SECTOR SKILLS STRATEGY
IN ADDITIVE MANUFACTURING

WP6 Short term Scenarios - Review Professional Profiles /Qualifications and Units of Learning Outcomes

D6.3 Part 1 - Revision of the Metal AM Coordinator

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1. Introduction

The International Metal Additive Manufacturing Coordinator (IMAMC) is a qualification that was developed in 2018 from the ADMIRE project (https://admireproject.eu). It is part of the International Additive Manufacturing Qualification System (IAMQS) and is for professionals who wish to be responsible for the implementation and coordination of Additive Manufacturing (AM) activities. The 'IMAMC' qualification was originally developed under the guidance of EWF, in the scope of the ADMIRE project. Some consortium members were involved in this process such as EWF and MTC that would enable familiarity with both projects. Students were required to register a set of mandatory Competence Units (CUs) in order to achieve this qualification. These are reported in Table 1. The existing 'IMAMC' qualification covers mandatory CUs Additive manufacturing Process Overview, DED-Arc Process, DED-LB Process, PBF-LB Process, Post Processing, Process Selection, Metal AM Integration and Coordination Activities. The Metal 'Binder Jetting process' CU was piloted by POLIMI, with support from MTC in Q1 2022 on 28th, 29th and 30th of March 2022, and the assessment was conducted on 31st of March 2022. The feedback was to include the 'Metal Binder Jetting process' related topics and inclusion of practical aspects in teaching and delivery. This report primarily reports about meetings and experts' recommendation in relation to inclusion of the CU on "Metal Binder Jetting process" into existing 'IMAMC'. This deliverable D6.3 provides a description of all meetings and the agreed actions.

Table 1: Original International Metal Additive Manufacturing Coordinator (IMAMC) - Recommended contact hours and expected workload

COMPETENCE UNITS	IMAMC	
	Recommended Contact Hours*	Expected Workload**
CU 00: Additive manufacturing Process Overview	3,5	7
CU 01: DED-Arc Process	42	84
CU 08: DED-LB Process	35	70
CU 15: PBF-LB Process	35	70
CU 25: Post Processing	14	28
CU 34: Process Selection	28	56
CU 35: Metal AM Integration	21	42
CU 36: Coordination Activities	7	14
TOTAL	**157.5**	**315**

Note: (1) * Contact Hours are the minimum recommended teaching hours for the Standard Routes. A contact hour shall contain at least 50 minutes of direct teaching time. (2) ** Workload is calculated in hours, corresponds to an estimation of the time students typically need to complete all learning activities required to achieve the defined learning outcomes in formal learning environments plus the necessary time for individual study. (3) ***A minimum of 2 CUs shall be selected from the list **Materials CUs** in order to successfully complete the qualification.

Metal AM Coordinators are the professionals with a specific knowledge, skills, autonomy and responsibility to assess the technical adequacy of AM processes for part requirements This qualification is for professionals who wish to be responsible for the implementation and coordination of AM activities. The coordinator's main tasks are to (1) 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; (2) Apply a wide variety of engineering techniques, contributing to projects in a team setting and compare procedures, techniques or methods to potential applications; (3) Coordinate the tasks distributions between the operators according to the work plan as well as managing the link between them and the management. The qualification outcome descriptor is presented in Table 2.

Table 2: Original IMAMC' – Qualification Outcome Descriptors

QUALIFICATION	PROFICIENCY LEVEL	KNOWLEDGE	SKILLS	AUTONOMY AND RESPONSIBILITY
International Metal AM Coordinator	Advanced	Advanced knowledge and critical understanding of the theory, principles and applicability of metal additive manufacturing processes.	Advanced problem-solving skills including critical evaluation, allowing to choose the proper technical and economical solutions, when selecting metal additive manufacturing processes, in complex and unpredictable conditions	Manage the selection of metal additive manufacturing processes in a highly complex context. Take responsibility in decision making and definition of the metal additive manufacturing personnel's tasks

Working Session Summary	
Date and Venue	(29/06/2022) (Online)
Participants	6
Working Group:	Metal AM
Leading Expert	David Wimpenny
Chairman (if applicable)	NA
Members of the WG	NA
Other participants (if applicable)	NA

Session topics	
Agenda	Review: International Metal Additive Manufacturing Coordinator by integrating CU72 Metal AM Binder Jetting

Templates	
D3.2 (Kit of Templates)	Link

Results and Recommendations
The revision of the International Metal Additive Manufacturing Coordinator (IMAMC) qualification involves: (1) introduction of Competence Unit 72: Metal Binder Jetting process (2) Discussions of recommended contact hours and workload.

