

Project title:

Creating knowLedge and skilLs in AddItive Manufacturing



Reference number:

2017-3309/591838-EPP-1-2017-1-ES-EPPKA2-SSA

WP 2

Deliverable 2.1

Report on RPL, EQF and European AM Profiles



Co-funded by the Erasmus+ Programme of the European Union





Open Licence

All these public and educational materials obtained from Erasmus+ funding are published free of charge and under an open license. Permission is granted for any use of this work/document, exploitation, sharing or adaptation of this resource, as well as the creation of derivative works without restriction. Only authorship must be recognized. Therefore, free access and possibility to use the deliverables is allowed. An open license is not a transfer of copyrights or Intellectual Property Rights (IPR) and the benefit.

© 2021 CCLAIM This work is licensed under a Creative Commons Attribution 4.0 International Licence.









Index

Index		3
Introduct	ion	5
1. Curr	ent state of the art on EQF and RPL per country	6
1.1.	Recognition of Prior Learning (RPL)	6
1.2.	Recognition of Prior Learning in Germany (LZH)	7
1.3.	Recognition of Prior Learning in United Kingdom (TWI)	9
1.4.	Recognition of Prior Learning in Spain (IDONIAL)	10
1.5. Qualifio	National Qualification Frameworks and their correspondence with the Eurocation Framework	opean 12
2. Euro	ppean Metal AM Profiles	15
2.1.	Methods	15
2.2.	Presentation and Discussion of Results	16
2.2.1	1 MAM Specialist/Supervisor	23
2.2.2	2 MAM Designer	26
2.2.3	3 MAM Inspector / Quality Assurance Supervisor	28
2.2.4	4 MAM Operator	31
2.3.	Summary of Results	34
3. Inpu	ts from the Focus Group Meetings	40
3.1 De	tails from focus group meetings - Germany	40
3.1.1	1 Objective of the focus meeting group report in Germany	40
3.1.2	2 Description of the focus meeting group report in Germany	40
3.1.3	3 Questionnaire results in Germany	41
3.1.4	Final considerations	52
3.2 De	tails from focus group meetings – United Kingdom	54
3.2.1	1 Objective of the focus meeting group report in United Kingdom	54
3.2.2	2 Description of the focus meeting group report in United Kingdom	54
3.2.3	3 Questionnaire Results in United Kingdom	54
3.2.4	Final considerations in United Kingdom	82
3.3 De	tails from focus group meetings - Spain	82
3.3.1	1 Objective of the focus meeting group report in Spain	82







	3.3.2	Description of the focus meeting group report in Spain	82
	3.3.3	Questionnaire results in Spain	83
	3.3.4	Final considerations	96
3	.4 Summ	ary of the result form Focus Group Meetings	97
4.	Conclus	ions 1	14
5.	Annex 1	- Survey on Skills part II1	16
6.	Annex 2	- Questionnaire1	30







Introduction

The present document settles the framework for the development of European Qualification Profiles, based on the results achieved through the surveys on the European AM profiles and the collected inputs from focus group meetings.

It also presents a summary description about the existing Recognition and Validation of Prior Learning Systems (RPL) and National Qualification Frameworks (NQF) and their correspondence with the European Qualification Framework (EQF)in CLLAIM project partner countries.

National results are presented by sector and country, highlighting the strategic relevance of the field for manufacturing in each consortium country and sector's specific needs, in order to:

- Accomplish a harmonized European qualification scheme.
- Round the potentialities of a European Additive Manufacturing Qualification body.

The increasing growth of Metal Additive Manufacturing (AM) technology is demanding the definition of new professional levels required by industry for personnel working in this area.





1. Current state of the art on EQF and RPL per country

1.1. Recognition of Prior Learning (RPL)

RPL is a process used to identify, assess and certify a person's knowledge, skills and competencies gained through work and life experiences. This RPL is based on the recognition of learning outcomes process of granting official status to learning outcomes knowledge, skills and competences either through:

- validation of non-formal and informal learning;
- grant of equivalence, credit units or waivers;
- award of qualifications (certificates, diploma or titles).

Thus, the RPL process (conducted by an authorised body) proves tha an individual has acquired learning outcomes measured against a relevant standard. The validation process consists of four distinct phases:

- identification through dialogue of particular experiences of an individual;
- documentation to make visible the individual's experiences;
- formal assessment of these experiences;
- certification of the results of the assessment which may lead to a partial or full qualification.

In this report, it is explained how the RPL is applied in each partner country in order to develop a common, and harmonized, RPL process for the different AM profiled defined in the frame of the CLLAIM projects.







1.2. Recognition of Prior Learning in Germany (LZH)

Crediting of vocational qualifications in Germany

The crediting or recognition of already acquired professional qualifications can take place in Germany in different contexts. On the one hand, people who have completed vocational training abroad can have them assessed in Germany for a possible credit, on the other hand, professional qualifications under certain conditions can be credited to universities. There is currently no information available on another third option, namely the horizontal transfer of qualifications from one (training) profession to another, so that this will not be discussed in this document.

- Recognition of professional qualifications acquired abroad:

Under the Recognition Act, it is possible to have vocational qualifications acquired abroad checked by an official body for equivalence with a German reference occupation. For this certificates and documents on training content and duration are necessary. Once all evidence has been provided, a letter of recognition will be issued, certifying equivalence as an official document. If certain points are not met, or if topics or contents have not been sufficiently dealt with, a subsequent qualification can take place within six months.

- Transfer of professional qualifications to universities:

Main objective is crediting professional qualifications to replace coursework or entire study periods. If this is not possible, at least the workload during study will be reduced. The challenge here is always the comparison of acquired knowledge and skills from different systems. In Germany, different procedures for crediting competencies have developed in recent years due to different legal frameworks and requirements of the individual federal states. Knowledge or skills acquired outside the university can in principle be counted as study or examination performance. The individual universities themselves are responsible for the recognition and thus also for the quality of the study and ultimately the success of the students. Therefore, in the following, we will not deal with specific individual cases, but only with basic options.







1. The university examines the submitted documents of an applicant, whether certain parts correspond to the content and level of study. Such examinations are done for the individual student.

2. In the case of homogeneous applicant groups (for example, through cooperation between company and university), the contents of several applicants may also be recognized blanket.

3. By examining knowledge and skills, an applicant may be classified in a higher semester.

4. In rare individual cases in certain federal states, applicants who have acquired skills and knowledge in other ways can be admitted directly to the university final examination.

Current application of ECVET in Germany

The ECVET (European Credit System for Vocational Education and Training) credit point system is currently used in Germany to increase vertical permeability in the national context, i.e. to demonstrate learning outcomes and transfer to other learning contexts. Therefore, ECVET functions more as a tool for the recognition possibilities described above and not as a system for Europe-wide description, registration and recognition of qualifications. However, there are currently various support offers for educational institutions to use the underlying ECVET principles, so that they should be more firmly established in the future.

"Because of the resolution taken by the German Bundestag, in 2014, the EU Commission submitted an external evaluation on the implementation of ECVET. Accordingly, ECVET is seen more as a "toolbox" than as a "system"; "Points" (credit points) are discussed controversially. For member states with existing credit point systems and countries with a holistic, work-related vocational training, such as Germany, ECVET appeared to be less profitable as countries without a credit transfer system or school-based system. ECVET projects have a cross-country and crosssystem understanding of the learning outcomes approach but they often lack a systemic connection. On the other hand, ECVET has proven itself in terms of mobility in important basic principles: the templates for partnership and learning arrangements have strengthened the mutual trust of the training institutions among themselves and improved the quality and didactic structure of learning stays. The share of actors using ECVET elements in mobility increased from 2.5% in 2013 up to 15.8% in 2015." Source: German Bundestag (Lower House of German Parliament)







Further recognition option: franchising

In addition, a form of cross-border cooperation between higher education and non-academic institutions has developed in recent years. This is referred to by the term "franchising". Here, the training takes place in parts or in whole at a non-academic institution. The degree award is then given by a university. The respective training partners can be in Germany or abroad.

1.3. Recognition of Prior Learning in United Kingdom (TWI)

In this section we can see three clear subsections:

- QCF system;
- Vocational qualifications;
- Apprenticeship systems.

Through the QCF (Qualifications and Credit Framework) system in the UK the learner is credited by completing units which may differ in the number of training hours and therefore credits. RPL (Recognition of Prior Learning) based upon work based learning can also be credited as part of the qualification in both the QCF and SCQF (Scottish Credit and Qualifications Framework) systems, however, these have to be agreed and are often assessed on a case by case basis through the application process, guidelines for acceptance fall under the regulatory approval system. However, after agreement credit points can be accumulated and transferred under both the QCF and SCQF systems. Recognition of qualifications gained overseas by the UK falls under European mutual recognition agreements and are assessed through the application process.

Vocational qualifications also exist in the UK, they fall under the same base QCF system of 8 levels and are regulated by NOS (National Occupation Standards). The aim is to provide the necessary knowledge and practical skills to carry a particular vocation, job within a sector. It is usual practice that those undergoing vocational qualifications and other qualifications within the QCF will be released by their employer (if employed) to attend training establishments which may include independent training organisations, colleges and universities on a part time or block basis.







Recent developments in the UK include an 'apprenticeship' based system. It is now established that certain employers depending on their annual wage bill will pay a percentage fee into the government apprenticeship initiative with additional subsidy by the government to facilitate and aid with the costs of training. Training organisations who wish to train apprentices under this system must apply and be approved, if successful they are entered onto a registry of approved training providers for the particular apprenticeship they have applied for. Apprenticeships may last for several years and variable funding is allotted accordingly by the government. The final sign off of the apprentice is then decided as successful or not through an end point assessor system. The end point assessment will assess documentation and also carry out oral interviews as necessary to verify competence at the level sort. This system is similar to professional Engineering institute assessments that deal with engineering technician, incorporated engineer and chartered engineer status.

A typical example of this apprenticeship can be seen in the recently developed UK 'NDT trailblazer apprenticeship'. This is split into 3 levels which includes Operator, Technician and Engineer levels. Each of these levels are mapped against the QCF level. Further information is detailed below.

Operator - http://www.bindt.org/downloads/Operator-Standards-Leaflet.pdf

Technician - http://www.bindt.org/downloads/Technician-Standards-Leaflet.pdf

Engineer -http://www.bindt.org/downloads/Engineer-Standards-Leaflet.pdf.

1.4. Recognition of Prior Learning in Spain (IDONIAL)

In Spain, the RPL process is defined in In the Royal Decree 1224/2009.

The procedure instruction will consist of the following phases:

- 1. Advice.
- 2. Evaluation of professional competence.
- 3. Accreditation and registration of professional competence.

ADVICE









In this step of the process, which is mandatory, the adviser or consultant will help to the candidate in the self-assessment of his/her competence, completing his/her personal and/or training history or to present evidences to justify it. As a result of this advice process, the consultant will develop an advisory report on the suitability of the candidate to access the evaluation phase and on the professional competences that he considers sufficiently justified.

If the mentioned report is positive, all the documentation provided, as well as the report drawn up duly signed, will be transferred to the corresponding evaluation committee.

If the report is negative, it will be indicated, to the candidate, the complementary training that should be done and the centres where he could receive it. However, due to that the content of the adviser's report is not binding, the candidate may decide to move on to the evaluation phase. In this case, the report and all the documentation provided will also be transferred to the evaluation committee.

EVALUATION OF PROFESSIONAL COMPETENCE

The aim of the evaluation is to verify if the candidate demonstrates the professional competence required in the professional achievements, in the levels established in the criteria of realization and in a situation of work, actual or simulated, fixed from the professional context.

The evaluation is carried out analysing the report of the assessor and all the documentation provided by the candidate and, where appropriate, gathering new evidence necessary to assess the professional competence required in the units of competence in which he has registered.

Different methods can be used to verify what was stated by the candidate submitting their application in the documentation provided. These methods are, among others, the observation of the candidate in the workplace, simulations, standardized tests of professional competence or professional interview. For each activity there will be a record signed by the applicant and the evaluator. For each activity a record signed by the applicant and the evaluator.

The result of the evaluation is expressed in terms of demonstrated or not demonstrated.

The candidate evaluated is reported of the results of the evaluation and he is entitled to claim to the Evaluation Commission.



Co-funded by the Erasmus+ Programme of the European Union





ACCREDITATION AND REGISTRATION OF PROFESSIONAL COMPETENCE.

Candidates who pass the evaluation process are issued an accreditation of each of the units of competence in which they have demonstrated their professional competence.

1.5. National Qualification Frameworks and their correspondence with the European Qualification Framework

The situation of the recognition of the EQF levels in the countries represented in the CLLAIM consortium (UK, Germany and Spain) has the particularity of the Spanish situation, because the EQF is not yet referenced due to the complicity in implementing the system in all of Spain's autonomous communities, despite of this situation, the MECU (Marco Español de Cualificaciones) make a correspondence between the MECU levels and EQF (European Qualification Framework).

In the other countries of the consortium (Germany and United Kingdom) the NQF are referenced to the EQF.

The correspondence between the NQF and the EQF according the summary of the CEDEFOP (European Centre for the Development of Vocational Training) can be checked in the <u>CEDEFOP</u> web.

The correspondence between the NQF and the EQF of the countries represented in the CLLAIM project can be checked in the following tables:

(Referred to the National qualifications framework (NQF)European inventory)







- German national qualifications framework (DQR)

DQR levels	Qualifications	EQF levels
8	Doctorate (Doktor)	8
7	Master degree (Master)	7
	Strategic IT professional (certified) (Strategischer IT Professional (Geprüfter))	
	Other further vocational training qualifications according to Vocational Training Act and Handicraft Code (level 7)	
6	Bachelor degree (Bachelor)	6
	Commercial specialist (certified) (Fachkaufmann (Geprüfter))	
	Business management specialist (certified) (Fachwirt (Geprüfter))	
	Master craftsman (certified) (Meister (Geprüfter))	
	Operative IT professional (certified) (Operativer IT Professional (Geprüfter))	
	Trade and technical school (State-certified) (Fachschule (Staatlich Geprüfter))	
	Other further vocational training qualifications according to Vocational Training Act and Handicraft Code (level 6)	
5	IT specialist (certified) (IT-Spezialist (Zertifizierter))	5
	Service technician (certified) (Service-techniker (Geprüfter))	
	Other further vocational training qualifications according to Vocational Training	
	Act and Handicraft Code (level 5)	
4	Upper secondary general education school leaving certificate (Allgemeine Hochschulreife (AHR))	4
	Qualification entitling holder to study particular subjects at a higher education institution (Fachgebundene Hochschulreife (FgbHR))	
	Qualification entitling holder to study at a university of applied sciences (Fachhochschulreife (FHR))	
	Dual VET (three-year and three-and-a-half-year training courses)	
	Full-time vocational school (regulated under Länder law) (Berufsfachschule)	
	Full vocational qualification (full-time vocational school) (Berufsfachschule)	
3	General education school leaving certificate after 10 years at Realschule (Mittlerer Schulabschluss)	3
	Dual VET (two-year training courses)	
	Full-time vocational school (general education school leaving certificate obtained on completion of grade 10 at <i>Realschule</i> or, under certain circumstances, at other lower secondary school types) (<i>Mittlerer</i> <i>Schulabschluss (Berufsfachschule</i>))	
2	Lower secondary school leaving certificate after 9 years (Hauptschulabschluss)	2
	Vocational training preparation (Berufsausbildungsvorbereitung)	
	Employment agency measures (Maßnahmen der Arbeitsagentur)	
	Year of pre-vocational training (Berufsvorbereitungsjahr)	
	Introductory training for young people (Einstiegsqualifizierung)	
	Basic vocational training (Berufliche Grundbildung)	
1	Vocational training preparation (Berufsausbildungsvorbereitung)	1
	Employment agency measures (vocational preparation schemes) (Maßnahmen der Arbeitsagentur) (Berufsvorbereitende Bildungsmaßnahmen)	
International Address	rear of pre-vocational training (Berutsvorbereitungsjahr)	

NB: The DQR database can be accessed at: https://www.dqr.de/content/2316.php The updated list of qualifications included in the DQR is available at:

https://www.dqr.de/media/content/2018_DQR_Liste_der_zugeordneten_Qualifikationen_01082018.pdf

Source: German Ministry of Education and Research; EQF-NCP, 2018.



