D2.3 encompasses the guidelines for the collection of Short-term Scenarios and details the following information:

- To whom is each tool targeted at;
- Inputs and outputs of the tool;
- Steps to be implemented and resources
- Timeframe to use the tool;
- Expected number of stakeholders and targets involved.

The implementation of the current kit for short-term scenario will serve as input to the methodology for revising, creating professional profiles and developing skills (WP3) and for the workshops conducted in the AM Observatory (WP4).

In summary:

D2.3 Short term Scenarios Kit	
AIM	Identify the short-term skills (3 years).
TOOLS USED	Surveys and interviews Brainstorming World cafe
TO WHOM	Industry (working and aiming to work in AM) Research and technology centres Training centres AM workers /professionals Recruitment Agencies
INDICATOR/LEVEL OF IMPACT	250 answers per target group
INPUT	Literature review and job offers; Analysis of the contents from previous interviews and surveys applied in the short term (3 years)
OUTPUT	Indication of emerging professional profiles. Identification of the need to review, update and/or development of qualifications and/or "Competence Units" Data on AM skills needs and up- or re-skilling existing professionals
TIMELINE	Every 3 years

2. Methodology

Figure 1 summarises the methodology to be followed in the short-term scenario in order to identify skills that need to be addressed in the timeframe of three years.

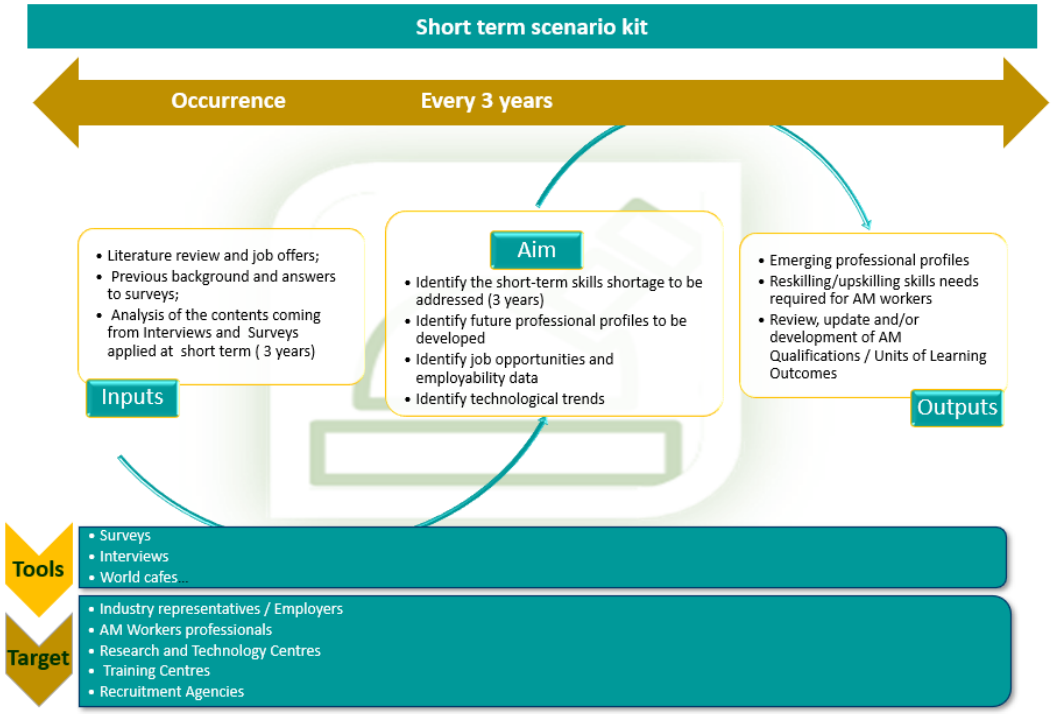

Figure 1 - Methodology applied for the Short-Term scenario

During the data collection and feedback phase, the information gathered on skills gaps and shortages are framed according to different scenarios established in the SAM project (1, 3 and 10 years respectively).

In terms of **scenario 2** (3 years), five groups were selected as target groups for "Short term Scenarios" with the aim of understanding how and to which extent skills apply or need to be addressed within 3 years. The involvement of these groups is explained in Table 1 below.

WHO?	WHY?
INDUSTRY/EMPLOYERS	To find out their future needs regarding AM skills and identify possible future gaps
CURRENT WORKFORCE/ PROFESSIONALS	To find out their future needs regarding technological green, digital and entrepreneurial skills
RECRUITMENT AGENCIES	To find out labour market job opportunities and employability in AM /3D printing

RESEARCH / TECHNOLOGY CENTERS	To find out which new technologies are appearing, and consequently which skills will be required in the future
TRAINING CENTERS	To map and identify future training offers /practices and challenges

Table 1- Target groups in scenario 2 (short term, 3 years)

3. Tools and templates

The tools to be used to collect data from the short-term scenario are surveys, interviews, brainstorming and world cafes. An explanation of the different target groups for Scenario 2 (3-year plan) are detailed in the section below.

3.1 Surveys

3.1.1 Survey to Industry/ Employers

The survey targets current AM and potential employers from industry in order to ask about their workers AM profiles/skills. For this, an "analysis phase" is taking place in which the AM skill needs and possible existing gaps will be identified.

The survey template, which should be used for the companies involved or willing to be involved in AM in a 3-year period is provided below:

Survey Introductory text:

Welcome to our survey on Additive Manufacturing Skills!

SAM is a European initiative addressing the workforce development for Additive Manufacturing (AM) by creating a common vision on skills and collaborative learning solutions for AM at European level.

We would like to know what kind of AM skills you look in a candidate taken into account the short-term needs (within the next three years) of your company.

The survey lasts approximately 5 to 10 min and is composed of two different sections:

- *Section 1: General info and background*
- *Section 2: Skills and profile needs*

Please take into account that some questions admit multiple choices, as indicated in the specific question text.

Thank you for helping us in designing Europe's AM workforce future!

The participation in this survey is anonymous and voluntary. By replying to it, you are consenting that the SAM project partners can process the data collected in conformity with the Contract Agreement signed with the EACEA. For any additional clarification, please contact ewf@ewf.be

Moreover, a prioritisation exercise has been carried out in order to select key questions to produce a shorter version of the survey. This short version will be applied in internal or external

events where industry is present to secure more replies. Tools such as Slido, Mentimeter or similar can be used for this purpose.

Survey:

Section 1: General info and background

Question 1. What type of organisation do you work for?
(only 1 can be chosen): •Start-up •Small-and medium-sized company •Large company •Industrial association •Other (please specify which)

Question 2. In which country is your organisation based? (dropdown question)
Austria Belgium Bulgaria Croatia Republic of Cyprus Czech Republic Denmark Estonia Finland France Germany Greece Hungary Ireland Italy Latvia Lithuania Luxembourg Malta Netherlands Poland Portugal Romania Slovakia Slovenia Spain Sweden UK Other (please specify which)

Question 3. Please indicate the name of your organisation

Question 4. What is your role within your organisation?

