D4.6 Pilot Activities Report

1st Stage Pilots:

Qualification/Professional Profile:
Process Engineer PBF-LB

2 Competence Units /Units of learning outcomes:
Simulation Analysis and Simulation Execution

Document Details

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Contents

WP5 Pilot Activities Report

Qualification/Professional Profile: Process Engineer PBF-LB | 2 Competence Units: Metal AM Designer

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

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1. Introduction

The present document provides an overview on the conducted piloting activities, these include the piloting for the guidelines and competence units (CUs) / Units of learning outcomes (ULOs) and the Quality Assurance System of the International Additive Manufacturing Qualification System (IAMQS), the related reporting activities and the achieved results of the 1st Stage of Real Case Scenarios of the SAM project. This overall report is a deliverable of WP4 (4.6) of the project, whereas the piloting events were conducted under the scope of WP5 (5.3 Piloting events of the 1st Stage Real Case Scenarios). The piloting stage included the implementation of the training of the selected content and the collection of feedback using the feedback kit developed in WP2 (2.7 Kit to collect feedback on the qualifications /training modules).

Following the Train-the-trainers event (5.1), the preparation of the piloting events started by the distribution of the competence units / units of learning outcomes amongst partners. The piloting partners were also provided with a guide for performing pilots, a template for national reporting and the detailed description of their competence unit/ unit of learning outcomes to be able to prepare, conduct and debrief the piloting activities. Specifically, the piloting training activities comprised virtual and in-person lectures, assessment of participants, the collection of feedbacks from students and trainers and also the issue of certificates for participants.

The preparation for the pilots of the 1st Stage Real Case Scenario started in June 2020. The period of implementation of 17 competence units / units of learning outcomes with training and reporting was encouraged and supported by various online alignment meetings and email support. All piloting and reporting activities were conducted between November 2020 and February 2021. 13 Competence Units were implemented virtually and 4 on-site as in-person training and face-to-face meeting according to the corona safety measures. In total, the implementation of the 1st Stage Real Case Scenarios had more than 500 participants in the lectures, about 40 trainers giving the lectures and 337 attendees passed the final assessments.

2. Overview on 1st stage Real Case Scenarios' piloting activities

2.1. Selection of piloting contents

In line with the findings of D4.5 (1st Report on the Analysis and Validation of Skills Needs), the Process Engineer PBF-LB according to the "EWF Guideline for European/International Process Engineer Powder Bed Fusion Laser Beam" was selected as the full professional profile/ qualification for implementation in the 1st Stage of Real Case Scenarios. In the beginning, a revision process was done by a group of experts (D5.2 1st stage of real case scenarios Professional Profiles/Qualifications and Competence Units). The implementation of the guideline comprised the preparation and the conduction as well as the compilation of results of the practical lectures, the piloting of the content of the guideline, the so-called piloting activities. According to the IAMQS Quality Assurance System, the final assessments of the IAMQS should be independent and comparable. Therefore, the developed exam questions were verified and approved by EWF prior to the exam and the conduction of the exam was also supervised by EWF or an independent expert certified by EWF. Furthermore, two individual competence units from

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another professional profile/ qualification were chosen, namely the competence units "Simulation Execution" (CU62) of the "International Metal AM Designer" and the competence unit "Simulation Analysis" (CU61).

2.2. Structure of the Metal AM Process Engineer PBF-LB Guideline

The International AM (Additive Manufacturing) Qualification Guideline for "European/International Process Engineer Powder Bed Fusion Laser Beam" was selected as full professional profile for the piloting activities in the 1st Stage of Real Case Scenarios. All 11 compulsory competence units (CUs), the optional CU and 3 Materials CUs were implemented during the 1st stage of Real Case Scenarios. Figure 1 shows the structure of the International Process Engineer Powder Bed Fusion Laser Beam Guideline. The piloted competence units are marked in red.

COMPETENCE UNITS	E/IE PBF-LB	
	Recommended Contact Hours*	Expected Workload**
CU 00: Additive manufacturing Process Overview	7	14
CU 01: DED-Arc Process	42	84
CU 08: DED-LB Process	35	70
CU 15: PBF-LB Process	35	70
CU 25: Post Processing	14	28
CU 34: Process selection	28	56
CU 35: Metal AM integration	21	42
CU 36: Coordination activities	7	14
CU 43: Production of PBF-LB parts	21	42
CU 44: Conformity of PBF-LB parts	35	70
CU 45: Conformity of facilities featuring PBF-LB	14	28
TOTAL	259	518
Optional CUs		
CU 26: Introduction to materials	14	28
TOTAL	273	546
Materials CUs*		
CU 27: AM with steels feedstock (excluding Stainless Steel)	21	42
CU 28: AM with Stainless Steel feedstock	14	28
CU 29: AM with Aluminium feedstock	7	14
CU 30: AM with Nickel feedstock	7	14
CU 31: AM with Titanium feedstock	14	28
CU 32: AM with Tungsten feedstock	3,5	7
CU 33: Biomedical metallic materials	7	14

* Contact Hours are the minimum recommended teaching hours for the Standard Routes. A contact hour shall contain at least 50 minutes of direct teaching time.

** Workload is calculated in hours, corresponds to an estimation of the time students typically need to complete all learning activities required to achieve the defined learning outcomes in formal learning environments plus the necessary time for individual study.

***A minimum of 2 CUs shall be selected from the list **Materials CUs** in order to successfully complete the qualification

Figure 1: Overview of Metal AM Process Engineer PBF-LB Modules

2.3. Pilot Activities according to the Metal AM Process Engineer PBF-LB Guideline

In total, 15 competence units of the International Process Engineer PBF-LB Guideline were piloted. For each competence unit, lectures were developed and conducted, an assessment was

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done using a multiple-choice exam and feedback of trainers and participants was collected afterwards. Table 1 concludes the most important information on the piloting lectures inter alia the number of participants, the period of implementation, the language of the piloting lectures and the results of assessment. Further information on the particular piloting activities is described in the Annex (6.1).

Table 1: Key facts on piloting activities of the Process Engineer PBF-LB professional profile/ qualification

Title and Number of CU	Number of Participants	Number of Trainers	Period of Implementation	Country	Language of Pilot	Way of implementation	Results of Assessment	Participants replying to the feedback survey
AM Process Overview (CU00)	16	3	10.11.2020 – 15.12.2020	ES	ES	On-site as in-person training	75% passed (12 of 16 participants)	16
DED–Arc Process (CU01)	18	3	11.01.2021 - 15.01.2021	ES	ES	On-site as in-person training	100% passed	18
DED-LB Process (CU08)	9-11	1	15.01.2021 – 26.02.2021	PT	EN	virtual	100% passed (5 of 5 participants)	8
PBF-LB Process (CU15)	26-41	1	15.12.2020 – 15.01.2021	IRL	EN	virtual	22% passed (8 of 36 participants)	40
Post Processing (CU25)	18	2	21.01.2021 – 22.01.2021	GR	GR/ EN	virtual	100% passed (13 of 13 participants)	14
Introduction to Materials (Metals and Alloys) (CU26)	47-60	2	02.11.2020 – 07.12.2020	UK	EN	virtual	91.7% passed (44 of 48 participants)	52
AM with Steel feedstock (CU27)	41-76	3	21.01.2021 – 16.02.2021	BE	EN	virtual	80.5% passed, (33 of 41 participants)	46
AM with Nickel feedstock (CU30)	47-52	3	11.01.2021 – 19.01.2021	BE	EN	virtual	84.4% passed (38 of 45 participants)	39
Additive Manufacturing with Titanium Feedstock (CU31)	16	1	07.01.2021 + 12.01.2021	ES	ES	On-site as in-person training	87.5% passed (14 of 16 participants)	16
Process Selection (CU34)	13	3	08.01.2021 – 15.01.2021	FR	EN	virtual	85 % passed the theoretical exam, only 53.8% also passed the practical exam (7 of 13 participants)	13
Metal AM integration (CU35)	18	3	05.01.2021 – 08.01.2021	ES	ES	On-site as in-person training	100% passed	18

Coordination of AM (CU36)	29	4	12.01.2021 + 19.01.2021	UK	17	virtual	100% passed	30
Production of PBF-LB parts (CU43)	35	2	03.11.2020 – 21.12.2020	IT	EN	virtual	94.3% passed (33 of 35 participants)	35
Conformity of PBF-LB parts (CU44)	35	2	12.11.2020 – 14.12.2020	IT	EN	virtual	74.3% passed (26 of 35 participants)	31
Conformity of facilities featuring PBF-LB (CU45)	17	2	06.01.2021 – 12.01.2021	PT	PT	virtual	100% passed	17

2.4. Structure of the Metal AM Designer for PBF Processes Guideline

In the 1st Stage Real Case Scenario, two individual competence units from the "International Metal AM Designer for PBF processes" were piloted. The structure of this professional profile/ qualification, that was developed within the CLLAIM project (2017-3309/591838-EPP-1-2017-1-ES-EPPKA2-SSA, 2017 - 2020), is shown in Figure 2. The conducted competence units are marked in red.

COMPETENCE UNITS	ED PBF	
	Recommended Contact Hours*	Expected Workload**
CU 00: Additive manufacturing Process Overview	7	14
CU 25: Post Processing	14	28
CU 59: Relevant principles of PBF Processes for Design	21	42
CU 60: Design Metal AM parts for PBF Processes	28	56
CU 61: Simulation Analysis	21	42
Subtotal (without optional CUs)		
CU 62: Simulation Execution	21	42
Total	**112**	**224**

* Contact Hours are the minimum recommended teaching hours for the Standard Routes. A contact hour shall contain at least 50 minutes of direct teaching time.

** Workload is calculated in hours, corresponds to an estimation of the time students typically need to complete all learning activities required to achieve the defined learning outcomes in formal learning environments plus the necessary time for individual study.

Figure 2: Overview of Metal AM Designer for PBF processes modules

2.5. Pilot Activities according to the Metal AM Designer for PBF Processes Guideline

Two individual competence units from the Metal AM Designer for PBF Processes were implemented during the 1st Stage of Real Case Scenarios. The piloting activities followed the similar procedure as described in section 2.3. The Table 2 below shows key facts of the pilot

activities for the Metal AM Designer for PBF Processes Guideline. Further information on these activities can be found in the annex.

Table 2: Key facts on piloting activities of the Designer for PBF processes competence units

Title and Number of CU	Number of Participants	Number of Trainers	Period of Implementation	Language of Pilot	Country	Way of implementation	Results of Assessment	Participants replying to the feedback survey
Simulation Analysis (CU61)	11-12	3	14.01-2021 – 21.01.2021	ES	ES	virtual	85.7% passed (6 of 7 participants)	10
Simulation Execution (CU62)	33	3	11.01.2021- 24.02.2021	EN	UK	virtual	100% passed (16 of 16 participant)	17

3. Final assessment

After giving the lectures according to the IAMQS Guidelines, a final assessment was conducted with the participants. For every theoretic module, the piloting partner prepared multiple choice questions to cover the subjects of the Competence Unit / Units of learning Outcomes, which were then analysed and approved by the International AM Qualification Council prior to the final assessment of participants. The students had limited time to reply to the multiple-choice questions and the exam was supervised by EWF, as part of the IAMQS Quality Assurance System procedures to ensure harmonised training and assessment. To pass the competence unit successfully, at least 60% of correct answers were required. Some partners offered a second exam for participants, who failed the first final assessment. One partner did also a practical assessment by having a case study. The students had to analyse a given scenario and had to perform a cost estimation based on different machine systems and targeted variables. Due to the situation caused by the coronavirus, a virtual assessment was conducted by the majority of the partners.

The main results of the exams are shown in the tables above (Table 1 and Table 2), further information can be found in the Annex. If the number of participants in the exam differs from the number of participants in the lectures, this is indicated in the tables. In total, 337 of 408 participants passed the final assessment during the implementation of the 1st Stage of Real Case Scenarios.

4. Feedback results and recommendations

After going through the piloting process of a competence unit, the participants and trainers were asked to fill out a feedback survey questionnaire. 420 of the participants answered to the feedback survey (21.67% female / 78.33% male), see Figure 3.
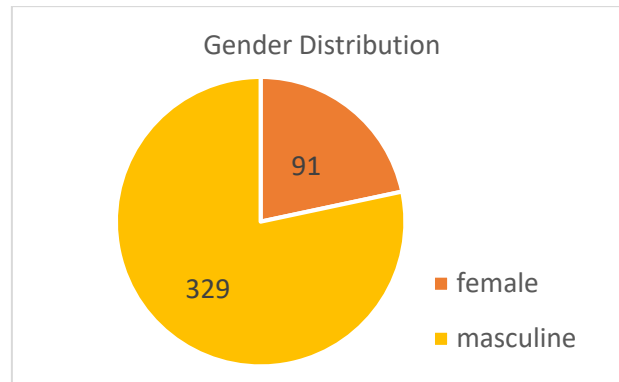
Figure 3: Gender distribution during 1st Stage of piloting

Below, the main results of the answers from the feedback survey are summarized:

- After visiting a piloting course and the respective assessment, the participants were asked if the course had met their expectations. 385 (91.67%) of the participants who did the feedback survey, answered with "YES". 35 (8.33%) participants stated the course had not met their expectations, see Figure 4.
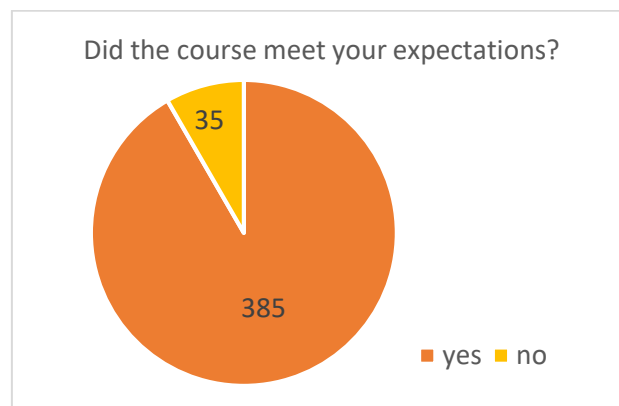
Figure 4: Distribution if the course met the expectations of the attendees

- The results of the feedback survey indicate the opinion of participants regarding the AM qualifications and training modules on relevance, quality, attractiveness and usability.
    - ❖ When asked to select the most applicable answer to the statement "The training sessions were quite dynamic, in the sense that they were engaging and involved interactive activities, instead of being just expositive", 72.86% (306) of all the participants from the survey agreed with this statement (198 (47.14%) agreed,

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108 (25.71%) agreed strongly). Only 25.48% (107) did not agree with the statement (84 (20%) disagreed, 23 (5.48%) disagreed strongly), see also Figure 5). There is slight a deviation in the overall numbers of participants because one early feedback survey had the possibility to tick "neutral" and this was used by 7 participants in the implementation of Competence Unit 26. Overall, there was a positive attitude towards the dynamic, engaging and interactive activity.

The training sessions were quite dynamic, in the sense that they were engaging and involved interactive activities, instead of being just expositive).

strongly disagree	disagree	neutral	agree	strongly agree
23	84	7	198	108
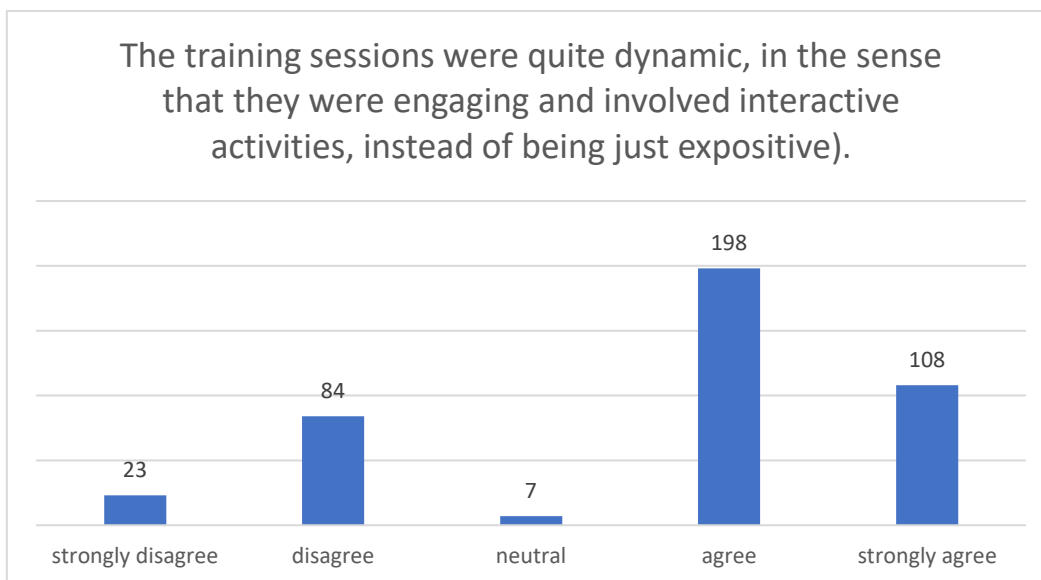
Figure 5: Opinions on the dynamics of the course

❖ To check the relevance and usability of the implemented content, the participants were asked to assess the relevance of the course to their job activities. The participants could rate the relevance as "poorly satisfied", "not satisfied enough", "satisfied enough" and "very satisfied". It was also possible to not give an answer on this question. The majority of the 420 participants (360 participants, 85.71%) rated the relevance of the course as "satisfied enough" or better. Only 9.52% of the other attendees rated the relevance as "not satisfied enough" or "poorly satisfied". The overall average was 3.36 of 4. [4 (0.95%) participants ticked "poorly satisfied", 36 (8.57%) "not satisfied enough" and 20 (4.76%) did not give an answer. 154 (36.67%) of the participants said "satisfied enough", a total of 206 (49.05%) even ticked "very satisfied".], please see also Figure 6. To sum up, the relevance of the activities was seen as satisfying by the majority of the participants.