Annexes	
Best Practice document	Link
Kit D2.8 (working sessions)	link (page 9)

2. TM8 meetings and Working Sessions with Experts

The 8th Technical Meeting was held from 23rd to 26th of May 2022 in Gijon, Spain. SAM partners, leading experts from the industry and research organisations, were also invited for follow up of pilot activities and feedback. A thorough discussion on short-term case scenarios and their revision was held. UBRUN initiated a brainstorming session on the review of Metal AM coordinator, **Error! Reference source not found.** shows UBRUN presentation at TM8. The power point presentation is available on SharePoint at web link: TM8 WP6.pptx (sharepoint.com). Overall, there was a consensus among SAM members that largely the quality and participants feedback from the pilot was satisfactory. Based on the feedback from both course attendees and trainers, a consensus was made by the experts to include the content from CU72 for Metal Binder jetting as a compulsory element in the Metal AM Coordinator professional profile.

2.1 Follow up actions – June 2022 monthly meeting

The monthly meeting of SAM members held on 22nd June 2022. Members discussed progress related to WP6. David Wimpenny (MTC) presented MTC's monthly presentation (**Error! Reference source not found.**), and a timescale of activities related to Metal AM coordinator is shown in Figure 2.

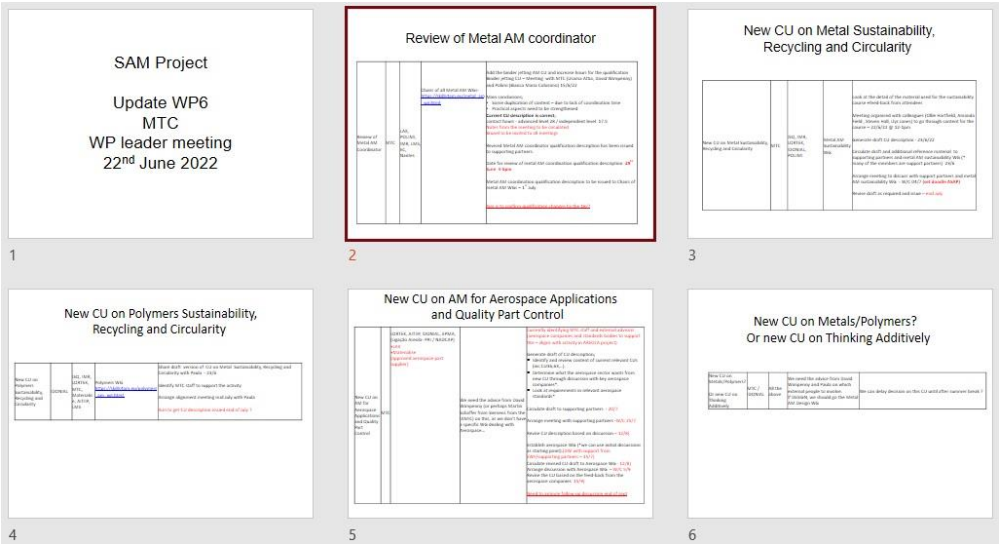

Figure 1: WP Leaders meeting - MTC presentation

Review of Metal AM Coordinator	MTC	LAK, POLIMI, IMR, LMS, EC, Nantes	Chairs of all Metal AM WGs- https://skills4am.eu/metal_am_wg.html	Add the binder jetting AM CU and increase hours for the qualification Binder jetting CU – Meeting with MTC (Usama Attia, David Wimpenny) and Polimi (Bianca Maria Colosimo) 15/6/22 Main conclusions; • Some duplication of content – due to lack of coordination time • Practical aspects need to be strengthened **Current CU description is correct;** contact hours - advanced level 28 / independent level 17.5 Notes from the meeting to be circulated Brunel to be invited to all meetings Revised Metal AM coordinator qualification description has been issued to supporting partners. Date for review of metal AM coordination qualification description **-29th June 4-5pm** Metal AM coordination qualification description to be issued to Chairs of metal AM WGs – 1st July Aim is to confirm qualification changes by the 18/7