Question 5. What is the main activity/sector of your organisation?
(Several answers can be chosen) •Aerospace •Automotive •Defence •Consumer Goods •Construction •Energy •Health and Medical •Industrial equipment and tooling •Other (please specify)

Question 6. Is your organisation currently using AM?
(*only 1 can be chosen*): •Yes •No

ROUTE 1: If answering YES to Question 6

Question 7 (6.1) Please indicate the AM area that your organisation is most involved in?
(*only 1 can be chosen*): •R&D •Service bureau •Original Equipment Manufacturers (OEMs) •Material Provider •Software Provider •Design •End-user •Other (please specify)

Question 8 (6.2): Which AM material/s will you mainly use in three years' time?
(Several answers can be chosen) •Metals •Plastics •Ceramics •Composites •Biomaterials •Multi-materials •Other (please specify)

Question 9(6.3): Which AM process/es will you mainly use in three years' time?
(Several answers can be chosen)

•Powder Bed Fusion •Vat Photopolymerization •Material Jetting •Material Extrusion •Sheet Lamination •Directed Energy Deposition •Binder Jetting •All of them •Other (please specify)

Section 2: Profiles and Skills needs

Question 10 (6.4) – For your future activities, indicate which AM professional profiles will be more required in your company?	**In 3 years' time**
• Designer • Process Engineer • Inspector • Inspector Technician • Non Destructive Testing Technician • Supervisor • Coordinator at the Engineer level • Metrology Engineer • Materials Engineer • Operator/Technician • Digital Expert • Data Manager • Quality Manager • Business Manager • Human Resources Technician • Other (please specify the AM profile)	

Question 11 (6.5). - For your future activities, indicate in which of the following AM domains knowledge will be required?	**In 3 years time**
(Several answers can be chosen) • AM processes • Numerical modelling/ topology optimisation • Design • Structural integrity • Metallurgical aspects • Pre-processing & material handling • Process control • Post-processing • Quality monitoring • Standardisation and certification • Testing/quality control	

• Environment, health, safety (EHS) • Resource efficiency/sustainability • Costs/ business models • Communication, marketing and sales • Other (please specify)	

Question 12 (6.6). For your future activities, indicate for which tasks you will need qualified personnel? *(Several answers can be chosen)*	**In 3 years' time**
• Performing AM Machines operations • Developing and building AM Machines • Developing solutions for AM processes • Development of AM materials • Characterization of AM materials • Designing AM solutions • Performing Post-processing operations • Coordinating AM tasks distribution • Performing AM product life cycle • Assessing technical and financial viability of AM implementation • Performing AM business strategies implementation • Other (please specify)	

Question 13 (6.7). - For your future activities, indicate which digital skills will be needed? *(Several answers can be chosen)*	**In 3 years' time**
• Digital data analysis (Artificial intelligence/ machine learning...) • Digital data management (Big data, statistics…) • Digital data analytics (Artificial intelligence, machine learning) • Ability to think 3D • Cybersecurity • Coding/programming • Other (please specify)	

Question 14 (6.8). For your future activities, indicate, which entrepreneurial skills will be needed by the AM Professionals 3 years' time? (*Several answers can be chosen*)	**In 3 years' time**
• Identify needs and challenging opportunities to create value • Develop creative and purposeful ideas /solutions • Visualize future scenarios to help guide effort and action • Assess the impact of ideas, opportunities and actions • Identify and assess individual and group strength and weaknesses • Be resilient under pressure • Gather and manage required resources • Develop financial and economic know-how • Communicate effectively, negotiate and lead • Take the initiative • Prioritise, organise and follow up • Make decisions dealing with uncertainty, ambiguity and risk • Work with others • Learn through experience • Other (please specify)	

Question 15 (6.9). For your future activities, indicate which green skills will be needed by the AM Professionals?	**In 3 years' time**
• Resource efficiency management • Life cycle analysis (LCA) • Eco-design • Reuse/recycling AM materials and products • Green resources • Green products • Green awareness • Other (please specify)	

Question 16 (6.10) Do you expect to extent your AM business/usage within the next three years?
(One answer) •Yes •Likely

- Not in the next 3 years

ROUTE 2: If answering NO to Question 6

Question 7: Do you plan to use / implement AM technologies in your organisation in the future?
(*only 1 can be chosen*): • Yes • Likely • Not in the next three years

* if answering "yes /likely"

Question7a: How do you plan to use and implement AM Technology?
• By reskilling/upskilling staff for AM • By hiring staff specialized in AM • Other (please specify)

If answering **NOT to Question 7- Please explain why. (END of survey)*

Your Survey is now completed!

Thank you for helping us designing Europe's AM workforce future!

For further information visit our website www.skills4am.eu

17. Please indicate your email address to be informed about the survey results.

Survey short version

Question 1. What is the main activity/sector of your organisation?
(Several answers can be chosen) • Aerospace Automotive • Defence • Consumer goods • Construction • Energy • Health and Energy • Industrial equipment and tooling • Other (please specify)

Question 2. For your future activities, indicate which AM professional profiles will be more required in your company?	**In 3 years' time**
• Designer • Process Engineer • Inspector • Inspector Technician • NDT Technician • Supervisor • Coordinator at the Engineer level • Metrology Engineer • Materials Engineer • Operator/Technician • Digital Expert • Data Manager • Quality Manager • Business Manager • Human Resources Technician • Other (please specify the AM profile)	

Question 3. For your future activities, indicate for which tasks you will need qualified personnel? *(Several answers can be chosen)*	**In 3 years' time**
• Performing AM Machines operations • Developing and building AM Machines • Developing solutions for AM processes • Development of AM materials • Characterization of AM materials • Designing AM solutions • Performing post-processing operations • Coordinating AM tasks distribution • Performing AM product life cycle • Assessing technical and financial viability of AM implementation • Performing AM business strategies implementation • Other (please specify)	

Question 4. For your future activities, indicate which digital skills will be needed? *(Several answers can be chosen)*	**In 3 years' time**
• Digital data analysis (Artificial intelligence/ machine learning...) • Digital data management (Big data, statistics,...)	

• Digital data analytics (Artificial intelligence, machine learning) • Ability to think 3D • Cybersecurity • Coding/programming • Other (please specify)	

Question 5. For your future activities, indicate, which entrepreneurial skills will be needed by the AM Professionals ? *(Several answers can be chosen)*	**In 3 years' time**
• Identify needs and challenging opportunities to create value • Develop creative and purposeful ideas /solutions • Visualize future scenarios to help guide effort and action • Assess the impact of ideas, opportunities and actions • Identify and assess individual and group strength and weaknesses • Be resilient under pressure • Gather and manage required resources • Develop financial and economic know-how • Communicate effectively, negotiate and lead • Take the initiative • Prioritise, organise and follow up • Make decisions dealing with uncertainty, ambiguity and risk • Work with others • Learn through experience • Other (please specify)	

Question 6. For your future activities, indicate which green skills will be needed by the AM Professionals?	**In 3 years' time**
Resource efficiency management Life cycle analysis (LCA) Eco-design Reuse/recycling AM materials and products Green resources Green products Green awareness Other (please specify)	

3.1.2 Survey to Research and Technology Centres

The survey targets at research and technology centres working with AM to find out what are the main challenges being addressed in AM R&I (research and innovation), what new technologies are appearing and, consequently, the survey shall help to identify the future AM skills require.

Moreover, a prioritisation exercise has been carried out in order to select key questions to produce a shorter version of the survey. This short version will be applied in internal or external events addressing research and technology centers and take profit of their presence to get more replies. Tools as Slido or Mentimeter or other of the same kind can be used for this purpose.

The survey template to be used for the research and technology centres is provided below:

Survey Introductory text:

Welcome to our survey on Additive Manufacturing (AM) Skills for Research & Technology entities!

SAM is a European initiative addressing workforce development for Additive Manufacturing (AM) by developing a common vision on work skills and collaborative learning solutions for the sector at the European level (www.skills4am.eu).

We would like to know how AM technology is evolving, what are the main challenges and trends for AM and consequently, which skills will be required.

The survey lasts for approximately 5 to 8 min. It is split into two sections:

- *Section 1: General info and background*
- *Section 2: AM trends and their impact on skills needs*

Please take into account that some questions admit multiple choices, as indicated in the specific question text.

Thank you for helping us designing the future of Europe's AM workforce!

Participation in this survey is anonymous and voluntary. By replying to it, you consent that SAM project partners process the data collected in conformity with the Contract Agreement signed with the EACEA. For any additional clarification, please contact ewf@ewf.be

Survey:

Section 1: General info and background

Question 1. What type of organisation do you work for?
Options (*only 1 can be chosen*): •University •Research Centre •Technology centre •Other (please specify which)

Question 2. In which country is your organisation based? (dropdown question)
Austria Belgium Bulgaria

Croatia
Canada
China
Republic of Cyprus
Czech Republic
Denmark
Estonia
Finland
France
Germany
Greece
Hungary
Ireland
Italy
Japan
Latvia
Lithuania
Luxembourg
Malta
Netherlands
Poland
Portugal
Republic of Cyprus
Romania
Slovakia
Slovenia
Spain
Sweden
Turkey
United Kingdom
Other (please specify which)

Question 3. Please choose your gender.