The relevance of the course to your job activities...
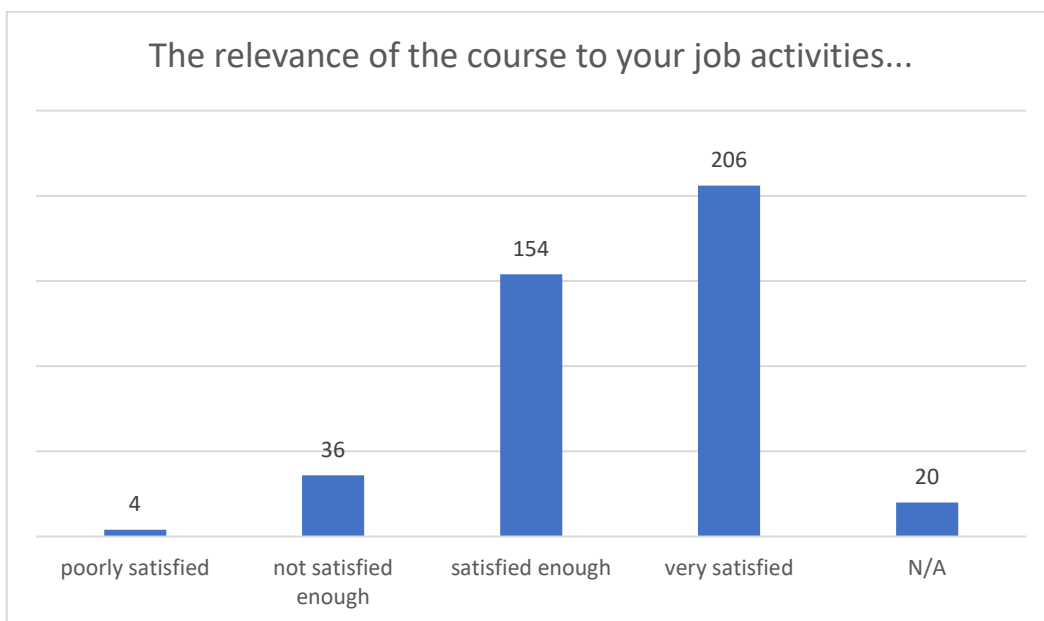
Figure 6: Opinions on the relevance of the course

- Altogether, the quality of the implemented Competence Units was seen as very high since 397 (94.52%) of 420 participants would recommend the visited course to others, only 23 (5.48%) would not recommend the course, see Figure 7.

Would you recommend this course to others?
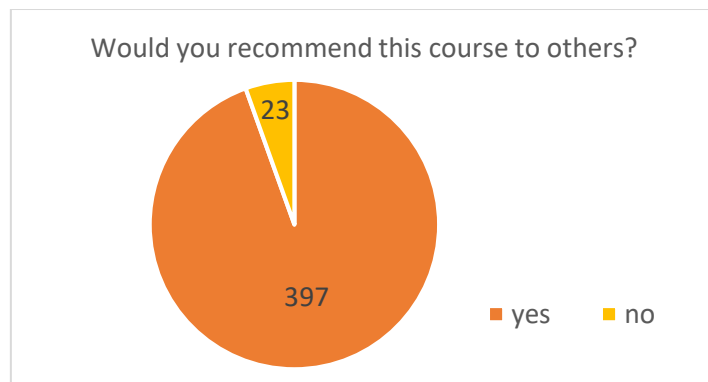
Figure 7: Proportions of those who would recommend the training to others or not

All partners wrote a report on their experiences during the 1st Stage of Real Case Scenarios, the collected feedback and recommendations as well as the outcomes of the piloting activities. Two debrief meetings with all partners were conducted to summarize the recommendations given and to discuss and elaborate possible improvements. Further detailed information on the feedback of some Competence Units can be found in the Annex (6.2). In the following, the main identified aspects and recommendations given are summarized:

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- Preparation of students and trainers:
  - ➢ The expectations and the process of training, assessment and feedback for SAM and the IAMQS (first feedback and follow-up feedback) will also be addressed for trainers and participants
  - ➢ The guidance document for piloting will be revised to help trainers when preparing the piloting activity
  - ➢ In the next piloting activities, to guarantee that the Learning Outcomes, subjects and the assessment procedure regarding the Competence Unit will be presented to all students / participants in the beginning of the course
  - ➢ Every student that wishes to visit several Competence Units is invited to do so, therefore, the dates of all piloting events of the 2nd stage will be published on the same date
  - ➢ It is recommended to have a basic knowledge on Additive Manufacturing (AM) before attending a more advanced Competence Unit, if the participants of the piloting events have no further basic knowledge on AM, they shall either visit CU00
  - ➢ few participants of the piloting events had difficulties to understand the objective of the piloting event, some had no knowledge on AM
- Attendance:
  - ➢ The participants will be informed in the beginning on the process of the piloting activity, so that they will be aware of all the steps/ actions included
  - ➢ The assessment will be scheduled early enough, so that participants can book it in their calendars
  - ➢ The feedback survey will be done directly after the assessment with multiple-choice questions to avoid drop out's and to lower a possible hurdle for the survey
  - ➢ The 1st Stage of Real Case Scenarios had only 21.7% women, the reaching of gender balance will be a focus in the 2nd Stage of Real Case Scenarios
  - ➢ there was a deviation between the number of participants of the lectures, the assessments and the feedback survey
- Virtual / distance learning:
  - ➢ By having virtual lectures, participants from all over the word (could) attend the piloting activities of the SAM project
  - ➢ It is recommended to follow a blended scheme (if possible according to the COVID-19 situation), to combine online / distance learning implementation with in-person practical sessions in the laboratory
  - ➢ If the lectures are implemented virtually, it is recommended to have shorter sessions per day (e.g. half day sessions or 2 hours per day), to use videos and to pay attention on an active link between teachers and trainers
  - ➢ Online / distance training requires the active assistance of trainers during / after the lectures
  - ➢ Due to the situation caused by the coronavirus, it was not possible to have all piloting events as in-person lectures

- Some participants who attended the virtual lectures wished to have in-person lectures
- Practical training:
  - virtual reality or more practical exercises can be used, break-out sessions during virtual lectures could be used
  - currently, the guidelines for each CU recommend the contact hours for the practical training, every organisation can deliver more practical sessions according to the demand or to have more active parts
  - some participants asked for more practical resources / practical training tools and examples
- Assessment method:
  - The wording from official standards will be used for the assessment (e.g. PBF-LB instead of SLM®) in order to guarantee a common understanding of the AM processes
  - One harmonized multiple-choice question per recommended contact hour is the minimum requirement in terms of assessment for all participants, additional methods can be developed for the assessment by each AM ATB (authorized training body) or AM ANB (authorized national body) to test the required skills described in the guideline and to offer to possibility for participants to improve their final result
  - Possible additional assessment methods are essay questions or case studies, which will be implemented in the 2nd stage of Real Case Scenarios Pilots
  - More time (1.5 minutes) will be considered to reply to the multiple-choice questions by participants of the advanced level
  - For each practical assessment, a practical assessment criteria matrix will be defined and prepared to harmonize the practical assessments
  - The multiple-choice questions for CU15, CU26 and CU36 will be reviewed.
  - some students and trainers stated that time devoted to answering multiple-choice question was too little and that multiple-choice questions cannot test all skills described in the guideline
- Revision of guidelines:
  - Some Competence Units will be revised by the IAMQS (International Additive Manufacturing Qualification System), as the partners recommended the revision: CU00, CU08, CU27, CU45, CU61 (in alignment with CU62). Some of the reasons were that the content has to be adjusted to the described learning outcomes or to the changed state of the art or the recommended contact hours did not match to the content described.
  - after preparing and conducting the lectures and assessments, some trainers reported, that adjustments to the guidelines would be useful

5. Conclusion & Outlook

A total of 17 Competence Units were implemented during the 1st Stage of Real Case Scenarios with over 500 participants (about 22% female), 40 trainers and 337 passed final assessments (of 408 students who attended the assessment). All partners wrote reports on their experiences and two debrief meetings with an internal discussion and summarizing of the recommendations given were conducted. The outcomes and recommendations for improvement achieved by these piloting activities will be considered for the 2nd Stage of Real Case Scenarios (i. a. the identified competence units and assessment questions will be revised, recommendations for practical assessments will be defined, participants will be informed on the guidelines and learning outcomes of the piloting activity, more advanced levels will receive 90 seconds per Multiple-Choice-Question). Furthermore, the template for the report as well as the guidance document for piloting will be revised according these results.

6. Annex

6.1. Further information on the conduction of lectures and assessment

The following section provides more detailed information on the pilot activities during the 1st Stage of Real Case Scenarios in the SAM project. All implemented Competence Units (CUs) belong to the IAMQS. The main information can be found in Table 1 and Table 2 above.

6.1.1. CU00: Additive manufacturing Process Overview

The Competence Unit CU00 was piloted by the SAM partner Lortek in Spain (Goierri Escola) and Spanish language on 10th, 19th and 26th November and 1st and 9th December 2020 as an in-person piloting event. They had 1-2 hours in the afternoon for every lecture. The pilot course was given within the Master's course "Master in Industrial AM", 16 of the students attended the full piloting process of CU00. An overview on the most important AM processes was given with factual and broad knowledge of theory, principles and applicability of the several processes by different professors. The final assessment was done on 15th December 2020, 75% (12 participants) passed the exam with 67% or 83%, 4 students failed with 33% or 50%.

6.1.2. CU01: DED-Arc Process

The Competence Unit CU01 (DED-Arc Process) was piloted by the SAM partner AITIIP in Spain from 11 to 15 January, 2021. The training was conducted as face-to-face training in the AITIIP facilities. Even practical demonstrations were possible in compliance with the hygiene measures required due to the pandemic caused by the coronavirus. The 18 participants (5 women and 13 men) were in the age range 26-55 and most of them came from the sectors industrial equipment and tooling and automotive. Their education background was mainly master of engineering. All 18 participants of the pilot event successfully passed the exam with results between 76% and 100%.

6.1.3. CU08: DED-LB Process

The SAM partner FavoritAnswer (FA) implemented the Competence Unit CU08 (DED-LB Process) virtually between 15th January and 26th February 2021 using Microsoft Teams in 4 half-day sessions. 9 to 11 participants joined the training sessions.

There were two final assessments conducted virtually via MS Teams on 24th (3 participants) and 26th February (2 participants). All 5 participants who did the exam, passed the exam with results between 64% and 93%.

6.1.4. CU15: PBF-LB Process

The Competence Unit CU15 was piloted virtually between the 15th December 2020 and 15th January 2021 by the SAM partner IMR (Irish Manufacturing Research) as there was no opportunity for onsite delivery of training due to COVID-19 restrictions. For a successful implementation of the qualification, representatives from industry, who are working actively in AM, were invited to join the piloting events. The main background was in the medical field,

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representative for the user base in Ireland. The 9 pre-recorded modules were shared at specific times with 26 to 41 participants. To guarantee the connection to trainers, different channel for communication were offered, a comments section on each page, feedback form for each lesson and email address and telephone numbers to contact the trainers directly.

The assessment for the pilot took place on Friday the 29th of January. Thirty-six of the course attendees participated in the exam which was invigilated by representatives from EWF and IMR. 22% of the 36 participants passed the exam. A second exam is planned for participants who failed or could not attend the first exam.

6.1.5. CU25: Post Processing

The Competence Unit CU25 was piloted as web session on 21st and 22nd January 2021 (5 hours each) with 18 students on each day by the SAM Partner Laboratory for Manufacturing Systems & Automation (LMS). 9 of the 13 students who answered the feedback questionnaire were male and 4 of them female and they came from Greece (4), India (3), Portugal (3), Belgium (1), Nigeria (1) and Turkey (1). Most of students belonged to the age range of 26-35 years old, 4 were under 26 years old and 1 at the age range of 36-55 years old. As educational background 10 of them have Engineer or Master's degree, 2 Bachelor's degree, 1 School certificate, 1 Doctoral degree, and 1 toward graduating from Engineering school (multiple answers by students). The sectors they came from are Aerospace (4), Defense (3) Industry (1), 4 are currently unemployed and seven belonged to the academic sector and education (multiple answers by students). After the lectures, 13 students took part in the theoretical exam, all passed with 64% to 100% correct answers.

6.1.6. CU26: Introduction to Materials (Metals and Alloys)

The Competence Unit CU26 was piloted by the SAM partners Brunel University London (UBRUN) and Ansys Granta (GRANTA). The course was conducted online via MS Teams on several days (2 hours each) in the period from 2nd November to 23rd December 2020 with each between 47 and 60 participants - 65% were male and 35% were female. The highest educational background of the participants varied from Engineer or Master's degree (44%), Bachelor's degree (29%), Doctoral degree (17%), School certificate (13%) and high degree vocational training (2%). The remaining 13% comprised undergraduate students, bachelors, masters and doctoral students. A substantial proportion (51%) of the participants were based in the UK. Turkey, India and Greece, which represented 14%, 8% and 6%, respectively, of the participants followed this. The remaining participants came from Bulgaria, Germany, Portugal, Spain, Pakistan, Mexico, China, USA, Malawi and Brazil. The pilot course gave the students a thorough introduction to materials with a focus on metals and alloys and covered the following topics: 1. Structure and properties of metals and alloys; 2. Solidification and Phase Diagrams; 3. Solid state transformations and TTT diagrams; 4. Failure mechanisms: fracture, fatigue, creep.

After attending the lectures, 45 participants attended the first theoretical assessment on 26th November, implemented virtually using Microsoft Forms. 41 participants passed, 4 failed. One did a second assessment successfully on 7th December. 3 Others did their first exam at 7th

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December, 2 passed. In total, 48 participants did the final assessment of CU26, 44 students (91.67) passed the exam with 64% to 100%.

6.1.7. CU27: AM with Steel feedstock

The Competence Unit CU27 (AM with Steel feedstock) was piloted by the SAM partner EPMA (European Powder Metallurgy Association). The course took place on 10 dates exclusively online via Microsoft Teams (21., 22., 26., 19.01.2021, 1., 2., 8., 9., 15., 16.02.2021). The individual sessions lasted 1.5 to 3 hours. Slightly more than half of the participants were not from Europe. All participants had an academic background and most of them were younger than 36. 24% of the participants were female.

After attending the pilot activity lectures, 41 students participated in the theoretical assessment. In the first assessment, 21 (51%) of the students passed. In the second test phase, 12 of the previously failed 20 students passed, so that a total of 33 students (80.5%) passed the assessment for CU27.

6.1.8. CU30: AM with Nickel feedstock

The Competence Unit CU30 was piloted online using MS Teams on 11th, 13th and 19th January 2021 with sessions of 2-3 hours each day by the Belgian SAM partner European Powder Metallurgy Association (EPMA). This course aimed to give students a thorough introduction to materials with a focus on different types of Nickel as feedstock for producing AM parts.
Each session was attended by 47 to 52 students from mainly Turkey, India and China. Students came from Aerospace (33%), Defense (23%), Automotive (13%), Industrial Equipment and Tooling (13%), and other (18%). Their educational background was mainly engineers with and MS degree (59%), and PhD degree (31%) followed by BS degree (21%). The expectations of the students were mostly satisfied in course CU30. 90% of the students replied that course has met their expectations, and 97% of the students replied that they would recommend the course to others. Some participants failed the first assessment but were successful in a second assessment, a total of 84.4% passed the exam.

6.1.9. CU31: Additive Manufacturing with Titanium Feedstock

The SAM partner Lortek also implemented CU31 (Additive Manufacturing with Titanium Feedstock) as in-person lecture at Goierri Escola in Spain with students of the "Master in Industrial AM". The pilot was carried out on two afternoons by one professor (07.01.2021 & 12.01.2021). 16 students had been selected to undergo the assessment after the lecture which was done online using the students' laptops. Only 2 students (12.5%) failed the exam with 57% or 50%, 12 participants (87.5%) passed the exam with a percentage between 64% and 93%.

