

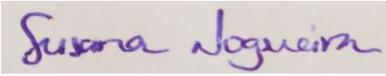


## **WP 6: Exchange of Knowledge Strategies' Implementation and Testing at National Level**

**D 6.2 – Additive Manufacturing World Café Meetings**

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## Executive Summary

Additive Manufacturing (AM) World Café Meetings were a set of events carried out in the scope of Work Package (WP) 6 – *Exchange of Knowledge Strategies' Implementation and Testing at National Level*, led by the European Federation for Welding, Joining and Cutting (EFW).

This WP aims to pilot the Additive Manufacturing (AM) exchange of knowledge strategies to verify their usefulness and feasibility:

- AM hub/platform developed in the scope of ADMIRE project,
- AM World Café Meetings at national level,
- AM Knowledge “Speed-Datings” at national level.

In order to carry out these pilots, ADMIRE partners, i.e. EWF (BE), Cranfield University, University of Birmingham (UK), Bremen University (DE) and Instituto Superior Técnico from University of Lisbon (PT), and Manufacturing Technology Centre (UK), IREPA Laser (FR) and GKN Aerospace (UK), selected which partners would be responsible for piloting which exchange of knowledge strategy.

EFW was chosen to pilot the AM World Café Meetings and this report was prepared to describe how these events were organized and carried out. The results from the questionnaires participants filled in the first AM World Café and from the discussions held between all participants from the second AM World Café are also reported.

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## 1 Introduction

The European Federation for Welding, Joining and Cutting (EFW) is a European Association with 27 years of experience in running European/International qualifications in place in 45 countries worldwide.

The increasing growth of Metal Additive Manufacturing (Metal AM) technology is demanding the definition of new professional levels required by industry for personnel working in this area. EFW is currently performing a research on this topic and is interested to know the views on the requirements for the European Metal AM Engineer, a qualification on which ADMIRE project is focused.

This report addresses the methodologies used to conduct two AM World Café meetings during specific events in which EFW was actively involved, and the results obtained. Those events were:

- “3D Printing Additive Manufacturing Skills & Data Workshop”, held in Aachen (Germany) in March 20<sup>th</sup>, 2018. The World Café meeting conducted at this event focused on the European Metal AM Engineer, in which participants had the chance to discuss about the knowledge and skills needed for the Metal AM sector (namely those required to become a Metal AM Engineer);
- EFW 4<sup>th</sup> AM Qualification Workshop, held in Porto Salvo (Portugal) in October 28<sup>th</sup>, 2019. The World Café meeting carried out focused on how Additive Manufacturing technology will be implemented in the next 5 years in terms of Materials, Processes and Sectors, at European level.

These meetings were carried out following the principles and components needed to implement a World Café:

- I. Set a welcoming environment, providing the essential material,
- II. Welcome and introduce the event,
- III. Constitute small group rounds for discussion,
- IV. Design powerful questions,
- V. Harvest insights and results.

AM World Café meetings were opportunities to develop a collaborative and innovative sharing and learning environment among participants connected to Education and Industry, one of the main objectives set for these meetings.

The analysis of these meetings in terms of their usefulness and feasibility, as well as the analysis of the remaining exchange of knowledge strategies that are part of this Work Package, will be further discussed by the project partners in the Common Partners' Roundtable, in order to decide on the improvements needed to be made to the methods and tools used for their implementation.

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Those improvements will be put in practice at ADMIRE Final Conference, where the AM Hub/Platform will be presented and the AM World Café Meeting and AM Knowledge “Speed-Dating” will be carried out once again, as a way to promote the sustainability of the project and keep the AM connections promoted by these strategies duly tied.

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## 2 Aim

The aim of this report is to detail the methodologies used and results obtained from the two ADMIRE AM World Café meetings. These World Café meetings, that gathered a total of 53 participants (stakeholders from education, manufacturing sector and industrial associations), were carried out in the scope of two parallel events:

1. The first ADMIRE AM World Café meeting was held during a collaborative Workshop about AM Skills entitled “3D Printing (Additive Manufacturing) Skills & Data Workshop”, which focused on AM required skills and knowledge, a concern not only for ADMIRE project, but also for the other projects presented during this event, which focus on similar subjects;
2. The second ADMIRE AM World Café meeting was carried out during an EWF event (“EWF 4<sup>th</sup> AM Qualifications Workshop”), which addressed EWF AM Qualification System and gathered participants from education, industry and manufacturing to discuss qualification guidelines that are being developed by EWF to address the industry’s needs for qualified personnel in AM.

This opportunity allowed EWF to collect feedback and inputs from both workshops’ participants, in the scope of their active participation on ADMIRE AM World Café meetings, on the Metal AM Engineer Qualification, on the Selective Laser Melting (SLM) specialization (to be carried out after the Metal AM Engineer Qualification) and on the growth of AM field in the next 5 years in terms of AM Materials, AM Processes and AM Sectors, based on participants’ expertise in the sector.

The results from the discussions held during ADMIRE AM World Café meetings are presented in the following pages, in addition to the information about the organization and conduction of those meetings.

### 3 Dissemination

Before carrying out ADMIRE's AM World Café meetings, EWF performed a set of activities aiming at their dissemination among EWF members, stakeholders from the manufacturing and industrial sectors, the target groups of this activity.

For the first session, in Aachen (Germany), a banner was produced to promote the collaborative Workshop where ADMIRE AM World Café took place, identifying the place, date and time of the event, as well as the main objectives of the Workshop and indication on how the registration could be done. The logos of the projects to be addressed during the event were also showed in the banner.



**Fig. 1** – Banner produced to promote the collaborative Workshop where ADMIRE AM World Café took place

As previously mentioned, the banner was disseminated among EWF partners (connected to industry), using EWF website and its social media in order to reach the highest number of potential interested people possible.



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**Figs. 2 and 3** – Publication of banner on EWF's Website and Facebook account referring the Workshop 3D printing (Additive Manufacturing) Skills & Data, with a link for registration



**Fig. 4** – Publication of the banner on EWF's Twitter account

After this dissemination activity, carried out in the beginning of March 2018, it was possible to collect 40 participants belonging to ADMIRE target groups for the AM World Café, in Aachen.

Regarding the second AM World Café meeting, and because it was carried out during EWF's "4<sup>th</sup> Edition of the AM Qualifications Workshop" event, the dissemination focused on the event itself through the publication of a banner on EWF website and social media (Fig. 5) and on a dedicated (i.e. personalized) email sent to EWF member organizations and network, and to participants from previous the EWF AM Workshops.



**Fig. 5** –Banner published on EWF's website and social media accounts

After this dissemination activity, carried out from July 2019 onwards, it was possible to gather 13 participants belonging to ADMIRE target groups for the AM World Café meeting, carried out in Porto Salvo (Portugal).

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## 4 AM World Café Meetings | Presentation of ADMIRE project

ADMIRE project was presented to participants of the events where AM World Café meetings took place using different approaches due to both Workshop sessions' organization and purposes.

The “3D Printing (Additive Manufacturing) Skills & Data Workshop” held in Aachen (Germany) was a collaborative Workshop. Thus, all projects covered by the event were presented to participants, not only as a way to disseminate them, their objectives and activities, but also as a way to engage participants in the theme of Skills for AM.

ADMIRE project was presented by EWF's project manager André Cereja, focusing on its scope, main purpose and partners involved (and their respective sectors).