- Male
- Female
- N/A

Question 4. Indicate the name of your organisation

Free Space

Question 5. What is your role within your organisation?

Free Space

Question 6. What is the main sector/s where your organisation is working on with regards to AM?

(Several answers can be chosen)

- Aerospace
- Automotive
- Defence
- Consumer
- Construction
- Energy
- Health and Medical
- Industrial equipment and tooling
- Other (please specify)

Question 7: Indicate the AM value chain position/s in which your organisation is mainly involved in?

(Several answers can be chosen)

- Modelling/Simulation
- Design
- Materials
- Process
- Products
- Post-processing
- End of life
- Other (please specify)

Question 8: Which AM material(s) do you mainly use or research on?

(Several answers can be chosen)

- Metal
- Plastic
- Ceramic
- Composite
- Biomaterials
- Multi-materials
- Other (please specify)

Question 9: Which AM process(es) do you mainly use/research on?

(Several answers can be chosen)

- Powder Bed Fusion
- Vat Photopolymerisation
- Material Jetting
- Material Extrusion
- Sheet Lamination
- Directed Energy Deposition
- Binder Jetting
- Other (please specify)

Section 2: AM trends and their impact on skills needs

Question 10. - Identify the industrial sector(s), whether you expect to be involved in AM R&D&I activities for the next three years ?
Options (*more than one answer is possible*): • Aerospace • Automotive • Health • Consumer goods • Electronics • Energy • Industrial equipment and tooling • Construction • Other (please specify)

Question 11. - Please identify the value chain segment in which R&D&I activities will be mainly focused on in the next three years?
Options (*more than one answer is possible*): • Modelling & simulation • Design • Materials • Process *(including equipment & ICT)* • Post-processing • Product *(including quality assessment & testing)* • End of life • Other (please specify)

Question 12-Rate from 1 to 4, the relevance of the different materials for your R&D&I activities within the next three years.	**3 years**			
	1 (low)	2 (regular)	3(high	4(very high)
• Metal				
• Polymer				
• Ceramic				
• Bio-material				
• Multi-material				
• Composite				
• Other (please specify)				

Question 13. -Rate from 1 to 4, the relevance of the different AM process(es) for your R&D&I activities within the next three years	**3 years**			
AM Process(es)	1 (low)	2(regular)	3 (high)	4(very high)
• Powder Bed Fusion (PBF)				

• Vat Photopolymerisation (VP)				
• Material Jetting (MJ)				
• Material Extrusion (ME)				
• Sheet Lamination (SL)				
• Directed Energy Deposition (DED)				
• Binder Jetting (BJ)				
• Other (please specify)				

Question 14. Which of the following AM material trends will your R&D&I activities address in the next three years?

(Several answers can be chosen)

- Implementation of new materials for applications and products
- Qualification, Certification and Standardisation of new materials
- Different forms of material feedstock (wires, pellets, sand, wax) for AM applications
- Thermo-mechanical modelling to validate mechanical/thermal properties of existing/new materials
- Environmental impact, LCA and Circular Economy
- Fit-for-purpose materials
- Multi-materials and functionally graded materials
- Hybrid materials, composites and metal alloys
- Use of recycled AM materials
- Materials for Bioprinting, Bio-compatible materials/ bio materials
- Materials for 4D printing (e.g. Shape memory alloys, shape memory polymers, etc.)
- Metamaterials
- None
- Others (Please specify)

Question 15. Which of the following AM process trends will your R&D&I activities address in the in three years?

- *(*Several answers can be chosen)
- Software interoperability
- More agile design for AM development frameworks
- Multiscale and multiphysics AM modeling
- Generative design
- Massive use of desktop and benchtop AM machines
- Faster build times for AM machines
- Production of AM products with larger dimensions
- New or increased automation concepts at machine level
- Hybrid machines
- More accurate in-situ monitoring
- Combination of multiple processes for efficient manufacturing
- AM machines for multi-materials
- Multifunctional parts, including parts with embedded sensors
- Connected modular printers operated by robots
- AM processes for bioprinting
- New business models enabled by AM
- Reduction of energy, resource consumption and environmental impacts of AM processes
- Other (Please specify)

Question 16. Which of the following AM post-processing trends will your R&D&I activities address in the next three years?

(Several answers can be chosen)

- Automation of support removal
- Improved and new heat treatments methods (sintering, HIP…)
- Debinding process
- Automation of surface finishing
- New surface finishing treatments
- Automation of powder/resin removal
- New coating and drying treatments
- Design to minimize post-processing
- New quality standards for post-processing
- Better material recovery for post-processing
- Better control of waste from post-processing
- More recycling options for AM materials
- Other (Please specify)

Question 17. Which of the following ICT and quality AM related trends will your R&D&I activities address in three years ?

(Several answers can be chosen)

- Advanced monitoring and acquisition systems
- Advanced data analytics based on machine learning and artificial intelligence
- Advanced close-loop controls for automated adaptation
- Integration of AM in Total Quality Management (TQM) systems
- Improved AM process control
- New inspection techniques
- Non-destructive testing
- Digital-twin
- Better and more accurate predictive analysis
- None
- Other (Please specify)

Question 18. In your opinion, has covid-19 fostered AM development in your organisation?

- Yes
- No

If yes to Q18

Question 19. Name the three areas within your organization where AM development are expected to increase due to covid-19.

Your survey is now completed!

Thank you for helping us designing Europe's AM workforce future!

For further information, visit our website: https://www.skills4am.eu/

18. Please indicate your email address to be informed about the survey results.

Survey short version

Question 1. What is the main sector/s where your organisation is working on with regards to AM?
(Several answers can be chosen) •Aerospace •Automotive •Defence •Consumer •Construction •Energy •Health and Medical •Industrial equipment and tooling •Other (please specify)

Question 2. Which of the following AM material trends will your R&D&I activities address in the next three years?
(Several answers can be chosen) •Implementation of new materials for applications and products •Qualification, Certification and Standardisation of new materials •Different forms of material feedstock (wires, pellets, sand, wax) for AM applications •Thermo-mechanical modelling to validate mechanical/thermal properties of existing/new materials •Environmental impact, LCA and Circular Economy •Fit-for-purpose materials •Multi-materials and functionally graded materials •Hybrid materials, composites and metal alloys •Use of recycled AM material •Materials for Bioprinting, Bio-compatible materials/ biomaterials •Materials for 4D printing (incl. memory shape alloys, shape memory polymers, etc.) •Metamaterials •Others (Please specify)

Question 3. Which of the following AM process trends will your R&D&I activities address in the in three years?
(Several answers can be chosen) • Software interoperability • More agile design for AM development frameworks • Multiscale and multiphysics AM modeling • Generative design • Massive use of desktop and benchtop AM machines • Faster build times for AM machines • Production of AM products with larger dimensions • New or increased automation concepts at machine level • Hybrid machines

- More accurate in-situ monitoring
- Combination of multiple processes for efficient manufacturing
- AM machines for multi-materials
- Multifunctional parts, including parts with embedded sensors
- Connected modular printers operated by robots
- AM processes for bioprinting

- New business models enabled by AM
- Reduction of energy, resource consumption and environmental impacts of AM processes
- Other (Please specify)

Question 4. Which of the following AM post-processing trends will your R&D&I activities address in the next three years?

(Several answers can be chosen)

- Automation of support removal
- Improved and new heat treatments methods (sintering, HIP…)
- Debinding process
- Automation of surface finishing
- New surface finishing treatments
- Automation of powder/resin removal
- New coating and drying treatments
- Design to minimize post-processing
- New quality standards for post-processing

- Better material recovery for post-processing
- Better control of waste from post-processing
- More recycling options for AM materials
- Other (Please specify)

Question 5. Which of the following ICT and quality AM related trends will your R&D&I activities address in three years (?

(Several answers can be chosen)

- Advanced monitoring and acquisition systems
- Advanced data analytics based on machine learning and artificial intelligence
- Advanced close-loop controls for automated adaptation
- Integration of AM in Total Quality Management (TQM) systems
- Improved AM process control
- New inspection techniques
- Non-destructive testing
- Digital-twin

- Better and more accurate predictive analysis
- Other (Please specify)

3.1.3 Survey to current workforce/ professionals

Survey addressing AM related professionals from different sectors to find out their specific technical skills needs over the next 3y ears.