6.1.10. CU34: Process Selection

The Competence Unit CU34 (Process Selection) was piloted online using Zoom between the 8th and 15th January 2021 (half day of 2-4 hours for each session) by the French SAM partner EC Nantes (École Centrale de Nantes). All 13 participants were Master's students in Industrial Engineering and most of them (85%) were not working at any organization when this pilot was

conducted. This pilot study took benefit from three trainers, in three different fields of expertise in AM education. The first part of the course, AM Job analysis, was taught by two trainers, the one was a full-professor in industrial engineering at EC Nantes who has been working in AM domain for around 30 years and another one was a training supervisor from Fraunhofer. Also, a PhD candidate in EC Nantes who is specifically doing research on cost models in AM lectured the second part of the course, economics and productivity. Due to the restrictions caused by the corona virus pandemic, the course was implemented virtually. Therefore, the number auf contact hours had to be decreased to 20, as demonstration, practices experiences and group discussions on-site were not possible.

After participating the piloting sessions of CU34, the 13 students did the theoretical assessment and a practical exam. First, students had 20 min to answer 20 multiple choice questions. Next, they were given a case study and had to analyze a given scenario and had to perform a cost estimation. 11 out of 13 students passed the theoretical exam, but only 6 out of 13 passed the practical exam.

6.1.11. CU35: Metal AM integration

The Competence Unit CU35 was implemented by AITIIP Technology Centre in Spain from 5th to 8th January 2021 as an in-person piloting event. 28% of the total of 18 participants (26 to 45 years old) were women. The most of participants defined their company's sector as Industrial equipment and tooling (44%) and automotive (39%). Jointly the sector mentioned in the questions, participants also mentioned robotics. The education background is mainly master or engineering (72%). All participants passed the assessment after the pilot activity. After the participants attended the lecture, they did an exam online through the Webex tool with 20 questions related to the CU35 content. All passed with 74% to 100%.

6.1.12. CU36: Coordination of AM

The Competence Unit CU36 (Coordination of AM) was piloted virtually via MS Teams twice by the SAM partner MTC with 22 participants on 12 January 2021 (2 further participants have completed parts of the course) and 11 participants on 19 January 2021 (4 further participants have completed parts of the course). Most attendees had several years of experience in the AM field although a small number had no direct experience and a couple had only recently graduated. 50% had aerospace links, 33% defence, 23% from automotive, 20% from industrial equipment and tooling, 17% with other sectors and only 3% from the consumer goods sector. All participants had a successful exam after the piloting activity and passed the assessment.

After participating the CU36 pilot course that was held twice on 12th and 19th January 2021, 27 students and 2 trainers of the pilot course successfully passed the exam with results between 60% and 100%. Two of the 29 participants made the assessment via email since it was not possible to take part in the online conducted assessment due to company security policy.

6.1.13. CU43: Production of PBF-LB parts

The SAM partner POLIMI from Italy piloted the Competence Unit 43 (Production of PBF-LB parts) between 2nd November 2020 and 21st December for Master's students at POLIMI. It was lectured virtually using the Cisco Webex platform on two full days (03.11.2020 & 12.11.2020) and one half day (17.11.2020). 35 of the students did the final assessment for CU43 conducted online, 94.3% of the participants passed.

6.1.14. CU44: Conformity of PBF-LB parts

The Competence Unit CU44 (Conformity of PBF-LB parts) was piloted virtually by the SAM Partner Politecnico Milano (POLIMI) on seven dates in November and December 2020 with 2-8 hours each. All online classes were carried out using the Cisco Webex platform or the Panopto platform when classes were delivered with the contribution of external speakers. 99 students participated the lectures. 35 students were selected to attend the full piloting activity with the final assessment and the feedback survey. 74.3% passed the exam.

6.1.15. CU45: Conformity of facilities featuring PBF-LB

The Competence Unit CU45 (Conformity of facilities featuring PBF-LB) was implemented virtually via a Zoom-Meeting by the SAM partner ISQ between 6th January and 12th January 2021 in Portugal. ISQ conducted the lectures in the evening between 18:30 and 22:00 o'clock on 4 days. From the 21 participants attended 17 participants all 4 lectures. These 17 did the final assessment on the 12th January 2021, all of them passed.

6.1.16. CU61: Simulation Analysis

The Competence Unit CU61 (Simulation Analysis) was piloted in January 2021 by the SAM partner Fundación IDONIAL as remote training. The training was given on 14th, 15th, 19th and 21st January 2021 with half day trainings between 9:00 to 14:00 o'clock using MS Teams. The participants were informed about the content of the course by some slides via email in the beginning. Different tools, such as ANSYS Workbench and ANSYS APDL, were used to conduct the training for CU61. The training was offered to Idonial's workers, 12 attended the lectures. The course was structured in a summarized way based on 3 axes: A first axis, focused on providing attendees with a complete introduction to the discipline of finite element simulation, starting with its basic concepts (initial definition, types of analysis, meshing, identification of materials, definition of loads, etc..), addressing the concepts of non-linearity and coupled calculation, and also making an introduction and approach to simulation tools. A second axis, aimed at addressing the finite elements analysis/simulation itself, addressing from the previous CAD design to the different simulation typologies (different scales and thermal and mechanical aspects) and their implications for additive manufacturing technology, complementing these contents with a practical case that is developed throughout it, and with a final section of documentation of the simulation. A third axis, which condenses the training around topological optimization. After attending the CU61 pilot course, 7 of the 12 students attended to online exam that was conducted online by CESOL as the ANB for the Spanish ATB IDONIAL. 6 participants passed the exam (85.7%), 1 failed the exam.

6.1.17. CU62: Simulation Execution

The Competence Unit CU62 (Simulation Execution) was implemented in January 2021 with 33 participants by the SAM partner Ansys Granta (41 had registered before). The lecture was implemented virtual by MS Teams, the maximum number of participants was limited, the participation was open to all countries. People from USA, Japan, UK, Portugal, Greece, South Africa, Italy, Spain, Turkey, Germany, India, Austria and Mexico attended the politing activity for CU62. The Ansys Learning Hub online platform was used for the implementation. Ansys Granta started with a live opening session and next, participants had 6 on-demand trainings with self-paced videos, presentations, short quiz, simulation software. Anytime, they had the possibility to chat with experts. In addition, three live Q & A sessions were conducted.

The assessment was carried out using a multiple-choice Forms survey shared with the students during a live Teams meeting under the invigilation of EWF representative. Only 16 of 33 participants attended the multiple-choice exam. 100% of the participants of the exam received over 60% total marks and passed the test, 13 participants received over 70%, 9 over 80% and 3 over 90%. Considering the "no attendance" at the exam accounting for fail, the overall pass rate would be 48%.

6.2. Further information on the feedback from trainers and participants

After going through the piloting of a competence units, participants and trainers were asked to fill out a feedback survey questionnaire. The following sections describe the gathered results from the students' and trainers' feedback survey.

6.2.1. Feedback on CU00: Additive manufacturing Process Overview

16 Spanish students answered the feedback survey after the in-person piloting of CU00, 3 feminine, 16 masculine, the majority (15) was younger than 26 years, one was between 26 and 35 years old. All participants had a pre-education as engineers, 62.5% had no previous AM knowledge. 94% were satisfied with the course and would recommend it.

The trainers were rated very positively. For some other aspects, the ratings were not satisfying. A reason is seen in the piloting of the methods on different days, though, the students might have had difficulties to connect the topics. It is recommended to have an introduction to the overall project in addition to the piloting of single competence units to reveal the purpose of the course.

The students liked the detailed process overview and value the new knowledge for their future. Feedback was given, that the time might be too short for all process details and participants missed more practical tasks and would prefer to see machines running with the AM processes and to have more practical time. The context is important as the participants only attended two CUs in the framework of the piloting events. CU00 should only give a short overview on the processes and has no practical work included. The information on the process which is focused in the respective professional profile will be more detailed and there will be more practical content in the following competence units when attending lectures and competence units of a full professional profile.

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3 trainers answered the feedback survey for CU00, they were mostly satisfied with the structure, content, infrastructure and support provided. They suggested for future pilots to give an introduction for the student to understand the context of a single competence unit, to add more practical content and to unify the questions in the assessment. They praised the possibility for the students to receive a certificate, the conduction of the online assessment, the industrial orientation and the interaction with the students.

6.2.2. Feedback on CU01: DED-Arc Process

2. Please select the gender you identify better with (for gender balance reporting duties, only)

3. Please select the age range you are in

2 Por favor, seleccione el género con el que se identifica (únicamente debido a la obligación de informar sobre el equilibrio de género)

3 Por favor, seleccione su rango de edad:

28% (5) Femenino

72% (13) Masculino

4 Standard Deviation

18 Responses

11% (2) < 26

33% (6) 26 - 35

56% (10) 36 - 55

0% (0) > 55

3.84 Standard Deviation

18 Responses

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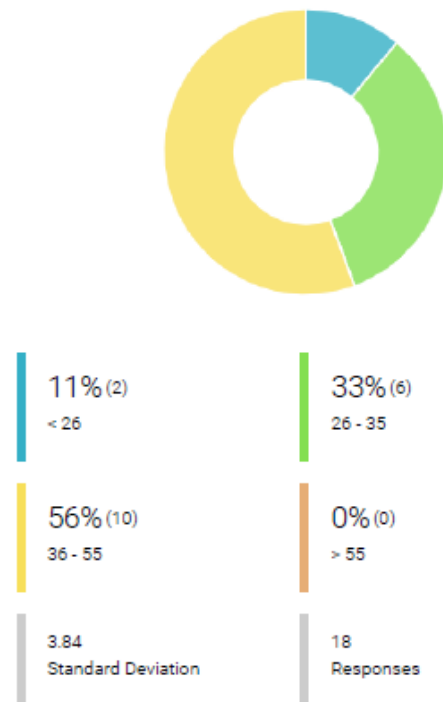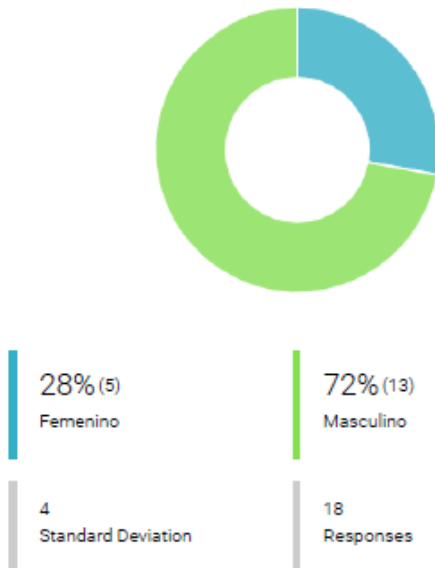
4. In which country is your AM training course taking place?

4 ¿En qué país ha tenido lugar su actividad formativa en FA?

100% (18) España	**0%** (0) Austria	**0%** (0) Bélgica	**0%** (0) Bulgaria
0% (0) Croacia	**0%** (0) República de Chipre	**0%** (0) República Checa	**0%** (0) Dinamarca
0% (0) Estonia	**0%** (0) Finlandia	**0%** (0) Francia	**0%** (0) Alemania
0% (0) Grecia	**0%** (0) Hungría	**0%** (0) Irlanda	**0%** (0) Other
4.36 Standard Deviation	18 Responses		

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5. What is the main activity/sector of your organisation?

5 ¿Cuál es el sector principal en el que se focaliza su organización?(más de una respuesta es posible)

28% (5) Aeroespacial	**39%** (7) Automoción	**17%** (3) Defensa	**22%** (4) Consumo
11% (2) Construcción	**11%** (2) Energía	**6%** (1) Salud	**44%** (8) Equipo y utillaje industrial
0% (0) En este momento, no estoy trabajando en ninguna organización	**17%** (3) Otro (por favor, especifique)		

35 Responses

Genérico industrial. Acoge múltiples sectores, desde aeroespacial, a automoción, construcción, energía, utilaje....

Packaging alimentario

Robotica

Multiple sectors (automotive, aerospace, construction, energy, tooling…)
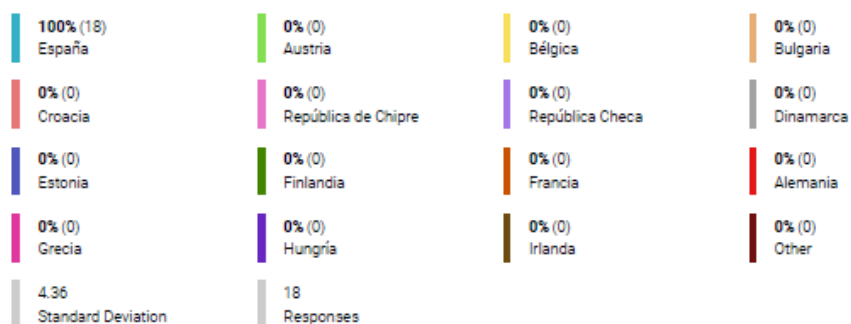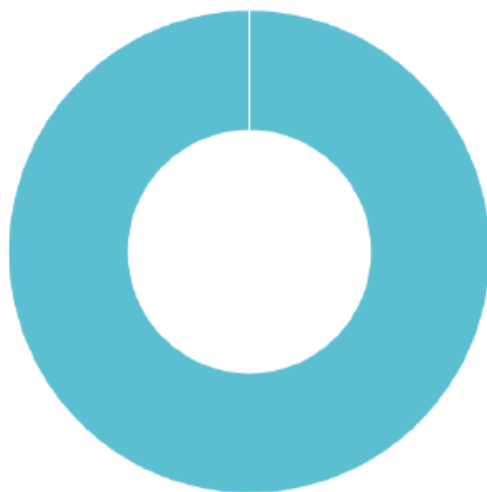
Food packaging

Robotics

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6. What is your Education background?

6 ¿Cuál es su formación académica?

0% (0) Graduado escolar	**17%** (3) Licenciatura	**11%** (2) Grado medio de Formación Profesional	**11%** (2) Grado superior de Formación Profesional
72% (13) Master o ingeniería	**6%** (1) Doctorado	**6%** (1) Otro (por favor, especifique)	
22 Responses			

Realizando el doctorado en estos momentos

7 ¿Cuál es su experiencia profesional previa en Fabricación Aditiva?/ What is your professional background/previous additive manufacturing experience?

- Con impresoras 3D libres y de Stratasys/ With Stratasys and free 3D printers
- Hay una máquina de SLM en mi empresa. Post procesado de piezas/ There is a SLM machine in my company. Post-processing parts
- Una witbox./ A witbox
- No tengo/ I don't have
- Escasa/Scarce
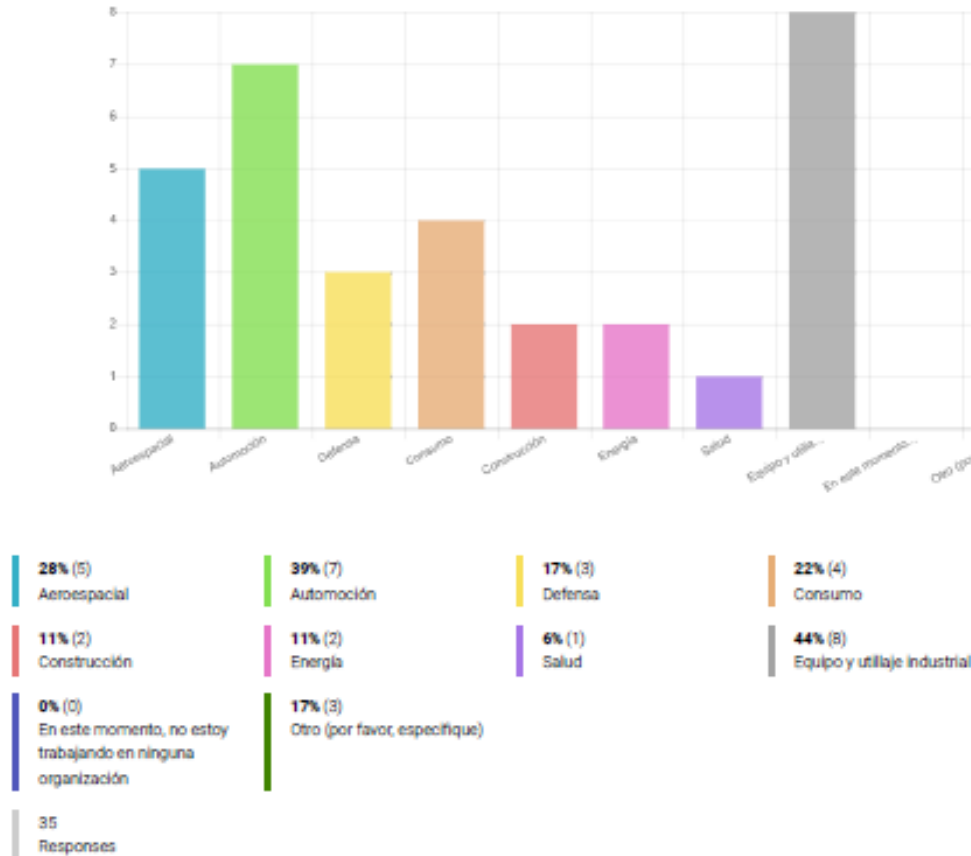- Impresión 3D en plásticos/3D printing on plastics
- Ninguna/None