Co-runded by the Erasmus+ Programme of the European Union Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

an





- Regulated qualifications framework (RQF) for England and Northern Ireland

Co-funded by the Erasmus+ Programme of the European Union

- Regulated qualifications framework (RQF) for England and Northern Ireland

RQF levels	Qualification types	
8	Technical/Vocational qualifications level 8	8
7	Technical/Vocational qualifications level 7	7
6	Technical/Vocational qualifications level 6	6
5	Technical/Vocational qualifications level 5, Higher national diplomas (HND)	5
4	Technical/Vocational qualifications level 4, Higher national certificates (HNC)	5
3	Technical/Vocational qualifications level 3, GCE AS and A levels	4
2	Technical/Vocational qualifications level 2, GCSEs at grade A* – C and from 2017 grade 4-9 (England), Functional skills level 2 (England), Essential skills qualifications (NI)	
1	1 Technical/Vocational qualifications level 1, GCSEs at grade D-G and from 2017 grade 3-1 (England), Functional skills level 1 (England), Essential skills qualifications (NI)	
Entry level certificates (sublevel 3), Entry level 3 Functional skills entry level (England) (English, mathematics & ICT), Essential skills qualifications (NI)		1
Entry levels 1-2	Entry level certificates (sublevels 1 and 2)	-
(*) The EQ	F levels are indicative, as the 2010 referencing report referred to the QCF, not the referencing report will be available in 2019.	RQF. An

Source: Adapted from Ofqual; QAA; SCQF; CCEA Regulation; Welsh government & QQI (2017). Qualifications can cross boundaries: a guide to comparing qualifications in the UK and Ireland. http://ccea.org.uk/sites/default/files/docs/accreditation/guidance/Qualifications_can_cross_Boundari es.pdf



This project has been co-funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.



- Spanish qualifications framework for higher education (MECES) and draft Spanish qualifications framework for lifelong learning (MECU) levels

Draft MECU levels	MECES levels	Higher education qualifications	QF-EHEA
8	4	Doctoral degree (Doctorado)	Third cycle
7	3	Master degree (Master)	Second cycle
6	2	Bachelor degree (Grado)	First cycle
5	1	Advanced technician (Técnico superior)	First cycle
4			
3			
2			
1			

Source: Adapted from the Royal Decree 1027/2011 of 15 July 2011 establishing the Spanish qualifications framework of higher education. http://www.boe.es/boe/dias/2011/08/03/pdfs/BOE-A-2011-13317.pdf

2. European Metal AM Profiles

Co-funded by the Erasmus+ Programme of the European Union

2.1. Methods

An objective of CLLAIM's project is to map the skills needed in AM industry, therefore survey to assess the relevance of the different Metal AM profiles was designed: Metal AM Operator, Designer, Inspector/Quality Assurance and Supervisor/Specialist. Besides CLLAIM metal AM profiles (Operator, Inspector, Specialist/Supervisor, Designer) the survey conducted addresses the Engineer Profile. CLLAIM aim is to develop an Harmonized Qualification System in Additive Manufacturing, being so besides evaluating the needs of the profiles included in the proposal stage, CLLAIM also took the opportunity to assess the Engineer profile in the surveys. The survey was therefore conducted in collaboration with ADMIRE project that tackles the industrial needs with regards to the Metal AM Engineer. Being the Qualifications developed in ADMIRE part of the European Harmonized AM Qualification System developed in CLLAIM.



Co-funded by the Erasmus+ Programme of the European Union This project has been co-funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.





The validation of the relevance of these profiles is of most importance for the project and for the development of European Skills in AM as it will ensure that the system developed is in accordance with the industry.

Two surveys were conducted under project scope: "Survey on Skills needs in Metal Additive Manufacturing-PART I" and "Survey on Skills needs in Metal Additive Manufacturing-PART II". The first survey (see figure 1 and 2) was launched on January 2018 and, overall, 126 answers from experts in the field and industry were collected across Europe, being the most representative countries Spain, Germany and United Kingdom (countries represented in CLLAIM's consortium). The second survey was launched on May 2018 and collected answers from 86 entities of the AM sector. To have a look on the questions of the second survey, please refer to Annex 1.

2.2. Presentation and Discussion of Results

The first survey was conceived to capture both the relevance of the different professional profiles and the topics to be embedded into their curricula, so that the construction of the Guidelines (D.3.1&3.2) for the mentioned profiles is aligned with industry needs. Figures 1 and 2 show the structure and content of the survey.



This project has been co-funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.





	Survey on Skills needs on Metal Additive Manufacturing	
Figure Survey Skills Part I,	Survey on Skills needs on Metal Additive Manufacturing The increasing growth of metal additive manufacturing is leading the need for defining the Professional Levels required by industry for personnel working in this area. Voor views on this need are crucial in achieving an understanding of the requirements. Please be aware that his survey will only be active until the end of July 2017. EWF is a European Association with 25 years of experience in running International qualifications used in 45 countries workheide. * 1. Your Name:	1 AM Needs Page 1
	1	

17



Co-funded by the Erasmus+ Programme of the European Union



				Inspector / Quality Assurance	
	Engineer	Supervisor	Designer	Supervisor	Operat
AM Processes					
Numerical Modelling					
Topology Optimisation					
Design					
Structural Integrity					
Metallurgical Analysis and Characteristics					
Post-Processing					
Pre-Processing and Material Handling					
Non-Destructive Testing					
Certification and Validation					
Testing / Quality Control					
Standards					
Costs					
HS&E					
Other (Please specify the q	ualification and/or	the required training)			
. Based on your organ evels (1-very low and	ization requirer 5-very high):	nents please ident	ify the relevance	need of the differe	ent Profess
Engineer	0		0	0	0
Supervisor	0		0	0	0
Designer	0		Õ	Ũ	Õ
Inspector/Quality assurance supervisor	0	0	0	0	0
Operator	0			0	

Figure 2 AM Survey Skills Needs Part I, Page 2

In the first survey, 126 answers were collected from AM experts and industry from 17 European countries (AT, BE, DE, FI, FR, DE, GR, HU, IT, NE, PO, RO, ES, SE, CH, TR, UK and IRL). Figure 3 shows that the most representative country is Germany with 22.2% of the answers provided, followed by Spain and United Kingdom, both with 19.8% of the answers. By having this extent list of Countries participating in the survey it is assured that the Qualifications developed are aligned around the world and not just for a specific set of Countries.



Co-funded by the Erasmus+ Programme of the European Union This project has been co-funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

Co-funded by the Erasmus+ Programme of the European Union



Figure 3 Countries coverage in AM Survey

This survey enabled the creation of a scale ranging from 1 to 5 to assess the relevance of the 4 different professional profiles – Figure 4. For that purpose, the lowest number (1) stands for "very low (relevance)" and the highest (5) stands for "very high (relevance)". According to a weighted average, all of them were considered relevant (above 2.5), being the one considered the most relevant, the European Metal AM Designer, assessed with 3.96 out of 5. It was followed by the Inspector/Quality Assurance Supervisor reaching 3.7, the Operator 3.6 and, finally, the Specialist/Supervisor reaching 3.5.



Figure 4 Professional Profiles Relevance, from AM Survey on Skills Needs



Co-funded by the Erasmus+ Programme of the European Union





Globally, the survey results confirmed the necessity of each of the profiles as illustrated is of most relevance to the project.

From the graphic above results is concluded that all the profiles identified are all relevant for the industry. The consortium will start to build the Guidelines (D3.1&3.2) for operator profile as it is easier concerning partners capabilities. Secondly, will be produced the Designer profile as it is considered the most relevant. Finally, will be produced the profiles for Inspector (taking into consideration the lack of ISO standards for this specific profiles), followed by the profile for Specialist/Supervisor.

Additionally, a second round of surveys were applied to (survey can be found in annex 1 of this document) assess the match of each professional profile to a specific set of skills (e.g. AM processes, Numerical Modelling, Topology Optimization, Design, Structural Integrity, etc.).

The results of this survey are described in this chapter, in which the professional profiles are divided in the following categories:

- Qualifications;
- Knowledge;
- Theoretical/Practical approach;

On the **"Qualifications"** topic, the areas addressed were:

- Cover all AM processes
- Cover one specific process
- Cover all materials
- Cover one material
- Other (specified by the specialist)

Identified in bold above "Cover all AM Processes" topic, is of most relevance to the development of the Guidelines for the AM profiles, as the results will be a primordial identification of the need to develop more than one Guideline for a specific profile (i.e. one profile per process).

20







On the **"knowledge"** topic, the addressed areas were:

- AM Processes;
- Subtractive Processes;
- Numerical Modelling
- Topology Optimisation
- Design
- Structural Integrity
- Metallurgical Analysis and Characteristics
- Post-Processing
- Pre-Processing and Material Handling
- Non-Destructive Testing
- Certification and Validation
- Testing/Quality Control
- Standards
- Costs
- Health, Safety & Environment
- Other (specified by the specialist)

The results of all these areas were concerned upon the development of different profiles for the project.

On the **theoretical/practical approach**, the areas analysed were:

- AM Processes
- Subtractive Processes
- Post-Processing
- Pre-Processing and Material Handling
- Non-Destructive Testing
- Testing / Quality Control
- Health, Safety & Environment
- Other (specified by the specialist)

The outcomes of the theoretical/practical experience are considered in each of the professional profiles created.



This project has been co-funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.





Figure 5 gives an overview of the results encountered with the survey.



Figure 5 Relevance of topics, AM Survey

The bigger and darker the circles are higher is the relevance of the topics. The topics marked in light blue (0-30%) are considered slightly relevant, whilst the ones in blue (31%-75%) are considered relevant and those in dark blue (76%-100%) are considered very relevant.

Looking at the top row (Operator), it is suggested that "Health, Safety and Environment (HS&E)" is very relevant topic to be addressed. Nevertheless, the topics "AM Processes", "Post-Processing" and "Pre-Processing and Material Handling" were considered relevant, collecting a higher amount of answers.

While considering the Inspector/ QA Supervisor the study concludes that the most relevant topics that education should address are "Testing/ QC" followed by "Non-Destructive Testing" and "Certification and Validation" and not as relevant but still important "Metallurgic Analysis and Characteristics" and "Standards".

The third row relative to Designer profile states that the most relevant characteristic is "Design" followed by "Topology Optimisation". Other not that relevant topics that the industry considers important for the Designer are "AM Processes", "Numerical Modelling", "Structural Integrity" and "Standards".

Subsequently, if we look at the second row (from the bottom) Supervisor profile, it can be settled that "Health, Safety and Environment (HS&E)" is the at most relevant topic. Other topics such







as "Costs", "Certification and Validation", "AM Processes" and "Standards" were still considered important.

All the results listed above are essential for the development of the professional profiles included in this project.

On the following sub-chapters, the profiles are assessed individually in terms of required knowledge the profile requires. All results listed below are essential for the development of the curriculum Guidelines (D.3.1&3.2) and therefore crucial for the project.

2.2.1 MAM Specialist/Supervisor

The questions for MAM Specialist/Supervisor represented 79,3% Figure 6 of the total number of the survey's respondents.





Qualification

Regarding the features of the qualification for the MAM Specialist/Supervisor, the majority of the respondents considered that this qualification should cover all materials (83%) and all processes (85%) (Figure 7)



Co-funded by the Erasmus+ Programme of the European Union





MAM Specialist/Supervisor



Figure 7 Results, in percentage, about the qualifications in which the professional profile needs to cover.

Some respondents also added the following statements/comments:

"Have an overview of all the process and materials but have a modularized knowledge in specific (regarding materials and processes)" and "Control of measurable processes i.e. calibration of assessment kit".

Knowledge

Having as reference the scale (1 - Basic knowledge, 2 - Intermediate knowledge, 3 - Advanced knowledge) to assess the depth of knowledge of each topic for the MAM Specialist/Supervisor, please refer to Figure 8.



MAM Specialist/Supervisor

24



Co-funded by the Erasmus+ Programme of the European Union





Figure 8 Results of the grades for each topic for the specific professional profile

It was captured that this professional should have Advanced knowledge in: "AM Processes". The majority of the respondents also considered that Specialist/Supervisor should also have advanced knowledge in "Certification and Validation", "Health, Safety and Environment", despite had been collected more balanced results.

It was also captured this professional should have Intermediate knowledge in: "Subtractive Processes", "Post Processing", "Pre-Processing and Material Handling". The results (more balanced) showed this professional would also need to have intermediate knowledge on "Testing/Quality Control", "Standards" and "Costs".

Theoretical/Practical approach

Having in mind the meaning of the labels presented in Figure 9, T for "Theoretical", T/P "Theoretical and Practical" and P "Practical", the respondents answered that, overall, the approach to the topics do be delivered during the Supervisor's training should be strongly theoretical and practical, simultaneously.



Figure 9 Results for the Theoretical/Practical Approach to take, regarding the different areas of expertise for the specific professional profile. The number associated to the bar presents the majority of answers, in percentage.



Co-funded by the Erasmus+ Programme of the European Union This project has been co-funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.





2.2.2 MAM Designer

The questions for this professional profile represented 75,9% (Figure 10) of the total number of the survey's respondents.



Figure 10 Percentage of respondents for the MAM Designer questions

Qualifications

In this category, it was captured that the curricula for the MAM Designer should cover one specific material (69%) and one specific process (55%) against all the other options Figure 11.



MAM Designer

Figure 11 Results, in percentage, about the qualifications in which the professional profile needs to cover

Given the possibility to add open answers, the respondents have also added it should be modularised.



This project has been co-funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.





Knowledge

In the category dedicated to the depth of knowledge of the Designer for each topic Figure 12 the respondents considered that the Designer should have Advanced knowledge on "AM processes", "Numerical Modelling", "Topology Optimisation", "Design" and "Structural Integrity".



Figure 12 Results of the depth of knowledge for Designer

On the other hand, the Designer should have Intermediate knowledge on "Post-processing", "Standards", "Costs" and though still not so clear, intermediate knowledge on "Subtractive Processes". Basic knowledge was associated to the respondents to "Health, Safety & Environment".