Moreover, a prioritisation exercise has been carried out in order to select key questions to produce a shorter version of the survey. This short version will be applied in internal or external events addressing professionals and take profit of their presence to get more replies. Tools such as Slido or Mentimeter or other of the same kind can be used for this purpose.

The survey template to be used with professionals working in AM is provided below.

Survey introductory text:

Welcome to our survey on Additive Manufacturing Skills for AM professionals!

SAM is a European initiative addressing the workforce development for Additive Manufacturing (AM) by developing a shared skills vision and collaborative learning solutions for the sector at European level.

We would like to identify relevant AM skills and new job demanded profiles, which will be translate in future education and training requirements.

The survey is to find out the needs concerning technical skills. It last for approximately 10 min and is structured in two different sections:

- *Section 1: General information*
- *Section 2: Professional profile and future AM skills Needs*

Please take into account that some questions admit only one answer. In the case that multiple choices are possible, it is indicated in the specific question text.

Thank you for helping us in designing Europe's AM workforce future!

Participation in this survey is anonymous and voluntary. By replying to it, you consent that SAM project partners process the data collected in conformity with the Contract Agreement signed with the EACEA. For any additional clarification, please contact ewf@ewf.be

Survey for AM skills workforce

Section 1: General info

Question 1. What type of organisation do you work for?
(*only 1 can be chosen*): • Start-up • Small-and medium-sized company • Large company • Industrial association • University • Training Centre • Research and/or Technology Center • Other (please specify which)

Question 2. In which country is your organisation bases? (dropdown question)
Austria
Belgium
Bulgaria
Croatia
Canada
China
Czech Republic
Denmark
Estonia
Finland
France
Germany
Greece
Hungary
Ireland
Italy
Japan
Latvia
Lithuania
Luxembourg
Malta
Netherlands
Poland
Portugal
Republic of Cyprus
Romania
Slovakia
Slovenia
Spain
Sweden
Turkey
United Kingdom
Other (please specify which)

Question 3. Indicate the name of your organisation

Question 4. What is the main sector of activity/sector of your organisation?
(Several answers can be chosen) • Aerospace • Automotive • Defence • Consumer goods • Construction • Energy • Health and Medical • Industrial equipment and tooling Other (please specify)

Section 2: Professional profile and future AM skills needs

Question 4. What is your current role within your organisation?

Question 5. Accordingly, which of the following profiles fits better with your current role?
• Designer • Process Engineer • Inspector • Inspector Technician • Non Destructive Testing Technician • Supervisor • Specialist at the Engineer level • Metrology Engineer • Materials Engineer • Operator/Technician • Any of them

Question 6. In 3 years', time, which of the following AM roles do you expect to be performing?

- Designer
- Process Engineer
- Inspector
- Inspector Technician
- Non Destructive Testing Technician
- Supervisor
- Specialist at the Engineer level
- Metrology Engineer
- Materials Engineer
- Operator/Technician
- Any of them
- I don't expect any change from my current role

Question 7- Which technological domains you estimate you will need to develop /improve in 3 years' time?

- AM processes
- Simulation
- Topology optimisation
- Design (CAD modelling)
- Structural integrity
- Material analysis and characterisation
- Pre-processing & material handling
- Process control
- Post-processing
- Destructive and Non-destructive testing
- Certification and qualification
- Quality monitoring and control
- Standards
- Environment Health and Safety (HSE)
- Marketing and sales
- Research and innovation
- Other (please specify)

Question 8- Which entrepreneurial skills you estimate you will need to develop /improve in 3 years' time?

(Several answers can be chosen)

- Identify needs and challenging opportunities to create value
- Develop creative and purposeful ideas /solutions
- Visualize future scenarios to help guide effort and action
- Assess the impact of ideas, opportunities and actions
- Identify and assess individual and group strength and weaknesses
- Be resilient under pressure
- Gather and manage required resources
- Develop financial and economic know-how
- Communicate effectively, negotiate and lead
- Take the initiative
- Prioritise, organise and follow up
- Make decisions dealing with uncertainty, ambiguity and risk
- Work with others
- Learn through experience
- Other (please specify)

Question 9 Which digital skills you estimate you will need to develop /improve in 3 years' time?

(Several answers can be chosen)

- Digital data analysis (Artificial intelligence/ machine learning...)
- Digital data management (Big data, statistics…)
- Ability to think 3D
- Cybersecurity
- Coding /programming
- Other (please specify)

Question 10. Which green skills you estimate you will need to develop / improve in 3 years' time ?

Several answers can be chosen)

- Resource efficiency management
- Green awareness
- Life cycle analysis (LCA)
- Eco-design

- Circular economy
- Green resources
- Green products
- Energy Efficiency
- Industrial Symbiosis
- Other (please specify)

Question 11. Thinking in your sector, what are the specific AM requirements that will request specific skills and training?
Free text

Your survey is now completed!

Thank you for helping us designing Europe's AM workforce future!

For further information, visit our website: https://www.skills4am.eu/

12. Please indicate your email address to be informed about the survey results.

Survey short version

Question 1- Which technological domains you estimate you will need to develop /improve in 3 years' time ?

- AM processes
- Simulation
- Topology optimisation
- Design (CAD modelling)
- Structural integrity
- Material analysis and characterisation
- Pre-processing & material handling
- Process control
- Post-processing
- Destructive and Non-destructive testing
- Certification and qualification
- Quality monitoring and control
- Standards
- Environment Health and Safety (HSE)
- Marketing and sales

Research and innovation Other (please specify)	

Question 2 - Which entrepreneurial skills you estimate you will need to develop /improve in 3 years' time?

(Several answers can be chosen)

- Identify needs and challenging opportunities to create value
- Develop creative and purposeful ideas /solutions
- Visualize future scenarios to help guide effort and action
- Assess the impact of ideas, opportunities and actions
- Identify and assess individual and group strength and weaknesses
- Be resilient under pressure
- Gather and manage required resources
- Develop financial and economic know-how
- Communicate effectively, negotiate and lead
- Take the initiative
- Prioritise, organise and follow up
- Make decisions dealing with uncertainty, ambiguity and risk
- Work with others
- Learn through experience
- Other (please specify)

Question 3 Which digital skills you estimate you will need to develop /improve in 3 years' time ?

(Several answers can be chosen)

- Digital data analysis (Artificial intelligence/ machine learning..)
- Digital data management (Big data, statistics,…)
- Ability to think 3D
- Cybersecurity
- Coding /programming
- Other (please specify)

Question 4. Which green skills you estimate you will need to develop / improve in 3 years' time?

Several answers can be chosen)

- Resource efficiency management
- Green awareness
- Life cycle analysis (LCA)
- Eco-design
- Circular economy
- Green resources
- Green products
- Energy Efficiency
- Industrial Symbiosis
- Other (please specify)

3.1.4 Survey to Training Centres

The survey targets at training centres to map and identify the current and future training offer, which combined with Industry/employers and Research Centre's needs identified, will enable to determine skills gaps.

This survey covers the questions applied in the survey developed within D2.3 Short Term scenarios kit, addressing Training Centres. Whenever the occurrence in time is the same, only this survey should be applied, containing both timeframes, being the achieved results taken into consideration for both scenarios.

As with previous survey, a prioritisation exercise has been carried out in order to select key questions to produce a shorter version of the survey. The idea is to use this short version in internal or external events addressing training centres and take profit of their presence to get more replies.

The Survey template to be used with education and training centres is provided below:

Survey Introductory text:

Welcome to our survey on Additive Manufacturing future training challenges!

SAM is a European initiative addressing the workforce development for Additive Manufacturing (AM) by developing a shared skills vision and collaborative learning solutions for the sector at European level.

We would like to understand how you envisage your AM training activities in 3 years scenario and to identify your future training needs and challenges.

The survey lasts for approximately 5 min. It is based in two different sections:

- Section 1: General info and background
- Section 2: Training practices: present and future training needs and challenges

Please take into account that some questions admit only one answer. In the case that multiple choices are possible, it is indicated in the specific question text.