The slide features the EWF logo on the left and the ADMIRE logo below it. The main title is 'ADMIRE Knowledge Alliance for Additive Manufacturing between Industry and Universities'. Below the title, there are logos for various partners: CMM, UNIVERSITY OF BIRMINGHAM, Universität Bremen, TÉCNICO LISBOA, mtc, IREPA LASER, and EWF. The text on the slide states: 'Project funded under the Erasmus+ Programme Knowledge Alliances', 'ADMIRE project builds upon the:', followed by two bullet points: 'Lack of qualified personnel in the Metal Additive Manufacturing field, particularly at the Engineer level' and 'The mismatch between skills required by industry and those available in the current teaching portfolio'. The goal is stated as: 'Goal: Create a full MSc course in Metal AM, by bringing together industrial organisations, universities, research institutions and students'.

**Fig. 6** – Excerpt from EWF's presentation on the collaborative Workshop, focusing on ADMIRE project, its partners, scope and main purpose

This presentation provided EWF with the motto for the discussions/debates to be carried out in ADMIRE AM World Café with the event's participants once it also focused on:

- New job profiles in Metal Additive Manufacturing (AM Operator, AM Supervisor, AM Designer, AM Inspector and AM Engineer),
- Results from surveys carried out about skills needed for each of these professional profiles, where respondents were asked to point out which materials and processes should be covered by which professional profile and how the training scheme should be,
- AM System Modularity for SLM Operator and SLM Engineer.

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Participants from this ADMIRE AM World Café were invited to participate in a similar survey/questionnaire, which content will be described in this Report.

As for the *4<sup>th</sup> Edition of the AM Qualifications Workshop* held in Porto Salvo (Portugal), and because it was an event that focused on two specific AM Qualifications under development by EWF and their validation in terms of contents and structure with help from all participants, ADMIRE project was presented by Francisco Barros, EWF project manager, in a more informal way to participants, who were informed of the project's objectives and the work that has been carried out by ADMIRE consortium, followed by an explanation of the activity that was going to be held (i.e. AM World Café meeting) in terms of dynamic and purposes.

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## 5 ADMIRE AM World Café: Settings

As mentioned in the beginning of this Report, ADMIRE AM World Café meetings' organization was based on a set of principles and components which were followed thoroughly in order to promote its success, not only in terms of logistic accomplishment but, above all, the accomplishment of its purposes.

These were the main settings:

### I. Set a welcoming environment, providing the essential material

The participants of the AM World Café meeting in Aachen (Germany) were welcomed to the session held in the scope of a collaborative workshop entitled "3D Printing (Additive Manufacturing) Skills & Data". A folder was already been provided to all participants containing the Agenda of the event (which included ADMIRE AM World Café session), blank paper and pen (for notes), as well as a set of promotional project flyers, which included ADMIRE project's flyer:

[www.ahqaic.eu](http://www.ahqaic.eu)

### AM Stakeholder Meeting Workshop 20.03.2018

1	Welcome	Ulrich Thombansen, ILT	08:30 – 08:35
2	AMable Aims and Objectives	AMable	08:35 – 08:45
3	Workshop Track on Digital Integration of AM		08:45 – 12:15
3.1	Authentication for Access to Data	Rene Fluis, CISCO	08:45 – 09:55
3.2	Data Formats for Storage and Exchange	Frits Feenstra, TNO	09:55 – 11:05
3.3	Machine Connectivity for digital integration	Antti Vaajoki, VTT	11:05 – 12:15
	Lunch		12:15 – 13:15
4	Skills and Education for AM	AM Motion	13:15 – 13:30
5	Workshop Track on Skills and Education		13:30 – 16:45
5.1	AM Motion - a strategic Vision for AM	Paula Queipo, PRODINTEC	13:30 – 13:45
5.2	Skills in AMable, ADMIRE and CLLAIM	Andre Cereja, EWF	13:45 – 14:00
5.3	Employer needs in AM Education	Olga Chilat, CECIMO	14:00 – 14:15
5.4	AM Education on the scientific side	Laura Thurn, FH Aachen	14:15 – 14:45
	Break		14:45 – 15:15
5.5	World Cafe on Skills & Education		15:15 – 16:45
6	Wrap-Up and Conclusion		16:45 – 17:00

**Fig. 7** – Agenda of the Workshop 3D printing (Additive Manufacturing) Skills & Data (indicating the time slots related to ADMIRE presentation and to ADMIRE AM World Café)

Participants of the AM World Café meeting held in the last day of the 4<sup>th</sup> EWF AM Qualifications Workshop were offered Porto wine and biscuits to set an open and welcoming environment to the session. As occurred in the first World Cafe, a folder was previously given to all partners, which included white paper, a pen and ADMIRE project flyer.

The room where the session took place had roll-ups from several projects in which EWF is actively involved, including one from ADMIRE.

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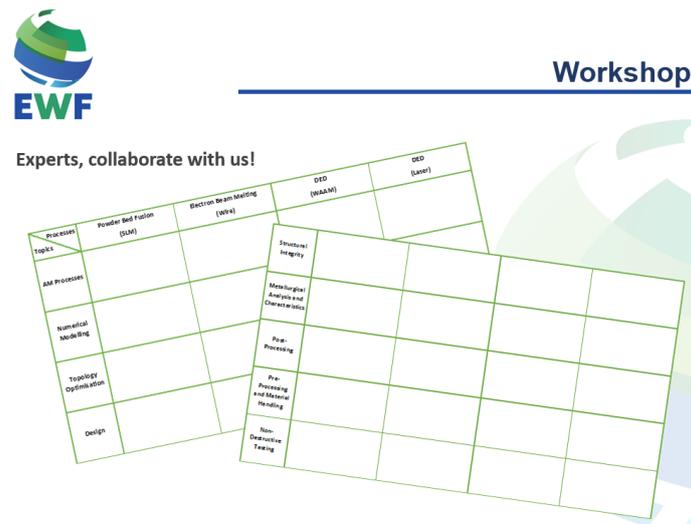


**Fig. 8** – ADMIRE flyer made available to both AM World Café meetings' participants during the events for dissemination purposes

## II. Welcome and introduce the event

As previously mentioned, all participants from both AM World Café meetings were welcomed and introduced to the event.

In the specific case of the AM World Café held in Aachen, after presenting ADMIRE project to participants (see Fig.6), EWF addressed a challenge to all participants to collaborate in a set of activities to be carried out in the scope of the meeting:



**Fig. 9** – Excerpt of EWF's presentation, urging the "3D Printing (Additive Manufacturing) Skills & Data Workshop's" participants to collaborate in the activities to be carried out under ADMIRE AM World Café

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In the World Café meeting held in Oeiras, the presentation of ADMIRE project was made in an informal way, as well as the information about the World Café meeting, its purposes and dynamics.

The difference between the approaches used to present the project and the World Café meeting session on both events had no impact on the sessions' implementation.

### **III. Constitute small group rounds for discussion**

All 40 participants of the AM World Café held in Aachen were divided in 5 groups, each group gathered in one table, in which a moderator belonging to EWF staff was present to promote discussion. This division had into account participants' different backgrounds, in an effort to join participants from different sectors. This way, the results from discussions/debates would reflect both visions.