Theoretical/Practical approach

Regarding the approach to consider when delivering the different topics during the Designer's training, the results were quite heterogeneous Figure 13.





Figure 13 Results for the Theoretical/Practical Approach to take, regarding the different areas of expertise for the specific professional profile. The number associated to the bar presents the majority of answers, in percentage.

On one hand, the respondents considered that the delivery of "Design" should be 100% Practical. On the other hand, "Health, Safety & Environment" should be covered in a purely theoretical manner (100% T). "Costs", "Structural Integrity", "Subtractive Processes" and "AM processes" should be approached giving more focus to theory (75%T). The topics "Standards", "Post-Processing" and "Numerical Modelling" were considered to be delivered strongly focusing on the theoretical and practical components (50% T/P).

2.2.3 MAM Inspector / Quality Assurance Supervisor

The questioners for this topic represented 75,9% (Figure 14) of the total number of the survey's respondents.



Figure 14 Percentage of respondents for the MAM Inspector / Quality Assurance Supervisor questions 28



Co-funded by the Erasmus+ Programme of the European Union





Qualifications

In this category, it was captured that the curricula for the MAM Inspector/Quality Control Supervisor should cover all materials (90%) and all AM processes (90%) against a small representativeness of all the other options Figure 15.



MAM Inspector/Quality

Figure 15 Results, in percentage, about the qualifications in which the professional profile needs to cover The respondents have stressed once again that the qualification should be modularised.

Knowledge

In this category (Figure 16) the respondents clearly considered that the Inspector/Quality Assurance Supervisor should have Advanced knowledge on "Standards", "Testing/Quality Control", "Certification and Validation", "Non-Destructive Testing" and there isn't a clear answer on "Metallurgical Analysis and Characteristics". Nevertheless, the majority considered that the depth of knowledge should be Advanced. Regarding the other topics, "AM Processes", "Subtractive Processes", Structural Integrity", "Post-Processing", "Pre-Processing and Material Handling" were considered to gain Intermediate knowledge on them. Not so clearly identified, they considered that the Inspector/Quality Assurance Supervisor" should have Intermediate knowledge on "Health, Safety & Environment".



Co-funded by the Erasmus+ Programme of the European Union This project has been co-funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.





Figure 16- Results of the grades for each area of knowledge for the specific professional profile.

Theoretical/Practical approach

Regarding the approach to consider when delivering the different topics during the Inspector/Quality Assurance Supervisor's training, the results showed a strong practical component should be envisioned (Figure 17)



Figure 17 Results for the Theoretical/Practical Approach to take, regarding the different areas of expertise for the specific professional profile. The number associated to the bar presents the majority of answers, in percentag

30



Co-funded by the Erasmus+ Programme of the European Union





"Subtractive Processes" was the only topic deemed to be fully theoretical (100%T) and "Pre-Processing and Material Handling" more focused on the theory as well (75%T). A merged approach (50%T/P) was considered for "Health, Safety & Environment", "Post Processing", "Metallurgical Analysis and Characteristics", "Structural Integrity" and "AM Processes". At last, "Standards", "Testing/Quality Control", "Certification and Validation", "Non-Destructive Testing" were considered as relevant to be delivered in a more practical way (75%P).

2.2.4 MAM Operator

The questioners for this topic represented 75,9% (Figure 18) of the total number of the survey's respondents.



Figure 18 Percentage of respondents for the MAM Operator questions.

Qualifications

In this category, it was clearly captured that the curricula for the MAM Operator should cover one specific process (82%). The same is not applicable to materials, answers were fairly distributed among covering "one material" or "all materials". Nevertheless, the majority considered that it should cover one material (66%) (Figure 19).



Co-funded by the Erasmus+ Programme of the European Union This project has been co-funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.





Figure 19 Results, in percentage, about the qualifications in which the professional profile needs to cover Respondents have also added that it should be "modularised", encompass "basic characteristics of the materials used" and that the Operator should be "qualified to operate the processes and materials used (parameters, welding)".

Knowledge

In the category dedicated to the depth of knowledge of the Operator should have for each topic (Figure 20) the respondents considered that the professional should have Advanced knowledge on "AM Processes", "Post-Processing", "Pre-Processing and Material Handling" and "Health, Safety & Environment". Opposing to this, it was considered that the professional should gain Basic knowledge on "Subtractive Processes", "Non-Destructive Testing" and most likely basic knowledge on "Testing/Quality Control".





Figure 20 Results of the grades for each area of knowledge for the specific professional profile

Theoretical/Practical approach

Regarding the approach to consider when delivering the different topics during the Operator's training, the results showed a strong practical component should be envisioned (Figure 21).



Figure 21 Results for the Theoretical/Practical Approach to take, regarding the different areas of expertise for the specific professional profile. The number associated to the bar presents the majority of answers, in percentage



Co-funded by the Erasmus+ Programme of the European Union





The majority considered that a 100% Practical approach (100%P) when delivering "Health, Safety & Environment" should prevail. At the same time, "Pre-Processing and Material Handling", "Post-Processing", "Subtractive Processes" and "AM Processes" should have a strong practical component (75%P). "Testing/Quality Control" and "Non-Destructive Testing" were the topics deemed to have the most theoretical foundation on their delivery.

Summary of Results 2.3.

At this point of the report it is summarized the conclusive results of the survey. It is also important to highlight that these results will have most influence on the development of the AM profiles Guidelines (D.3.1&3.2).

This survey also aims to develop industry requirements regarding each of the professional profiles in terms of the needs in knowledge and the theoretical/practical approach. The results found in the survey are described in following tables. Furthermore, not forget mentioning that the partnership (upon the development of the Guidelines for the professional profiles) considers all these results, aiming to keep the same balance between practical and theoretical training when developing the Guidelines (D.3.1&3.2). The profiles to be developed during the CLLAIM project are: Supervisor, Designer, Inspector and Operator.

Supervisor	Knowledge	Theoretical-Practical Approach	
AM Processes	Advanced	50%T	
Subtractive processes	Intermediate	75%T	
Post-processing	Intermediate	75%T	
Pre-processing and material	Intermediate	75%T	
handling			
Certification and validation	Intermediate/Advanced	50%T	
Testing/Quality Control	Intermediate/Advanced	50%T	
Standards	Intermediate/Advanced	50%T	
Costs	Intermediate/Advanced	50%T	
Health, Safety & Environment	Intermediate/Advanced	50%T	

34

Table 1: Grading of the specific areas of knowledge associated with the theoretical-practical approach for the MAM Supervisor. With close grading values, the one with the majority is found in bold.





 Table 2: Grading of the specific areas of knowledge associated with the theoretical-practical approach for the MAM

 Designer. With close grading values, the one with the majority is found in bold.

Co-funded by the Erasmus+ Programme of the European Union

Designer	Knowledge	Theoretical-Practical Approach
AM Processes	Advanced	75%T
Subtractive processes	Basic/Intermediate	75%T
Numerical modelling	Advanced	50%T
Topology optimization	Advanced	25%T
Design	Advanced	0%T
Structural Integrity	Advanced	75%T
Post-processing	Intermediate	50%T
Standards	Intermediate	50%T
Costs	Intermediate	75%T
Health, Safety & Environment	Basic	100%T

 Table 3: Grading of the specific areas of knowledge associated with the theoretical-practical approach for the MAM

 Inspector/Quality Assessor. With close grading values, the one with the majority is found in bold.

Inspector/Quality Assessor	Knowledge	Theoretical-Practical	
		Approach	
AM Processes	Intermediate	50%T	
Subtractive processes	Intermediate	100%T	
Structural Integrity	Intermediate	50%T	
Metallurgical analysis and	Intermediate / Advanced	50%T	
characteristics			
Post-processing	Intermediate	50%T	
Pre-processing and material	Intermediate	75%T	
handling			
Non-Destructive Testing	Advanced	25%T	
Certification and validation	Advanced	25%T	
Testing/Quality Control	Advanced	25%T	
Standards	Advanced	25%T	
Health, Safety & Environment	Intermediate/Advanced	50%T	

 Table 4: Grading of the specific areas of knowledge associated with the theoretical-practical approach for the Operator. With close grading values, the one with the majority is found in bold.

Operator	Knowledge	Theoretical-Practical Approach
AM Processes	Advanced	25%T
Subtractive processes	Basic	25%T
Post-processing	Advanced	25%T
Pre-processing and material handling	Advanced	25%T
Non-Destructive Testing	Basic	75%T
Testing/Quality Control	Basic/Intermediate	75%T
Health, Safety & Environment	Advanced	0%T



This project has been co-funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.





The previous tables summarize the results obtained from industry needs in terms of the knowledge required for the professional profile as well as the theoretical/practical approach percentage. The results listed above will be used upon the development of the Guidelines (D.3.1&3.2) for the professional profiles the project aims to develop.

Moreover, the survey allowed us to reach some conclusions regarding the knowledge required in terms of processes and materials to be taught. The following table illustrates the results

	Cover 1 Material	Cover all Materials	Cover 1 Process	Cover all Processes
Supervisor		X	*	x
Designer	_	x		x
Inspector/Quality Assessor	_	x	x	x
Operator	х	х	x	

 Table 5 Professional levels coverage on different areas on MAM technology.

*Tie of 50%

The data collected allowed to conclude that Designers and Supervisors should cover all materials and all the processed used in Metal AM.

The Inspector/ Quality Assessor should cover more than one material but a knowledge of all the materials is preferred as well as the know-how on at least 1 process.

The operator, on the other hand, **is required to cover one material and one process** but covering all materials is also an option. So, there should be an **Operator Profile for each one of the processes considered (Powder Bed Fusion – Electron Beam, Powder Bed Fusion – Laser Beam, Direct Energy Deposition – Arc and Direct Energy Deposition – Laser Beam)**.

In conclusion, we can look at the results of this survey as a starting point while defining the education methodologies for the AM professional profiles. Some of the topics addressed are common to all the different profiles, but others are specific to each. This study concludes that all profiles are viewed as directed to a specific set of skills.




Table 6: Grading of the specific areas of knowledge associated with the theoretical-practical approach for all the Professional Profiles. With close grading values, the one with the majority is found in bold.

	Type of Informatio n	MAM Engineer	MAM Supervisor	MAM Designer	MAM Inspector/Quality	MAM Operator
	Knowledge	Advanced	Advanced	Advanced	Intermediate	Advanced
AM Processes	T/P Approach	50%T/P	50%T/P	75%T	50%T/P	75%P
Subtractive	Knowledge	Basic /Intermediate	Intermediate	Basic/Intermedia te	Intermediate	Basic
processes	T/P Approach	75%T	75%T	75%T	100%T	75%P
Numorical	Knowledge	Intermediate		Advanced		
modelling	T/P Approach	75%T	_	50%T/P	_	
Topology	Knowledge	Intermediate		Advanced		
optimization	T/P Approach	50%T/P		75%P		
Decian	Knowledge	Intermediate/Advanc ed		Advanced		
Design	T/P Approach	50%T/P		100%P		
Structural	Knowledge	Intermediate		Advanced	Intermediate	
Integrity	T/P Approach	50%T/P		75%T	50%T/P	

37



This project has been co-funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

(Continue)





	Type of Informatio n	MAM Engineer	MAM Supervisor	MAM Designer	MAM Inspector/Quality	MAM Operator
Metallurgical analysis and	Knowledge	Intermediate			Intermediate/Advanc ed	
characteristic s	T/P Approach	50%T/P	—	—	50%T/P	—
Post-	Knowledge	Intermediate/Advanc ed	Intermediate	Intermediate	Intermediate	Advanced
processing	T/P Approach	75%P	75%P	50%T/P	50%T/P	75%P
Pre- processing	Knowledge	Intermediate/Advanc ed	Intermediate		Intermediate	Advanced
and material handling	T/P Approach	75%P	75%T		75%T	75%P
Non-	Knowledge	Intermediate			Advanced	Basic
Destructive Testing	T/P Approach	50%T//P			75%P	75%T
Certification	Knowledge	Intermediate	Intermediate/Advanc ed		Advanced	
validation	T/P Approach	100%T	50%T/P		75%P	
Testing/Quali ty Control	Knowledge	Intermediate	Intermediate/ Advanced		Advanced	Basic/Intermedia te

38



Co-funded by the C Erasmus+ Programme of the European Union





	Type of Informatio n	MAM Engineer	MAM Supervisor	MAM Designer	MAM Inspector/Quality	MAM Operator
	T/P Approach	50%T/P	50%T/P		75%P	75%T
Standards	Knowledge	Intermediate	Intermediate/Advanc ed	Intermediate	Advanced	
Stanuarus	T/P Approach	100%T	50%T/P	50%T/P	75%P	
Costa	Knowledge	Basic/Intermediate	Intermediate/Advanc ed	Intermediate		_
COSIS	T/P Approach	100%T	50%T/P	75%T		_
Health, Safety	Knowledge	Intermediate/Advanc ed	Intermediate/Advanc ed	Basic	Intermediate/Advanc ed	Advanced
& Environment	T/P Approach	100%T	50%T/P	100%T	50%T/P	100%P





Co-funded by the Erasmus+ Programme of the European Union





3. Inputs from the Focus Group Meetings

This section will collect the results of each country that were obtained in the surveys (annex 2).

3.1 Details from focus group meetings - Germany

3.1.1 Objective of the focus meeting group report in Germany

The purpose of this national report is to present the perceptions on the European Designer, Specialist, Operator and Inspector profiles in AM to be designed. These perceptions were obtained through the performing of a national meeting group, in which the questionnaire attached in Annex 2 was used.

3.1.2 Description of the focus meeting group report in Germany

The survey regarding the EWF SYSTEMS FRAMEWORK & CORRESPONDENCE TO EQF was send to 4 different meetings in the DVS System (see the description below: Name of the focus group meeting, date, place, hosting organization, number of participants). Each participant received the questionnaire 4 weeks before the meeting. This questionnaire was additionally explained to the participants during the different meetings.

Conducted Meetings:

- The Research Association on Welding and Allied Processes e. V. of DVS,
- The Expert Committee 6 "Blasting Procedures", 12 September 2018, Aachen, 57 participants,
- The Expert Committee 13 "Additive Manufacturing", 11 October 2018, Hannover, 47 participants,
- The Education Committee (AfB) of DVS and
- The Expert Group 4.13 "Education in Additive Manufacturing", 8 November 2018, Aachen, 7 participants.







3.1.3 Questionnaire results in Germany

This chapter introduces the results of the returned questionnaires. In total there were 5 participants. These 5 participants are experts in their field and are therefore representatives. Multiple answers were allowed. Therefore, the number of responses varies.

- **Question 1.** Type of company

Type of organisation	Number of answers
University	0
Research centres	2
Industry	4
Education Providers	0

Table 7 Type of Organisation



Figure 22. Type of Organisation

- **Question 1.1** What is your role in the company?

Table 8 Role in Entity

	Role of the person who fulfilled the survey.
1	Head of development
2	Research engineer in laser welding technology
3	Head of department R + D projects
4	AM Lab coordinator
5	Research scientist

- **Question 2.** Are you currently working in additive manufacturing?