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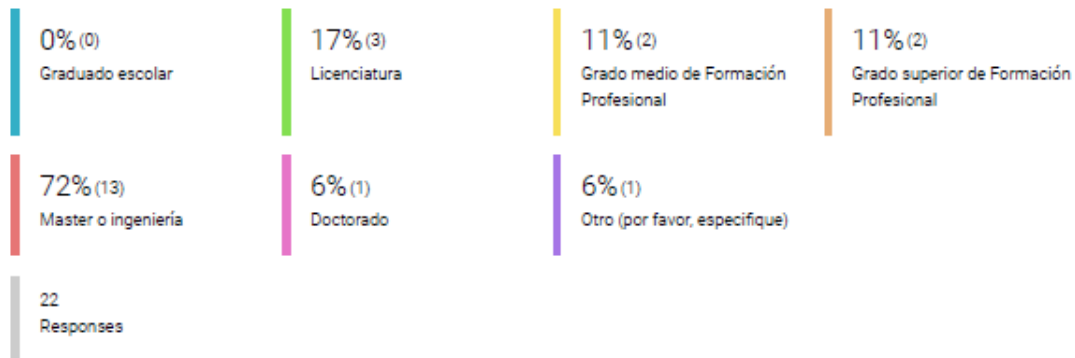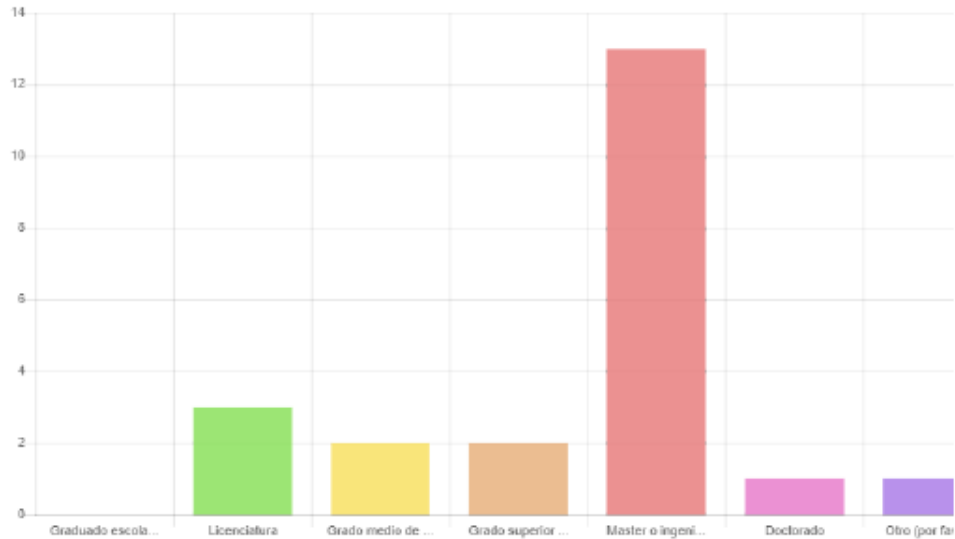
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- Ninguna/None
- Diseño de utillajes para fabricación por fabricación aditiva/ Additive manufacturing tooling design
- Fabricación de utillajes/ Tooling manufacturing
- USUARIO/ User
- Proyectos de robótica y aeroespacial para la CE/ Robotics and aerospace projects for the EC.
- Ninguna/None
- Conocimiento general/ General knowledge
- Poca experiencia/ Little experience
- Trabajo con impresoras 3D pero con materiales termoplasticos/ I work with 3D printers but with thermoplastic materials.
- He dado apoyo en proyectos sobre WAAM y fabricación aditiva con resina de poliuretano/ I have supported projects on WAAM and additive manufacturing with polyurethane resin.

8. Which pilot course did you attend?

8 ¿A qué curso piloto ha asistido?

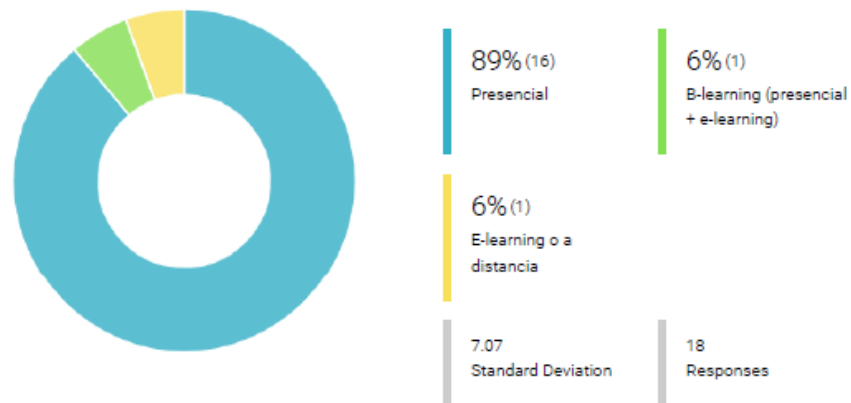|			
100% (18) CU 01: DED-Arc Process	**0%** (0) CU 00: Additive manufacturing Process Overview	**0%** (0) CU 08: DED-LB Process	**0%** (0) CU 15: PBF-LB Process
0% (0) CU 25: Post Processing	**0%** (0) CU 34: Process selection	**0%** (0) CU 35: Metal AM integration	**0%** (0) CU 36: Coordination activities
0% (0) CU 43: Production of PBF-LB parts	**0%** (0) CU 44: Conformity of PBF-LB parts	**0%** (0) CU 45: Conformity of facilities featuring PBF-LB	**0%** (0) CU 26: Introduction to materials (optional)
0% (0) CU 27: AM with steels feedstock (excluding Stainless Steel)	**0%** (0) CU 28: AM with Stainless Steel feedstock	**0%** (0) CU 30: AM with Nickel feedstock	**0%** (0) Other
4.36 Standard Deviation	18 Responses		

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9 ¿Cuántas horas presenciales incluía su curso? (es decir, cuántas horas ha estado en contacto directo con su profesor?/ How many contact hours were there in your course? (i.e., how many hours were there of contact with your trainer(s)?)

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10. What was the regime in your course?

10 ¿Qué tipo de curso era?

|	
89% (16) Presencial	6% (1) B-learning (presencial + e-learning)
6% (1) E-learning o a distancia	
7.07 Standard Deviation	18 Responses

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11. How would you rate your level of satisfaction with...

11 Valore su nivel de satisfacción respecto a las siguientes condiciones
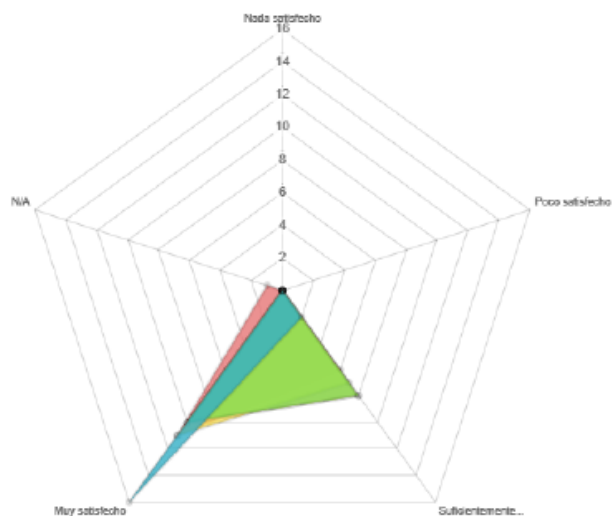
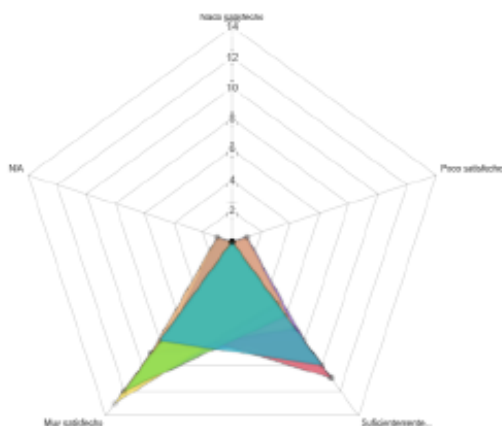|	Nada satisfecho	Poco satisfecho	Suficientemente satisfecho	Muy satisfecho	N/A	Standard Deviation	Responses	Weighted Average
a) La infraestructura proporcionada por la entidad de formación	0 (0%)	0 (0%)	2 (11%)	16 (89%)	0 (0%)	6.25	18	3.89 / 4
b) El apoyo proporcionado por el personal (distinto de los formadores)	0 (0%)	0 (0%)	8 (44%)	10 (56%)	0 (0%)	4.45	18	3.56 / 4
c) La claridad/comunicación de los objetivos y resultados de aprendizaje del curso	0 (0%)	0 (0%)	7 (39%)	11 (61%)	0 (0%)	4.59	18	3.61 / 4
d) Los canales de comunicación usados durante la formación	0 (0%)	0 (0%)	8 (44%)	10 (56%)	0 (0%)	4.45	18	3.56 / 4
e) El equipo usado en la formación práctica	0 (0%)	0 (0%)	6 (33%)	11 (61%)	1 (6%)	4.32	18	3.65 / 4

How would you rate your level of satisfaction with...	1. Poorly satisfied	2. Not satisfied enough	3. Satisfied enough	4. Very satisfied	n.a.
a) The infrastructure conditions provided by the training provider	❑	❑	❑	❑	❑
b) The support provided by the staff (other than trainers)	❑	❑	❑	❑	❑
c) The transparency/communication of the learning outcomes associated to the course	❑	❑	❑	❑	❑
d) The communication channels used during the training	❑	❑	❑	❑	❑
e) The equipment used in the practical training	❑	❑	❑	❑	❑

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12. How would you rate your level of satisfaction with…

12 Valore su nivel de satisfacción respecto a…

	Nada satisfecho	Poco satisfecho	Suficientemente satisfecho	Muy satisfecho	N/A	Standard Deviation	Responses	Weighted Average
a) La estructura del curso	0 (0%)	0 (0%)	10 (56%)	8 (44%)	0 (0%)	4.45	18	3.44 / 4
b) Los contenidos abordados durante el curso	0 (0%)	0 (0%)	6 (33%)	12 (67%)	0 (0%)	4.8	18	3.67 / 4
c) La coherencia del curso respecto el programa de formación (¿el formador respetó el orden de presentación de los contenidos?)	0 (0%)	0 (0%)	5 (28%)	13 (72%)	0 (0%)	5.08	18	3.72 / 4
d) El número de horas de contacto	0 (0%)	1 (6%)	7 (39%)	9 (50%)	1 (6%)	3.67	18	3.47 / 4
e) El equilibrio entre formación teórica y práctica	0 (0%)	0 (0%)	11 (61%)	7 (39%)	0 (0%)	4.59	18	3.39 / 4
f) El número de horas de contacto asignadas a la formación práctica	0 (0%)	0 (0%)	11 (61%)	7 (39%)	0 (0%)	4.59	18	3.39 / 4
g) La relevancia del curso para sus actividades laborales	0 (0%)	1 (6%)	8 (44%)	9 (50%)	0 (0%)	4.03	18	3.44 / 4
h) La correspondencia entre los resultados de aprendizaje previstos para el curso y lo que cubrió el curso	0 (0%)	0 (0%)	6 (33%)	12 (67%)	0 (0%)	4.8	18	3.67 / 4
i) La cantidad de tiempo para formarse con una impresora 3D	0 (0%)	0 (0%)	11 (61%)	6 (33%)	1 (6%)	4.32	18	3.35 / 4
								3.51 / 4

How would you rate your level of satisfaction with…	1. Poorly satisfied	2. Not satisfied enough	3. Satisfied enough	4. Very satisfied	n.a.
a) The structure of the course	❑	❑	❑	❑	❑
b) The contents addressed during the course	❑	❑	❑	❑	❑
c) The coherence of the course with the training programme (was the order of contents presentation [foreseen in the ULO] respected by the training provider?)	❑	❑	❑	❑	❑
d) The number of contact hours	❑	❑	❑	❑	❑
e) The balance between theoretical and practical training	❑	❑	❑	❑	❑
f) The number of contact hours allocated to practical training	❑	❑	❑	❑	❑
g) The relevance of the course to your job activities	❑	❑	❑	❑	❑
h) The match between learning outcomes foreseen for the course and what the course covered	❑	❑	❑	❑	❑
i) The amount of time to train with an AM machine	❑	❑	❑	❑	❑

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13. What is your opinion regarding the following statements?

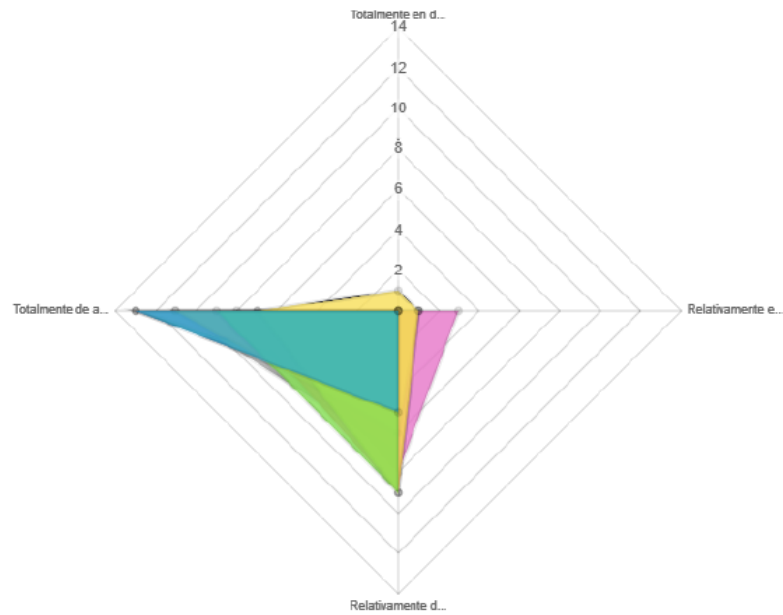**13** ¿Cuál es su opinión respecto a las siguientes afirmaciones?

WP5 Pilot Activities Report
Qualification/Professional Profile: Process Engineer PBF-LB | 2 Competence Units: Metal AM Designer
Project No. 601217-EPP-1-2018-1-BE-EPPKA2-SSA-B

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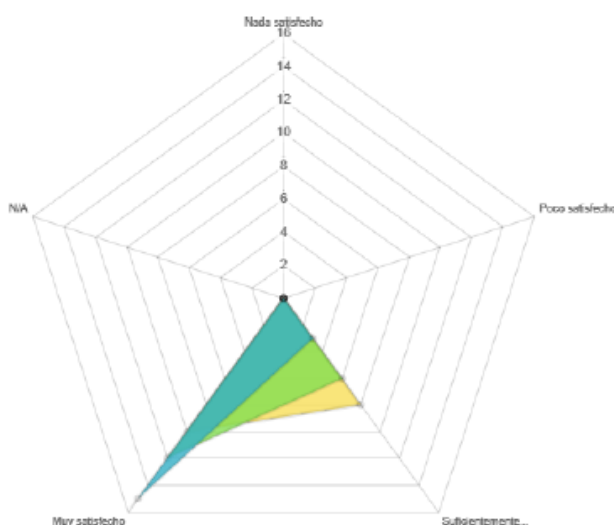|	Totalmente en desacuerdo	Relativamente en desacuerdo	Relativamente de acuerdo	Totalmente de acuerdo	Standard Deviation	Responses	Weighted Average
a) Los materiales de aprendizaje (es decir, presentaciones de diapositivas, manuales, videos, muestras) fueron útiles	0 (0%)	0 (0%)	5 (28%)	13 (72%)	5.32	18	3.72 / 4
b) Las sesiones de formación fueron bastante dinámicas, (en el sentido de que fueron atractivas e involucraron actividades interactivas, en lugar de ser solo expositivas)	0 (0%)	0 (0%)	9 (50%)	9 (50%)	4.5	18	3.5 / 4
c) Las jornadas de formación promovieron el uso de herramientas digitales	1 (6%)	1 (6%)	9 (50%)	7 (39%)	3.57	18	3.22 / 4
d) Hubo espacio para metodologías de aprendizaje activo, como el aprendizaje basado en problemas, el aprendizaje basado en proyectos, la gamificación, la realidad aumentada, la realidad virtual, el aprendizaje colaborativo, etc.	0 (0%)	1 (6%)	6 (33%)	11 (61%)	4.39	18	3.56 / 4
e) Las horas presenciales asignadas al curso fueron adecuadas a la cantidad y naturaleza de los contenidos del curso	0 (0%)	1 (6%)	9 (50%)	8 (44%)	4.03	18	3.39 / 4
f) Hubo un buen equilibrio de conocimientos entre los participantes y no se notaron grandes discrepancias en los conocimientos previos	0 (0%)	3 (17%)	8 (44%)	7 (39%)	3.2	18	3.22 / 4
g) El (los) formador(es) se desempeñó/ desempeñaron adecuadamente (buena gestión del tiempo, capacidad para comunicarse con claridad)	0 (0%)	1 (6%)	4 (22%)	13 (72%)	5.12	18	3.67 / 4
h) El (los) formador(es) estaba(n) bien preparados y mostraron una buena comprensión del tema	0 (0%)	0 (0%)	7 (39%)	11 (61%)	4.72	18	3.61 / 4
i) El apoyo brindado por el(los) formador(es) fue bueno y se realizó una buena gestión de preguntas y respuestas	0 (0%)	0 (0%)	5 (28%)	13 (72%)	5.32	18	3.72 / 4