Figure 2: Revision of Metal AM coordinator – proposed timescale of activities

2.2 First working session – overview

The first session was held on 29th June 2022 which was organised by David Wimpenny from the MTC. This was a complete virtual meeting session held using the MS-TEAMS platform. The meeting recording was provided on MTC's SharePoint.

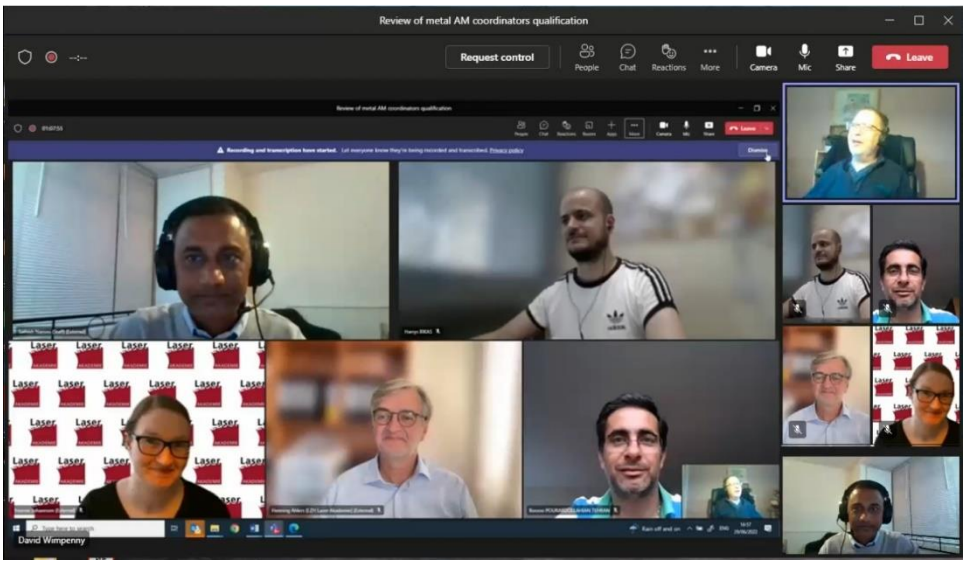

Figure 3: Virtual working session on revision of Metal AM coordinator with SAM members and experts

2.3 First working session – Participants

A total of 6 representatives from project participated in the group meeting whose affiliations are provided in

Table 3. This allowed a good diversity of views, feedback and suggestions to be collected during the session.

Table 3: Participating experts in the first review session

	Name of Expert	Organisation
1	David Wimpenny	MTC
2	Harrys Bikas	LMS
3	Henning Ahlers	LAK
4	Sathish Nammi	UBRUN
5	Yvonne Johannsen	LAK
6	Borzoi Pourabdollahian	EC NANTES

2.4 First working session – content and discussion

David Wimpenny (DW) from MTC who organised the meeting opened the session with a reminder of the TM8 agreed framework, and the information on the inclusion of 'Binder Jetting' related CU. The main objective was to introduce a new CU relevant to 'Binder Jetting' topics into the existing 'IMAMC' qualification. The methodology developed in WP3 regarding the Revision of Professional Profiles and/or Competence Units was used as a reference for the working session aiming to update CU 72 content. In this case for CU 72 which is already an existing Competence Units/Units of Learning Outcomes that requires an update and what needs to be changed, the templates below were used:

- **Stage 0 – PreSkill gap origin**

  Key question:

  - What is the origin of the skill gap?