Table 9 People Working in AM





Figure 23 Peolple Working in AM

- **Question 3.** Please select the technology(s) you are currently working with.

Table 1	0 AM	Technol	logy
---------	------	---------	------

Technology	Number of answers
DED Wireplus arc	1
DED Laser	2
Laser Powder Bed Fusion	2
Other:	2



Figure 24 AM Technology

- **Question 4.** If you are currently working in additive manufacturing, where does your company/organisation fit in the value chain?



This project has been co-funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.





Value chain	Number of answers
Modelling & Design	1
Materials	2
Process	4
Post-Processing	1
Product	1
End of Life	-





Figure 25 Value Chain

Question 5. Which access requirements (e.g. professional experience, knowledge or competencies or education level) do you think should be stablished of each AM profile training course?

Table 12 Access	Requirements
-----------------	--------------

Entry Requirements	Operator (Level 3)	Inspector (Level 4)	Specialist (Level 5)	Designer (Level 6)
Professional experience	-	1	2	1
Education level/education background	2	1	2	2
Knowledge or competences	1	1	2	2

- **Question 6.** Do you agree with the specified coverage/scope of each AM profile (following table)? If not, please indicate which coverage/scope should be modified?







	Cover 1 Material	Cover all Materials	Cover 1 Process	Cover all Processes
Supervisor	-	Х	Х	Х
Designer	-	Х	-	Х
Inspector/Quality Assurance Supervisor	-	Х	Х	Х
Operator	Х	Х	Х	-

Table 13 Scope of the AM Profile

- **Question 7.** Do you agree with the required knowledge topics of each AM profile?
 - <u>7.1 Specialist/supervisor</u>

Table 14 Required Knowledge for Specialist/Supervisor

Specialist/Supervisor	Knowledge	Number of questions	
		Yes	No
AM Processes	Advanced	5	0
Subtractive processes	Intermediate	5	0
Post-processing	Intermediate	5	0
Pre-processing and material	Intermediate	5	0
handling			
Certification and validation	Intermediate/Advanced	4	1
Testing/Quality Control	Intermediate/Advanced	5	0
Standards	Intermediate/Advanced	5	0
Costs	Intermediate/Advanced	5	0
Health, Safety & Environment	Intermediate/Advanced	4	1

If not, please indicate which knowledge topics should be modified

Certification and validation – Advanced	
Health, Safety & Environment – Advanced	



This project has been co-funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.





Figure 26 Required Knowledge for Specialist/Supervisor

o 7.2 Designer

Table 15 Required Knowledge for Designer

Designer	Knowledge	Number of questions	
		Yes	No
AM Processes	Advanced	4	1
Subtractive processes	Basic/Intermediate	2	3
Numerical modelling	Advanced	5	0
Topology optimization	Advanced	4	1
Design	Advanced	5	0
Structural Integrity	Advanced	5	0
Post-processing	Intermediate	5	0
Standards	Intermediate	5	0
Costs	Intermediate	5	0
Health, Safety & Environment	Basic	4	1

If not, please indicate which knowledge topics should be modified

Subtractive process - Intermediate

Topology optim. - Intermediate

45



Co-funded by the Erasmus+ Programme of the European Union







Advanced level for subtractive processes

Figure 27 Required Knowledge for Designer

o <u>7.3 inspector/quality Assessor</u>

Table 16 Required Knowledge for Inspector/Quality Assessor

Inspector/Quality Assessor	Knowledge	Number of questions	
		Yes	No
AM Processes	Intermediate	5	0
Subtractive processes	Intermediate	4	1
Structural Integrity	Intermediate	5	0
Metallurgical analysis and characteristics	Intermediate/Advanced	5	0
Post-processing	Intermediate	4	1
Pre-processing and material handling	Intermediate	4	1
Non-Destructive Testing	Advanced	5	0
Certification and validation	Advanced	5	0
Testing/Quality Control	Advanced	5	0
Standards	Advanced	5	0
Health, Safety & Environment	Intermediate/Advanced	5	0



This project has been co-funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.





If not, please indicate which knowledge topics should be modified

Post-processing - Intermediate Health, Safety & Environment - Advanced



Figure 28 Required Knowledge for Inspector/Quality Assessor

o <u>7.4 Operator</u>

Table 17 Required Knowledge for Operator

Operator	Knowledge	Number of questions	
		Yes	No
AM Processes	Advanced	5	0
Subtractive processes	Basic	5	0
Post-processing	Advanced	5	0
Pre-processing and material handling	Advanced	5	0
Non-Destructive Testing	Basic	5	0
Testing/Quality Control	Basic/Intermediate	4	1
Health, Safety & Environment	Advanced	4	1





Co-funded by the Erasmus+ Programme of the European Union









Figure 29 Required Knowledge for Operator

- **Question 8.** Do you agree with the required Theoretical/Practical approaching of each AM profile, on the different topics?

- 8.1 Specialist/Supervisor

Table 18 Theoretical and Practical Approaching for Specialist/Supervisor

Specialist/Supervisor	Theoretical (T)-Practical	Number of	questions
	Approach(P)	Yes	No
AM Processes	50% T/P	5	0
Subtractive processes	75% T	5	0
Post-processing	75% T	5	0
Pre-processing and material handling	75% T	5	0
Certification and validation	50%T/P	5	0
Testing/Quality Control	50% T/P	5	0
Standards	50% T/P	5	0
Costs	50% T/P	5	0
Health, Safety & Environment	50% T/P	5	0



This project has been co-funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.



Figure 30 Theoretical and Practical Approaching for Specialist/Supervisor

- 8.2 Designer

Table 19 Theoretical and Practical Approaching for Designer

Designer	Theoretical (T)-Practical	Number of	questions
	Approach(P)	Yes	No
AM Processes	75% T	5	0
Subtractive processes	75% T	5	0
Numerical modelling	50% T/P	5	0
Topology optimization	75% P	5	0
Design	100% P	5	0
Structural Integrity	75% T	5	0
Post-processing	50% T/P	5	0
Standards	50% T/P	5	0
Costs	75% T	5	0
Health, Safety & Environment	100% T	5	0







Figure 31 Theoretical and Practical Approaching for Designer

- 8.3. Inspector/Quality Assessor

Table 20 Theoretical and Practical Approaching for Inspector/Quality Assessor

Inspector/Quality Assessor	Theoretical (T)-Practical	Number of questions	
	Approach(P)	Yes	No
AM Processes	50% T/P	5	0
Subtractive processes	100 %T	5	0
Structural Integrity	50% T/P	5	0
Metallurgical analysis and characteristics	50% T/P	5	0
Post-processing	50%T/P	5	0
Pre-processing and material handling	75% T	5	0
Non-Destructive Testing	75% P	5	0
Certification and validation	75% P	5	0
Testing/Quality Control	75% P	5	0
Standards	75% P	5	0
Health, Safety & Environment	50% T/P	5	0







Figure 32 Theoretical and Practical Approaching for Inspector/Quality Assessor

- 8.4 Operator

Table 21 Theoretical and Practical Approaching for Operator

Operator	Theoretical (T)-Practical	Number of	questions
	Approach(P)	Yes	No
AM Processes	75% P	5	0
Subtractive processes	75% P	5	0
Post-processing	75% P	5	0
Pre-processing and material handling	75% P	5	0
Non-Destructive Testing	75% T	5	0
Testing/Quality Control	75% T	5	0
Health, Safety & Environment	100% P	5	0





Figure 33 Theoretical and Practical Approaching for Operator

3.1.4 Final considerations.

The survey was distributed to a huge group of industry, researchers and universities. Nevertheless, the responses were limited and must be evaluated carefully.

From the point of view in the present situation: it was, and it is challenging to analyse the specific interests of the AM machining sector in the economy in Germany. The education topic had a great agreement from the participants in the meetings. The suggestions for the education concept were accepted with only few comments for possible improvement. But even though the participants were interested, the participation to the survey was not as high as it was expected. Reasons might be:

- The complex content. The different profiles needed to be introduced thoroughly in the sessions. This took a long time and concentration from the participants. A more intuitive design of the survey might help.
- 2. The extent of the survey. It is a very long survey. Maybe a focus on the most important topics would have made it more attractive to participate.

To sum up, the feedback to the project CLLAIM and an education standard for AM was very positive. The willingness to participate in the survey was limited. Suggestions for improvement



Co-funded by the Erasmus+ Programme of the European Union This project has been co-funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.





to the survey were not made by the participants, but on national level improvements were discussed by the project team and listed in this chapter.





3.2 Details from focus group meetings – United Kingdom

3.2.1 Objective of the focus meeting group report in United Kingdom.

The purpose of this national report is to present the perceptions on the European Designer, Specialist, Operator and Inspector profiles in AM to be designed. These perceptions were obtained through the performing of a national meeting group, in which the questionnaire attached in Annex A was used.

3.2.2 Description of the focus meeting group report in United Kingdom.

The focus group meeting report was based around 11 inputs from various AM backgrounds including affiliates, managers and technicians etc. of TWI heavily involved across various additive manufacturing processes. Each person completed a questionnaire aimed at looking at the various objectives and answering questions in accordance with their individual opinion. Below are presented the inputs obtained from questionnaires applied in the national focus meeting group.

3.2.3 Questionnaire Results in United Kingdom

This chapter introduces the results of the returned questionnaires. In total, there were 11 participants. These 4 participants are experts in their field and are therefore representatives. Multiple answers were allowed. Therefore, the number of responses varies.

- Question 1. Type of company

Table 22: Type of organisation

Type of organisation	Number of answers
University	2
Research centres	9
Industry	2
Education Providers	1









Figure 29: Type of Organisation

- Question 1.1 What is your role in the company?

Table 23 Role in entity

	Role of the person who completed the survey.
1	AM Senior Project Leader
2	AM Senior Project leader
3	AM Laboratory team leader
4	Research AM Student
5	AM Project Leader
6	Affiliate AM
7	LAM Technician
8	AM Technician
9	Affiliate AM
10	SLM Technician
11	Numerical model manager (Designer)

- Question 2. Are you currently working in additive manufacturing?

Table 24 People working in AM

Answer	Number of answers
Yes	11
No	0











- **Question 3.** Please select the technologie(s) you are currently working with.

Technology	Number of answers
DED Wireplus arc	2
DED Laser	6
Laser Powder Bed Fusion	5
Other:	0



This project has been co-funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.





Figure 31 AM Technology

- **Question 4.** If you are currently working in additive manufacturing, where does your company/organisation fit in the value chain?

Value chain	Number of answers
Modelling & Design	1,5
Materials	2,5
Process	9
Post-Processing	0
Product	1
End of Life	0

Table 26 Value Chain



Co-funded by the Erasmus+ Programme of the European Union

> This project has been co-funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.







Figure 32 Value Chain



This project has been co-funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.





Question 5. Which access requirements (e.g. professional experience, knowledge or competencies or education level) do you think should be stablished of each AM profile training course?

	Operator	Inspector	Specialist	Designer
Entry Requirements	(Level 3)	(Level 4)	(Level 5)	(Level 6)
	A minimum of 2-3 years working as an operator in AM or welding industry	A minimum of 2-3 years working as an inspector in AM or welding industry	A minimum of 5 years working in AM or welding industry	A minimum of 5 years working in AM or welding industry
	Some Experience with additive manufacturing and the process	Recognised history within additive, or within the certification of finished products	Good level Experience within the specific additive manufacturing and the process	Experience with CAD design and drawings and manufacture process specific to additive
Professional experience			May have some industrial experience	Experience using CAD, knowledge of machine capabilities
			Basic experience in project and time management	Minimum 5 years' experience + Professional Qualification (Eur Ing, CEng, etc)
			Experience presenting work (i.e. papers or conference)	

Table 27 Access requirements for each AM profile training course



Co-funded by the Erasmus+ Programme of the European Union

This project has been co-funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.





			Minimum 5 years' experience + Professional Qualification (Eur Ing, CEng, etc)	
	Minimum required national education for engineering	Minimum required national education for engineering	Degree or equivalent in engineering or science	Degree or equivalent in engineering or science
	NVQ level 2+	Chartership or similar level	Degree	Degree
	NVQ	Degree	Degree in a relevant subject (Materials, engineering)	Minimum Master's degree; preferred PhD (but this can be offset by experience)
background			PhD and/or experience in industry	
			Chartership	
			Minimum Master's degree; preferred PhD (but this can be offset by experience)	
	Operation of mechanised or automatic equipment	Operation of general inspection equipment	Knowledge in arc and/or power beam processes	Knowledge in design for engineering products
Knowledge or competences	Operation of power tools	Operation of specialised inspection equipment	Knowledge in metallurgy	Knowledge in metallurgy

60



Co-funded by the C Erasmus+ Programme of the European Union





Operation of lifting equipment	Certification of at least 1 NDT technique	Knowledge in mechanised or automated machinery	Knowledge in CAD or/and CAD
Use of pressured industrial gases	General knowledge in metallurgy	Programming of mechanised or automated systems	Knowledge in structural integrity and relevant standards
Operation of pre-/post-heating equipment	General knowledge in structural integrity	Knowledge in CAM	Mechanics
HSE knowledge for general workshop operations	engineering background	Knowledge in control systems	Topology optimisation
Practical minded	knowledge of process	HSE knowledge in arc and/or power beam processes	process knowledge
Competent with the machine in use and the supporting equipment	Quality assurance	business awareness	Competent with design aspects of engineering drawings tailored towards additive
	Competent understanding of the supporting test certification of the components	market awareness	
		supply chain knowledge	
		Competent with the	
		machine and	
		background engineering	
		Intermediate to	
		advanced knowledge of	
		relevant AM systems	
		(ideally theoretical and	
		practical)	



Co-funded by the Erasmus+ Programme of the European Union

This project has been co-funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.





	Good knowledge of	
	materials (general)	
	Good knowledge of	
	common AM alloys	
	General knowledge of	
	testing (may have some	
	practical experience)	
	General knowledge of	
	post-processing	

62



Co-funded by the Erasmus+ Programme of the European Union





- **Question 6.** Do you agree with the specified coverage/scope of each AM profile (following table)? If not, please indicate which coverage/scope should be modified?