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What is your opinion regarding the following statements?	1. Strongly disagree	2. Somewhat disagree	3. Somewhat agree	4. Strongly agree
a) The learning materials (i.e. slide shows, handbooks, videos, samples) were useful	❏	❏	❏	❏
b) The training sessions were quite dynamic, in the sense that they were engaging and involved interactive activities, instead of being just expositive)	❏	❏	❏	❏
c) The training sessions promoted the use of digital tools	❏	❏	❏	❏
d) There was space for active learning methodologies, such as problem-based learning, project-based learning, gamification, augmented reality, virtual reality, collaborative learning, etc.	❏	❏	❏	❏
e) The contact hours allocated to the course was adequate to the amount and nature of the course contents	❏	❏	❏	❏
f) There was a good balance of knowledge among the participants and no big discrepancies in the background knowledge were noticed	❏	❏	❏	❏
g) The trainer(s) showed a good performance (good time management, ability to communicate clearly)	❏	❏	❏	❏
h) The trainer(s) was well prepared and showed a good understanding of the subject	❏	❏	❏	❏
i) The support provided by the trainer(s) was good and a good management of questions and answers was done	❏	❏	❏	❏

14. How would you rate your level of satisfaction with…

14 Defina su nivel de satisfacción con respecto a…

	Nada satisfecho	Poco satisfecho	Suficientemente satisfecho	Muy satisfecho	N/A	Standard Deviation	Responses	Weighted Average
a) El conocimiento adquirido en la formación	0 (0%)	0 (0%)	3 (17%)	15 (83%)	0 (0%)	5.82	18	3.83 / 4
b) Las habilidades adquiridas en la formación	0 (0%)	0 (0%)	6 (33%)	12 (67%)	0 (0%)	4.8	18	3.67 / 4
c) La metodología de evaluación utilizada	0 (0%)	0 (0%)	8 (44%)	10 (56%)	0 (0%)	4.45	18	3.56 / 4
								3.69 / 4

How would you rate your level of satisfaction with…	1. Poorly satisfied	2. Not enough satisfied	3. Satisfied enough	4. Very satisfied	n.a.
a) The knowledge acquired in the training	❑	❑	❑	❑	❑
b) The skills acquired in the training	❑	❑	❑	❑	❑
c) The evaluation methods used	❑	❑	❑	❑	❑

15 ¿Ha satisfecho el curso sus expectativas?   **16** ¿Recomendaría este curso

100% (18)	0% (0)	100% (18)	0% (0)
Sí	No	Sí	No

9	18	9	18
Standard Deviation	Responses	Standard Deviation	Responses

15. and 16. Closure	YES	NO
a) Did the course meet your expectations?	❑	❑
b) Would you recommend this course to others?	❑	❑

17 ¿Cuál fue el aspecto más positivo del curso? ¿Por qué?/ What was the most positive aspect of the training course? Why?

- Me encanta la soldadura y esto es similar/I love welding and this is similar
- Buen ambiente/Good environment
- Colaboración de los profesores y compañeros/ Collaboration of teachers and colleagues
- Aprender algo nuevo/Learn something new
- La visita a las instalaciones/ Visit to the facilities.
- Ejemplos que puedo aplicar en el trabajo/ Examples that I can apply at work
- Los conocimientos adquiridos sobre un ámbito que se alejaba completamente de mi ámbito de actuación. Hacerlo presencial/ Knowledge acquired about a field that was completely outside my scope of action. Do it in person
- La combinación teórico-práctica/ Theoretical-practical combination.
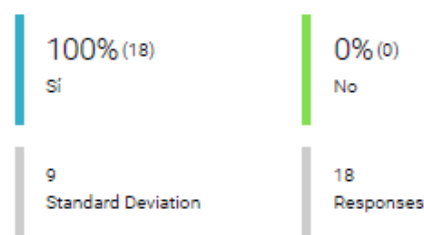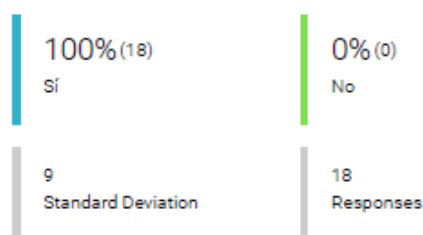
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- LA AMPLITUD DE TEMARIO APORTADO Y EXPERIENCIA DE LOS FORMADORES/ THE WIDENESS OF SUBMITTED SUBJECT AND EXPERIENCE OF THE TRAINERS
- El nivel de conocimientos de los docentes/ The level of knowledge of teachers
- La disponibilidad de los profesores para aclarar dudas/The availability of teachers to clarify doubtsLa interacción y las explicaciones del profesorado/ The interaction and explanations of the teachersAprender sobre métodos de fabricación novedosos, de los cuales la información es escasa en algunos campos, de la mano de expertos sobre la materia./ Learn about novel manufacturing methods, of which information is scarce in some fields, from experts in the field.

18 ¿Cuál fue el aspecto menos positivo del curso? ¿Por qué?/ What was the less positive aspect of the training course? Why?

- Son demasiadas horas/ too many hours
- Curso demasiado largo para hacerlo en un tiempo tan corto/ Course too long to do in such a short time.
- Demasiado concentrado/ Too concentrated
- Un poco demasiado teórico/ A little too theoretical.
- La situación actual limitaba el contacto/ The current situation limited contact
- La dificultad de ciertos conceptos/ The difficulty of certain concepts
- Ninguno todo muy bien/ None, everything very well
- Ninguno que destacar/ None to highlight.
- NINGUNO/NONE
- Ninguno en concreto/ None in particularFalta de horas practicas de taller / laboratorio/ Lack of practical workshop / laboratory hours
- La presencialidad y horario de clases durante la jornada laboral/ The presence and schedule of classes during the working day

19 Comentarios adicionales y sugerencias/ Further comments and suggestions:

- Más contenido práctico/ More practical content.-
- Recomendable para todas aquellas personas que quieran profundizar en contenidos especícos sobre la Fabricación Aditiva, su aplicación práctica y las posibilidades que ofrece/ Recommended for all those who want to delve into specific content on Additive Manufacturing, its practical application and the possibilities it offers.
- ESTOY MUY SATISFECHO/ I AM VERY SATISFIED.
- El momento que a mi personalmente más me sirvió fue la parte practica/ The moment that personally served me the most was the practical part

Analysis of results:

In the CU01 course 28% **women** (5) and 72% **men** (13) took part (total: 18). 89 % of participants were in the **age range** 26-55. The course was done in **Spain**, in AITIIP facilities. The most of participants defined their company's sector as **Industrial equipment** and tooling (44%) and

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automotive (39%). Jointly the sector mentioned in the questions, participants also mentioned robotics and food packaging. The **education background** was mainly master or engineering (72%). Regarding the **AM experience** varies between general knowledge and expertise in plastic AM. Two of them are expertise in metal AM (WAAM and robotics & aeronautics projects). Two of them were confused about the **regime** of the session, probably because the session was face to face but the certification was online and some information was sent previously to the course. The satisfaction about the **course conditions** (facilities, supporting, communication, etc.) was high, especially in infrastructures (3.89/4). About course **characteristics** (structure, contents, etc.) the results were high too (3.51 average). Regarding materials, training sessions, etc. the participants value everything in a positive way. The best results were for **materials** and **training support** (3.72). The satisfaction with **course effectiveness** was 3.69 average. A 100% was satisfied with the course and would recommend it. The participants value **positively** the environment and the course contents. The main **negative** aspects was the duration and the balance between theory and practice.

6.2.3. Feedback on CU08: DED-LB Process

2. Please select the gender you identify better with (for gender balance reporting duties, only)

3. Please select the age range you are in

2 Por favor, selecione o género com que melhor se identifica (apenas para efeitos de reporte de equilíbrio de género)

25% (2)	75% (6)
Feminino	Masculino
2	8
Standard Deviation	Responses

3 Selecione a sua faixa etária:
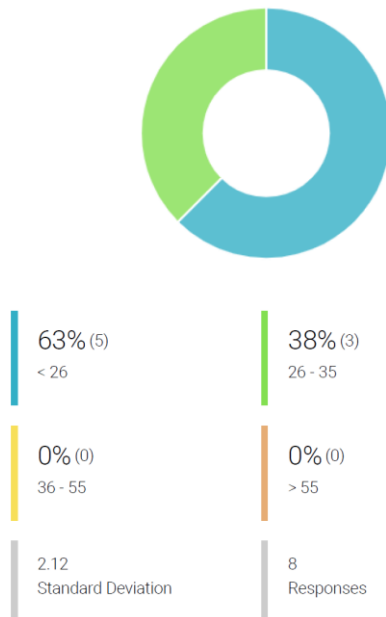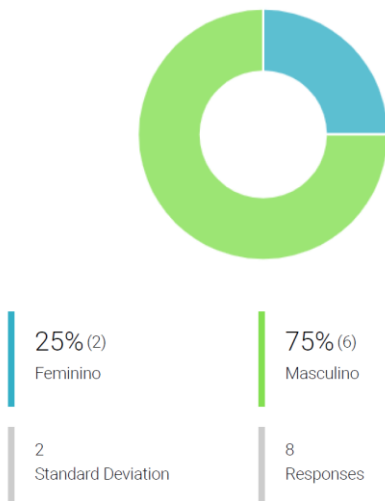
63% (5)	38% (3)
< 26	26 - 35
0% (0)	0% (0)
36 - 55	> 55
2.12	8
Standard Deviation	Responses

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4. In which country is your AM training course taking place?

4 Em que país está a decorrer o seu curso?

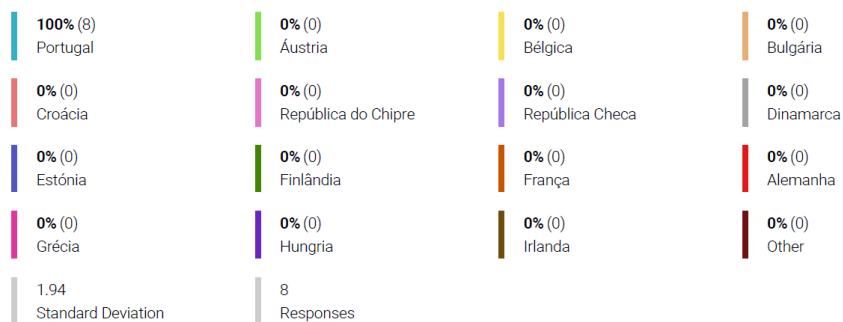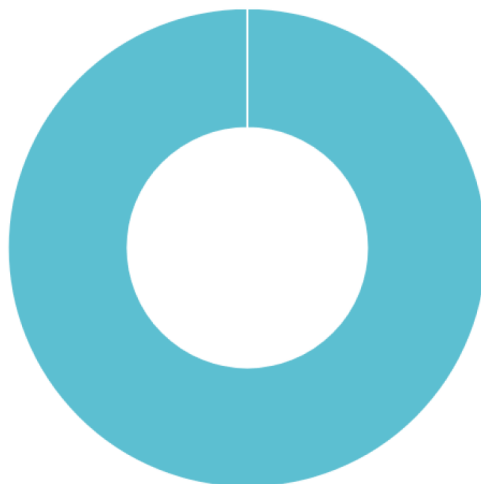|			
100% (8) Portugal	**0%** (0) Áustria	**0%** (0) Bélgica	**0%** (0) Bulgária
0% (0) Croácia	**0%** (0) República do Chipre	**0%** (0) República Checa	**0%** (0) Dinamarca
0% (0) Estónia	**0%** (0) Finlândia	**0%** (0) França	**0%** (0) Alemanha
0% (0) Grécia	**0%** (0) Hungria	**0%** (0) Irlanda	**0%** (0) Other
1.94 Standard Deviation	8 Responses		

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5. What is the main activity/sector of your organisation?

5 Qual a principal atividade / setor da sua organização(pode selecionar mais do que uma opção)

0% (0)
Aeroespacial

0% (0)
Automóvel

0% (0)
Defesa

0% (0)
Bens de consumo

0% (0)
Construção

0% (0)
Energia

0% (0)
Saúde

50% (4)
Equipamento industrial e ferramentaria

0% (0)
De momento, não estou a trabalhar para nenhuma organização

50% (4)
Other (Please Specify)

8
Responses

Outro

investigação Mecânica Computacional

Industrial Association

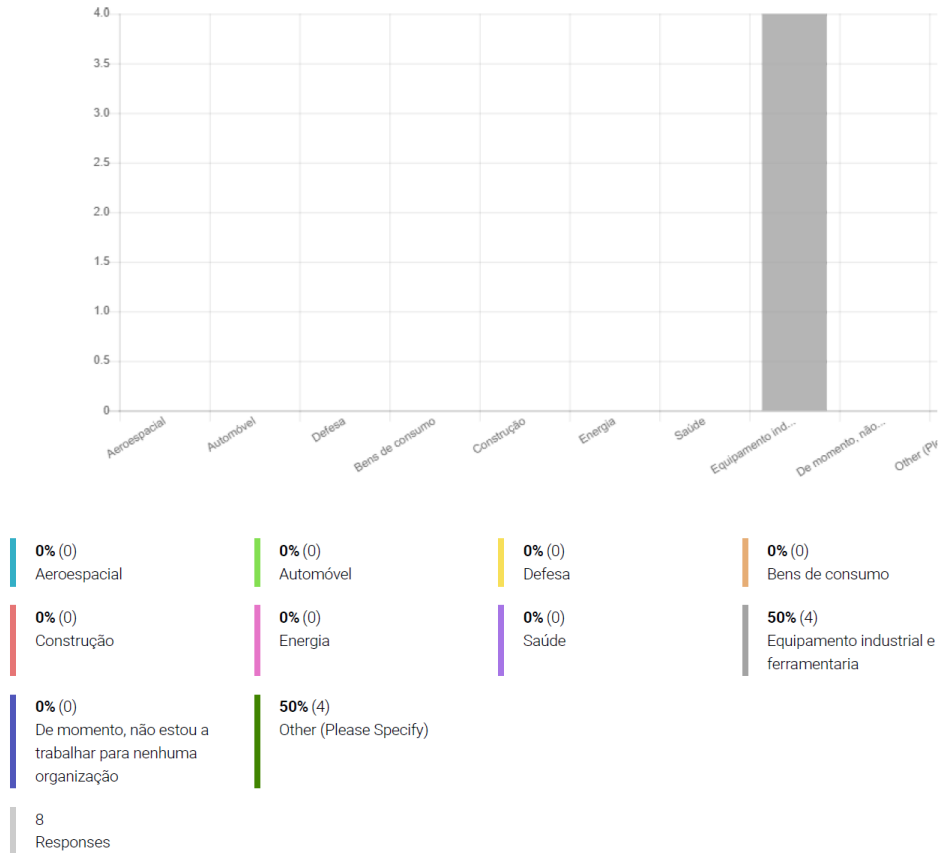Informática

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6. What is your Education background?