Thank you for helping us in designing Europe's AM workforce future!

The participation in this survey is anonymous and voluntary. By replying to it, you are consenting that SAM project partners process the data collected in conformity with the Contract Agreement signed with the EACEA. For any additional clarification, please contact ewf@ewf.be.

Survey for Training Centres

Section 1: General info and background

Question 1. To which type of organisation do you belong?
Options (*only 1 can be chosen*): •University •VET school •Research / Technology Centre •Private Training Centre •Other (please specify)

Question 2. In which country is your organisation based? (dropdown question)
Austria Belgium Bulgaria Croatia Canada China Czech Republic Denmark Estonia Finland France Germany Greece Hungary Ireland Italy Japan Latvia Lithuania Luxembourg Malta Netherlands Poland Portugal Republic of Cyprus Romania Slovakia Slovenia Spain Sweden Turkey United Kingdom Other (please specify which)

Question 3. Indicate the name of your organisation

Question 4. What is your role within your organisation?

Section 2: Training practices future needs and challenges

Question 5. Please indicate the main perceived barriers to the adoption and exploitation of AM training?

(Several answers can be chosen)

- Need for design guidelines,
- Understanding properties of different processes
- Lack of appropriate skills preventing adoption,
- Lack of in-process inspection and controls
- Lack of collaborative and community-oriented networks
- Lack of cross-functional teamwork
- Increase the use of AM for green solutions,
- Lack of funding to increase awareness and reduce risk of adoption,
- IP and legal systems not appropriate for digital networks
- No full AM industrial deployment yet
- Other (please specify)

Question 6. Do you currently offer courses specifically related to AM?

Options (*only one can be chosen*):

- Yes
- No

ROUTE 1: If *YES* in Q6

Question 7. Name three new tool or methods that have facilitated the AM training?

Question 8. Do you plan to increase your AM Training Offers in the next three years?

- Yes
- No

Question 9. Please estimate the growth rate of your AM training offer for the next 3 years, e.g. concerning the percentage of new topics covered, nº of run courses and targeted students? (open question)

Please type your answer here

Question 10. In which domains do you plan to increase your training offer?

(Several answers can be chosen)

- AM processes
- Numerical modelling /Topology optimisation
- Design
- Structural integrity
- Metallurgical analysis and characterisation
- Pre-processing & material handling
- Post-processing
- Non-destructive testing
- Certification and Validation
- Quality control
- Standards
- Costs
- Environment, health, safety (EHS)
- Marketing and sales
- Communication
- Resource Efficiency/sustainability
- Other (please specify)

Question 11. Which Entrepreneurial skills will your AM courses address in 3 years' time?

(Several answers can be chosen)

- Course does not address any Entrepreneurial skill
- Identify needs and challenging opportunities to create value
- Develop creative and purposeful ideas /solutions
- Visualize future scenarios to help guide effort and action
- Assess the impact of ideas, opportunities and actions
- Identify and assess individual and group strength and weaknesses
- Be resilient under pressure
- Gather and manage required resources
- Develop financial and economic know-how
- Communicate effectively, negotiate and lead
- Take the initiative
- Prioritise, organise and follow up
- Make decisions dealing with uncertainty, ambiguity and risk
- Work with others
- Learn through experience
- Other (please specify)

Question 12. Which digital skills will be addressed in your AM Courses in 3 years' time?

(Several answers can be chosen)

- Course will not address any digital skills
- Digital data analysis (Artificial intelligence/ machine learning...)
- Digital data management (Big data, statistics…)
- Ability to think 3D
- Cybersecurity
- Other (please specify)

Question 13. Which green skills will be addressed in your AM courses in 3 years' time?

(Several answers can be chosen)

- Course will not address any green skills
- Resource efficiency management
- Green awareness
- Life cycle analysis (LCA)
- Eco-design
- Reuse /recycling AM Materials and products
- Green resources
- Green products
- Energy Efficiency
- Industrial Symbiosis
- Other (please specify)

ROUTE 2: If *NO* in Q6

Question 7. Do you plan to offer courses specifically related to AM in 3 years' time?

Options (*only one can be chosen*):

- Yes
- No
- Maybe

Question 8. Please indicates some of the below factors which could help into the enhancement of offering training in the AM field?

(Several answers can be chosen)

- Funded programs for training centers for AM equipment
- Funded courses for professionals (trainees) in the field of AM
- Free courses for professionals (trainers) in the field of AM
- Recognized certification awarded after the completion of the training
- Other (please specify)

Your survey is now completed!

Thank you for helping us designing Europe's AM workforce future!

For further information, visit our website: www.skills4am.eu

13. Please indicate your email address to be informed about the survey results.

Survey short version

Question 1. In which domains do you plan to increase your training offer?

(Several answers can be chosen)

- AM processes
- Numerical modelling /topology optimisation
- Design
- Structural integrity
- Metallurgical analysis and characterisation
- Pre-processing & material handling
- Post-processing
- Non-destructive testing
- Certification and validation
- Quality control
- Standards
- Costs
- Environment, health, safety (EHS)
- Marketing and sales
- Communication
- Resource efficiency/sustainability
- Other (please specify)

Question 2. Which Entrepreneurial skills will your AM courses address in 3 years' time?

(Several answers can be chosen)

- Course does not address any entrepreneurship skill
- Creativity
- Vison spotting opportunities
- Financial and economic literacy

- Working with others
- Learning through experience
- Other (please specify)

Question 3. Which digital skills will be addressed in your AM Courses in 3 years' time?

(Several answers can be chosen)

- Course will not address any specific digital skills
- Digital data analysis (Artificial intelligence/ machine learning...)
- Digital data management (Big data, statistics…)
- Ability to think 3D
- Cybersecurity
- Other (please specify)

Question 4. Which green skills will be addressed in your AM courses in 3 years' time?

(Several answers can be chosen)

- Course will not address any specific green skills
- Resource efficiency management
- Green awareness
- Life cycle analysis (LCA)
- Eco-design
- Reuse /recycling AM Materials and products
- Other (please specify)

3.1.4 Survey to Recruitment Agencies

This survey targets Recruitment Agencies to find out labour market job opportunities and employability in AM /3D printing.

As with other surveys, a prioritisation exercise has been carried out in order to select key questions to produce a shorter version of the survey. The idea is to use this short version in internal or external events addressing training centres and take profit of their presence to get more replies.

Survey introductory text:

Welcome to our survey on Additive Manufacturing Job Opportunities and Employability!

SAM is a European initiative addressing the workforce development for Additive Manufacturing (AM) / 3D Printing by developing a shared skills vision and collaborative learning solutions for the sector at European level. Please find more info at: www.skills4am.eu/

With this survey, we would like to understand and characterize the ***current labour market job opportunities and Employability towards AM/3D printing*** *in Europe, as this information is important for us to adequate the AM/3D Printing training and Skills development to the market needs.*

The survey lasts for around 5 minutes. It is based in two different sections:

- *Section 1: General information*
- *Section 2: Employability in AM*

Thank you in advance for helping us in designing Europe's AM workforce future!

The participation in this survey is voluntary. By replying to it, you are consenting that SAM project partners process the data collected in conformity with the Contract Agreement signed with the EACEA. For any additional clarification, please contact ewf@ewf.be

Survey

Section 1: General information

Question 1. In which country is your Recruitment Agency/Organisation based? (dropdown question)
If you are represented in several countries, just select the country where you are based.

- Austria
- Belgium
- Bulgaria
- Croatia
- Canada
- China
- Czech Republic
- Denmark
- Estonia
- Finland
- France
- Germany
- Greece
- Hungary
- Ireland
- Italy
- Japan
- Latvia
- Lithuania
- Luxembourg
- Malta
- Netherlands
- Poland
- Portugal
- Republic of Cyprus
- Romania
- Slovakia
- Slovenia
- Spain
- Sweden
- Turkey
- United Kingdom

Other (please specify which)

Question 2. Indicate the name of your Recruitment Agency/Organisation.

Question 3. What is your role within your Recruitment Agency/Organisation?