Table 28 Scope of the AM Profile

	Cover 1 Material	Cover all Materials	Cover 1 Process	Cover all Processes
Supervisor	-	Х	х	Х
Designer	-	Х	-	Х
Inspector/Quality Assurance Supervisor	-	Х	х	Х
Operator	Х	Х	Х	-

63



Co-funded by the Erasmus+ Programme of the European Union





- Question 7. Do you agree with the required knowledge topics of each AM profile? If not, please indicate which knowledge topics should be modified.
- 7.1 Specialist/Supervisor

Specialist/Supervisor	Knowledge	Numb		If not, please indicate which knowledge topics should be modified
		ques	stions	
		Yes	No	
AM Processes	Advanced	11	-	
Subtractive processes	Intermediate	8	3	Only basic knowledge need, maybe 'aware of the options'?
				(At entry level) Basic/intermediate to work towards intermediate
				They should have advanced knowledge
Post-processing	Intermediate	10	1	They should have advanced knowledge
Pre-processing and material	Intermediate	10	1	They should have advanced knowledge
handling				
Certification and validation	Intermediate/Advanced	9	2	Intermediate
				(At entry level) Basic/intermediate to work towards intermediate
Testing/Quality Control	Intermediate/Advanced	11	-	Advanced
Standards	Intermediate/Advanced	10	1	Advanced
				I think supervisors/specialists should have advanced knowledge of standards to
				ensure work is being carried out correctly
Costs	Intermediate/Advanced	11	-	Advanced
Health, Safety & Environment	Intermediate/Advanced	10	1	Advanced

Table 29 Required Knowledge for Specialist/Supervisor and suggestions

64









Figure 33 Required Knowledge for Specialist/Supervisor

65



Co-funded by the Erasmus+ Programme of the European Union





- 7.2 Designer

Designer	Knowledge	Number of questions		If not, please indicate which knowledge topics should be modified
		Yes	No	
AM Processes	Advanced	11	-	
Subtractive processes	Basic/Intermediate	11	-	intermediate
Numerical modelling	Advanced	10	1	Numerical modelling is a highly specialised skillset I see that their will be various types of AM designers just like what currently exists, as not all current designers know about CFD analysis etc
Topology optimization	Advanced	10	1	Numerical modelling is a highly specialised skillset I see that their will be various types of AM designers just like what currently exists, as not all current designers know about CFD analysis etc
Design	Advanced	11	-	
Structural Integrity	Advanced	11	-	
Post-processing	Intermediate	10	1	I think a designer should have advanced knowledge all elements of production Post processing is an important aspect to the AM design, as designed support structure is important and also making it easier for post processing
Standards	Intermediate	10	1	Advanced If a designer is not up to speed with the standards and understands them, how do they expect to design parts that can be functional
Costs	Intermediate	10	1	Designers should have advanced knowledge of costing to ensure designs are kept to a minimal/justifiable cost

Table 30 Required Knowledge for Designer and suggestions



Co-funded by the C Erasmus+ Programme of the European Union

This project has been co-funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.





Health, Safety &	Basic	9	2	As engineers are being expected more and more to design with a life span intention and also look at
Environment				the life cycle of products, it is prevalent that they have a better understanding of this topic.
				Should have intermediate level of health, safety and environment











Figure 34 Required Knowledge for Designer

68



Co-funded by the





- 7.3 Inspector/Quality Assessor

Table 31: Required Knowledge for Inspector/Quality Assessor and suggestions

Inspector/Quality Assessor	Knowledge	Number of		If not, please indicate which knowledge topics should be modified
		Yes	No	
AM Processes	Intermediate	10	1	Basic
Subtractive processes	Intermediate	10	1	Basic
Structural Integrity	Intermediate	10	1	Basic
Metallurgical analysis and characteristics	Intermediate/Advanced	10	1	Advanced
Post-processing	Intermediate	9	2	Intermediate/Advanced They should know the limitations to the post processing and what may or may not go wrong within that process in detail
Pre-processing and material handling	Intermediate	10	1	Not relevant to QC
Non-Destructive Testing	Advanced	10	1	Intermediate
Certification and validation	Advanced	11	-	
Testing/Quality Control	Advanced	11	-	
Standards	Advanced	11	-	
Health, Safety & Environment	Intermediate/Advanced	11	-	Intermediate



Co-funded by the Co Erasmus+ Programme of the European Union

This project has been co-funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.







Figure 35: Required Knowledge for Inspector/Quality Assessor

70







7.4 Operator

-

Operator	Knowledge	Number of		If not, please indicate which knowledge topics should be modified
		questions		
		Yes	No	
AM Processes	Advanced	11	-	But only for the relevant process
Subtractive processes	Basic	8	3	Basic/Intermediate
				If they are required to understand Advanced post-processing (some of
				which is machining - subtractive), then they should have Intermediate
				in Subtractive
Post-processing	Advanced	10	1	Basic or intermediate
Pre-processing and material handling	Advanced	11	-	
Non-Destructive Testing	Basic	10	1	Role of the inspector
Testing/Quality Control	Basic/Intermediate	8	3	Should be more Intermediate to advanced. Operators should understand the importance and requirements for quality control during the process to which they are operating
Health, Safety & Environment	Advanced	11	-	

Table 32 Required Knowledge for Operator and suggestions



Co-funded by the Erasmus+ Programme of the European Union

This project has been co-funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.







Figure 36: Required Knowledge for Operator



by the ramme Union Union This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.




- **Question 8** Do you agree with the required Theoretical/Practical approaching of each AM profile, on the different topics? If not, please indicate which knowledge topics should be modified.
- 8.1 Specialist/Supervisor

_

Specialist/Supervisor	Theoretical	Number of questions		If not, please indicate which knowledge topics should be		
	(T)-Practical Approach(P)	Yes	No	modified		
AM Processes	50% T/P	10	1	A specialist may want to be have a little more practical experience		
Subtractive processes	75% T	9	2	It is not relevant to the role. Only basic theory is needed 100T Practical experience on machining is not necessary, but an understanding of post processing is		
Post-processing	75% T	8	3	100% T It think it should be more 50% T with practical 50%. They need to understand how each of them impact the finishing of a component. If they are a specialist, they should be able to also demonstrate all types of post processing		
Pre-processing and material handling	75% T	10	1	100% T		
Certification and validation	50%T/P	11	-			
Testing/Quality Control	50% T/P	10	1	Could be 100%T		
Standards	50% T/P	11	-			
Costs	50% T/P	11	-			
Health, Safety & Environment	50% T/P	10	1	100% T. Not sure how this would practiced this during a course		

Table 33 Theoretical and Practical Approaching for Specialist/Supervisor and suggestions

73



Co-funded by the Erasmus+ Programme of the European Union



Creating knowLedge and skilLs in AddItive Manufacturing





74



Co-funded by the Erasmus+ Programme of the European Union







Figure 37 Theoretical and Practical Approaching for Specialist/Supervisor



Co-funded by the Erasmus+ Programme of the European Union





- 8.2 Designer

Table 34 Theoretical and Practical Approaching for Designer and suggestions

Designer	Theoretical (T)-	Number of questions		If not, please indicate which knowledge topics should be modified
	Practical Approach(P)	Yes	No	
AM Processes	75% T	10	1	If they don't know how to use a machine, how do they know what problems a design may face whilst being processed by one
Subtractive processes	75% T	11	-	
Numerical modelling	50% T/P	10	1	100% T - highly specialised area
Topology optimization	75% P	10	1	100% T - highly specialised area
Design	100% P	11	-	
Structural Integrity	75% T	11	-	
Post-processing	50% T/P	11	-	
Standards	50% T/P	11	-	
Costs	75% T	11	-	
Health, Safety & Environment	100% T	11	-	



Co-funded by the Erasmus+ Programme of the European Union

This project has been co-funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

76



Creating knowLedge and skilLs in AddItive Manufacturing





Figure 38 Theoretical and Practical Approaching for Designer







- 8.3 Inspector/Quality Assessor

Inspector/Quality Assessor	Theoretical (T)-Practical	Number of	questions	If not, please indicate which knowledge topics should be modified	
	Approach(P)	Yes	No		
AM Processes	50% T/P	11	-		
Subtractive processes	100 %T	10	1	Should always have a small amount of practical experience, purely for a knowledge basis	
Structural Integrity	50% T/P	11	-		
Metallurgical analysis and characteristics	50% T/P	11	-		
Post-processing	50%T/P	10	1	100% T	
Pre-processing and material handling	75% T	10	1	100% T	
Non-Destructive Testing	75% P	10	1	50T/50P	
Certification and validation	75% P	10	1	50T/50P	
Testing/Quality Control	75% P	10	1	50T/50P	
Standards	75% P	10	1	50T/50P	
Health, Safety & Environment	50% T/P	10	1	100% T	

Table 35 Theoretical and Practical Approaching for Inspector/Quality Assessor and suggestions



Co-funded by the Co Erasmus+ Programme of the European Union

This project has been co-funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

78







Figure 39: Theoretical and Practical Approaching for Inspector/Quality Assessor



Co-funded by the Erasmus+ Programme of the European Union





- 8.4 Operator

Operator	Theoretical (T)-	Number of	questions	If not, please indicate which knowledge topics should be	
	Practical Approach(P)	Yes	No	modified	
AM Processes	75% P	11	-		
Subtractive processes	75% P	10	1		
Post-processing	75% P	10	1	50% T	
Pre-processing and material handling	75% P	11	-		
Non-Destructive Testing	75% T	11	-		
Testing/Quality Control	75% T	11	-		
Health, Safety & Environment	100% P	8	3	25T/75P Risk Assessments must be read before work is complete and reviewed after use by operator Should have a small theoretical understanding	

Table 36 Theoretical and Practical Approaching for Operator and suggestions



Co-funded by the Erasmus+ Programme of the European Union

This project has been co-funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

80







Figure 40 Theoretical and Practical Approaching for Operator





This project has been co-funded with support from the European Co-funded by the Commission. This publication reflects the views only of the Erasmus+ Programme author, and the Commission cannot be held responsible for any of the European Union use which may be made of the information contained therein.





3.2.4 Final considerations in United Kingdom

From the attached data the main areas for consideration are access/Entry requirements, particularly for those at specialist and designer level. The recommended entry requirements for these levels was high often going to PhD level and Chartered level. However, consideration for those with a high level of experience in AM should be considered to replace some of the higher academic qualifications via a mature candidate route.

An increased knowledge level for Specialist/Supervisor and operator may also need to be increased/considered particularly in the subtractive processes.

An increased knowledge level in post processing may need to be considered for Inspector level.

An increased knowledge level for operators in quality and testing including Health and Safety may need to be considered.

The split of practical verses theory in health and safety for operators would need to consider some theoretical aspects and it was recommended by 27% of the people taking part in the questionnaire.

Overall there was agreement with the questionnaire statistical assessments presented.

3.3 Details from focus group meetings - Spain

3.3.1 Objective of the focus meeting group report in Spain.

The purpose of this national report is to present the perceptions on the European Designer, Specialist, Operator and Inspector profiles in AM to be designed. These perceptions were obtained through the performing of a national meeting group, in which the questionnaire attached in Annex A was used.

3.3.2 Description of the focus meeting group report in Spain







The survey, regarding the EWF SYSTEMS FRAMEWORK & CORRESPONDENCE TO EQF, was sent to many different industrial partners with a wide variety of applications, in field of their own activities, after the meeting group they assisted.

Each of these participants/partners received the questionnaire, giving feedback 4 weeks before they received it. This questionnaire was additionally explained to the participants/partners during the meeting previously developed.

3.3.3 Questionnaire results in Spain.

This chapter introduces the results of the returned questionnaires. In total, there were 4 participants. These 4 participants are experts in their field and are therefore representatives. Multiple answers were allowed. Therefore, the number of responses varies.

- Question 1. Type of company

Table 37 Type of Organisation

Type of organisation	Number of answers
University	0
Research centres	0
Industry	4
Education Providers	0

83









Figure 41Type of Organisation

- **Question 1.1** What is your role in the company?

Table 38 Role in Entity

	Role of the person who fulfilled the survey.			
1	CEO			
2	Manager			
3	Manager			
4	CEO			

- Question 2. Are you currently working in additive manufacturing?

Table 39 People working in AM

Answer	Number of answers
Yes	4
No	0

84









Question 3. Please select the technology(s) you are currently working with.

Table 40 AM Technology

Technology	Number of answers
DED Wireplus arc	0
DED Laser	0
Laser Powder Bed Fusion	4
Other:	2



Figure 43 AM Technology

85







- **Question 4.** If you are currently working in additive manufacturing, where does your company/organisation fit in the value chain?

Value chain	Number of answers
Modelling & Design	3
Materials	0
Process	2
Post-Processing	2
Product	4
End of Life	0



Figure 44 Value Chain

- **Question 5.** Which access requirements (e.g. professional experience, knowledge or competencies or education level) do you think should be stablished of each AM profile training course?

Entry Requirements	Operator (Level 3)	Inspector (Level 4)	Specialist (Level 5)	Designer (Level 6)
Professional experience	1	2	2	1
	None	None	None	None
	None	1	1	1
	1	1	1	1

86

Table 42 Access Requirements







Education level/education background	FP2	FP2	Technical or Science Degree	Technical or Science Degree
Knowledge or competences	None	1	None	None
	None	None	None	None
	1	None	None	None

- **Question 6.** Do you agree with the specified coverage/scope of each AM profile (following table)? If not, please indicate which coverage/scope should be modified?

	Cover 1 Material	Cover all Materials	Cover 1 Process	Cover all Processes
Supervisor	-	Х	Х	Х
Designer	-	Х	-	Х
Inspector/Quality Assurance Supervisor	-	X	x	X
Operator	X	Х	Х	

Table 43 Scope of the AM Profile

- Question 7. Do you agree with the required knowledge topics of each AM profile?
- <u>7.1 Specialist/supervisor</u>

Specialist/Supervisor	Knowledge	Number of questions	
		Yes	No
AM Processes	Advanced	3	0
Subtractive processes	Intermediate	3	1
Post-processing	Intermediate	3	1







Pre-processing and material	Intermediate	3	1
handling			
Certification and validation	Intermediate/Advanced	3	1
Testing/Quality Control	Intermediate/Advanced	3	1
Standards	Intermediate/Advanced	4	0
Costs	Intermediate/Advanced	4	0
Health, Safety & Environment	Intermediate/Advanced	3	1





Figure 45 Required Knowledge for Specialist/Supervisor

- 7.2 Designer

Table 45 Required Knowledge for Designer

Designer	Knowledge	Number of questions	
		Yes	No
AM Processes	Advanced	3	1
Subtractive processes	Basic/Intermediate	2	2







ſ



Numerical modelling	Advanced	3	1
Topology optimization	Advanced	3	1
Design	Advanced	4	0
Structural Integrity	Advanced	2	2
Post-processing	Intermediate	3	1
Standards	Intermediate	4	0
Costs	Intermediate	3	1
Health, Safety & Environment	Basic	3	1

If not, please indicate which knowledge topics should be modified
AM Processes - Intermediate
Subtractive process - Intermediate
Numerical modelling - Intermediate
Topology optim Intermediate
Structural Integrity - Intermediate
Post-processing - Advanced
Costs - Advanced
Health, Safety & Environment - Intermediate





- <u>7.3 Inspector/Quality Assessor</u>

Table 46 Required Knowledge for Inspector/Quality Assessor

89



Co-funded by the Erasmus+ Programme of the European Union





Inspector/Quality Assessor	Knowledge	Number of questions	
		Yes	No
AM Processes	Intermediate	2	2
Subtractive processes	Intermediate	2	2
Structural Integrity	Intermediate	4	0
Metallurgical analysis and characteristics	Intermediate/Advanced	4	0
Post-processing	Intermediate	3	1
Pre-processing and material handling	Intermediate	3	1
Non-Destructive Testing	Advanced	4	0
Certification and validation	Advanced	4	0
Testing/Quality Control	Advanced	4	0
Standards	Advanced	4	0
Health, Safety & Environment	Intermediate/Advanced	4	0