6 Qual a sua escolaridade?(pode selecionar mais do que um)

0% (0)
Certificado escolar/
Secundária

38% (3)
Licenciatura / Bacharelato

0% (0)
Formação Profissional
(cursos médios)

0% (0)
Formação Profissional
(cursos especialista)

50% (4)
Engenharia ou Mestrado

13% (1)
Doutoramento

0% (0)
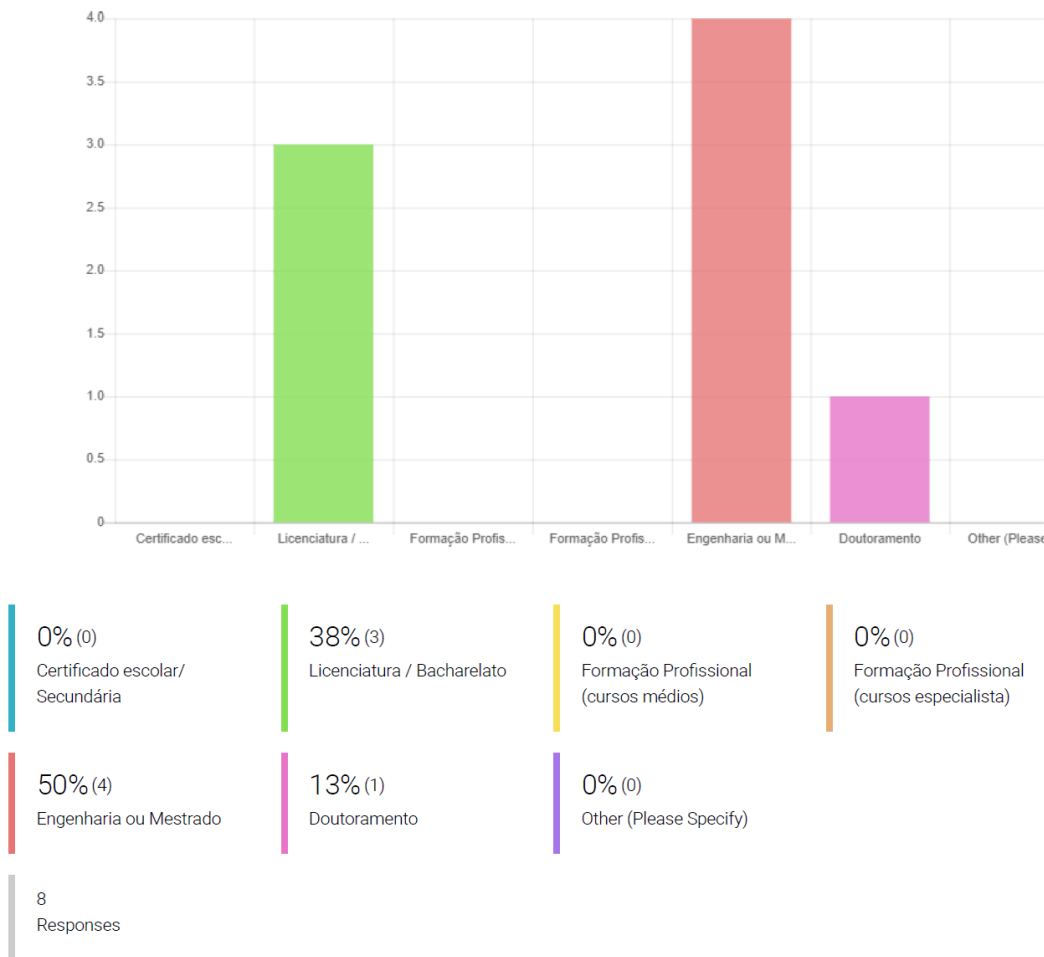Other (Please Specify)

8
Responses

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7. What is your professional background/previous additive manufacturing experience?

7 Qual a sua formação profissional / experiência anterior em Fabrico Aditivo?

Nenhuma

nenhuma

EWF CU 00
Projectos de investigação
Actividades normalização

Doutoramento em AM

nenhuma

8 anos de FFF/FDM e 2 anos de SLA

Extracurricular
CU-00
Uso doméstico de impressora 3d

Estágio num FabLab e participação como aluno bolseiro num projeto de cunhagem de moedas obtidas por fabrico aditivo
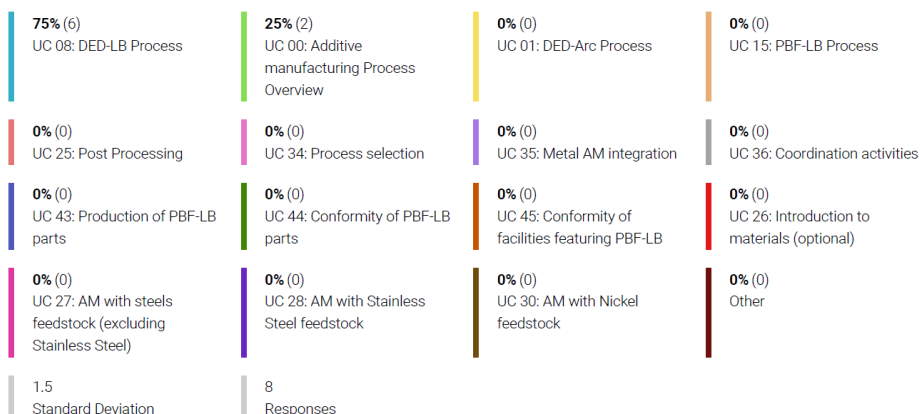
- Nenhuma/None
- nenhuma/None
- EWF CU 00, Projetos de Investigação/RTD Projects and Actividades normalização/Standardization activities
- Doutoramento em AM/PhD in AM
- nenhuma/None
- 8 anos de FFF/FDM e 2 anos de SLA/8 years of FFF/FDM and 2 years of SLA processes
- Extracurricular/extracurricular, Cu-00, Uso doméstico de impressora 3d/Domestic use of a 3D printer
- Estágio num FabLab e participação como aluno bolseiro num projeto de cunhagem de moedas obtidas por fabrico aditivo/Internship in a FabLab and a scholarship student participant in a special coin minting project using additive manufacturing

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8. Which pilot course did you attend?

8 Qual o curso que frequentou?

75% (6) UC 08: DED-LB Process	**25%** (2) UC 00: Additive manufacturing Process Overview	**0%** (0) UC 01: DED-Arc Process	**0%** (0) UC 15: PBF-LB Process
0% (0) UC 25: Post Processing	**0%** (0) UC 34: Process selection	**0%** (0) UC 35: Metal AM integration	**0%** (0) UC 36: Coordination activities
0% (0) UC 43: Production of PBF-LB parts	**0%** (0) UC 44: Conformity of PBF-LB parts	**0%** (0) UC 45: Conformity of facilities featuring PBF-LB	**0%** (0) UC 26: Introduction to materials (optional)
0% (0) UC 27: AM with steels feedstock (excluding Stainless Steel)	**0%** (0) UC 28: AM with Stainless Steel feedstock	**0%** (0) UC 30: AM with Nickel feedstock	**0%** (0) Other
1.5 Standard Deviation	8 Responses		

9. Quantas horas de contacto/ letivas houve no seu curso?(i.e., horas de contacto com o seu formador)/How many contact hours were there in your course? (i.e., how many hours were there of contact with your trainer(s)?)
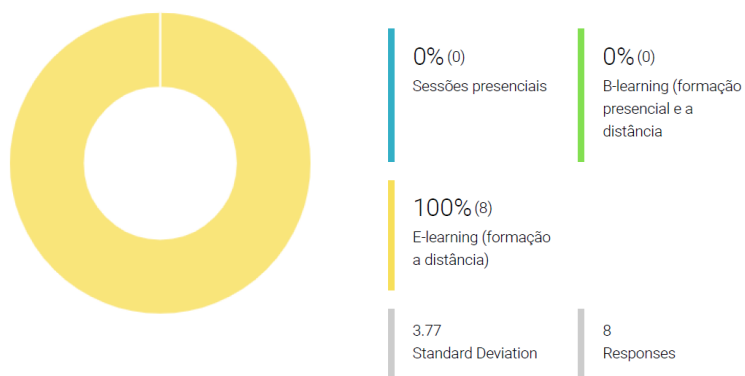
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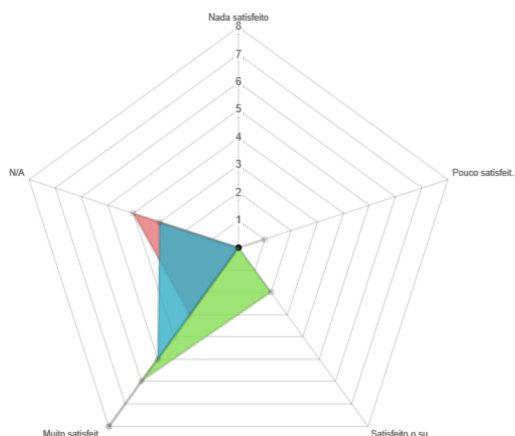
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10. What was the regime in your course?

10 Qual o regime do curso?

0% (0) Sessões presenciais	**0%** (0) B-learning (formação presencial e a distância
100% (8) E-learning (formação a distância)	
3.77 Standard Deviation	8 Responses

11. How would you rate your level of satisfaction with…

11 Como avalia o seu grau de satisfação com…

	Nada satisfeito	Pouco satisfeito	Satisfeito o suficiente	Muito satisfeito	N/A	Standard Deviation	Responses	Weighted Average
a) As infraestruturas oferecidas pela entidade formadora	0 (0%)	0 (0%)	0 (0%)	**5 (63%)**	3 (38%)	2.06	8	4 / 4
b) O apoio prestado pelo pessoal (sem ser o(s) formador(es))	0 (0%)	0 (0%)	2 (25%)	**6 (75%)**	0 (0%)	2.33	8	3.75 / 4
c) A transparência / comunicação dos resultados de aprendizagem associados ao curso	0 (0%)	0 (0%)	0 (0%)	**8 (100%)**	0 (0%)	3.2	8	4 / 4
d) Os canais de comunicação utilizados durante a formação	0 (0%)	0 (0%)	0 (0%)	**8 (100%)**	0 (0%)	3.2	8	4 / 4
e) O equipamento usado na componente prática	0 (0%)	1 (13%)	0 (0%)	3 (38%)	**4 (50%)**	1.62	8	3.5 / 4
								3.85 / 4

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How would you rate your level of satisfaction with…	1. Poorly satisfied	2. Not satisfied enough	3. Satisfied enough	4. Very satisfied	n.a.
a) The infrastructure conditions provided by the training provider	❏	❏	❏	❏	❏
b) The support provided by the staff (other than trainers)	❏	❏	❏	❏	❏
c) The transparency/communication of the learning outcomes associated to the course	❏	❏	❏	❏	❏
d) The communication channels used during the training	❏	❏	❏	❏	❏
e) The equipment used in the practical training	❏	❏	❏	❏	❏

12. How would you rate your level of satisfaction with…

12 Como avalia o seu grau de satisfação com …
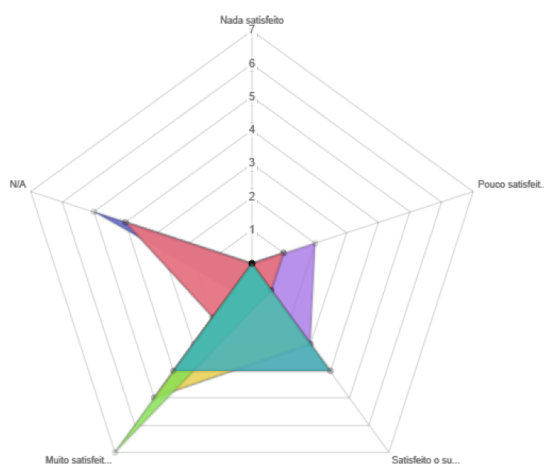
	Nada satisfeito	Pouco satisfeito	Satisfeito o suficiente	Muito satisfeito	N/A	Standard Deviation	Responses	Weighted Average
a) A estrutura do curso	0 (0%)	0 (0%)	4 (50%)	4 (50%)	0 (0%)	1.96	8	3.5 / 4
b) Os conteúdos abordados durante o curso	0 (0%)	0 (0%)	1 (13%)	7 (88%)	0 (0%)	2.73	8	3.88 / 4
c) A coerência do curso com o programa de formação (a ordem de apresentação dos conteúdos prevista na unidade foi respeitada pelo formador?)	0 (0%)	0 (0%)	3 (38%)	5 (63%)	0 (0%)	2.06	8	3.63 / 4
d) O número de horas de contacto	0 (0%)	0 (0%)	4 (50%)	4 (50%)	0 (0%)	1.96	8	3.5 / 4
e) O equilíbrio entre a Formação teórica e prática	0 (0%)	1 (13%)	1 (13%)	2 (25%)	4 (50%)	1.36	8	3.25 / 4
f) O número de horas alocadas a Formação prática	0 (0%)	1 (13%)	1 (13%)	2 (25%)	4 (50%)	1.36	8	3.25 / 4
g) A relevância do curso para a sua atividade profissional	0 (0%)	2 (25%)	3 (38%)	3 (38%)	0 (0%)	1.36	8	3.13 / 4
h) A correspondência entre os resultados de aprendizagem previstos para o curso, e o que o curso cobriu	0 (0%)	0 (0%)	3 (38%)	5 (63%)	0 (0%)	2.06	8	3.63 / 4
i) O tempo disponível para manusear uma máquina de FA	0 (0%)	1 (13%)	1 (13%)	1 (13%)	5 (63%)	1.74	8	3 / 4
								3.42 / 4

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How would you rate your level of satisfaction with...	1. Poorly satisfied	2. Not satisfied enough	3. Satisfied enough	4. Very satisfied	n.a.
a) The structure of the course	❏	❏	❏	❏	❏
b) The contents addressed during the course	❏	❏	❏	❏	❏
c) The coherence of the course with the training programme (was the order of contents presentation [foreseen in the ULO] respected by the training provider?)	❏	❏	❏	❏	❏
d) The number of contact hours	❏	❏	❏	❏	❏
e) The balance between theoretical and practical training	❏	❏	❏	❏	❏
f) The number of contact hours allocated to practical training	❏	❏	❏	❏	❏
g) The relevance of the course to your job activities	❏	❏	❏	❏	❏
h) The match between learning outcomes foreseen for the course and what the course covered	❏	❏	❏	❏	❏
i) The amount of time to train with an AM machine	❏	❏	❏	❏	❏

13. What is your opinion regarding the following statements?

13 Qual a sua opinião relativamente às seguintes afirmações?

|	Discordo totalmente	Discordo parcialmente	Concordo	Concordo plenamente	Standard Deviation	Responses	Weighted Average
a) Os materiais de formação (ou seja, apresentações de slides, manuais, vídeos, amostras) foram úteis	0 (0%)	0 (0%)	3 (38%)	**5 (63%)**	2.12	8	3.63 / 4
b) As sessões de formação foram bastante dinâmicas, sendo cativantes e envolvendo atividades interativas, ao invés de serem apenas expositivas)	0 (0%)	1 (13%)	2 (25%)	**5 (63%)**	1.87	8	3.5 / 4
c) As sessões de Formação promoveram o uso de ferramentas digitais	0 (0%)	1 (13%)	**5 (63%)**	2 (25%)	1.87	8	3.13 / 4
d) Foram utilizadas metodologias de aprendizagem ativa, como a aprendizagem com base em problemas, aprendizagem com base em projetos, gamificação, realidade aumentada, realidade virtual, aprendizagem colaborativa, etc	0 (0%)	2 (25%)	2 (25%)	**4 (50%)**	1.41	8	3.25 / 4
e) As horas de contacto alocadas ao curso foram adequadas à quantidade e natureza dos conteúdos do curso	0 (0%)	0 (0%)	2 (25%)	**6 (75%)**	2.45	8	3.75 / 4
f) Houve um bom equilíbrio de conhecimento entre os participantes e não foram observadas grandes discrepâncias no seu conhecimento prévio	0 (0%)	0 (0%)	3 (38%)	**5 (63%)**	2.12	8	3.63 / 4
g) O(s) formador(es) mostraram um bom desempenho (boa gestão do tempo, capacidade de comunicação	0 (0%)	0 (0%)	3 (38%)	**5 (63%)**	2.12	8	3.63 / 4
h) O(s) formador(es) estavam bem preparados e demonstraram um bom conhecimento do assunto	0 (0%)	0 (0%)	1 (13%)	**7 (88%)**	2.92	8	3.88 / 4
i) O apoio dado pelo(s) formador(es) foi bom e foi feita uma boa gestão de perguntas e respostas	0 (0%)	0 (0%)	2 (25%)	**6 (75%)**	2.45	8	3.75 / 4
							3.57 / 4

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What is your opinion regarding the following statements?	1. Strongly disagree	2. Somewhat disagree	3. Somewhat agree	4. Strongly agree
a) The learning materials (i.e. slide shows, handbooks, videos, samples) were useful	❑	❑	❑	❑
b) The training sessions were quite dynamic, in the sense that they were engaging and involved interactive activities, instead of being just expositive)	❑	❑	❑	❑
c) The training sessions promoted the use of digital tools	❑	❑	❑	❑
d) There was space for active learning methodologies, such as problem-based learning, project-based learning, gamification, augmented reality, virtual reality, collaborative learning, etc.	❑	❑	❑	❑
e) The contact hours allocated to the course was adequate to the amount and nature of the course contents	❑	❑	❑	❑
f) There was a good balance of knowledge among the participants and no big discrepancies in the background knowledge were noticed	❑	❑	❑	❑
g) The trainer(s) showed a good performance (good time management, ability to communicate clearly)	❑	❑	❑	❑
h) The trainer(s) was well prepared and showed a good understanding of the subject	❑	❑	❑	❑
i) The support provided by the trainer(s) was good and a good management of questions and answers was done	❑	❑	❑	❑

14. How would you rate your level of satisfaction with…

14 Como avalia o seu grau de satisfação com…
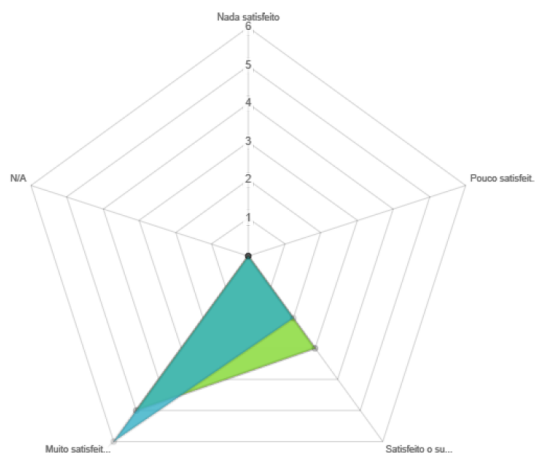
	Nada satisfeito	Pouco satisfeito	Satisfeito o suficiente	Muito satisfeito	N/A	Standard Deviation	Responses	Weighted Average
a) O conhecimento adquirido no curso	0 (0%)	0 (0%)	2 (25%)	**6 (75%)**	0 (0%)	2.33	8	3.75 / 4
b) As competências adquiridas no curso	0 (0%)	0 (0%)	3 (38%)	**5 (63%)**	0 (0%)	2.06	8	3.63 / 4
c) Os métodos de avaliação utilizados	0 (0%)	0 (0%)	3 (38%)	**5 (63%)**	0 (0%)	2.06	8	3.63 / 4
								3.67 / 4