Question 4. Do you work specifically with AM/3D printing companies or industries with AM specific needs?
• Yes • No • Other (please specify)

Question 5. Do you have interest to access a dedicated European platform to search for AM/3D Printing professionals available to work in the field?
• Yes • No • We have our own platform • Other (please specify)

Question 6. Do you have interest to post your job offers in a dedicated platform for AM/ 3D printing?
• Yes • No • Other (please specify)

What will be the ideal feature you would like to see in this platform?
Non-compulsory...it can maybe bring ideas if they answer

Section 2: Job Opportunities and Employability in AM

General types of Professional Profiles are identified along the survey, based on prior market research undertaken by the project consortium, as described below.

AM Designer	Design parts optimised for function, cost and manufacture. Design AM solutions for specific AM process ensuring and validating those parts can be made cost-effective and efficiently. Validate specific AM process design projects by verifying requirements for production with engineer as well as process requirements, ensuring liaison with other technical areas to sign of drawings.

AM Process Engineer	Create the manufacturing process for the efficient production and post-processing of additively manufactured parts. Develop and execute Specific AM Process plans including validation of design, implementation, pre and post processing operations, assurance of parts conformity and identification of the causes and the corrective actions of technical production problems; Coordinate tasks' distribution between the operators according to the workplan as well as manage the link between them and the management.
AM Inspector	Carry out quality assessments and inspection of AM parts. Interpret Destructive and Non-Destructive Testing reports.
Inspection Technician	Carry out the dimensional inspection of complex geometries of additively manufactured parts to the clients' requirements
NDT Technician	Carry out the safe and reliable non-destructive testing of complex geometry additively manufactured parts.
AM Supervisor	Define and carry out inspection of additively manufactured parts. Supervise AM production on shop floor ensuring quality and Health, Safety and Environment procedures
AM Specialist – at the Engineer level	Evaluate manufacturing suitability for customers' requests defining which processes are fit for the request, based on the application, material, design and cost of the part.
Metrology Engineer	Use their comprehensive knowledge of metrology to specify the optimal measurement method to meet the functional and manufacturing requirements of the part
Materials Engineer	Use their comprehensive knowledge of materials to specify the optimal material to meet the functional and manufacturing requirements of the part and implement material handling processes for the entire material life cycle.
AM Operator / Technician	Carry out the safe and reliable production and simple post-processing of additively manufactured parts and operate AM machines, incl. maintenance and specific repairs.

Question 7. Please indicate which sectors demand for AM profiles?

(Several answers can be chosen)

- Aerospace
- Automotive
- Defence
- Consumer
- Construction
- Energy
- Health and Medical
- Industrial equipment and tooling
- Other (please specify)

Question 8 – Rate the level of job/hiring demand in Metal AM/ 3D printing for each of the following Professional Profiles/ Occupational Standards. 1 (low), 2 (regular), 3 (high), 4 (very high) ? (definitions on previous table)
• Designer • Process Engineer • Inspector • Inspector Technician • Non-Destructive Technician • Supervisor • Coordinator at the Engineer level • Metrology Engineer • Materials Engineer • Operator/Technician • Other (please specify the AM profile)

Question 9 – Rate the level of job/hiring demand in Polymer /plastic AM/ 3D printing for each of the following Professional Profiles/ Occupational Standards. 1 (low), 2 (regular), 3 (high), 4 (very high) ?
• Designer • Process Engineer • Inspector • Inspector Technician • Non-Destructive Testing Technician • Supervisor • Coordinator at the Engineer level • Metrology Engineer • Materials Engineer • Operator/Technician • Other (please specify the AM profile)

Question 10. In your opinion, is there an increasing number of Job Offers for AM/3D printing professionals in the past three years?
• Yes (proceed to 10a) • No • Other (please specify)

If yes

Question 10a. Please classify the growth in the past three years?
• 0-5% • 6-10% • 11-20% • 21-30% • >30% • Other (please specify)

Your survey is now completed!

Thank you for helping us designing Europe's AM workforce future!

If you have any further comment/suggestion, please leave it here:

For further information, visit our website: www.skills4am.eu

11. Please indicate your email address to be informed about the survey results.

Short survey

Question 1. Please indicate which sectors demand for AM profiles? (several options)

- Aerospace
- Automotive
- Defence
- Consumer
- Construction
- Energy
- Health and Medical
- Industrial equipment and tooling
- Other (please specify)

Question 2 – Which of the following Professional Profiles/ Occupational Standards have high hiring demand in Metal AM.

- Designer
- Process Engineer
- Inspector
- Inspector Technician
- Non-Destructive Testing Technician
- Supervisor
- Coordinator at the Engineer level
- Metrology Engineer
- Materials Engineer
- Operator/Technician
- Other (please specify the AM profile)

Question 3 – Which of the following Professional Profiles/ Occupational Standards have high hiring demand in plastics AM.

- Designer
- Process Engineer
- Inspector
- Inspector Technician
- Non-Destructive Testing Technician
- Supervisor
- Coordinator at the Engineer level
- Metrology Engineer
- Materials Engineer
- Operator/Technician
- Other (please specify the AM profile)

Question 4. In your opinion, is there an increasing number of Job Offers for AM/3D printing professionals in the past three years?

- Yes
- No
- Other (please specify)

3.2 Interviews

3.2.1 Interview to industry/ Employers

The interview is designed to explore relevant information in order to support the understanding and analysis of the AM related sector's skills agenda and needs.

People to be interviewed will be mainly selected from the companies' representatives who previously answered the employers' survey. The interview intends to build up on this preliminary data provided and will be based on different AM employers' profiles.

After checking the companies replying to the survey and analysing the info to select who of them will be interviewed, the next step is to send the invitations to the selected stakeholders. This is done via email, addressing the person and/or the entity he/she represents.

Below is the text that can be used for inviting stakeholders.

Invitation text for the interview

We would like to invite you for an interview. Before you decide on your participation, it is important that you understand the purpose of the interview and what it will involve. Please take time to read the following information carefully.

You have been selected as a key AM employer/ as a key employer from those who replied to the industry skills survey/ as an associated partner (to select one option) under the framework of SAM project. SAM is a four years Sector Skills Strategy in Additive Manufacturing project, funded by the European Commission Erasmus+ programme, aiming to tackle the current European need for developing an effective system to identify and anticipate the right skills for the Additive Manufacturing sector http://www.skills4am.eu.
The objective of this interview is to further explore and analyse skills gaps and the real

industrial needs with regard to professionals working in AM

The participation in this interview is anonymous and voluntary. You will be engaged in a phone/online or face-to-face interview and will be asked 11 questions. Estimated duration of the interview is from 30 minutes to 1 hour.

By participating, you are consenting that SAM project partners will be able to process the data collected in conformity with the Contract Agreement signed with the EACEA. The project Coordinator, EWF, commits to adopt all necessary measures to guarantee the safe keeping of data against any possible abuse or against unauthorized access. For any additional clarification, please contact ewf@ewf.be.

Please let us know whether or not you wish to take part. If you do decide to take part, please sign the consent form attached and send it back to us.

Consent form

An interview consent form needs to be sent together with the invitation, to the person who is going to be interviewed and get it back signed prior to the interview. Printable version can be found in the annex A.

Employers' interview template

***Interview with stakeholders that have previously replied to the survey:**	
Q1: How many workers in your company are involved in Additive Manufacturing?	
Q2. In your opinion, what are the challenges regarding AM skills in the next 3 years?	
Q2a. Do you think your company is prepared to face those challenges? (Yes / No)	
If answering YES:	**If answering NO:**
Q Why do you think that your company is well prepared to meet those challenges?	**Q** Why do you think that your company is not well prepared to meet those challenges?
	Q What are the main difficulties in implementing AM within your company? Is this related to the lack of skills in your workers, lack of AM professionals in the labour market, or other reasons?
Q Although you feel your company is prepared, what do you think may be needed to improve the skills and knowledge in AM within your company? (e.g., new qualification system more adapted to industry needs, practical training, short-term courses for very specific topics in AM, training in new AM	**Q** In general, what do you think is needed to improve the skills and knowledge on AM in your company (e.g. new qualification system more adapted to industry needs, practical training, short-term courses for very specific topics in AM, training in new AM technologies, knowledge about new materials, training on business opportunities for AM….)?

technologies, knowledge about new materials….)?	
Q3. Have you experienced any difficulties in finding AM skilled professionals you were searching for? (Yes / No)	
If answering YES:	**If answering NO:**
Q If so, which particular profile were you searching for?	**Q** How did you find this profile? Through internal recruitment, external recruitment, etc.? Or did you prefer to reskill or upskill your current workers?
Q What main problems did this cause?	
Q4. Regarding professional profiles, from the 10 selected in SAM (please show the list, at this point), how do you see their relationship with materials and processes: i.e. for the next 3 years, is there any profile that you think will be material /process related?	
Q5. How do you think the following topics and respective technological AM skills will evolve (e.g. will increase or decrease) in the next 3 years? Why do you think this will happen?	