If not, please indicate which knowledge topics should be modified

AM Processes – Intermediate/Advanced

Subtractive processes – Advanced

Post-processing – Intermediate/ Advanced

Pre-processing and material handling - Intermediate/ Advanced



Figure 47 Required Knowledge for Inspector/Quality Assessor

- 7.4 Operator

90



Co-funded by the Erasmus+ Programme of the European Union





Table 47 Required Knowledge for Operator

Operator	Knowledge	Number of questions	
		Yes	No
AM Processes	Advanced	4	0
Subtractive processes	Basic	3	1
Post-processing	Advanced	4	0
Pre-processing and material handling	Advanced	4	0
Non-Destructive Testing	Basic	2	2
Testing/Quality Control	Basic/Intermediate	4	0
Health, Safety & Environment	Advanced	4	0

If not, please indicate which knowledge topics should be modified Subtractive processes – Intermediate

Non-Destructive Testing – Intermediate



Figure 48 Required Knowledge for Operator

- **Question 8.** Do you agree with the required Theoretical/Practical approaching of each AM profile, on the different topics?
- 8.1 Specialist/Supervisor

91



Co-funded by the Erasmus+ Programme of the European Union





Table 48 Theoretical/Practical Approaching for Specialist/Supervisor

Specialist/Supervisor	Theoretical (T)-Practical	Number of questions	
	Approach(P)	Yes	No
AM Processes	50% T/P	4	0
Subtractive processes	75% T	4	0
Post-processing	75% T	4	0
Pre-processing and material handling	75% T	3	1
Certification and validation	50%T/P	4	0
Testing/Quality Control	50% T/P	4	0
Standards	50% T/P	3	1
Costs	50% T/P	4	0
Health, Safety & Environment	50% T/P	4	0







92

8.2 Designer



Co-funded by the **Erasmus+ Programme** of the European Union



Γ



Table 49 Theoretical/Practical Approaching for Designer

Designer	Theoretical (T)-Practical	Number of questions	
	Approach(P)	Yes	No
AM Processes	75% T	3	1
Subtractive processes	75% T	4	0
Numerical modelling	50% T/P	3	1
Topology optimization	75% P	4	0
Design	100% P	4	0
Structural Integrity	75% T	4	0
Post-processing	50% T/P	3	1
Standards	50% T/P	3	1
Costs	75% T	3	1
Health, Safety & Environment	100% T	3	1

If not, please indicate which knowledge topics should be modified
AM Processes - 100% T
Numerical modelling - 75% T
Post-processing - 75% T
Standards - 75% T
Costs - 100% T
Health, Safety & Environment - 75% T



This project has been co-funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

93







Figure 50 Theoretical/Practical Approaching for Designer

- 8.3 Inspector/Quality Assessor

Table 50 Theoretical/Practical Approaching for Inspector/Quality Assessor

Inspector/Quality Assessor	Theoretical (T)-Practical	Number of questions	
	Approach(P)	Yes	No
AM Processes	50% T/P	3	1
Subtractive processes	100 %T	4	0
Structural Integrity	50% T/P	4	0
Metallurgical analysis and characteristics	50% T/P	4	0
Post-processing	50%T/P	4	0
Pre-processing and material handling	75% T	3	1
Non-Destructive Testing	75% P	4	0
Certification and validation	75% P	4	0
Testing/Quality Control	75% P	4	0
Standards	75% P	4	0
Health, Safety & Environment	50% T/P	4	0

If not, please indicate which knowledge topics should be modified <u>AM Processes – 75% T/P</u> Pre-processing and material handling – 100% T

94



Co-funded by the Erasmus+ Programme of the European Union





Figure 51 Theoretical/Practical Approaching for Inspector/Quality Assessor

- 8.4 Operator

4

Operator	Theoretical (T)-Practical	Number of questions			
	Approach(P)	Yes	No		
AM Processes	75% P	4	0		
Subtractive processes	75% P	4	0		
Post-processing	75% P	4	0		
Pre-processing and material handling	75% P	4	0		
Non-Destructive Testing	75% T	3	1		
Testing/Quality Control	75% T	4	0		
Health, Safety & Environment	100% P	4	0		

If not, please indicate which knowledge topics should be modified

Non-Destructive Testing – 100% T



This project has been co-funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

95



Figure 52 Theoretical/Practical Approaching for Operator

3.3.4 Final considerations

The survey was distributed to a huge group of industry, researchers and universities (compare chapter. Nevertheless, the responses were limited and must be evaluated carefully.

From the point of view in the present situation: it was, and it is challenging to analyse the specific interests of the AM machining sector in the economy in Spain. The education topic had a great agreement from the participants in the meetings. The suggestions for the education concept were accepted with only few comments for possible improvement. But even though the participants were interested, the participation to the survey was not as high as it was expected. Reasons might be:

- The complex content. The different profiles needed to be introduced thoroughly in the sessions. This took a long time and concentration from the participants. A more intuitive design of the survey might help.

To sum up, the feedback to the project CLLAIM and an education standard for AM was very positive. The willingness to participate in the survey was limited. Suggestions for improvement

96







to the survey were not made by the participants, but on national level improvements were discussed by the project team and listed in this chapter.

3.4 Summary of the result form Focus Group Meetings

Question 1 Type of company

Table 52: Type of organisation

	Country	Germany	UK	Spain
Туре	University	1	2	0
company	Research centre	2	9	0
	Industry	4	2	4
	Education	0	1	0
	providers	0	Ŧ	0

As can be seen in the summary table, there is variety between the UK and Germany and Spain, the main company being the industry instead for the UK, the main one is the Research centre.

- Question 1.1 What is your role in the company?

Table 53 Role in entity

	Germany	UK	Spain
	Head of development	AM Senior Project Leader	CEO
	Research engineer in laser welding technology	AM Senior Project leader	Manager
	Research scientist	AM Laboratory team leader	Manager
Role in Entity	Head of department R+D welding technology	Research AM Student	CEO
	AM lab coordinator	AM Project Leader	
		Affiliate AM	
		LAM Technician	
		AM Technician	

97







Affiliate AM	
SLM Technician	
Numerical model manager (Designer)	

You can see in the summary table that it's great variety when we reference of the role entity between the different countries

- Question 2. Are you currently working in additive manufacturing?

Table 54 People Working in AM

	Number of answers						
Answer	Germany	UK	Spain				
Yes	4	11	4				
No	1	0	0				

Question 3 Please select the technology(s) you are currently working with.

Table 55 AM Technology

	Germany	UK	Spain
DED Wireplus arc	1	2	0
DED Laser	2	6	0
Laser Powder Bed Fusion	2	5	4
Other	2	0	2

As can be seen in the summary table, in the case of Germany used a variety from AM technology, in the case of UK they mainly use DED Laser and Laser powder Bed Fusion and in the case of Spain mainly is the Laser powder Bed Fusion

Question 4 If you are currently working in additive manufacturing, where does your company/organisation fit in the value chain?

Table 56 Value Chain

	Germany	UK	Spain
Modelling & Design	1	1,5	3
Material	2	2,5	0

98



Co-funded by the Erasmus+ Programme of the European Union





Process	4	9	2
Post-Processing	1	0	2
Product	1	1	4
End of Life	0	0	0

When it's refence of Value chain, Germany and UK give more importance from the process, however Spain give importance from the product and the modelling & Design.



This project has been co-funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

99





- **Question 5** Which access requirements (e.g. professional experience, knowledge or competencies or education level) do you think should be stablished of each AM profile training course?

Table 57 Access Requirements

Germany= G; United Kingdom= UK; Spain=S

	G	UK	S	G	UK	S	G	UK	S	G	UK	S
Entry Requirements		Operator (Level 3)			Inspector (Level 4)			Specialist (Level 5)			Designer (Level 6)	
		A minimum of 2-3 years working as an operator in AM or welding industry	1		A minimum of 2-3 years working as an inspector in AM or welding industry	2		A minimum of 5 years working in AM or welding industry	n		A minimum of 5 years working in AM or welding industry	1
		Some Experience with	Ţ		Recognised history within additive, or	Z		Good level Experience within the specific additive manufacturing and the process	Z		Experience with CAD design and drawings and manufacture process specific to additive	Ţ
experience	-	additive manufacturing and the process		1	within the certification of finished products		2	May have some industrial experience		1	Experience using CAD, knowledge of machine capabilities	
			None			None		Basic experience in project and time management	None		Minimum 5 years' experience + Professional Qualification (Eur Ing, CEng. etc)	None
			none			1		Experience presenting work (i.e. papers or conference)	1			1

100



Co-funded by the Erasmus+ Programme of the European Union





								Minimum 5 years' experience + Professional Qualification (Eur Ing, CEng, etc)				
	G	UK	s	G	UK	S	G	UK	S	G	UK	S
Entry Requirements		Operator (Level 3)			Inspector (Level 4)			Specialist (Level 5)			Designer (Level 6)	
		Minimum required national education for engineering			Minimum required national education for engineering			Degree or equivalent in engineering or science			Degree or equivalent in engineering or science	
	2	NVQ level 2+	1		Chartership or similar level	1		Degree	1		Degree	1
Education								Degree in a relevant subject (Materials, engineering)			Minimum Master's degree:	
level/education background		NVQ		1	Degree		2	PhD and/or experience in industry		2	preferred PhD (but this can be offset by experience)	
								Chartership	Technical			Technical
			FP2			FP2		Minimum Master's degree; preferred PhD (but this can be offset by experience)	science Degree			science Degree



Co-funded by the Erasmus+ Programme of the European Union

Co-funded by the Erasmus+ Programme of the European Union	
---	--



Entry	G	UK	S	G	UK	S	G	UK	S	G	UK	S	
Requirements	Operator (Level 3)				Inspector (Level 4)			Specialist (Level 5)			Designer (Level 6)		
Knowledge or competences		Operation of mechanised or automatic equipment			Operation of general inspection equipment			Knowledge in arc and/or power beam processes			Knowledge in design for engineering products		
		Operation of power tools			Operation of specialised inspection equipment			Knowledge in metallurgy	Neve		Knowledge in metallurgy		
		Operation of lifting equipment	None		Certification of at least 1 NDT technique	1	2	Knowledge in mechanised or automated machinery	None		Knowledge in CAD or/and CAD	None	
	1	Use of pressured industrial gases		2	General knowledge in metallurgy			Programming of mechanised or nonautomated systems		2	Knowledge in structural integrity and relevant standards		
		Operation of pre-/post- heating equipment			General knowledge in structural integrity			Knowledge in CAM		Mechanics			
		HSE knowledge for general workshop operations	None	lone	engineering background	None		Knowledge in control systems	None		Topology optimisation	None	
		Practical minded			knowledge of process			HSE knowledge in arc and/or power beam processes			process knowledge		



Co-funded by the Erasmus+ Programme of the European Union





		Quality assurance		business awareness					
Competent with the machine in use and the supporting equipment	1	Competent understanding of the supporting test certification of the components	None	market awareness supply chain knowledge Competent with the machine and background engineering Intermediate to advanced knowledge of relevant AM systems (ideally theoretical and practical) Good knowledge of materials	None	Competent wi aspects of en drawings tailord additiv	ith design gineering ed towards ve	None	
				(general) Good knowledge of common AM alloys General knowledge of testing (may have some practical experience) General knowledge of post- processing					



Co-funded by the Erasmus+ Programme of the European Union





- **Question 6** Do you agree with the specified coverage/scope of each AM profile (following table)? If not, please indicate which coverage/scope should be modified?

Table 58 Scope of the AM Profile

	Germany/UK/Spain										
	Cover 1 material	cover all materials	cover 1 process	cover all process							
supervisor	-	Х	-	Х							
designer	-	Х	-	Х							
inspector	-	Х	Х	Х							
operator	Х	Х	Х								

In terms of the scope of the AM profile it is similar for the three countries



This project has been co-funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

104





Question 7 Do you agree with the required knowledge topics of each AM profile?

Table 59 Required Knowledge

Que	stion 7.1	Germ	any	Uł	K	Spain	
Creation interview	Kranuladaa	Number of	questions	Number of	questions	Number of questions	
Specialist/Supervisor	Knowledge	Yes	No	Yes	No	Yes	No
AM Processes	Advanced	5	0	11	0	3	0
Subtractive processes	Intermediate	5	0	8	3	3	1
Post-processing	Intermediate	5	0	10	1	3	1
Pre-processing and material handling	Intermediate	5	0	10	1	3	1
Certification and validation	Intermediate/Advanced	4	1	9	2	3	1
Testing/Quality Control	Intermediate/Advanced	5	0	11	0	3	1
Standards	Intermediate/Advanced	5	0	10	1	4	0
Costs	Intermediate/Advanced	5	0	11	0	4	0
Health, Safety & Environment	Intermediate/Advanced	4	1	10	1	3	1

105



Co-funded by the Erasmus+ Programme of the European Union





Que	stion 7.2	Germ	any	Uk	K	Spain	
Dosignor	Knowlodzo	Number of	questions	Number of	questions	Number of questions	
Designer	Kilowiedge	Yes	No	Yes	No	Yes	No
AM Processes	Advanced	4	1	11	0	3	1
Subtractive processes	Basic/Intermediate	2	3	11	0	2	2
Numerical modelling	Advanced	5	0	10	1	3	1
Topology optimization	Advanced	4	1	10	1	3	1
Design	Advanced	5	0	11	0	4	0
Structural Integrity	Advanced	5	0	11	0	2	2
Post-processing	Intermediate	5	0	10	1	3	1
Standards	Intermediate	5	0	10	1	4	0
Costs	Intermediate	5	0	10	1	3	1
Health, Safety & Environment	Basic	4	1	9	2	3	1



Co-funded by the Erasmus+ Programme of the European Union





Que	stion 7.3	Germ	any	Uk	< colored and set of the set of t	Spain	
Inspector/Quality	Knowledge	Number of	questions	Number of	questions	Number of questions	
Assessor	Knowledge	Yes	No	Yes	No	Yes	No
AM Processes	Intermediate	5	0	10	1	2	2
Subtractive processes	Intermediate	4	1	10	1	2	2
Structural Integrity	Intermediate	5	0	10	1	4	0
Metallurgical analysis and characteristics	Intermediate/Advanced	5	0	10	1	4	0
Post-processing	Intermediate	4	1	9	2	3	1
Pre-processing and material handling	Intermediate	4	1	10	1	3	1
Non-Destructive Testing	Advanced	5	0	10	1	4	0
Certification and validation	Advanced	5	0	11	0	4	0
Testing/Quality Control	Advanced	5	0	11	0	4	0





Co-funded by the Cor Erasmus+ Programme of the European Union





Ques	stion 7.4	Germ	any	Uk	(Spain		
Onereter	Knowledge	Number of	questions	Number of	questions	Number of questions		
Operator	Knowledge	Yes	No	Yes	No	Yes	No	
AM Processes	Advanced	5	0	11	0	4	0	
Subtractive processes	Basic	5	0	8	3	3	1	
Post-processing	Advanced	5	0	10	1	4	0	
Pre-processing and material handling	Advanced	5	0	11	0	4	0	
Non-Destructive Testing	Basic	5	0	10	1	2	2	
Testing/Quality Control	Basic/Intermediate	4	1	8	3	4	0	
Health, Safety & Environment	Advanced	4	1	11	0	4	0	



Co-funded by the Erasmus+ Programme of the European Union




Question 8. Do you agree with the required Theoretical/Practical approaching of each AM profile, on the different topics?