Skill Gap Origin			
Reference: SG		**Instance Ref:**	
Creator:	**AM Observatory Management Team**	**Creation date:**	**13.06.2022**
Validator:	**Metal AM WG**	**Validation date:**	**TBD**
New Professional Profile	**N.A.**	**Professional Profile designation**	**Metal AM Coordinator**
Review of existing Professional Profile	**Metal AM Coordinator**		
Technological process	Material		Qualification

New technological process	Advancement in technological process	New material	Being updated in use	Systematic review
				X

Stage 1 – Professional profile

Systematic review of Qualification/Professional profile

Key questions:

- What job functions/activities are reviewed to update the qualification/professional profile?

Systematic review of Qualification/Professional Profile						
Reference:				**Instance Ref:**		
Creator:		**AM Observatory Management Team**		**Creation date:**	**13.06.2022**	
Validator:		**Metal AM WG**		**Validation date:**	**TBD**	
Supporting documents:		D4.5 3rd Report on Skills Needs D4.6 2nd Report on students' feedbacks				
Professional Profile/qualification/Unit of Learning Outcomes		Metal AM Coordinator				
Topic	**Section**	**Update required**	**Yes**		**No**	x
Professional profile description	**Introduction**					
Topic	**Section**	**Update required**	**Yes**		**No**	x
Access conditions	**2**					
Topic	**Section**	**Update required**	**Yes**		**No**	x
Qualification descriptors	**I.1**					
Topic	**Section**					
Job Functions/Activities	**I.2**	**Update required**	**Yes**		**No**	x

CU Nr	Job Function	Job Activities	Job Function	Job Activities
	JF_i	JA_{i1}	JF_1 " ...	

Systematic review of Qualification/Professional Profile				
Update required in Competence Unit/Units of Learning Outcomes	**Yes**	**X**	**No**	
List of impacted CU/ULO	New CU 72 added to the qualification.			

This was followed by David Wimpenny (DW) presenting a revised 'IMAMC' qualification that introduces CU72. One comment that was raised was about the number of hours and the expected workload. The level of time committed to the metal AM process CUs was seemed to be disproportionately high, when compared to the CUs dedicated to process selection, metal AM integration and coordination activities that were more applicable to the Metal AM Coordinator's role.

There was **general consensus for the experts** who took part to consider these the changes in terms of the addition of the **Metal Binder Jetting process CU as an advanced level and as a compulsory element** to the qualification. However, several issues were raised: The duration of the training required to achieve the qualification was now very long, making it less feasible for people to complete all of the CUs and the qualification awarded. Many companies would struggle to release staff for this amount of time thus undermining the attractiveness of the IAMQS system. Even if delivered for full-time students, the duration would reach the maximum expected hours for a full-time master's courses (typically 160-180 contact hours). Moreover, as new metal AM processes are developed in the future and are added to the list of CUs, then this would further increase the duration of teaching required for the qualification. Apart from the comment that was raised was about the number of hours and the expected workload, **the level of time committed for the Metal AM process CUs seemed to be disproportionately high, when compared to the CUs dedicated to process selection, metal AM integration and coordination** activities which seem that these were more applicable to the Metal AM Coordinator's role.

Henning Ahlers (HA) - The level of time committed to the metal AM process CUs is proportionately high compared to the CUs dedicated to process selection, metal AM integration and coordination activities which seem more applicable to the Metal AM coordinator's role. **To overcome this problem, it was proposed that attendees could select two of the four metal AM process CUs to be undertaken at independent level and two to be undertaken at advanced level.** This would reduce the number of contact hours and enable the course to be tailored to the particular requirements of the sponsoring company and/or interest of the student.

Harrys Bikas (HB) raised concerns about the potential duplication between the post processing included in the metal AM process CUs, including the new metal binder jetting process CU, and the CU dedicated to post processing. DW responded by confirming that although there was risk of some duplication of material in the case of the metal binder jetting, the post processing content was very specific to the process (i.e. for debinding and sintering).