	Increase	Decrease
Simulation		
Numerical modelling/ Topology optimisation		
Design		
Structural integrity		
Materials analysis and characterisation		
Pre-processing & material handling		
AM processes		
Process control		
Post-processing		
Testing /quality control		
Certification and qualification		
Environment, health, safety (EHS)		
Standardisation and Certification		
Costs/ business models		
Communication, marketing and sales		

Q6 Which of the following AM trends do you consider will be relevant for your activity? 3 Categories: not relevant, relevant, very relevant

	Not relevant	Relevant	Very relevant
New metallic materials /plastic/ bio			
Zero defects manufacturing			
Real time control/ monitoring systems			
Traceability			
Hybrid Technology			
Robotics			
Predictive maintenance			
Bio printing process			
4D printing			
Other (Please specify)			

Q7. Which of the following digital and green skills do you think are relevant or not relevant for AM professionals in the near future (3 years)?

	Relevant	Not relevant
Digital data analysis (Artificial intelligence/ machine learning..)		
Cybersecurity		
Coding /programming		
Ability to think 3D		
Digital data management (big data, statistics,…)		
Resource Efficiency management		
Eco-design		
Life cycle analysis		
Other (please specify)		

Q8. Which of the following transversal skills do you think are relevant or not relevant for AM professionals in the near future (3 years)?

	Relevant	Not relevant
Leadership		
Self-management /Self-regulation		
Motivation & perserverance		
Flexibility		
Sociability		

Cultural awareness and expression		
Creativity		
Communication		
Time-management		
Making decision		
Entrepreneurship		
Critical thinking		
Problem solving		
Learning to learn		
Planning and organisation		
Team work /Collaboration		
Other (please specify)		

Q9. How do you expect to increase the use of AM technologies in 3 years' time?

	YES
By increasing the number of applications	
By testing new AM technologies*	
By testing new materials**	
By moving from prototyping to industrial production***	
By hiring new staff specialized in AM****	
By reskilling and upskilling existing staff on AM technology*****	
By collaborating with others that also move in the AM field	
By promoting R&D in AM in your company	
Other (please specify)	

Ask more about the answer selected: e.g. if increasing the use of AM – Ask how?
Options depending on reply:
*Which Technologies?
** Which materials
*** In which volume (prototyping versus series production)
**** Which profiles?
*****Which professional profiles working in your company would benefit from upskilling/reskilling in AM and why?
On which subjects? Which skills are lacking?

Q10. In your opinion, what could be the best training approach to address skills development in AM within the next 3 years?

	3 years
Classroom type (e.g. at University, VET centre...)*	
On the job training by external *	
On the job training by internal (mentoring) *	

Online courses	
Virtual reality courses	
Blended Learning' (i.e. combination of online and face-2-face)	
Apprenticeships*	
PhDs	
Other (please specify)	

**to ask about the time, e.g. intensive courses or other type?*

Q11. Do you think "Maker spaces and fab labs" can help students to get familiar with the technology and to develop transversal skills?

And what about possible "Industrial experience accelerators"?

What about Summer Schools for youngsters? Would you be willing to collaborate with training providers in that sense?

Any other thoughts/ideas/comments?

For those stakeholders that have not replied to the survey, the starting point will be the survey's section 1

- Which type of organisation do you work for/represent?

- In which country is your organisation based?

-What is the main activity/sector of your organisation?

-What is your role within your organisation?

-Indicate the AM Supply position in which your organisation is involved in

-Which AM material/s do you mainly use?

-Which AM process/s do you mainly use?

Followed by the interview

3.2.2 Interview to Research and Technology centres

The interview is designed to explore relevant information in order to support the understanding and analysis of the AM related sector's skills agenda and needs.

People to be interviewed will be mainly selected from the representatives of research and technology centres (RTOs) that previously answered the RTOs' survey. The interview intends to build on this preliminary data provided and will be based on different RTO's profiles.

Below is the text that can be used for inviting stakeholders involved in research:

Invitation text for the interview

You are being invited to be interviewed. Before you decide about your participation, it is important for you to understand why the interview is being done and what it will involve. Please take time to read the following information carefully.

You have been selected as a key RTO / as a key RTO from those who replied to the research and technology centres survey/ as an associated partner (to select one option) under the framework of SAM project. SAM is a four-year Sector Skills Strategy in Additive Manufacturing Project (SAM), funded by the European Commission Erasmus+ programme, aiming to tackle the current European need of developing an effective system to identify and anticipate the right skills for the Additive Manufacturing (AM) sector http://www.skills4am.eu.

The objective of this interview is to further explore and support our understanding and analysis of the AM new developments and trends to cover the possible skills gap.
The participation in this interview is anonymous and voluntary. You will be engaged in an online, phone or face-to-face interview. Estimated duration of the interview is from 30 minutes to 1 hour.

By participating, you are consenting that SAM project partners will be able to process the data collected in conformity with the Contract Agreement signed with the EACEA. The project Coordinator, EWF, undertakes to adopt all necessary measures to guarantee the safe keeping of data against any possible abuse or against unauthorized access. For any additional clarification, please contact ewf@ewf.be
Please let us know whether or not you wish to take part. If you do decide to take part, please sign the consent form attached and send it back.

Consent form

An interview consent form needs to be sent together with the invitation, to the person who is going to be interviewed and get it back signed prior to the interview. Consent printable version can be found in Annex A.

***Interview to stakeholders from RTOs that have previously participated in the survey:**

Q1. With regards to Additive Manufacturing, what experience do you have? (*number of years working in A*M, *type of job developed…)*

Q2. How do you think the following AM skills need will evolve (e.g. will increase or decrease) in the next 3 years?
Why do you think this will happen?

	Increase	Decrease
Simulation		
Numerical modelling/ Topology optimisation		

Design		
Structural integrity		
Materials analysis and characterisation		
Pre-processing & material handling		
AM processes		
Process control		
Post-processing		
Testing /quality control		
Certification and qualification		
Environment, health, safety (EHS)		
Standardisation and Certification		
Costs/ business models		
Communication, marketing and sales		

Q3. Which of the following transversal skills do you think are relevant for current AM professionals? And for future ones (3 years)?

	Relevant
Leadership	
Self-management	
Motivation	
Flexibility	
Sociability / Interpersonal	
Communication	
Time-management	
Decision-making	
Entrepreneurship	
Critical thinking	
Problem solving	
Learning to learn	
Planning and organisation	
Costs and value creation	
Team work	
Other (please specify)	

Q4. During the survey, you were asked to rate the following AM trends in your R&D&I activity. From the following list, please filter only the ones that you see as of higher relevance to your organisation in the next 3 years:

- New materials
- Zero defects manufacturing
- Real time control/ monitoring systems
- Traceability
- 4D printing
- Data management / Artificial intelligence
- End of life/ circular economy
- Bio printing process
- Bio-printing materials
- Cybersecurity
- Other (Please specify)

Q5. Based on the high rated trends, which of the following profiles will be most needed at industrial level? (description of each of the following profiles are detailed in Annex B)

	Most needed
AM Designer	
Process Engineer	
AM Inspector	
Inspector Technician	
NDT Technician	
AM Coordinator	
Specialist at the Engineer level	
Metrology Engineer	
Materials Engineer	
Operator/Technician	
Other (please specify)	

Based on the high rated trends,: how do you envisage the industrial application of these areas in terms of:

Time? – when will it be applied at industrial level
Skills- Which skills?
Challenges /barriers in their implementation of the new areas?