Question 8.1		Germany		UK		Spain	
	Theoretical (T) Bractical	Number of questions		Number of questions		Number of questions	
Specialist/Supervisor	Approach(P)	Yes	No	Yes	No	Yes	No
AM Processes	50% T/P	5	0	10	1	4	0
Subtractive processes	75% T	5	0	9	2	4	0
Post-processing	75% T	5	0	8	3	4	0
Pre-processing and material handling	75% T	5	0	10	1	3	1
Certification and validation	50%T/P	5	0	11	0	4	0

Table 60 Theoretical and Practical Approaching

109



Co-funded by the Erasmus+ Programme of the European Union



Creating knowLedge and skilLs in AddItive Manufacturing



Testing/Quality Control	50% T/P	5	0	10	1	4	0
tandards 50% T/P		5	0	11	0	3	1
Costs	50% T/P	5	0	11	0	4	0
Health, Safety & Environment	50% T/P	5	0	10	1	4	0

Question 8.2		Germany		UK		Spain	
Designer	Theoretical (T)-Practical	Number of questions		Number of questions		Number of questions	
	Approach(P)	Yes	No	Yes	No	Yes	No
AM Processes	75% T	5	0	10	1	3	1
Subtractive processes	75% T	5	0	11	0	4	0
Numerical modelling	50% T/P	5	0	10	1	3	1
Topology optimization	75% P	5	0	10	1	4	0
Design	100% P	5	0	11	0	4	0
Structural Integrity	75% T	5	0	11	0	4	0

110



Co-funded by the Erasmus+ Programme of the European Union





Post-processing	50% T/P	5	0	11	0	3	1
Standards	50% T/P	5	0	11	0	3	1
Costs	75% T	5	0	11	0	3	1
Health, Safety & Environment	100% T	5	0	11	0	3	1

Question 8.3		Germany		UK		Spain	
Inspector/Quality	Theoretical (T)-Practical Approach(P)	Number of questions		Number of questions		Number of questions	
Assessor		Yes	No	Yes	No	Yes	No
AM Processes	50% T/P	5	0	11	0	3	1
Subtractive processes	100 %T	5	0	10	1	4	0
Structural Integrity	50% T/P	5	0	11	0	4	0

111



Co-funded by the Erasmus+ Programme of the European Union





Metallurgical analysis and characteristics	50% T/P	5	0	11	0	4	0
Post-processing	50%T/P	5	0	10	1	4	0
Pre-processing and material handling	75% T	5	0	10	1	3	1
Non-Destructive Testing	75% P	5	0	10	1	4	0
Certification and validation	75% P	5	0	10	1	4	0
Testing/Quality Control	75% P	5	0	10	1	4	0
Standards	75% P	5	0	10	1	4	0
Health, Safety & Environment	50% T/P	5	0	10	1	4	0

Question 8.4		Germany		UK		Spain	
Operator	Theoretical (T)-Practical	Number of questions		Number of questions		Number of questions	
	Approach(P)	Yes	No	Yes	No	Yes	No

112



Co-funded by the Erasmus+ Programme of the European Union



Creating knowLedge and skilLs in AddItive Manufacturing



AM Processes	75% P	5	0	11	0	4	0
Subtractive processes 75% P		5	0	10	1	4	0
Post-processing	75% P	5	0	10	1	4	0
Pre-processing and material handling	75% P	5	0	11	0	4	0
Non-Destructive Testing	75% T	5	0	11	0	3	1
Testing/Quality Control	75% T	5	0	11	0	4	0
Health, Safety & Environment	100% P	5	0	8	3	4	0

113



Co-funded by the Erasmus+ Programme of the European Union





4. Conclusions

CLLAIM project conducted two surveys to map the required knowledge and skills in Metal AM per level in order to define a path to build a harmonised qualification system. Based on these surveys on skills in AM it was possible to set a path for the creation of AM Qualifications and prioritize which Qualifications to start developing.

The results achieved enables CLLAIM project partners to settle the strategy for the development of the European Qualification Profiles.

One of the main outcomes deriving from the analysis of the achieved results, is that for the Metal AM Operator Profile, there should be four different Guidelines in order to individually cover the processes PBF-EB, PBF-LB, DED-Arc and DED-LB, oppositely to the other Professional profiles that should cover all processes in the same training guideline. Through the close relation with the industry was concluded that these 4 different Operators' profiles were needed to cover Additive Manufacturing Processes for Metal. For the remaining profiles, it is concluded that will only be needed one Guideline per profile, although partners are aware that this may change in the future.

Additionally, with the surveys the relevance of several topics to be taking into account in each profile were assessed, upon the development of the Guidelines for the 4 professional profiles project these topics are considered and the results of the survey used in order to have a clear alignment between project's Guidelines (D.3.1&3.2) and industry needs (we avoid Engineer Profile because that profile was conducted in collaboration with ADMIRE project and we are not going to develop it in the CLLAIM project). Moreover, during the survey it is summarized some knowledge that the profiles should address and also a division between practical and theoretical work was assessed, not forget mentioning that these results will be used upon the development of the Guidelines (D.3.1&3.2) for the different professional profiles.

Regarding the EQF levels for the professional profiles, is clear that the EQF level for the Operator is EQF level 4, For the other profiles (Designer, Specialist/Supervisor and Inspector/Quality assurance) the EQF level maybe will need to be validated by the stakeholders during the develop of the project. Please refer to the following table to check the correspond EQF levels of the profiles.



Co-funded by the Erasmus+ Programme of the European Union

114





Table 61 Correspond EQF levels of the profiles

FIELD C)F Fiy	F EQF LEVEL EWF LEVEL		KNOWLEDGE	SKILLS	AUTONOMY AND RESPONSIBILITY
ators/managers		7	EXPERT	Highly specialised and forefront know ledge including original thinking, rese arch and critical assessment of theory , principles and applicability of metal additive manufacturing processes.	Highly specialised problem- solving ski Ils including critical and original evaluation, allowing to define or develop the best technical and eco nomical solutions, when applying met al additive manufacturing processes, in complex and unpredictable conditi ons	Manage and transform the metal additive man ufacturing processes in a highly complex context. Fully responsible for the definition an d revision of personnel's tasks.
UPERVISORS/ COORDIN		6	ADVANCED	Advanced knowledge and critical und erstanding of the theory, principles an d applicability of metal additive manu facturing processes.	Advanced problem- solving skills including critical evaluati on, allowing to choose the proper tec hnical and economical solutions, whe n applying metal additive manufacturi ng processes, in complex and unpredictable conditi ons	Manage the applications of metal add itive manufacturing processes in a highly complex context. Act autonomously in decision making and definition in the definition of the metal additive manufacturing person nel's tasks.
INSPECTORS &S		5	SPECIALIZED	Specialised, factual and theoretical of theory, principles and applicability of metal additive manufacturing proce.s ses	Specialised range of cognitive and pra ctical skills, allowing to develop soluti ons or choose the appropriate metho ds, when applying metal additive man ufacturing processes in common/regu ar problems.	Manage and supervise common or standard m etal additive manufacturing processes , in an unpredictable context. Take responsibility in standard work a nd supervise the metal additive manu facturing personnel's tasks.
	OPERATORS	4	INDEPENDENT	Factual and broad concepts in the fiel d of metal additive manufacturing pro cesses.	Fundamental cognitive and practical s kills required to develop proper soluti ons and application of procedures an d tools on simple and specific metal additive manufactu ring problems.	Self- manage of professional activities and simple standard applications of metal additive manufacturing processes in p redictable contexts but subject to cha nge. Supervise routine tasks and similar fu nction workers, as well as take respon sibility for decision making in basic wo rk.

As it has said in the chapter 1 of this document, concerning the RPL and the correspondence between NQF and EQF levels, despite of the situation of Spain in this field not referenced yet the NQF to the EQF levels, the recognition of the NQF qualifications and their correspondence to the EQF is in progress and it will assure the sustainability of the qualifications and the recognition of the of the knowledge of the experienced professionals in the field of the AM.



Co-funded by the Erasmus+ Programme of the European Union This project has been co-funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.





5. Annex 1 - Survey on Skills part II





Survey on Skills needs in Metal Additive Manufacturing - PART II

1. INTRODUCTION

The European Welding Federation for Welding, Joining and Cutting (EWF) is a European Association with 25 years of experience in running International qualifications used in 45 countries worldwide. The increasing growth of Metal Additive Manufacturing (MAM) technology is demanding the definition of new professional levels required by industry for personnel working in this area. EWF is currently performing a research on this topic, being this the second part of a preliminary survey. We are very must interested in collecting your views on the requirements for the following professional profiles:

European Metal AM Engineer European Metal AM Supervisor European Metal AM Designer European Metal AM Inspector / Quality Assurance Supervisor European Metal AM Operator

This survey was structured based on the results of the first survey.

Please be aware that this survey will be closed by the 8th of December 2017.

* 1. Your Name:

* 2. Organization Name:



Co-funded by the Erasmus+ Programme of the European Union This project has been co-funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.





2. EUROPEAN METAL ADDITIVE MANUFACTURING (MAM) ENGINEER - Introduction

European MAM Engineer degree introduction.

- * 1. Do you want to answer the European MAMEngineer set of questions?
 - Yes
 - No

Survey on Skills needs in Metal Additive Manufacturing - PART II

3. EUROPEAN METAL ADDITIVE MANUFACTURING (MAM) ENGINEER

European MAM Master Degree's features.

* 1. Please select the required coverage/scope of the MAMEngineer qualification.

	Yes	No
Cover all AM processes	0	\bigcirc
Cover one specific process	\bigcirc	0
Cover all materials	\bigcirc	0
Cover one material	0	0
Other (please specify)		



Co-funded by the Erasmus+ Programme of the European Union This project has been co-funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.





* 2. Having as reference the following scale (1 - 3), please rate the knowledge for the European MAM Engineer on the listed topics.

	1 - Basic	2 - Intermediate	3 - Advanced
AM Processes	\bigcirc	0	\bigcirc
Subtractive Processes	\bigcirc	0	0
Numerical Modelling	\bigcirc	0	\bigcirc
Topology Optimisation	0	0	0
Design	\bigcirc	0	\bigcirc
Structural Integrity	0	0	0
Metallurgical Analysis and Characteristics	\bigcirc	\circ	0
Post-Processing	0	0	0
Pre-Processing and Material Handling	0	0	0
Non-Destructive Testing	0	0	0
Certification and Validation	\bigcirc	0	0
Testing/Quality Control	\bigcirc	0	0
Standards	\bigcirc	\odot	\odot
Costs	\bigcirc	0	0
Health, Safety & Environment	0	\circ	0
Other (please specify)			



Co-funded by the Erasmus+ Programme of the European Union This project has been co-funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.





- * 3. Having as reference the following scale (1 5), being:
- 1 100% Theory
- 2 75% Theoretical 25% Practical
- 3 50% Theoretical 50% Practical
- 4 25% Theoretical 75% Practical
- 5 100% Practical

Please choose the applicable weights of Theory and Practice for the European MAMEngineer on the listed topics.

	1	2	3	4	5
AM Processes	\odot	0	0	0	0
Subtractive Processes	\bigcirc	0	0	0	\odot
Numerical Modelling	\bigcirc	0	\odot	0	0
Topology Optimisation	0	0	0	0	0
Design	0	0	0	0	0
Structural Integrity	0	0	0	0	0
Metallurgical Analysis and Characteristics	\bigcirc	\bigcirc	\bigcirc	\bigcirc	\bigcirc
Post-Processing	\bigcirc	0	0	0	0
Pre-Processing and Material Handling	\odot	0	\odot	\odot	0
Non-Destructive Testing	0	0	0	0	0
Certification and Validation	\bigcirc	\bigcirc	\odot	\bigcirc	\bigcirc
Testing/Quality Control	\bigcirc	0	0	0	0
Standards	\bigcirc	\bigcirc	\bigcirc	\bigcirc	0
Costs	\bigcirc	0	0	\bigcirc	\bigcirc
Health, Safety & Environment	0	0	0	0	0
Other (please specify)					

Survey on Skills needs in Metal Additive Manufacturing - PART II

4. EUROPEAN METAL ADDITIVE MANUFACTURING (MAM) SUPERVISOR - Introduction

European MAM Supervisor introduction.

* 1. Do you want to answer the European MAM Supervisor set of questions?

\cap	Yes
U.	100

🔵 No



Co-funded by the Erasmus+ Programme of the European Union This project has been co-funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.





5. EUROPEAN METAL ADDITIVE MANUFACTURING (MAM) SUPERVISOR

European MAM Supervisor Qualification's features.

* 1. Please specify the required coverage/scope of the MAM Supervisor qualification.

	Yes	No
Cover all AM processes	0	0
Cover one specific process	\circ	\bigcirc
Cover all materials	0	0
Cover one material	0	0
Other (please specify)		

* 2. Having as reference the following scale (1 - 3), please rate the knowledge for the European MAM Supervisor on the listed topics.

	1 - Basic	2 - Intermediate	3 - Advanced
AM Processes	0	0	0
Subtractive Processes	0	0	0
Post-Processing	0	0	0
Pre-Processing and Material Handling	\bigcirc	\circ	0
Certification and Validation	0	0	0
Testing/Quality Control	0	0	0
Standards	0	0	0
Costs	0	0	0
Health, Safety & Environment	0	0	0
Other (please specify)			

-02

Co-funded by the Erasmus+ Programme of the European Union This project has been co-funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.





- * 3. Having as reference the following scale (1 5), being:
 - 1 100% Theory
 - 2 75% Theoretical 25% Practical
 - 3 50% Theoretical 50% Practical
 - 4 25% Theoretical 75% Practical
 - 5 100% Practical

Please choose the applicable weights of Theory and Practice for the European MAMSupervisor on the listed topics.

	1	2	3	4	5
AM Processes	0	0	\odot	0	0
Subtractive Processes	0	0	0	0	0
Post-Processing	\odot	0	\odot	0	0
Pre-Processing and Material Handling	0	0	0	0	0
Certification and Validation	0	\bigcirc	\odot	\bigcirc	0
Testing/Quality Control	0	0	0	0	0
Standards	0	0	\odot	0	0
Costs	0	0	0	0	0
Health, Safety & Environment	0	0	0	\bigcirc	0
Other (please specify)					

Survey on Skills needs in Metal Additive Manufacturing - PART II

6. EUROPEAN METAL ADDITIVE MANUFACTURING (MAM) DESIGNER - Introduction

European MAM Designer introduction.

- * 1. Do you want to answer the European MAMDesigner set of questions?
 - Yes
 - 🔵 No



Co-funded by the Erasmus+ Programme of the European Union This project has been co-funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.