**Fig. 10** – Constitution of the groups/tables for ADMIRE AM World Café, in Aachen (Germany)

As for the participants of the World Café meeting carried out in Porto Salvo, there were three different tables with one moderator, each with its specific issue to be discussed regarding “How is AM going to be implemented in the next 5 years”: one table specific to AM Materials, other for AM Processes and another for AM Sectors. The 13 participants were divided in three groups, one group per table, to discuss one issue for 15 minutes, after which they had to change tables to address other issue, and so forth.

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**Fig. 11** –Group/table with some of the participants of ADMIRE AM World Café, in Porto Salvo (Portugal)

#### **IV. Design powerful questions**

In the organization of the ADMIRE AM World Café meetings, a set of questions were designed in order to focus on the main issues to be addressed in the sessions, complying with the project's WP's/Deliverable's purposes.

For the World Café meeting in Aachen, and as mentioned in section **4 ADMIRE Presentation on the Workshop** of this report, a questionnaire was prepared and delivered to this session's participants in order to collect inputs for the work done in ADMIRE project.

This questionnaire started with a list of knowledge and skills:

1. Select adequate AM process
2. Define pre-processing operations
3. CAD design for AM/topology
4. Multiphysics/CAE for AM
5. Perform metallurgical analysis
6. Select process parameters
7. Define post-processing operations
8. Develop inspection & testing plan
9. Certification of process/products
10. Manage AM operators' work
11. Create HSE procedures
12. Quotations of AM parts
13. Perform training activities
14. Integrate AM in the manufacturing chain
15. Troubleshooting

The first question of the questionnaire was: "From the list of Knowledge and Skills above, fit each item number where you believe it is most appropriate [for the cross-cutting knowledge and skills of the MAM Engineer and the specialized AM Process Engineer]".

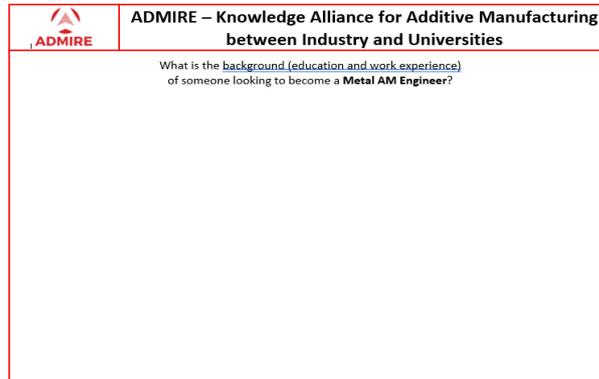
The second question asked what other Knowledge and Skills could be added for both profiles. Question three enquired about the necessary amount of training hours to acquire the topics on the list of Knowledge and Skills provided.

The last question was about the way a full course should be attended: should it be a full time, a part time or made of intensive blocks.

Participants had the chance to discuss in groups all these questions and reply individually to the questionnaire.

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In addition to those questions, a poster was made available to participants of the session, asking them to reply to a question: “What is the background (education and work experience) of someone looking to become a Metal AM Engineer?”



**Fig. 12** – Poster presented to ADMIRE AM World Café’s participants

Participants were then invited to write their replies on a *post-it* and to place it in the poster, as illustrated by Fig. 13, below, and to discuss among themselves those replies.



**Fig. 13** – Participants replying to the question on Poster

Regarding the AM World Café meeting carried out in Porto Salvo, a set of questions were prepared for each group/issue to lead participants to address specific matters (i.e. AM Materials, AM Processes and AM Sectors) under a specific topic: “How is AM going to be implemented in the next 5 years?”. Each table/topic had a specific objective (as described in table 1, below).

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**Table 1 – Topics addressed by each table, their objectives and questions asked to each group of participants**

<b>How is AM going to be implemented in the next 5 years?</b>		
<b>Group</b>	<b>Objective</b>	<b>Questions</b>
<b>AM Materials</b>	Identify the materials to be used in the next 5 years and relate them with required AM skills.	<ul style="list-style-type: none"> <li>- What harmonized qualifications will we be needed for AM with composites/plastics in the next 5 years?</li> <li>- Which materials are not typically used, but will be in the next 5 years?</li> <li>- What will be the challenges/opportunities in using the identified materials in AM?</li> <li>- Which AM knowledge and Skills will be required?</li> </ul>
<b>AM Processes</b>	Identify the processes to be used in the next 5 years and relating them with required AM skills.	<ul style="list-style-type: none"> <li>- What will be the most used processes within the next 5 years? What will be the expected used of metal binder jetting?</li> <li>- What will be the challenges/opportunities in using the identified processes in AM?</li> <li>- Which AM knowledge and Skills will be required?</li> </ul>
<b>AM Sectors</b>	Identify the sectors where AM will have major impact in the next 5 years. Relate the type of products produced with the required AM Knowledge and skills.	<ul style="list-style-type: none"> <li>- Which sectors (e.g. Construction, Defense, Health, Automotive, Aerospace) will be more influenced by AM in the next 5 years?</li> <li>- What products will be produced?</li> <li>- Which Professional Profiles will be involved? New Harmonized profiles? Or Upskilled/reskilled workers?</li> <li>- Which AM Knowledge and Skills will be required?</li> </ul>

These questions were asked to participants of each table by its moderator, and the replies were written by the moderator on a flip chart. The same questions were asked to the different groups, and the moderators led the discussions in a way that allowed to collect different answers per group, enriching the results obtained from each table/discussion.



**Fig. 14** – Discussion group in one of the tables of the AM World Café meeting, in Porto Salvo (Portugal)

As previously mentioned, participants had to change tables every 15 minutes for a different round. In each round, a new insight was provided by participants regarding the theme at hand with help from the tables' moderators, who explained the outcomes from previous rounds to launch complementary questions, if necessary, to generate new insights.

By the end of the World Café meeting, the moderators of each table presented to the audience the main conclusions drawn from the discussions held in each table, regarding the respective topics addressed. After this presentation, a wrap up was

## **V. Harvest insights and results**

Main conclusions were withdrawn from both ADMIRE AM World Café meetings' results and are presented on **Section 6. Results from the ADMIRE AM World Café meetings** of this report.

As previously mentioned, those results/ conclusions are and will be embodied in the products that have been and will be developed in the scope of ADMIRE project.

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## 6 Results from the ADMIRE AM World Café meetings

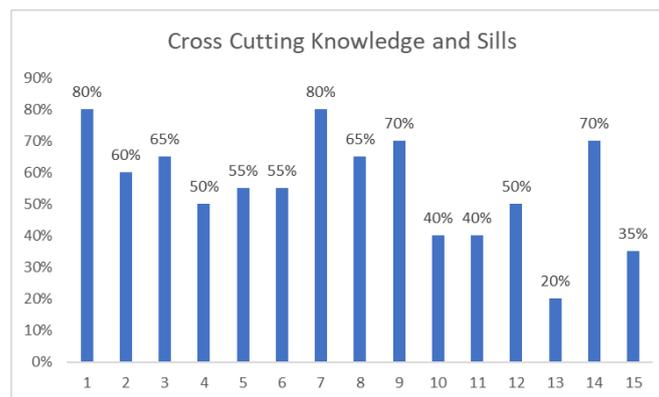
Both AM World Café meetings were very fruitful once they allowed to collect important information for the project's development and engage participants in future events/activities in the scope of ADMIRE.

Below are the results obtained both from the questionnaire handed out to participants of the AM World Café held in Aachen (please see Annex 1) and from the discussions carried out in the scope of the AM World Café held in Porto Salvo.