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How would you rate your level of satisfaction with...	1. Poorly satisfied	2. Not enough satisfied	3. Satisfied enough	4. Very satisfied	n.a.
a) The knowledge acquired in the training	❑	❑	❑	❑	❑
b) The skills acquired in the training	❑	❑	❑	❑	❑
c) The evaluation methods used	❑	❑	❑	❑	❑

15. Did the course meet your expectations?

16. Would you recommend this course to others?

15 O curso foi ao encontro das suas expectativas?

16 Recomendaria este curso a outras pessoas?

100% (8)	0% (0)	100% (8)	0% (0)
Sim	Não	Sim	Não
4	8	4	8
Standard Deviation	Responses	Standard Deviation	Responses

15. and 16. Closure	YES	NO
a) Did the course meet your expectations?	❑	❑
b) Would you recommend this course to others?	❑	❑

17. What was the most positive aspect of the training course? Why?

17 Qual foi o aspeto mais positivo desta formação? Porquê?

Formadores

Simpatia e clareza na formação, o que permitiu a qualqur participante conseguir seguir independente das suas bases no tópico

Contacto com componentes mais teóricas do DED-LB

Conhecimento bastante profundo sobre o processo DED-LB

Diferentes oradores

- Formadores/Trainers

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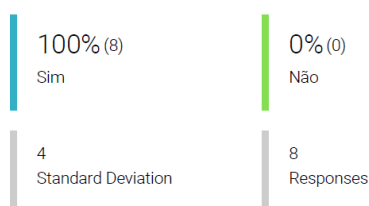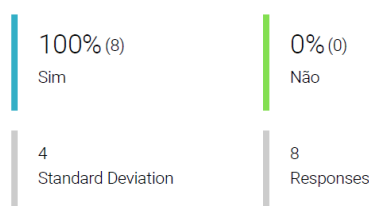
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- Simpatia e clareza na formação, o que pode fazer um participante qualqur conseguir seguir independente das suas bases no tópico/Friendliness and clarity in training, which can make any participant understand the training regardless of their background in the topic
- Contacto com componentes mais teóricas do DED-LB/Contact with theoretical components of the DED-LB
- Conhecimento bastante profundo sobre o processo DED-LB/Very in-depth knowledge of the DED-LB process
- Diferentes oradores/Different speakers

18. What was the less positive aspect of the training course? Why?

18 Que aspeto julga que poderia ser melhorado?

Inclusão de formação pratica

mas sessões de menos horas

participação dos oradores externos. tratando-se da primeira formação de CU-08 e do enquadramento atual (covid-19), é compreensível, ainda assim sugiro uma melhor organização da parte dos formadores.

Componente prática

- Inclusão de formação pratica/ Addition of practical training
- Mais sessões de menos horas/ more sessions of less hours
- participação dos oradores externos. tratando-se da primeira formação de CU-08 e do enquadramento atual (covid-19), é compreensível, ainda assim sugiro uma melhor organização da parte dos formadores/participation of external speakers. Regarding the first formation of CU-08 and the current pandemic state (covid-19), it is understandable, even so I suggest a better organization on the part of the trainers.
- Componente prática/ Practical component

19. Further comments and suggestions:

19 Outros comentários ou sugestões:

Obrigado!

- Obrigado!/Thank you!

Analysis of results:

CU08 was lectured via Teams, therefore it was an online course, and it was applied in Portugal. A gender balance of 1 to four was observed, this means 25% women (2) and 75% men (6). Regarding the age of range, FA had 63% of the attendees in the range of <26 (5) and 38% in the

range of 26-35 (3). Most of participants defined their company's sector as being from Industrial equipment and tooling (50%) and the rest from different sectors as research and informatic sectors. With respect to the education background, for half of them is master or engineering (4). Regarding the AM experience, varies between expertise in plastic AM and no knowledge at all. Two of the attendees misunderstood what course they attended, mainly because they miss some of the sessions. Nevertheless, all the information was sent previously, and the training materials sent after the lectures. When the satisfaction regarding the course conditions (3,85/4,00), course characteristics (average of 3,5/4) and course effectiveness (3,67/4,00) is observed, high marks can be noted. Therefore, it was natural that all of the participants were positively satisfied and would recommend it. Finally, the positive side of this pilot of CU 08 was the clarity and know-how of the speakers and the less positive was the lack of practical lecturing.

6.2.4. Feedback on CU15: PBF-LB Process

The following section will discuss the results from the Pilot 1 of CU15. This is the most crucial aspect of Pilot 1 as the purpose is to build upon and improve the existing qualifications and dissemination of such. In the interest of brevity, the results of the surveys will be placed in the appendices and only the highlights will be discussed here.

Firstly, we can use the attendee surveys to determine the profile of our attendees:

- 95% of participants were male.
- 53% were between the ages of 26 and 35.
- 50% of all attendees were working in the Health Industry.
- 95% of attendees had a Bachelor's or Master's degree.

The consensus across the feedback was that the experience was a positive one as the majority of responses were above three on a scale of one to four in terms of satisfaction across all aspects of the course.

Excel sheet for the evaluation of the questionnaires is available here on the Sharepoint. A summary of the analysis is as follows:

Analysis of results:

Irish Manufacturing Research (IMR) successfully attracted a large pool of attendees with almost sixty (60) persons attending the training pilot and just under forty (40) the examination. Embracing the agile training design methodology of co-designing with stakeholders, this large cohort attracted by IMR, is representative of different industries based in Ireland. A responsive learning design approach demands a diverse team of subject experts, managers and attendees who can provide insight and design evaluation on iterations of the training design.

Attendee feedback indicated that most respondents were aged over 26 years old with zero in the over 55 age range. Industries included were automotive, health which contained the highest number of the cohort, along with other industries. Almost all the cohort's educational backgrounds were either at degree level or beyond and included a high proportion of those who

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had an engineering degree/background. Gender distribution was majority male with 2 of the 38 attendees being female.

The least satisfaction occurred in relation to training content design and contact hours.

Attendees evaluation stated the course was too heavy on theory and more physical workshops and practices were more appropriate and useful for learning outcomes and the quality of the learner experience.

Key Feedback from Attendees:

- The time allowed for the multiple-choice exam was too short.
- The exam question difficulty was reasonable but, one minute a question was not feasible particularly on certain questions within the exam paper.
- The course was too theory heavy and this is not relevant to industry where expertise in practice is vital.

6.2.5. Feedback on CU25: Post Processing

In total, 13 **students** participated in the survey (the same students that also participated in the theoretical assessment). The findings are presented hereafter:

- From 13 students participating to the pilot course the 8 of them belong at the age range of 26-35 years old, 4 are under 26 years old and 1 at the age range of 36-55 years old.
- From 13 students participating to the pilot course 4 of them have as main activity/sector of their organization the Aerospace, 3 the Defence, 1 the Industrial sector, 4 are currently unemployed and 7 of them belong to another sector like academic sector and education. It has to be mentioned here that participants had the opportunity to give more than one answer to this question, so we totally received 20 answers.
- As Education background of 13 students participating to the pilot course, 10 of them have Engineer or Master's degree, 2 Bachelor's degree, 1 School certificate, 1 Doctoral degree, and 1 toward graduating from Engineering school. It has to be mentioned here that participants had the opportunity to give more than one answer to this question, so we totally received 16 answers.
- As professional background participants and previews experience at additive manufacturing have answered, 8 of them have answered that they have previews professional experience for example working on Metal Additive manufacturing using laser cladding, research work on composite materials, and GAS turbine design part with AM. The rest of them either they do not have any professional experience, or have dealt with additive manufacturing during their studies or as a hobby interest.
- About the contact hours of the pilot course from the 13 participants 7 of them have gave as answer 10 hours, 2 answered 7 hours, 2 answered 8 hours, 1 answered 12 hours and 1 gave as an answer 2 days.
- From 13 students participating to the pilot course 9 of them are Male and 4 of them Female.

- The AM training course has taken place for 13 students participating, as follows: 1 at Belgium, 4 at Greece, 3 at Portugal, 3 at India, 1 at Turkey, and 1 at Nigeria.
- At the questions of Satisfaction with the training conditions for:
    - The infrastructure conditions provided by the training provider, 11 of 13 participants claimed very satisfied, 1 satisfied enough, and 1 not satisfied enough.
    - The support provided by the staff (other than trainers), 10 of 13 participants claimed very satisfied, 2 satisfied enough, and 1 not satisfied enough.
    - The transparency/communication of the learning outcomes associated to the course 12 of 13 participants claimed very satisfied, and 1 satisfied enough.
    - The communication channels used during the training 11 of 13 participants claimed very satisfied and 2 satisfied enough.
    - The equipment used in the practical training 6 of 13 participants claimed Very satisfied 2 satisfied enough, and 1 not satisfied enough and 4 answered "not available" (N/A).
- At the question of the level of satisfaction with:
    - The structure of the course 12 of 13 participants declared very satisfied, and 1 satisfied enough.
    - The contents addressed during the course 11 of 13 participants declared very satisfied, and 2 satisfied enough.
    - The coherence of the course with the training program (was the order of contents presentation respected by the training provider?) 10 of 13 participants declared very satisfied, and 3 satisfied enough.
    - The number of contact hours 9 of 13 participants declared very satisfied, and 4 satisfied enough.
    - The balance between theoretical and practical training 4 of 13 participants declared very satisfied, 2 satisfied enough, and 2 not satisfied enough and 5 answered "not available" (N/A).
    - The number of contact hours allocated to practical training 2 of 13 participants declared very satisfied 2 satisfied enough, and 1 not satisfied enough, 2 poorly satisfied and 6 answered "not available" (N/A).
    - The relevance of the course to your job activities 10 of 13 participants declared very satisfied, 2 satisfied enough, and 1 not satisfied enough.
    - The match between learning outcomes foreseen for the course and what the course covered 10 of 13 participants declared very satisfied and 2 satisfied enough.
    - The amount of time to train with an AM machine 2 of 13 participants declared very satisfied 1 satisfied enough, and 1 not satisfied enough, 2 poorly satisfied and 7 answered "not available" (N/A).
- About the question of "What is your opinion regarding the following statements?"
    - The learning materials (i.e. slide shows, handbooks, videos, samples) were useful 11 of 13 participants answered that they strongly agree, and 2 agree.

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- The training sessions were quite dynamic, in the sense that they were engaging and involved interactive activities, instead of being just expositive) 6 of 13 participants answered that they strongly agree, 5 agree and 2 disagree.
- The training sessions promoted the use of digital tools 6 of 13 participants answered that they Strongly agree, 5 agree and 2 strongly disagree.
- There was space for active learning methodologies, such as problem-based learning, project-based learning, gamification, augmented reality, virtual reality, collaborative learning, etc. 3 of 13 participants answered that they strongly agree, 4 agree, 4 disagree and 2 strongly disagree.
- The contact hours allocated to the course was adequate to the amount and nature of the course contents 7 of 13 participants answered that they strongly agree, 4 agree, and 2 disagree.
- There was a good balance of knowledge among the participants and no big discrepancies in the background knowledge were noticed 7 of 13 participants answered that they strongly agree, 5 agree, and 1 disagree.
- The trainer(s) showed a good performance (good time management, ability to communicate clearly) 10 of 13 participants answered that they strongly Agree, and 3 agree.
- The trainer(s) was well prepared and showed a good understanding of the subject 11 of 13 participants answered that they strongly agree, and 2 agree.
- The support provided by the trainer(s) was good and a good management of questions and answers was done 11 of 13 participants answered that they strongly agree, and 2 agree.
- About the question of "How would you rate your level of satisfaction with…"
  - The knowledge acquired in the training 11 of the 13 participants answered Very satisfied, and 2 satisfied enough.
  - The skills acquired in the training 5 of the 13 participants answered Very satisfied, 4 Satisfied enough, 2 Not enough satisfied, and 2 answered "not available" (N/A).
  - The evaluation methods used 7 of the 13 participants answered very satisfied, and 6 satisfied enough.
- All the participants declared that the course has met their expectations.
- All the participants declared that they would recommend this course to others.
- At the question of "What was the most positive aspect of the training course and why?" 11 of 13 participants declared that the training course was totally detailed so it clarified any doubts about Additive Manufacturing, it covered a good range of AM methods, gave a good view of pre and post processing methods. Only 2 of the 13 participants has answered N/A (not applicable).
- At the question of "What was the less positive aspect of the training course and why?" we received totally 10 answers, so 6 of them had not mention anything as less positive aspect. The rest of them suggested more practical examples would be useful and the duration was suggested to be separated in a longer duration of time like 2 hours courses for five weeks.

- Finally, as a final comment or suggestion the big majority, 8 of 13 participants, have declared to be thankful and happy for the course and they are expecting new courses like this one. 6 of the 13 participants did not give any comment.

It has to be mentioned that two people were involved in the overall process. The **trainer** feedback can be summarized as follows:

- At the question how satisfied are you with the:
  – Support provided by the training provider staff, both of them declared that they were very satisfied.
  – Infrastructure conditions provided by the training institution (furnishing, heating, lighting, sanitation, etc.). This question is not applicable, as due to the limitations imposed by COVID-19, the event was held remotely.
- At the question how satisfied are you with the:
  – Structure of the course (Units of Learning Outcomes /Competence Units) from the two trainers; one has declared satisfied and the other one very satisfied.
  – Contents addressed; both of them declared that they were very satisfied.
  – Established contact hours; from the two trainers one has declared satisfied and the other one very satisfied.
  – Balance between theoretical and practical training; from the two trainers one has declared satisfied and the other one very satisfied.
  – Relationship between the contents and the learning outcomes; both of them declared that they were very satisfied.
- The positive aspects of the training course remarked by the trainer's point of view are as follows:
  – Covered a good range of AM post-processing methods
  – Good attendance
  – Active participation with interesting questions from the audience
  – Highly interesting topic
- The question of what aspects of the course learning program could be improved from the trainers' point of view, replies are as follows:
  – The order of contents could be modified so that it makes more sense and follows a typical AM workflow
  – The course could be broken down into more and smaller interactions
- At the question how satisfied are you with the:
  – Available equipment both of the trainers declared that they were very satisfied.
  – Allocated contact hours for the theoretical classes both of the trainers declared that they were very satisfied.
  – Allocated contact hours for the practical work; from the two trainers one has declared satisfied and the other one very satisfied.
  – Evaluation (tests and examinations) methods used both of the trainers declared that they were very satisfied.

- At the question, if there any other aspect(s) they would like to refer to, none of the trainers have mentioned any other, additional aspect.

6.2.6. Feedback on CU26: Introduction to Materials (Metals and Alloys)

Based on the CU26 course **participants** who completed the feedback survey, 65% were male, and 35% were female. About half (48%) of the course participants were under the age of 25, 40% were in the age range of 26 – 35, and 12% were between 36 – 55.

The highest educational background of the participants varied from Engineer or Master's degree (44%), Bachelor's degree (29%), Doctoral degree (17%), School certificate (13%) and high degree vocational training (2%). The remaining 13% comprised undergraduate students, B tech, masters and doctoral students.

Although 31% of the participants are currently not working in an organization, 31% were from the Aerospace sector. This was followed by the Automotive sector (19%) and Industrial equipment and tooling sector (15%). After that, the Defense, Energy, Consumer Goods, Construction and Health sectors had 13%, 10%, 6%, 4% and 4%, respectively. Sectors listed in the "Other" category, which was about 33%, included Research (Academia), Powder metallurgy, Software, Oil and Gas, Materials Science and Manufacturing.

A substantial proportion (51%) of the participants were based in the UK. Turkey, India and Greece, which represented 14%, 8% and 6%, respectively, of the participants followed this. The remaining participants came from Bulgaria, Germany, Portugal, Spain, Pakistan, Mexico, China, USA, Malawi and Brazil.

The participants were predominantly "satisfied" and "very satisfied" with the course, training conditions, training sessions and course effectiveness. However, regarding the question about "equipment used in the practical training", although some participants selected "not satisfied enough", the survey question was not applicable because it was a completely virtual course without practical training. This reason also applies to the questions on "The balance between theoretical and practical training", "The number of contact hours allocated to practical training", "The amount of time to train with an AM machine". These questions were not relevant to the CU26 course, as it did not include practical elements and were completely virtual.