HA wanted to know how the metal AM coordinator role was different, for example to the process engineer's role. The precise role of the metal AM coordinator needs to be clarified, particularly to differentiate it from the metal AM supervisor's role. Further information was obtained as shown below:

AM Coordinator	AM Supervisor

Role Evaluates manufacturing suitability for customers' requests defining which processes are fit for the request, based on the application, material, design and cost of the part. Coordinates the work with AM team.	**Role** Supervises the AM production on shop floor ensuring quality and HSE procedures
Professional with knowledge, skills and responsibility to: 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; • Apply a wide variety of engineering techniques, contributing to projects in a teaming environment and compare procedures, techniques or methods to potential applications; • Coordinate the tasks distributions between the operators according to the workplan as well as managing the link between them and the management.	**Professional** with knowledge, skills and responsibility to supervise AM production on shop floor, being its main tasks to: • Implement Quality Procedures • Ensure Health & Safety Environment Procedures • Record the essential information during the AM manufacturing process
Level 6 (advanced)	**Level 4 (Independent)**

The new revised qualification raised some important questions which needed to be approved by SAM members. SAM members have correctly identified a conundrum with respect to the IAMQS qualification and CUs which are indivisible. DW proposed that attendees could select two of the four metal AM process CUs to be undertaken at an independent level and two to be undertaken at advanced level. This would reduce the number of contact hours and enable the course to be tailored to the particular requirements of the sponsoring company and/or interest of the student. The question was whether such amendment to the IAMQS system was possible. **Thus, follow up discussions and further approvals from metal AM WG were needed.** To ensure a robust and fully revised qualification, it was agreed that a piloting will be carried out for the revised full Qualification, and with a reduced amount of contact hours in order to undertake a proper assessment of the evaluation. This piloting will be reported in a separate document, D6.3 Part 2 that will be written by LAK.

2.5 First working session - Results

DW and Adelaide Almeida (AA) organised a meeting on 1st July 2022. DW discussed potential solutions and requested for a formal response from EWF. It was agreed on the revision structure and it was decided that no further sessions were necessary. The feedback given by the experts were noted and DW revised the SKILLS and KNOWLEDGE sections of the learning outcomes. The recorded session can be checked for more details on individual experts' feedback and discussion. During the review of CU72, the duration of the course had been reduced slightly for the piloting and it was concluded that the addition of practical elements would enable the course to comply with the durations outlined in the CU

description – 17.5 and 28 contact hours respectively for independent and advanced levels. The revised Metal AM coordinator qualification description, together with these notes from the review meeting (29/6/23) were circulated to the Chairs of the Metal AM sub WG for comments.

3. Introduction of Competence Unit CU72 into the Qualification

The Metal AM Coordinator qualification is the highest technical level qualification offered under the IAMQS. The Metal AM Coordinator should be knowledgeable in all of the commercially applied metal AM processes. Following introduction and piloting of CU72 - Metal binder jetting competence unit, it was proposed that CU72 would be added as a compulsory component at an advanced level for the Metal AM Coordinator qualification.

3.1 Competence Unit – Recommended Contact Hours

The structure of CU72 is presented in Table 4.

Table 4: CU72 - Recommended contact hours

CU 72 : Metal BJ Process	**RECOMENDED CONTACT HOURS**	
LEVEL	**INDEPENDENT (I) (applied to Operators and Engineers)**	**ADVANCED (A) (applied only to Engineers)**
MBJ Process Steps	4	0
MBJ System – Hardware and Software	4	0
MBJ Feedstock and Consumables	3	0
MBJ Parameters	3.5	0
Sintering Principles	0	5
MBJ Process Capabilities	2	0
Post Processing	1	0
Industrialization of MBJ	0	5.5
Subtotal Per Level	**17.5**	**10.5**
Cumulated Subtotal	**17.5**	**28**
		WORKLOAD
PER LEVEL	35	21
CUMULATED	**35**	**56**

3.2 Competence Unit – Learning Outcomes

The learning outcomes structure – Knowledge and Skills are listed in Table 5.