7. EUROPEAN METAL ADDITIVE MANUFACTURING (MAM) DESIGNER

European MAM Designer qualification's features.

* 1. Please specify the required coverage/scope of the MAM Designer qualification.

	Yes	No
Cover all AM processes	0	\bigcirc
Cover one specific process	0	0
Cover all materials	0	0
Cover one material	0	0
Other (please specify)		

* 2. Having as reference the following scale (1 - 3), please rate the knowledge for the European MAM Designer on the listed topics.

	1 - Basic	2 - Intermediate	3 - Advanced
AM Processes	\bigcirc	0	\bigcirc
Subtractive Processes	0	0	0
Numerical Modelling	0	0	0
Topology Optimisation	0	0	0
Design	\odot	0	0
Structural Integrity	0	0	0
Post-Processing	\bigcirc	0	0
Standards	0	0	0
Costs	0	0	0
Health, Safety & Environment	0	\bigcirc	0
Other (please specify)			

Co-funded by the Erasmus+ Programme of the European Union This project has been co-funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.





- * 3. Having as reference the following scale (1 5), being:
- 1 100% Theory
- 2 75% Theoretical 25% Practical
- 3 50% Theoretical 50% Practical
- 4 25% Theoretical 75% Practical
- 5 100% Practical

Please choose the applicable weights of Theory and Practice for the European MAMDesigner on the listed topics.

	1	2	3	4	5
AM Processes	\bigcirc	0	0	\odot	0
Subtractive Processes	0	0	0	0	0
Numerical Modelling	\bigcirc	0	0	0	0
Topology Optimisation	0	0	0	0	0
Design	\bigcirc	0	0	\odot	0
Structural Integrity	0	0	0	0	0
Post-Processing	\bigcirc	0	\odot	\odot	0
Standards	\bigcirc	0	0	0	0
Costs	0	0	0	0	0
Health, Safety & Environment	\bigcirc	\bigcirc	\circ	\bigcirc	\bigcirc
Other (please specify)					

Survey on Skills needs in Metal Additive Manufacturing - PART II

8. EUROPEAN METAL ADDITIVE MANUFACTURING (MAM) INSPECTOR / QUALITY ASSURANCE SUPERVISOR - Introduction

European MAM Inspector / Quality Assurance Supervisor introduction.

* 1. Do you want to answer the European MAM Inspector / Quality Asurance Supervisor set of questions?

- 🔵 Yes
- 🔵 No



Co-funded by the Erasmus+ Programme of the European Union This project has been co-funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.





9. EUROPEAN METAL ADDITIVE MANUFACTURING (MAM) INSPECTOR / QUALITY ASSURANCE SUPERVISOR

European MAM Inspector / Quality Assurance qualification's features.

* 1. Please specify the required coverage/scope of the MAM Inspector / Quality Assurance Supervisor qualification.

	Yes	No
Cover all AM processes	0	0
Cover one specific process	0	0
Cover all materials	0	0
Cover one material	0	0
Other (please specify)		



Co-funded by the Erasmus+ Programme of the European Union This project has been co-funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.



* 2. Having as reference the following scale (1 - 3), please rate the knowledge for the European MAM Inspector / Quality Assurance Supervisor on the listed topics.

Co-funded by the Erasmus+ Programme of the European Union

	1 - Basic	2 - Intermediate	3 - Advanced
AM Processes	\bigcirc	0	\bigcirc
Subtractive Processes	\bigcirc	\bigcirc	\bigcirc
Structural Integrity	\bigcirc	0	\bigcirc
Metallurgical Analysis and Characteristics	\bigcirc	\bigcirc	\bigcirc
Post-Processing	\bigcirc	\bigcirc	\bigcirc
Pre-Processing and Material Handling	\bigcirc	\bigcirc	\bigcirc
Non-Destructive Testing	\bigcirc	0	\bigcirc
Certification and Validation	\bigcirc	\bigcirc	\bigcirc
Testing / Quality Control	\bigcirc	\bigcirc	\bigcirc
Standards	\bigcirc	\bigcirc	\bigcirc
Health, Safety & Environment	\bigcirc	\bigcirc	0
Other (please specify)		1	

125



Co-funded by the Erasmus+ Programme of the European Union





- * 3. Having as reference the following scale (1 5), being:
 - 1 100% Theory
 - 2 75% Theoretical 25% Practical
 - 3 50% Theoretical 50% Practical
 - 4 25% Theoretical 75% Practical
 - 5 100% Practical

Please choose the applicable weights of Theory and Practice for the European MAMInspector / Quality Assurance Supervisor on the listed topics.

	1	2	3	4	5
AM Processes	\bigcirc	\bigcirc	\bigcirc	\bigcirc	\bigcirc
Subtractive Processes	\bigcirc	\bigcirc	\bigcirc	\bigcirc	\bigcirc
Structural Integrity	\bigcirc	\bigcirc	\bigcirc	\bigcirc	\bigcirc
Metallurgical Analysis and Characteristics	\bigcirc	\bigcirc	\bigcirc	\bigcirc	\bigcirc
Post-Processing	\bigcirc	\bigcirc	\bigcirc	\bigcirc	\bigcirc
Pre-Processing and Material Handling	\bigcirc	\bigcirc	\bigcirc	\bigcirc	\bigcirc
Non-Destructive Testing	\bigcirc	\bigcirc	\bigcirc	\bigcirc	\bigcirc
Certification and Validation	\bigcirc	\bigcirc	\bigcirc	\bigcirc	\bigcirc
Testing / Quality Control	\bigcirc	\bigcirc	\bigcirc	\bigcirc	\bigcirc
Standards	\bigcirc	\bigcirc	\bigcirc	\bigcirc	\bigcirc
Health, Safety & Environment	\bigcirc	\bigcirc	\bigcirc	\bigcirc	\bigcirc
Other (please specify)					

126



Co-funded by the Erasmus+ Programme of the European Union





10. EUROPEAN METAL ADDITIVE MANUFACTURING (MAM) Operator - Introduction

European MAM Operator introduction.

- * 1. Do you want to answer the European MAMOperator set of questions?
 - Yes
 - No



Co-funded by the Erasmus+ Programme of the European Union This project has been co-funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.





11. EUROPEAN METAL ADDITIVE MANUFACTURING (MAM) OPERATOR

European MAM Operator qualification's features.

* 1. Please specify the required coverage/scope of the MAMInspector / Quality Assurance Supervisor qualification.

	Yes	No
Cover all AM processes	0	0
Cover one specific process	0	0
Cover all materials	\circ	\bigcirc
Cover one material	0	\bigcirc
Other (please specify)		

* 2. Having as reference the following scale (1 - 3), please rate the knowledge for the European MAM Operator on the listed topics.

	1 - Basic	2 - Intermediate	3 - Advanced
AM Processes	\odot	0	0
Subtractive Processes	0	0	0
Post-Processing	\bigcirc	0	\bigcirc
Pre-Processing and Material Handling	\bigcirc	0	0
Non-Destructive Testing	\bigcirc	\bigcirc	0
Testing / Quality Control	\bigcirc	0	0
Health, Safety & Environment	0	0	0
Other (please specify)			



Co-funded by the Erasmus+ Programme of the European Union This project has been co-funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.





- * 3. Having as reference the following scale (1 5), being:
 - 1 100% Theory
 - 2 75% Theoretical 25% Practical
 - 3 50% Theoretical 50% Practical
 - 4 25% Theoretical 75% Practical
 - 5 100% Practical

Please choose the applicable weights of Theory and Practice for the European MAMOperator on the listed topics.

	1	2	3	4	5
AM Processes	\bigcirc	\bigcirc	\bigcirc	\bigcirc	\bigcirc
Subtractive Processes	\bigcirc	\bigcirc	\bigcirc	\bigcirc	\bigcirc
Post-Processing	\bigcirc	\bigcirc	\bigcirc	\bigcirc	\bigcirc
Pre-Processing and Material Handling	\bigcirc	\bigcirc	\bigcirc	\bigcirc	\bigcirc
Non-Destructive Testing	\bigcirc	\bigcirc	\bigcirc	\bigcirc	\bigcirc
Testing / Quality Control	\bigcirc	\bigcirc	\bigcirc	\bigcirc	\bigcirc
Health, Safety & Environment	\bigcirc	\bigcirc	\bigcirc	\bigcirc	\bigcirc
Other (please specify)					

This project has been co-funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.





6. Annex 2 - Questionnaire

PART I – Background Information

1. Type of company

Type of organisation	Please mark
Universities	
Research Centres	
Industry	
Education provider	

1.1 What is your role in the company?

2. Are you currently working in additive manufacturing?

No

3. Please select the technology(s) you are currently working with.

Technologies					
DED Wire plus Arc	DED Laser	Laser Powder Bed Fusion	Other		

4. If you are currently working in additive manufacturing, where does your company/organisation fit in the value chain? (Please mark)

Company/	Value Chain					
Organisation	Modelling & Design	Materials	Process	Post- Processing	Product	End of Life

130



Co-funded by the Erasmus+ Programme of the European Union





PART II – Assessment of the AM profiles

The national assessments will be compiled into a common european report, setting the framework for the development of the European AM Designer, Specialist, Operator and European AM Inspector profiles, training curriculum and units of learning outcomes:

5. Which access requirements (e.g. professional experience, knowledge or competencies or education level) do you think should be stablished of each AM profile training course?

Entry Requirements	Operator (Level 3)	Inspector (Level 4)	Specialist (Level 5)	Designer (Level 6)
(if applicable) Professional experience				
Education level/education background				
Knowledge or competences				

6. Do you agree with the specified coverage/scope of each AM profile (following table)? If not, please indicate which coverage/scope should be modified?

Table 1: Professional levels coverage on different areas on MAM technology.

	Cover 1 Material	Cover all Materials	Cover 1 Process	Cover all Processes	Yes	No
Supervisor		Х	*	Х		



Co-funded by the **Erasmus+ Programme** of the European Union

This project has been co-funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.





Designer		Х		х	
Inspector/Quality Assurance Supervisor		Х	Х	Х	
Operator	Х	Х	Х		

*Tie of 50%

If no, please explain.

European AM Designer	European AM Specialist/Supervisor	European AM Operator	European AM Inspector

7. Do you agree with the required knowledge topics of each AM profile? If not, please indicate which knowledge topics should be modified at the end of the tables!

7.1 Specialist/Supervisor

Specialist/Supervisor	Knowledge	Yes	No
AM Processes	Advanced		
Subtractive processes	Intermediate		
Post-processing	Intermediate		
Pre-processing and material handling	Intermediate		
Certification and validation	Intermediate/Advanced		



Co-funded by the Erasmus+ Programme of the European Union This project has been co-funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.





Testing/Quality Control	Intermediate/Advanced	
Standards	Intermediate/Advanced	
Costs	Intermediate/Advanced	
Health, Safety & Environment	Intermediate/Advanced	

7.2 Designer

Designer	Knowledge	Yes	No
AM Processes	Advanced		
Subtractive processes	Basic/Intermediate		
Numerical modelling	Advanced		
Topology optimization	Advanced		
Design	Advanced		
Structural Integrity	Advanced		
Post-processing	Intermediate		
Standards	Intermediate		
Costs	Intermediate		
Health, Safety & Environment	Basic		

7.3 Inspector/Quality Assessor

Inspector/Quality Assessor	Knowledge	Yes	No
AM Processes	Intermediate		
Subtractive processes	Intermediate		
Structural Integrity	Intermediate		
Metallurgical analysis and characteristics	Intermediate/Advanced		
Post-processing	Intermediate		
Pre-processing and material handling	Intermediate		
Non-Destructive Testing	Advanced		





Co-funded by the Erasmus+ Programme of the European Union





Certification and validation	Advanced	
Testing/Quality Control	Advanced	
Standards	Advanced	
Health, Safety & Environment	Intermediate/Advanced	

7.4 Operator

Operator	Knowledge	Yes	No
AM Processes	Advanced		
Subtractive processes	Basic		
Post-processing	Advanced		
Pre-processing and material handling	Advanced		
Non-Destructive Testing	Basic		
Testing/Quality Control	Basic/Intermediate		
Health, Safety & Environment	Advanced		

If no, please explain.

European AM Designer	European AM Specialist/Supervisor	European AM Operator	European AM Inspector

8 Do you agree with the required Theoretical/Practical approaching of each AM profile, on the different topics? If not, please indicate which knowledge topics should be modified? (T: Theoretical; P: Practical)

8.1 Specialist/Supervisor

134



Co-funded by the Erasmus+ Programme of the European Union





Specialist/Supervisor	Knowledge	Theoretical- Practical Approach	Yes	No
AM Processes	Advanced	50%T/P		
Subtractive processes	Intermediate	75%T		
Post-processing	Intermediate	75%T		
Pre-processing and material handling	Intermediate	75%T		
Certification and validation	Intermediate/Advanced	50%T/P		
Testing/Quality Control	Intermediate/Advanced	50%T/P		
Standards	Intermediate/Advanced	50%T/P		
Costs	Intermediate/Advanced	50%T/P		
Health, Safety & Environment	Intermediate/Advanced	50%T/P		

8.2 Designer

Designer	Knowledge	Theoretical- Practical Approach	Yes	No
AM Processes	Advanced	75%T		
Subtractive processes	Basic/Intermediate	75%T		
Numerical modelling	Advanced	50%T/P		
Topology optimization	Advanced	75%P		
Design	Advanced	100%P		
Structural Integrity	Advanced	75%T		
Post-processing	Intermediate	50%T/P		
Standards	Intermediate	50%T/P		
Costs	Intermediate	75%T		
Health, Safety & Environment	Basic	100%T		

8.3 Inspector/Quality Assessor

Inspector/Quality	Knowledge	Theoretical-	Yes	No
Assessor		Practical		
		Approach		



Co-funded by the Erasmus+ Programme of the European Union





AM Processes	Intermediate	50%T/P	
Subtractive processes	Intermediate	100%T	
Structural Integrity	Intermediate	50%T/P	
Metallurgical analysis and characteristics	Intermediate/Advanced	50%T/P	
Post-processing	Intermediate	50%T/P	
Pre-processing and material handling	Intermediate	75%T	
Non-Destructive Testing	Advanced	75%P	
Certification and validation	Advanced	75%P	
Testing/Quality Control	Advanced	75%P	
Standards	Advanced	75%P	
Health, Safety & Environment	Intermediate/Advanced	50%T/P	

8.4 Operator

Operator	Knowledge	Theoretical- Practical Approach	Yes	No
AM Processes	Advanced	75%P		
Subtractive processes	Basic	75%P		
Post-processing	Advanced	75%P		
Pre-processing and material handling	Advanced	75%P		
Non-Destructive Testing	Basic	75%T		
Testing/Quality Control	Basic/Intermediate	75%T		
Health, Safety & Environment	Advanced	100%P		

If no, please explain.

European AM Designer	European AM Specialist/Supervisor	European AM Operator	European AM Inspector
----------------------	--------------------------------------	----------------------	-----------------------



Co-funded by the Erasmus+ Programme of the European Union This project has been co-funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.







Co-funded by the Erasmus+ Programme of the European Union This project has been co-funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.