Based on the preliminary results from the surveys:

Q7. Process: xx, xxx, xxx are the most relevant process for the period xxxx with regards to R&D&I. Do you agree?

How do you think industry needs in AM processes will evolve? In your opinion, what are the implications in terms of required Skills?

Q8. How do you think materials will evolve in AM?
In your opinion, what are the implications in terms of required Skills?

Q9. In your opinion, what would be the best training approach to address skills development in AM: for the next or 3 years?

- Classroom type (e.g. at University, VET providers, ...)
- On the job training by external
- On the job training by internal (mentoring)
- Online courses
- Virtual reality courses
- Blended Learning' (i.e. combination of online and face-2-face training sessions)
- Apprenticeships
- Other (please specify)

Q10. In your organisation, do AM specialised workers jump to AM industrial positions?

Any other thoughts / ideas/comments?

For those RTOs that have not participated in the survey, the starting point will be the survey's section 1.

- Which type of organisation do you work for?

- In which country is your organisation based?

- What is the main activity/sector of your organisation?

- What is your role within your organisation?

-Indicate the AM value chain position in which your organisation is involved in.

-Which AM material/s will you mainly research on?

-Which AM process/s will you mainly research on?

Followed by the interview

3.3 Brainstorming and World Cafes

Brainstorming activities and World Cafes are methods used for encouraging group thinking and generation of ideas.

The context in which these types of activities occur is crucial for achieving results. Within SAM project, the ideal scenarios for these tools applications will be during the implementation of Workshops with AM Experts, Awareness campaigns events and other relevant events/or meetings with representatives from the Industry and Research Centres in the sector.

Some basic rules for implementing Brainstorming sessions are given below:

Recommended number of participants: 7 to 12 participants.

The brainstorm session needs to address one specific theme, and be profoundly explored, e.g. *what are the main tasks of an AM designer*?

The facilitator should ask all participants to provide ideas related to the subject in the discussion following these principles:

- *"(a) no criticism and judgements. To encourage creativity and improve the value of ideas, all ideas are presented and accepted without any negative comment or negative evaluation;*
- *(b) all opinions are equal. All participants should feel free to present their ideas, regardless of their status or position in the social hierarchy. Nothing is considered as undesirable;*
- *(c) quantity exceeds quality. Generating as many solutions as possible to tackle defined problems is the required output of this technique;*

- *(d) evaluation after discussion. To prevent a distortion or prioritisation of some ideas, evaluation should be done after the brainstorming. It is recommended to wait a couple of days for this (Potu˚c˘ek, 2006).”*[1]

The results achieved during the brainstorming session should be collected and analysed after the session.

World Cafes can be implemented with large groups, since participants are organized into small discussion groups.

Below is presented a template (already filled in with a concrete example) and instructions for implementation of world cafes:

WORLD “CAFÉ” – Main Theme e.g. How is AM going to be implemented within 5 years ?	
Duration - e.g. *45 minutes – 3 rounds of 15 each* **Moderators -** *1 per table*	
Phases *1) Setting: Create a “special” environment (Toast to start- Port wine/biscuits); - All participants* *2) Introduction: (explain objective of the activity + dynamic) – Host of the World Café* *3) Small Group Rounds / Questions: (15 minutes each) x3 – In each round new insight are given by the participants regarding the theme; Moderators explains outcomes from previous round and launch complementary questions if necessary to generate new insights). Results should be written in flipchart / post its – All moderators* *4) Wrap Up: These results are reflected visually in a variety of ways, most often using graphic recording in the front of the room – All moderators*	
Group 1 – e.g. AM Materials	(Moderator: 1)
Objective: e.g. *Identify the materials to be used in the next 5 years and relate them with required AM skills.*	**Possible Questions** What harmonized qualifications will we be needed for AM with composites/plastics in the next 5 years? Which materials are typically not used, but will become in the next 5 years? What will be the challenges/opportunities in using the identified materials in AM. Which AM knowledge and Skills will be required?
Group 2 – e.g. AM Processes	(Moderator: 1)
Objective: e.g *Identify the processes to be used in the next 5 years and relating them with required AM skills.*	**Possible Questions** What will be the most used processes within the next 5 years? What will be the expected used of metal binder jetting? What will be the challenges/opportunities in using the identified processes in AM. Which AM knowledge and Skills will be required?
Group 3 – e.g. Sectors	(Moderator: 1)
Objective: e.g. *Identify the sectors where AM will have major impact in the next 5 years. Related the type of products produced with the required AM Knowledge and skills.*	**Possible Questions** Which sectors (Construction, Defense, Health, Automotive, Aerospace) will be more influenced by AM in the next 5 years? What products will be produced? Which Professional Profiles will be involved? New Harmonized profiles? Or Upskilled/reskilled workers? Which AM Knowledge and Skills will be required?
Materials: Flipcharts, Pens, blocks of paper, post its, etc.	

[1] DEVELOPING SKILLS FORESIGHTS, SCENARIOS AND FORECASTS, GUIDE TO ANTICIPATING AND MATCHING SKILLS AND JOBS VOLUME 2, European Training Foundation / European Centre for the Development of Vocational Training, 2016, pp 37.

The results achieved during the world cafe should be collected and analysed after the session.

ANNEX A: Interviews' Consent form

CONSENT FORM: Sector Skills Strategy in Additive Manufacturing (SAM) The participant should complete the whole of this form *Please tick the appropriate box*	
Have you read the Interview invitation /Information text?	YES / NO
Have you a clear understanding about the goal and outcomes of the interview?	YES / NO
Do you understand that you will not be referred to by name in any report concerning this interview?	YES / NO
(Where relevant) I agree to my interview being recorded.	YES / NO
(Where relevant) I agree to the use of non-attributable direct quotes when the study is written up or published.	YES / NO
Do you agree to take part in this interview study?	YES / NO
Signature of Interviewee:	
Date:	
Name in capitals:	
I am satisfied that the above-named has given informed consent.	
Interviewer name:	Signature:
Project Partner name:	Signature:

ANNEX B: SAM professional profiles

Professional Profile (Roles)	Description
AM Designer (Professionals that are able to **design parts optimised for function, cost and manufacture.)**	Design AM solutions for specific AM process ensuring and validating that parts can be made cost-effective and efficiently. Validate specific AM process design projects by verifying requirements for production with engineer as well as process requirements, ensuring liaison with other technical areas to sign of drawings.
AM Process Engineer (Professionals that are able to **create the manufacturing process** for the efficient production and post-processing of additively manufactured parts.)	Develop and execute Specific AM Process plans including validation of design, implementation, pre and post processing operations, assurance of parts conformity and identification of the causes and the corrective actions of technical production problems; Coordinate the tasks distribution between the operators according to the workplan as well as manage the link between them and the management.
AM Inspector (Professionals that are able to define and carry out **inspection of** additively manufactured parts)	Carry out quality assessments and inspection of AM parts. Interpret DT and NDT reports
Inspection Technician	Carry out the **dimensional inspection of complex geometries** of additively manufactured parts to the clients requirements
NDT Technician	**Carry out the** safe and reliable non-destructive testing **of complex geometry additively manufactured parts**.
AM Supervisor	Supervise AM production on shop floor ensuring quality and HSE procedures
AM Coordinator – at the Engineer level	Evaluate manufacturing suitability for customers' requests defining which processes are fit for the request, based on the application, material, design and cost of the part. Coordinate the work with AM team.
Metrology Engineer	Use their comprehensive knowledge of metrology to **specify the optimal measurement method** to meet the functional and manufacturing requirements of the part
Materials Engineer	Use their comprehensive knowledge of materials to **specify the optimal material** to meet the functional and manufacturing requirements of the part and **implement material handling processes** for the entire material life cycle
AM Operator / Technician (Professionals that are able to carry out the safe and reliable production and simple post-processing of additively manufactured parts.)	Operate AM machines, including fitting and setting up, maintenance and specific repairs.