Table 5: CU72 – Learning Outcomes

LEARNING OUTCOMES – CU MBJ Process		
LEVEL	**INDEPENDENT (applied to Operators and Engineers)**	**ADVANCED (applied only for Engineers)**
KNOWLEDGE	Factual and broad knowledge of: – MBJ Technology – Hardware - MBJ process capability – Processable materials with MBJ – Debinding and Sintering principles – Main parameter influence – Post-processing options – Advantages and Disadvantages compared to other AM technologies	Advanced knowledge and critical understanding of the theory, principles and applicability of: – MBJ process parameters and variables, including post processing operation – Advanced Sintering principles – Process selection – Manufacturing strategies – Costs and value
SKILLS	Describe the MBJ process steps towards the AM part production. Describe MBJ systems, including the components for debinding and sintering and their functions Distinguish the differences between MBJ consumables (e.g. feedstock, binder, etc.). Recognize the MBJ parameters and the influence of their adjustment on the as-built part Recognize the interaction between process steps and thermal treatment on build part Identify the problems associated with inadequate preparation and setup of the build platform, handling and storage of feedstock and application of the gases used in MBJ Discuss the influence of build platform, feedstock and other consumable characteristics on part manufacturing Recognize post-processing options for MBJ manufactured parts. List the advantages and disadvantages of MBJ from a manufacturing process chain point of view.	Adjust process parameters, manufacturing strategy and set up to prevent part defects and process related issues. Explain the influence of the sintering process on part design and manufacturing. Identify the cause of sintering defects and propose methods for their mitigation. Discuss the adequacy of selected equipment and accessories on the part manufacturing with respect to process capabilities. Distinguish the different regimes and processes of failure and describe the factors controlling them and the boundaries and limits between them Select specific materials for different applications to meet part requirements Identify specific metallurgical aspects of MBJ parts. Identify the variables used to define the MBJ manufacturing strategy. Identify costs and values when industrializing MBJ process

4. Revised International Metal AM Coordinator (IMAMC)

The "IMAMC" qualification was developed in 2018 from the ADMIRE project (https://admireproject.eu), and later to be integrated in the IAMQS. The qualification is for professionals who wish to be responsible for the implementation and coordination of Additive Manufacturing (AM) activities. During SAM, CU72 was developed and piloted by POLIMI, with support from MTC and the Metal AM working group. It was concluded that the addition of practical element would enable the CU course to comply with the durations outlined in the CU description – 17.5 and 28 contact hours respectively for independent and advanced levels in harmony with other CUs that are already integrated with IAMQS. The review of the IMAMC profile /qualification was undertaken to integrate CU72, and circulated to all partners for feedback. It should be noted that the piloting for the revised qualification of the Metal AM Coordinator will be carried out, and a subsequent report, D6.2 Part 2 will be produced by LAK. The structure of the revised qualification is given in Table 4

Table 4 - Revised International Metal Additive Manufacturing Coordinator Qualifcation – Recommeded contact hours and workload

COMPETENCE UNITS	IMAMC	
	Recommended Contact Hours*	Expected Workload**
CU 00: Additive manufacturing Process Overview	3,5	7
CU 01: DED-Arc Process	42	84
CU 08: DED-LB Process	35	70
CU 15: PBF-LB Process	35	70
CU 25: Post Processing	14	28
CU 34: Process Selection	28	56
CU 35: Metal AM Integration	21	42
CU 36: Coordination Activities	7	14
CU 72: Metal Binder Jetting process	28	56
TOTAL	**185.5**	**371**

The review of the AM Coordinator Qualification, did not imply any change to the professional profile description, thus the same scope of tasks and responsibilities are expected from this professional. Important concerns have been pointed out by the AM Experts regarding the overall length of the qualification course, as well as the level of time devoted to Metal AM process CUs compared to the CUs dedicated to process selection, metal AM integration and coordination. To overcome this problem, several solutions were proposed, such as: selection of two of the four metal AM process CUs to be undertaken at independent level and two to be undertaken at advanced level; reduce the recommended contact hours t enable a shorter course and avoid repetition. This last approach will be tested in the piloting course.

5. References

[1]. Report on Real Case Scenarios – New Professional Profiles/Qualifications and Competence Units/ Training Modules. SAM -Deliverable-D6.1.

[2]. Kit of templates – Revision and Creation of Professional Profiles. SAM -Deliverable-D3.2.

[3]. TM8 - Minutes, SAM Project.