### 6.1 AM World Café in Aachen | Questionnaire Results

*Question 1. From the list of Knowledge and Skills above, fit each item number where you believe it is most appropriate. Feel free to write other topics that you consider relevant and that may be missing.*

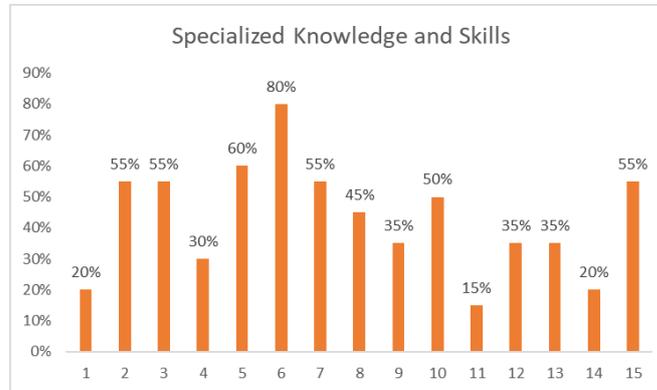
The majority of participants replied *Select adequate AM process, Define post-processing operations (both with 80% of replies), Certification of process/products and Integrate AM in the manufacturing chain (both with 70%)* as the most appropriate Cross-Cutting Knowledge and Skills for MAM Engineer, as showed in the following Graphic:



Graph. 1 – Results, in percentage, for the first question, on Cross-Cutting Knowledge and Skills (for MAM Engineer)

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In terms of specialized Knowledge and Skills for SLM Engineer, the majority of replies focused on *Select process parameters* (80%), followed by *Perform metallurgical analysis* (60% of replies) and *Define pre-processing operations, CAD design for AM/topology, Define post-processing operations* and *Troubleshooting*, all with 55% of replies.



Graph. 2 – Results, in percentage, for the first question about Specialized Knowledge and Skills (for SLM Engineer)

**Question 2 – Besides the above, what other Knowledge and Skills may a cross-cutting Metal Additive Manufacturing Engineer or a specialized SLM Engineer be interested in?**

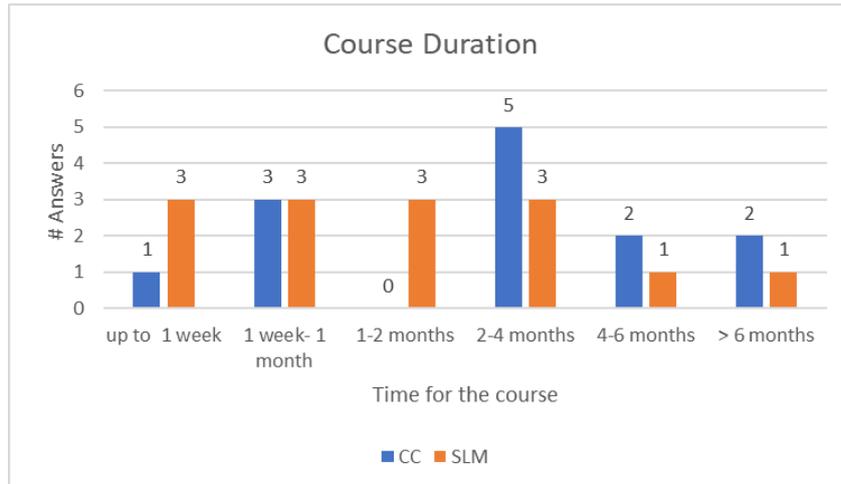
When asked about what other Knowledge and Skills could be added for both profiles, these were the answers from participants:

- Selection of parts appropriate for AM;
- Mechanical properties and the influence of AM on it;
- Simulation;
- Data analysis;
- Same Knowledge about materials (more than Multiphysics);
- Machinery-Precision, Accuracy cycle time-optimization;
- Data AM formats; Machine connectivity;
- Open minded; hands-on;
- Management of AM related data;
- Microstructure analysis, quality assurance, standards;
- In both cases, an additional profile machine developer but also LOT, sensors and in-line control.

**Question 3 – Considering the above distributions, what should you consider to be the necessary amount of training hours for a trainee to acquire the above Knowledge and Skills?**

When asked what the necessary amount of training hours are to acquire the listed Knowledge and Skills (K&S), most participants replied *2-4 months* for Cross-Cutting K&S, for MAM Engineer. For SLM Engineer, results show some division among partners once their replies range from *up to 1 week* to *2-4 months*, as showed in the graphic below:

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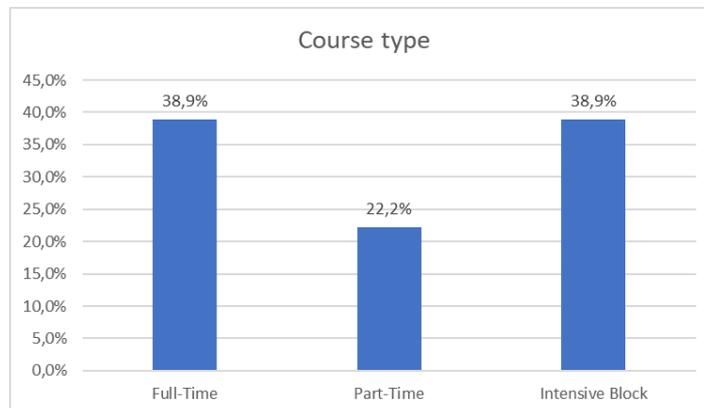


Graph. 3 – Results of the time necessary for the training course, for each profile: Cross-Cutting (CC) and SLN Engineer (SLM)

Question 4 – Considering the full course (cross cutting Metal AM qualification + SLM Engineer specialization), how would you prefer to attend the course?

The last question was about the way the full course should be attended. If it should be full-time, part-time or intensive blocks.

Full-time and Intensive Blocks had the same amount of replies from participants (38,9%), showing these are the preferred course types among them.



Graph. 4 – Results on the course attendance.

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## 6.2 AM World Café in Porto Salvo | Discussion Results

### A. AM Materials

Regarding the first question about this specific theme (“*What harmonized qualifications will we need for AM with composites/plastics in the next 5 years?*”), all participants provided a common reply: AM Operator, AM Engineer, AM Designer and AM Inspector qualifications.

In participants’ opinion new types of ceramic, semi-conductors, copper and high-speed steels (HSS) will be materials that are not typically used in AM but will be in the next 5 years, in addition to multi-materials, bio and hybrid materials and materials for tooling production.

The next 5 years will also be characterized by challenges, but also by opportunities in AM, specifically in the use of the identified materials in the sector. Technological capabilities available are considered by participants of the AM World Café as potential bottleneck for the applicability of certain materials. However, the creation of standards/methods of qualification for such materials can be an opportunity if the cost-efficiency inherent to it is taken into consideration. Another challenge identified by participants is based on combining materials and applications, which could be an opportunity to foster research and to apply these materials on e-Mobility and Space (e.g. NASA, ESA, etc.).

In order to apply the above-mentioned materials in AM, professionals are required a set of skills and knowledges which, in participants’ opinion, involve a continuous monitoring of AM process (i.e. data analytics) and the capacity to “speed up” technology, which required a continuous material and process development. Skills and knowledge must be in line with the industry needs, including design and process chain.

### B. AM Processes

AM World Café participants agreed that some of the main AM Processes to be used Metal AM in the next 5 years will be Powder Bed Fusion-Laser Beam (PBF-LB) and Directed Energy Deposition-Arc (DED-Arc) and DED-LB, in addition to Powder Bed Fusion-Electron Beam (PBF-EB), DED-EB and Hybrid Processes (in accordance with one participant, eventually all DED will become Hybrid). Fused Deposition modeling (FDM), sheet lamination and sand Binder Jetting were also identified by participants as processes that will be used in the next 5 year in Metal AM.

As for Plastic, Binder Jetting, FDM composite plastic, Vat Photopolymerization and material extrusion were the ones mentioned for this type of material. Processes like Cold-Spray (also identified by participants) are quite recent in the market and not all participants were aware of it.

In sum, the results differed from each group to the other but PBF, DED and Hybrid Processes were a common understanding among all groups as the most relevant processes in the next 5 years.

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### C. AM Sectors

Participants agreed that the sectors to be more influenced by AM in the next 5 years will be aerospace, automotive, energy (nuclear power), health/medical industry, tooling, oil and gas, maritime, railways, retail and fashion and machinery.

The moderator asked participants to identify which products will, in their opinion, be produced for each identified sector within the timeframe provided. In the table below are the results obtained from that discussion which, in some cases, also refer materials:

Sector	Product
<b>Aerospace</b>	This sector has the largest users in Metal AM for performance and material saving. In one year, composite will be the most used material, as well as titanium, nickel alloys and aluminum to build parts inside the aircrafts, engine components, space propulsion pieces and primary/secondary structure components.
<b>Automotive</b>	According to participants, Metal mass production for car body parts and power train will be used to avoid initial investment and ensure cost-efficiency. Aluminum and steel for structural parts, mixtures for tires, composite materials to replace plastics and customized 3D printed dashboards will also be produced in this sector.
<b>Energy (nuclear power)</b>	Stainless steel (which according to participants is not very expensive) will be used to improve performance and save materials (e.g. nickel alloy). This sector will also benefit from AM for inspection technology, blades for steam turbines, senses technology in 3D and production of spare parts.
<b>Health/medical industry</b>	AM is a very fast emerging technology that allows customization. Organ transplants using LB processes will be produced. According to participants, this sector will be benefitted from AM in terms of production of prosthetics, limbs and surgery guides. This technology will be used for hip replacements, teeth, cosmetics, organs (e.g. ears, liver and hearth components, etc.).
<b>Tooling</b>	AM will be used to produce specific tools such as fixture for stamping tools, and will be used to create tools for performance, functionalization and cost-effectiveness, including molds, internal channels for cooling and injection molding.
<b>Oil and Gas</b>	Drill bits and process pipes were the main products identified by participants.
<b>Maritime</b>	AM process will be used for spare parts and for building structures in this sector within 5 years to replace obsolete parts and components and to foster customization, among others.
<b>Railways</b>	Controls and production of obsolete and spare parts were also identified.
<b>Retail and fashion</b>	AM will be used to produce shoes in carbon, dresses and jewelry. Overall, this process will allow this sector to produce intelligent clothing.
<b>Machinery</b>	AM will be used for enhancing performance and high temperature resistant components.

Table 2 – Types of products (including the use of specific materials) according to the identified sectors

When asked which type of professional profile will be involved in these sectors, participants agreed that an AM Quality Engineer, with specification for each sector and a definition on how he/she could fit in different sectors, would be the right choice. Such professional would control quality of production chain and would need to know all processes to manage quality for all processes' requirements. (e.g. Metal AM Engineer, with an add-on in AM Quality Engineer).

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## 7 Conclusion

From the discussions held during ADMIRE AM World Café meetings and the results from the surveys/questionnaires delivered to participants, it is possible to conclude the following:

### 7.1 Regarding the meeting carried out in Aachen:

- a. By assessing Question 1, MAM Engineers should have knowledge regarding all materials and processes. SLM Engineer should be more specialized on performing metallurgical analysis, select process parameters, manage AM operators' work, perform training activities and troubleshooting.
- b. Courses should be held on a full-time or intensive block basis.
- c. In terms of course duration, from cross cutting, it should be done in 2 to 4 months. However, for SLN, there was not a clear agreement, having the answers ranged from 1 week up to 4 months. Both results should be validated on a different poll since this question had an open question option.

### 7.2 Regarding the meeting carried out in Porto Salvo:

- a. In the next five years, the AM Engineer Qualification will be one of the most needed to face AM industry's needs;
- b. PBF-LB, DED-Arc and DED-LB, in addition to PBF-EB, DED-EB and Hybrid Processes will be some of the most used processes in AM sectors such as aerospace, automotive, maritime and railways to, among other concerns, address customization and cost-effectiveness;
- c. AM Quality Engineer, specialized in a specific sector (e.g. the ones mentioned in the table above), is the professional profile identified by participants as the most important to address the needs of AM industry.

Overall, the results obtained among the different groups sustain the theory that the AM market is unpredictable, probably due to the fact that it is relatively new and, even so, it is growing exponentially. All participants found a way to discuss and broaden their knowledge about the AM sector. They also had the opportunity for networking and strengthen relations between them.

The results from the Satisfaction Survey applied to participants from both AM World Café meetings allowed to conclude that the steps followed to organize these sessions were successful to the point they should be used in future World Cafes:

- Welcome participants and present the project;
- Introduction to the event, summarizing its activities and purposes;
- Split participants in smaller groups for discussion;
- Have a moderator that can adapt to different types of groups (e.g. quiet groups that need someone who can motivate participants to discuss);
- Design powerful questions and discussion topics that help moderators lead discussions and help participants to exchange experiences and know-how and provide inputs that are important for the project event's objectives;

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**TITLE:** WP 6: Exchange of Knowledge Strategies' Implementation and Testing at National Level

**Subject/Deliverable:** D 6.2 – Additive Manufacturing World Café Meetings



- Present a summary of the main results achieved from the insights collected as a wrap-up.

In addition, it is also important to refer that ADMIRE AM World Café meetings provided its participants the opportunity to discuss important issues referring to their sector of activity and professions with professionals from other sectors, bringing some light to the future of their own organizations.

The methodology and strategies put in place to conduct both World Cafe meetings will be discussed on the Common Partners' Roundtable (to be held in the scope of WP6/D 6.4 Roundtables) by all ADMIRE partners. The report to be developed after this Roundtable will provide suggestions about the necessary improvements to be made to enhance results and future AM World Cafe meetings.

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## ANNEX 1 | Questionnaires applied on World Café meeting (Aachen, DE) and participants' replies

(A)



### ADMIRE – Knowledge Alliance for Additive Manufacturing between Industry and Universities

#### Metal AM Engineer – Knowledge and Skills topics

<ol style="list-style-type: none"> <li>1. Select adequate AM process</li> <li>2. Define pre-processing operations (handling and storage, etc.)</li> <li>3. CAD design for AM/topology</li> <li>4. Multiphysics/CAE for AM</li> <li>5. Perform metallurgical analysis</li> </ol>	<ol style="list-style-type: none"> <li>6. Select process parameters</li> <li>7. Define post-processing operations (machining, surface finish, etc.)</li> <li>8. Develop inspection &amp; testing plan</li> <li>9. Certification of process/products</li> <li>10. Manage AM operators' work</li> </ol>	<ol style="list-style-type: none"> <li>11. Create HSE procedures</li> <li>12. Quotation of AM parts</li> <li>13. Perform training activities</li> <li>14. Integrate AM in the manufacturing chain</li> <li>15. Troubleshooting</li> </ol>
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1. From the list of Knowledge and Skills above, fit each item number where you believe it is most appropriate. Feel free to write other topics that you consider relevant and that may be missing.

Cross-cutting Knowledge and Skills	Cross-cutting qualification: <b>Metal Additive Manufacturing Engineer</b> 1, (2), 4, (7), 9, 11, 12, 13, 14, (15)
Specialized Knowledge and Skills	Specialization #1: <b>SLM Engineer</b> 2, 5, 6, 7, 8, 10, 13, 15, (4), 3

2. Besides the above, what other Knowledge and Skills may a cross-cutting Metal Additive Manufacturing Engineer or a specialized SLM Engineer be interested in?

Optional Knowledge and Skills	N/A
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3. Considering the above distribution, what would you consider to be the necessary amount of training hours for a trainee to acquire the above Knowledge and Skills?

Cross-cutting Metal Additive Manufacturing Engineer qualification _____ h	SLM Engineer specialization (after completing the Metal AM Engineer training) _____ h <b>11 weeks</b>
--	--

4. Considering the full course (cross-cutting Metal AM qualification + SLM Engineer specialization), how would you prefer to attend the course?

Full-time (7h per day)
  Part-time (e.g. week evenings and Saturdays)
  Intensive blocks (1 full week per month)

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	<b>ADMIRE – Knowledge Alliance for Additive Manufacturing between Industry and Universities</b>
<b>Metal AM Engineer – Knowledge and Skills topics</b>	
<p>1. Select adequate AM process      6. Select process parameters      11. Create HSE procedures</p> <p>2. Define pre-processing operations (handling and storage, etc.)      7. Define post-processing operations (machining, surface finish, etc.)      12. Quotation of AM parts</p> <p>3. CAD design for AM/topology      8. Develop inspection &amp; testing plan      13. Perform training activities</p> <p>4. Multiphysics/CAE for AM      9. Certification of process/products      14. Integrate AM in the manufacturing chain</p> <p>5. Perform metallurgical analysis      10. Manage AM operators' work      15. Troubleshooting</p>	
<p>1. From the list of Knowledge and Skills above, fit each item number where you believe it is most appropriate. Feel free to write other topics that you consider relevant and that may be missing.</p>	
Cross-cutting Knowledge and Skills	<p>Cross-cutting qualification: <u>Metal Additive Manufacturing Engineer</u> <sup>3,4</sup></p> <p>1, 2, 5, 6, 7, 8, 10, 12, 14</p>
Specialized Knowledge and Skills	<p>Specialization #1: <u>SLM Engineer</u></p> <p>3, 5, 6, 10, 14</p>
<p>2. Besides the above, what other Knowledge and Skills may a cross-cutting Metal Additive Manufacturing Engineer or a specialized SLM Engineer be interested in?</p>	
Optional Knowledge and Skills	<p>Mechanical properties and the influence of AM on it.</p>
<p>3. Considering the above distribution, what would you consider to be the necessary amount of training hours for a trainee to acquire the above Knowledge and Skills?</p>	
<p>Cross-cutting Metal Additive Manufacturing Engineer qualification</p> <p>~ <u>800</u> h</p>	<p>SLM Engineer specialization (after completing the Metal AM Engineer training)</p> <p>+ <u>400</u> h</p>
<p>4. Considering the full course (cross-cutting Metal AM qualification + SLM Engineer specialization), how would you prefer to attend the course?</p> <p><input type="checkbox"/> Full-time (7h per day)      <input type="checkbox"/> Part-time (e.g. week evenings and Saturdays)      <input checked="" type="checkbox"/> Intensive blocks (1 full week per month)</p>	

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<h3>Metal AM Engineer – Knowledge and Skills topics</h3>																
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<b>Cross-cutting Knowledge and Skills</b>	<p>Cross-cutting qualification: <b>Metal Additive Manufacturing Engineer</b>  <span style="color: blue;">1, 3, 4, 7, 8, 9, 12, 14</span></p>															
<b>Specialized Knowledge and Skills</b>	<p>Specialization #1: <b>SLM Engineer</b>  <span style="color: blue;">2, 5, 6, 10, 11, 13, 15</span></p>															
<p>2. Besides the above, what other Knowledge and Skills may a cross-cutting Metal Additive Manufacturing Engineer or a specialized SLM Engineer be interested in?</p>																
<b>Optional Knowledge and Skills</b>	<p><span style="color: blue;">SIMULATION</span></p>															
<p>3. Considering the above distribution, what would you consider to be the necessary amount of training hours for a trainee to acquire the above Knowledge and Skills?</p>																
<table style="width: 100%; border: none;"> <tr> <td style="width: 50%; text-align: center; border: none;">                 Cross-cutting Metal Additive Manufacturing Engineer qualification  <span style="color: blue;">500 h ?</span> </td> <td style="width: 50%; text-align: center; border: none;">                 SLM Engineer specialization (after completing the Metal AM Engineer training)  <span style="color: blue;">50 h ?</span> </td> </tr> </table>		Cross-cutting Metal Additive Manufacturing Engineer qualification <span style="color: blue;">500 h ?</span>	SLM Engineer specialization (after completing the Metal AM Engineer training) <span style="color: blue;">50 h ?</span>													
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<p>4. Considering the full course (cross-cutting Metal AM qualification + SLM Engineer specialization), how would you prefer to attend the course?</p>																
<p> <input type="checkbox"/> Full-time (7h per day)                      <input type="checkbox"/> Part-time (e.g. week evenings and Saturdays)                      <input checked="" type="checkbox"/> Intensive blocks (1 full week per month)             </p>																

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(B)



## ADMIRE – Knowledge Alliance for Additive Manufacturing between Industry and Universities

### Metal AM Engineer – Knowledge and Skills topics

1. Select adequate AM process
2. Define pre-processing operations (handling and storage, etc.)
3. CAD design for AM/topology
4. Multiphysics/CAE for AM
5. Perform metallurgical analysis

6. Select process parameters
7. Define post-processing operations (machining, surface finish, etc.)
8. Develop inspection & testing plan
9. Certification of process/products
10. Manage AM operators' work

11. Create HSE procedures
12. Quotation of AM parts
13. Perform training activities
14. Integrate AM in the manufacturing chain
15. Troubleshooting

1. From the list of Knowledge and Skills above, fit each item number where you believe it is most appropriate. Feel free to write other topics that you consider relevant and that may be missing.

Cross-cutting Knowledge and Skills	Cross-cutting qualification: <b>Metal Additive Manufacturing Engineer</b> EXPED 2-4, 14, 15 7, 8
Specialized Knowledge and Skills	Specialization #1: <b>SLM Engineer</b> 2-4, 6, 7, 8, 10, 11, 12, 14, 15.

2. Besides the above, what other Knowledge and Skills may a cross-cutting Metal Additive Manufacturing Engineer or a specialized SLM Engineer be interested in?

Optional Knowledge and Skills	Selection of parts appropriate for AM.
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3. Considering the above distribution, what would you consider to be the necessary amount of training hours for a trainee to acquire the above Knowledge and Skills?

Cross-cutting Metal Additive Manufacturing Engineer qualification	SLM Engineer specialization (after completing the Metal AM Engineer training)
<u>100</u> h	<u>20</u> h

4. Considering the full course (cross-cutting Metal AM qualification + SLM Engineer specialization), how would you prefer to attend the course?

Full-time (7h per day)
  Part-time (e.g. week evenings and Saturdays)
  Intensive blocks (1 full week per month)

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E

 <b>ADMIRE</b>	<h2 style="margin: 0;">ADMIRE – Knowledge Alliance for Additive Manufacturing between Industry and Universities</h2>															
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Cross-cutting Knowledge and Skills	Cross-cutting qualification: <b>Metal Additive Manufacturing Engineer</b> <i>1, 2, 6, 7, 8, 9 (products), 10, 11, 14, 15</i>															
Specialized Knowledge and Skills	Specialization #1: <b>SLM Engineer</b> <i>3, 4, 5, 9 (process), 12, 13</i>															
<p>2. Besides the above, what other Knowledge and Skills may a cross-cutting Metal Additive Manufacturing Engineer or a specialized SLM Engineer be interested in?</p>																
Optional Knowledge and Skills	<span style="font-size: 2em;">?</span>															
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**ADMIRE – Knowledge Alliance for Additive Manufacturing between Industry and Universities**

**Metal AM Engineer – Knowledge and Skills topics**

1. Select adequate AM process
2. Define pre-processing operations (handling and storage, etc.)
3. CAD design for AM/topology
4. Multiphysics/CAE for AM
5. Perform metallurgical analysis

6. Select process parameters
7. Define post-processing operations (machining, surface finish, etc.)
8. Develop inspection & testing plan
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10. Manage AM operators' work

11. Create HSE procedures
12. Quotation of AM parts
13. Perform training activities
14. Integrate AM in the manufacturing chain
15. Troubleshooting

1. From the list of Knowledge and Skills above, fit each item number where you believe it is most appropriate. Feel free to write other topics that you consider relevant and that may be missing.

Cross-cutting Knowledge and Skills	<p>Cross-cutting qualification: <b>Metal Additive Manufacturing Engineer</b></p> <p>1, 2, 3 4, 5, 6, 7, 8, 10</p>
Specialized Knowledge and Skills	<p>Specialization #1: <b>SLM Engineer</b></p> <p>2, 3 5, 6, 7, 10</p>

2. Besides the above, what other Knowledge and Skills may a cross-cutting Metal Additive Manufacturing Engineer or a specialized SLM Engineer be interested in?

Optional Knowledge and Skills	<p>writing proposals dissemination</p>
-------------------------------	--

3. Considering the above distribution, what would you consider to be the necessary amount of training hours for a trainee to acquire the above Knowledge and Skills?

<p>Cross-cutting Metal Additive Manufacturing Engineer qualification</p> <p>_____ h</p>	<p>SLM Engineer specialization (after completing the Metal AM Engineer training)</p> <p>_____ h</p>
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4. Considering the full course (cross-cutting Metal AM qualification + SLM Engineer specialization), how would you prefer to attend the course?

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Cross-cutting Knowledge and Skills	Cross-cutting qualification: <b>Metal Additive Manufacturing Engineer</b> 1, 8, 9, 11, 12															
Specialized Knowledge and Skills	Specialization #1: <b>SLM Engineer</b> 2, 3, 4, 5, 6, 7, 10, 13, 14, 15															
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**ADMIRE**

**ADMIRE – Knowledge Alliance for Additive Manufacturing between Industry and Universities**

**Metal AM Engineer – Knowledge and Skills topics**

1. Select adequate AM process	6. Select process parameters	11. Create HSE procedures
2. Define pre-processing operations (handling and storage, etc.)	7. Define post-processing operations (machining, surface finish, etc.)	12. Quotation of AM parts
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5. Perform metallurgical analysis	10. Manage AM operators' work	15. Troubleshooting

1. From the list of Knowledge and Skills above, fit each item number where you believe it is most appropriate. Feel free to write other topics that you consider relevant and that may be missing.

Cross-cutting Knowledge and Skills	<p>Cross-cutting qualification: <b>Metal Additive Manufacturing Engineer</b></p> <p><i>1, 2, (3), 5*, 6*, 7, 8, 9, 12, 14</i></p> <p><i>5* interpret, not perform; 6* - select previously tested <sup>set of</sup> parameters.</i></p>
Specialized Knowledge and Skills	<p>Specialization #1: <b>SLM Engineer</b></p> <p><i>the same as above</i></p>

2. Besides the above, what other Knowledge and Skills may a cross-cutting Metal Additive Manufacturing Engineer or a specialized SLM Engineer be interested in?

Optional Knowledge and Skills	
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3. Considering the above distribution, what would you consider to be the necessary amount of training hours for a trainee to acquire the above Knowledge and Skills?

Cross-cutting Metal Additive Manufacturing Engineer qualification <i>360</i> h	SLM Engineer specialization (after completing the Metal AM Engineer training) <i>40</i> h
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4. Considering the full course (cross-cutting Metal AM qualification + SLM Engineer specialization), how would you prefer to attend the course?

Full-time (7h per day)
  Part-time (e.g. week evenings and Saturdays)
  Intensive blocks (1 full week per month)

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<p>2. Besides the above, what other Knowledge and Skills may a cross-cutting Metal Additive Manufacturing Engineer or a specialized SLM Engineer be interested in?</p>																
Optional Knowledge and Skills	Data analysis,															
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<b>Metal AM Engineer – Knowledge and Skills topics</b>	
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Cross-cutting Knowledge and Skills	<p>Cross-cutting qualification: <b>Metal Additive Manufacturing Engineer</b></p> <p><i>1, 3, 5, 4, 8, 9, 10, 11, 14</i></p>
Specialized Knowledge and Skills	<p>Specialization #1: <b>SLM Engineer</b></p> <p><i>6, 2, 7, 12, 13, 15</i></p>
<p>2. Besides the above, what other Knowledge and Skills may a cross-cutting Metal Additive Manufacturing Engineer or a specialized SLM Engineer be interested in?</p>	
Optional Knowledge and Skills	<p><i>Some knowledge about materials (more than multiphysics)</i></p>
<p>3. Considering the above distribution, what would you consider to be the necessary amount of training hours for a trainee to acquire the above Knowledge and Skills?</p>	
<p>Cross-cutting Metal Additive Manufacturing Engineer qualification</p> <p><i>24 h (3x8h)</i></p>	<p>SLM Engineer specialization (after completing the Metal AM Engineer training)</p> <p><i>16 h (2 week long)</i></p>
<p>4. Considering the full course (cross-cutting Metal AM qualification + SLM Engineer specialization), how would you prefer to attend the course?</p>	
<p><input checked="" type="checkbox"/> Full-time (7h per day) <i>and advanced after lunch and evening 12.00-18.00</i></p> <p><input type="checkbox"/> Part-time (e.g. week evenings and Saturdays)</p> <p><input checked="" type="checkbox"/> Intensive blocks (1 full week per month)</p>	

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**Metal AM Engineer – Knowledge and Skills topics**

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1. From the list of Knowledge and Skills above, fit each item number where you believe it is most appropriate. Feel free to write other topics that you consider relevant and that may be missing.

Cross-cutting Knowledge and Skills	<p>Cross-cutting qualification: <b>Metal Additive Manufacturing Engineer</b></p> <p><i>From Design to post 3D printing processing</i></p>
Specialized Knowledge and Skills	<p>Specialization #1: <b>SLM Engineer</b></p> <p><i>1-4-5-6-8-10</i></p>

2. Besides the above, what other Knowledge and Skills may a cross-cutting Metal Additive Manufacturing Engineer or a specialized SLM Engineer be interested in?

Optional Knowledge and Skills	
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3. Considering the above distribution, what would you consider to be the necessary amount of training hours for a trainee to acquire the above Knowledge and Skills?

<p>Cross-cutting Metal Additive Manufacturing Engineer qualification</p> <p><i>1200</i> h</p>	<p>SLM Engineer specialization (after completing the Metal AM Engineer training)</p> <p><i>800</i> h</p>
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4. Considering the full course (cross-cutting Metal AM qualification + SLM Engineer specialization), how would you prefer to attend the course?

Full-time (7h per day)
  Part-time (e.g. week evenings and Saturdays)
  Intensive blocks (1 full week per month)

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<p>1. From the list of Knowledge and Skills above, fit each item number where you believe it is most appropriate. Feel free to write other topics that you consider relevant and that may be missing.</p>	
Cross-cutting Knowledge and Skills	Cross-cutting qualification: <b>Metal Additive Manufacturing Engineer</b>  9, 11, 14
Specialized Knowledge and Skills	Specialization #1: <b>SLM Engineer</b>  3, 5, 8, 9
<p>2. Besides the above, what other Knowledge and Skills may a cross-cutting Metal Additive Manufacturing Engineer or a specialized SLM Engineer be interested in?</p>	
Optional Knowledge and Skills	MACHINERY – PRECISION, ACCURACY CYCLE TIME – OPTIMIZATION DATA AM FORMATS, MACHINE CONNECTIVITY
<p>3. Considering the above distribution, what would you consider to be the necessary amount of training hours for a trainee to acquire the above Knowledge and Skills?</p>	
Cross-cutting Metal Additive Manufacturing Engineer qualification	SLM Engineer specialization (after completing the Metal AM Engineer training)
60 h	200 h
<p>4. Considering the full course (cross-cutting Metal AM qualification + SLM Engineer specialization), how would you prefer to attend the course?</p>	
<p> <input type="checkbox"/> Full-time (7h per day)                          <input checked="" type="checkbox"/> Part-time (e.g. week evenings and Saturdays)                          <input type="checkbox"/> Intensive blocks (1 full week per month)                 </p>	

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Cross-cutting Knowledge and Skills	Cross-cutting qualification: <b>Metal Additive Manufacturing Engineer</b> 5 7 8 9 11 12				
Specialized Knowledge and Skills	Specialization #1: <b>SLM Engineer</b> 2 6 10 15				
2. Besides the above, what other Knowledge and Skills may a cross-cutting Metal Additive Manufacturing Engineer or a specialized SLM Engineer be interested in?					
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Cross-cutting Metal Additive Manufacturing Engineer qualification	SLM Engineer specialization (after completing the Metal AM Engineer training)				
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Specialized Knowledge and Skills	<p>Specialization #1: <b>SLM Engineer</b></p> <p style="font-size: 1.2em; color: blue;">1, 3, 6, 7, 12, 14, 15</p>															
<p>2. Besides the above, what other Knowledge and Skills may a cross-cutting Metal Additive Manufacturing Engineer or a specialized SLM Engineer be interested in?</p>																
Optional Knowledge and Skills	<div style="border: 1px solid black; height: 40px; width: 100%;"></div>															
<p>3. Considering the above distribution, what would you consider to be the necessary amount of training hours for a trainee to acquire the above Knowledge and Skills?</p> <table style="width: 100%; border: none;"> <tr> <td style="width: 50%; text-align: center;">                 Cross-cutting Metal Additive Manufacturing Engineer qualification                  _____ h             </td> <td style="width: 50%; text-align: center;">                 SLM Engineer specialization (after completing the Metal AM Engineer training)                  _____ h             </td> </tr> </table>		Cross-cutting Metal Additive Manufacturing Engineer qualification _____ h	SLM Engineer specialization (after completing the Metal AM Engineer training) _____ h													
Cross-cutting Metal Additive Manufacturing Engineer qualification _____ h	SLM Engineer specialization (after completing the Metal AM Engineer training) _____ h															
<p>4. Considering the full course (cross-cutting Metal AM qualification + SLM Engineer specialization), how would you prefer to attend the course?</p> <p> <input type="checkbox"/> Full-time (7h per day)                      <input type="checkbox"/> Part-time (e.g. week evenings and Saturdays)                      <input type="checkbox"/> Intensive blocks (1 full week per month)             </p>																

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	<b>ADMIRE – Knowledge Alliance for Additive Manufacturing between Industry and Universities</b>
<b>Metal AM Engineer – Knowledge and Skills topics</b>	
<p>1. Select adequate AM process      6. Select process parameters      11. Create HSE procedures</p> <p>2. Define pre-processing operations (handling and storage, etc.)      7. Define post-processing operations (machining, surface finish, etc.)      12. Quotation of AM parts</p> <p>3. CAD design for AM/topology      8. Develop inspection &amp; testing plan      13. Perform training activities</p> <p>4. Multiphysics/CAE for AM      9. Certification of process/products      14. Integrate AM in the manufacturing chain</p> <p>5. Perform metallurgical analysis      10. Manage AM operators' work      15. Troubleshooting</p>	
<p>1. From the list of Knowledge and Skills above, fit each item number where you believe it is most appropriate. Feel free to write other topics that you consider relevant and that may be missing.</p>	
Cross-cutting Knowledge and Skills	<p>Cross-cutting qualification: <b>Metal Additive Manufacturing Engineer</b></p> <p><i>different profiles</i>  <b>DESIGNER: 1-3-4-6 / PROCESSER: 2-5-6-7-8-9</b>  <b>FOR BOTH PROFILES: 10 11 12 13</b></p> <p><i>14</i></p>
Specialized Knowledge and Skills	<p>Specialization #1: <b>SLM Engineer</b></p> <p><i>different profiles</i>  <b>DESIGNER: 1-3-4-6</b>      <b>FOR BOTH: 10 11 12 13</b>  <b>PROCESSER: 2-5-6-7-8-9</b></p>
<p>2. Besides the above, what other Knowledge and Skills may a cross-cutting Metal Additive Manufacturing Engineer or a specialized SLM Engineer be interested in?</p>	
Optional Knowledge and Skills	<p><i>in both cases an additional profile</i>  <b>MACHINE DEVELOPER: 4-6-10-13-14 BUT ALSO</b>  <b>IOT, SENSORS AND IN LINE CONTROLS</b></p>
<p>3. Considering the above distribution, what would you consider to be the necessary amount of training hours for a trainee to acquire the above Knowledge and Skills?</p>	
<p>Cross-cutting Metal Additive Manufacturing Engineer qualification</p> <p style="text-align: center;"><u>400</u> h</p>	<p>SLM Engineer specialization (after completing the Metal AM Engineer training)</p> <p style="text-align: center;"><u>200</u> h</p>
<p>4. Considering the full course (cross-cutting Metal AM qualification + SLM Engineer specialization), how would you prefer to attend the course?</p> <p> <input type="checkbox"/> Full-time (7h per day)              <input type="checkbox"/> Part-time (e.g. week evenings and Saturdays)              <input checked="" type="checkbox"/> Intensive blocks (1 full week per month)       </p>	

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