Some of the **positive aspects** of the course are shown below:

- "Content of the course. It was very good for all participants from beginner to advanced"
- "The presenters had good material and slides"
- "The resources were really good."
- "The positive interaction and collaborative learning"
- "The fact that we could ask questions and see practical simulations of the Granta"
- "Allowed us to ask questions and also provided a vast amount of resources for self-learning"
- "Lovely people giving teaching us. Great software used."

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- "The trainers were very knowledgeable and the interaction was great. The quiz too was useful"
- "GRANTA EduPack"
- "It was nice to have clear explanation and questions were answered quickly"
- "Working with others and doing interactive question sessions using sli.do"
- "I enjoyed the depth of material covered, it didn't seem too lacking or too advanced for the given timeframe."
- "I now revised my knowledge of basic materials study. Because I am starting a new project that requires me to revise general materials science and engineering. I got this course and very helpful."

On the other hand, details of the aspects of the course that **could be improved** are shown below:

- "Granta Edupack. I could not setup the program"
- "I wanted to use the Granta for a little longer. But it is limited for a month."
- "I suppose more sessions could have been useful"
- "Sessions are a bit long"
- "Training during business hours"
- "Course time not fexiable"
- "Unfortunately it clashed a lot with my lectures."
- "AM application and processing"
- "Lack of AM focus"
- "The course was at a more beginners level than expected"
- "It was very dull many topics were very basic"

Overall, 94% of the course participants stated that the course met their expectations, and 98% said that they would recommend the course to other participants.

For the CU26 Pilot course, two **trainers** completed the trainer's feedback survey, and the course took place in the UK. The first trainer was from Brunel University London, who is a current Research Fellow, and has Bachelors and PhD degrees in Engineering. The second trainer was from Ansys Granta with over 20 years of teaching experience in Materials. The second trainer also has MSc and PhD degrees in Physics and a current part-time Associate Professor in Materials Science.

The rating for the support provided by the training provider staff, infrastructure conditions provided by the training institution (furnishing, heating, lighting, sanitation, etc.), and contents addressed were all ranked 4 out of 4, thereby showing the best rating.

The rating for the structure of the course (Units of Learning Outcomes/Competence Units) showed both 3 out of 4 and 4 out of 4, equally. Similarly, the rating for the established contact hours showed both 3 out of 4 and 4 out of 4, equally, both representing good feedback.

Also, the balance between theoretical and practical training was rated as 3 out of 4. However, the course did not have any practical element. The relationship between the contents and the learning outcomes showed both 2 out of 4 and 3 out of 4. The reflects the need for improvement in this regard, especially aligning and learning outcomes and contents better.

Based on the trainer's feedback survey, the positive aspects are shown below:

- "Useful information about fundamental concepts of Materials (Metals and Alloys)"
- "The virtual nature and delivery of the course meant that participants from all over the world could attend the sessions"
- "Partnership with an academic institution (Brunel University) and company (Ansys Granta) was very beneficial and led to positive engagement"
- "We were two instructors sharing the content"
- "There were good interactive and engaging elements interlaced"
- "Good supplementary software and resources available"

On the other hand, details of the aspects of the course learning program that could be improved are shown below:

- "Coherence between learning outcomes and examination (cannot assess explain... etc. by multiple choice)"
- "Ensuring the verbs/words/terms of the learning outcomes are clear enough"
- "Ensuring the verbs/words/terms of the learning outcomes can be clearly assessed"

6.2.7. Feedback on CU27: AM with Steel feedstock

The lecturers and participants of have taken separate surveys to have their feedback about the course. 3 responses in lecturers survey and 46 responses in students survey have been received and analysed as below.

46 responses have been received for the students survey. The gender balance and age range is given in Figure 8.

| 24% (11) Female | 76% (35) Male | | 39% (18) < 26 | 41% (19) 26 - 35 | 17% (8) 36 - 55 | 2% (1) > 55 |
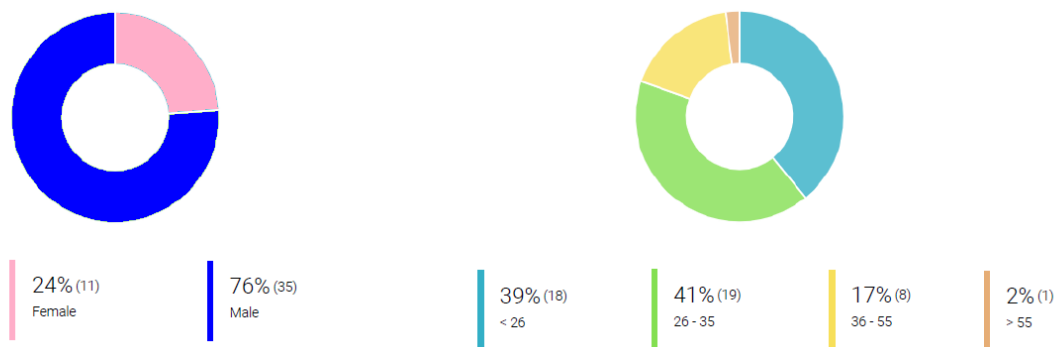
Figure 8: The gender balance and age range of students in CU27

The geographical distribution of attendees was in a wide range with more than 50% being out of Europe, mainly countries like Turkey, India and China. The main activity of the students were Aerospace (17%), Defense (20%), Automotive (22%), Industrial Equipment and Tooling (22%), and other (24%). The educational background of students were mainly engineers with and MS degree (58%), and PhD degree (22%) followed by BS degree (14%). The level of satisfaction was quite high (3.34/4.00) with respect to several factors like the relevance of the course to job

activities (3.65/4.00), The coherence of the course with the training programme (3.57/4.00), and the structure of the course (3.53/4.00).
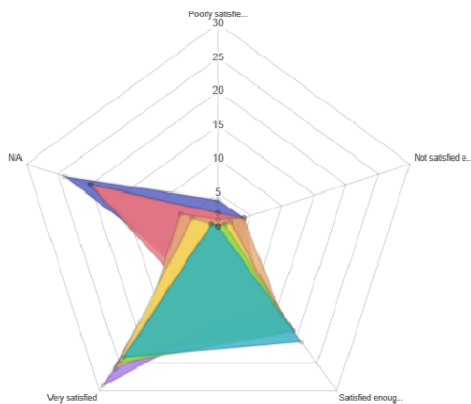
	Poorly satisfied	Not satisfied enough	Satisfied enough	Very satisfied	Weighted Average
a) The structure of the course	0 (0%)	0 (0%)	21 (46%)	24 (52%)	3.53 / 4
b) The contents addressed during the course	0 (0%)	1 (2%)	19 (41%)	25 (54%)	3.53 / 4
c) The coherence of the course with the training programme (was the order of contents presentation respected by the training provider?)	0 (0%)	2 (4%)	14 (30%)	26 (57%)	3.57 / 4
d) The number of contact hours	1 (2%)	4 (9%)	16 (35%)	19 (41%)	3.33 / 4
e) The balance between theoretical and practical training	2 (4%)	4 (9%)	10 (22%)	10 (22%)	3.08 / 4
f) The number of contact hours allocated to practical training	2 (4%)	2 (4%)	13 (28%)	9 (20%)	3.12 / 4
g) The relevance of the course to your job activities	0 (0%)	1 (2%)	13 (28%)	29 (63%)	3.65 / 4
h) The match between learning outcomes foreseen for the course and what the course covered	0 (0%)	2 (4%)	19 (41%)	23 (50%)	3.48 / 4
i) The amount of time to train with an AM machine	4 (9%)	4 (9%)	6 (13%)	8 (17%)	2.82 / 4

Figure 9 : The level of satisfaction in CU27

Opinions of the students were asked to students to be rated as 1 to 4 as Strongly disagree, disagree, agree, strongly agree. The highest agreement was on the trainers being well prepared and showing a good understanding of the subject, the support provided by the trainers and a good management of questions and answers. The lowest agreement was on the space for active learning methodologies, such as problem-based learning, project-based learning, gamification, augmented reality, virtual reality, collaborative learning, etc.

	Strongly Disagree	*Disagree*	*Agree*	*Strongly Agree*	*Weighted Average*
The learning materials (i.e. slide shows, handbooks, videos, samples) were useful	*0*	*1*	*19*	*26*	*3.54*
The training sessions were quite dynamic, in the sense that they were engaging and involved interactive activities, instead of being just expositive)	*4*	*13*	*15*	*14*	*2.85*
The training sessions promoted the use of digital tools	*4*	*7*	*20*	*15*	*3.00*
There was space for active learning methodologies, such as problem-based learning, project-based learning, gamification, augmented reality, virtual reality, collaborative learning, etc.	*8*	*13*	*15*	*10*	*2.59*

The contact hours allocated to the course was adequate to the amount and nature of the course contents	*0*	*6*	*20*	*20*	*3.30*
There was a good balance of knowledge among the participants and no big discrepancies in the background knowledge were noticed	*1*	*3*	*24*	*18*	*3.28*
The trainer(s) showed a good performance (good time management, ability to communicate clearly)	*0*	*2*	*19*	*25*	*3.50*
The trainer(s) was well prepared and showed a good understanding of the subject	*1*	*0*	*17*	*28*	*3.57*
The support provided by the trainer(s) was good and a good management of questions and answers was done	*1*	*2*	*19*	*24*	*3.43*

Figure 10: Student opinions in CU27

The level of satisfaction was rated from 1 to 4 as poorly satisfied, not enough satisfied, enough satisfied and very satisfied. The results were quite high in the course regarding the three different aspects, as can be seen in Figure 11.

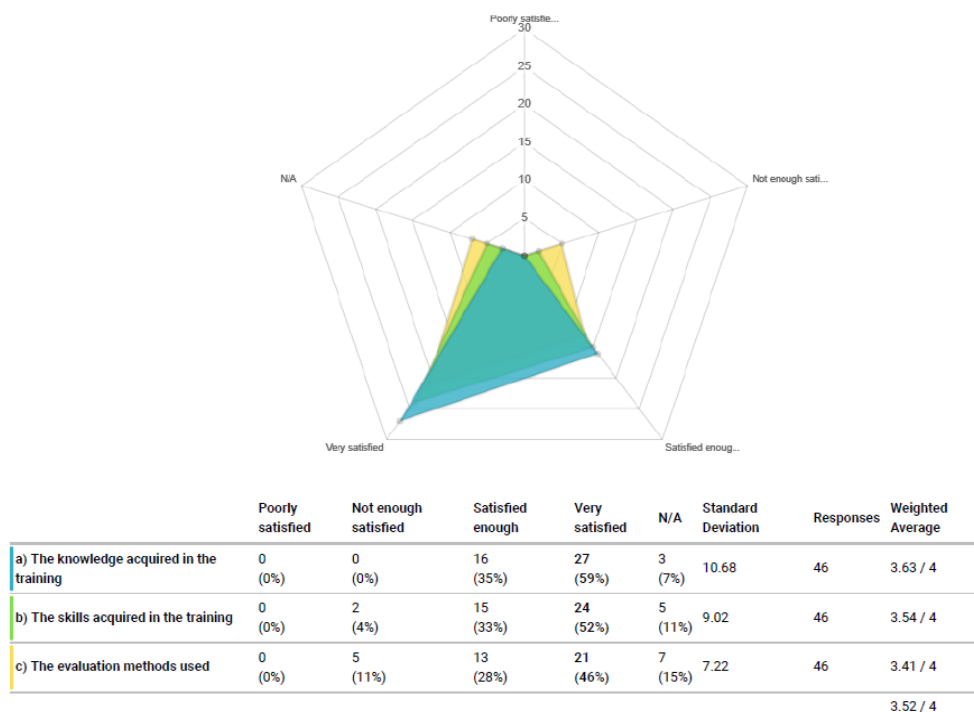|	Poorly satisfied	Not enough satisfied	Satisfied enough	Very satisfied	N/A	Standard Deviation	Responses	Weighted Average
a) The knowledge acquired in the training	0 (0%)	0 (0%)	16 (35%)	27 (59%)	3 (7%)	10.68	46	3.63 / 4
b) The skills acquired in the training	0 (0%)	2 (4%)	15 (33%)	24 (52%)	5 (11%)	9.02	46	3.54 / 4
c) The evaluation methods used	0 (0%)	5 (11%)	13 (28%)	21 (46%)	7 (15%)	7.22	46	3.41 / 4
								3.52 / 4

Figure 11:: The level of satisfaction in CU27

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The expectations of the students were mostly satisfied in course CU27. 98% of the students replied that course has met their expectations, and 96% of the students replied that they would recommend the course to others.

6.2.8. Feedback on CU30: AM with Nickel feedstock

The lecturers and participants of have taken separate surveys to have their feedback about the course. 3 responses in lecturers survey and 39 responses in students survey have been received and analyzed as below.

Of the 39 responses received for the **student** survey, 18% of the responses were from women and 82% were from men. The gender balance and age range is given in Figure 12: The gender balance and age range of students in CU30.

18% (7)	82% (32)		33% (13)	46% (18)	21% (8)	0% (0)
Female	Male		< 26	26 - 35	36 - 55	> 55
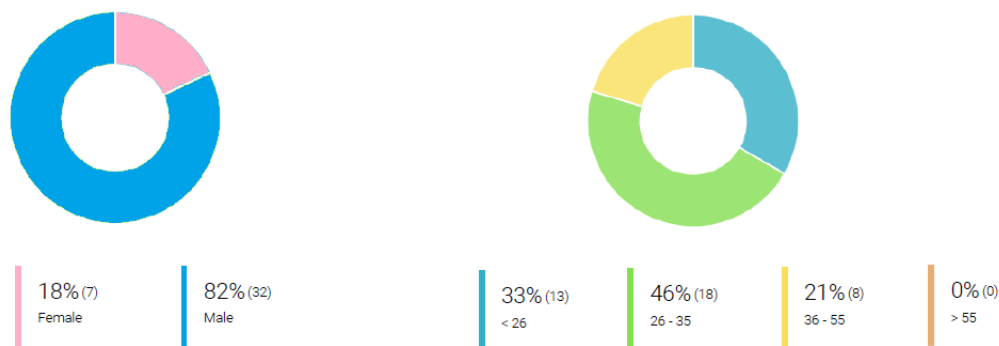
Figure 12: The gender balance and age range of students in CU30

The geographical distribution of attendees was in a wide range with more than 50% being out of Europe, mainly countries like Turkey, India and China. The main activity of the students were Aerospace (33%), Defense (23%), Automotive (13%), Industrial Equipment and Tooling (13%), and other (18%). The educational background of students were mainly engineers with and MS degree (59%), and PhD degree (31%) followed by BS degree (21%).

The level of satisfaction was quite high (3.32/4.00) with respect to several factors like the relevance of the course to job activities (3.62/4.00), The contents addressed during the course (3.58/4.00), and the structure of the course (3.53/4.00) (Figure 13: The level of satisfaction in CU30).

	Poorly satisfied	Not satisfied enough	Satisfied enough	Very satisfied	Weighted Average
a) The structure of the course	0 (0%)	1 (3%)	16 (41%)	21 (54%)	3.53 / 4
b) The contents addressed during the course	0 (0%)	2 (5%)	12 (31%)	24 (62%)	3.58 / 4
c) The coherence of the course with the training programme (was the order of contents presentation respected by the training provider?)	0 (0%)	2 (5%)	14 (36%)	21 (54%)	3.51 / 4
d) The number of contact hours	0 (0%)	7 (18%)	10 (26%)	21 (54%)	3.37 / 4
e) The balance between theoretical and practical training	1 (3%)	6 (15%)	14 (36%)	9 (23%)	3.03 / 4
f) The number of contact hours allocated to practical training	2 (5%)	6 (15%)	8 (21%)	12 (31%)	3.07 / 4
g) The relevance of the course to your job activities	0 (0%)	1 (3%)	12 (31%)	24 (62%)	3.62 / 4
h) The match between learning outcomes foreseen for the course and what the course covered	0 (0%)	4 (10%)	13 (33%)	21 (54%)	3.45 / 4
i) The amount of time to train with an AM machine	6 (15%)	1 (3%)	9 (23%)	7 (18%)	2.74 / 4

Figure 13: The level of satisfaction in CU30

Opinions of the students were asked to students to be rated as 1 to 4 as "Strongly disagree", "disagree", "agree", "strongly agree". The highest agreement was on the trainers being well prepared and showing a good understanding of the subject, the support provided by the trainers and a good management of questions and answers. The lowest agreement was on the space for active learning methodologies, such as problem-based learning, project-based learning, gamification, augmented reality, virtual reality, collaborative learning, etc.

	Strongly Disagree	Disagree	Agree	Strongly Agree	Weighted Average
The learning materials (i.e. slide shows, handbooks, videos, samples) were useful	0	0	18	21	3.54
The training sessions were quite dynamic, in the sense that they were engaging and involved interactive activities, instead of being just expositive)	5	6	20	8	2.79
The training sessions promoted the use of digital tools	2	9	12	16	3.08
There was space for active learning methodologies, such as problem-based learning, project-based learning, gamification, augmented reality, virtual reality, collaborative learning, etc.	6	10	16	7	2.62
The contact hours allocated to the course was adequate to the amount and nature of the course contents	1	7	21	10	3.03

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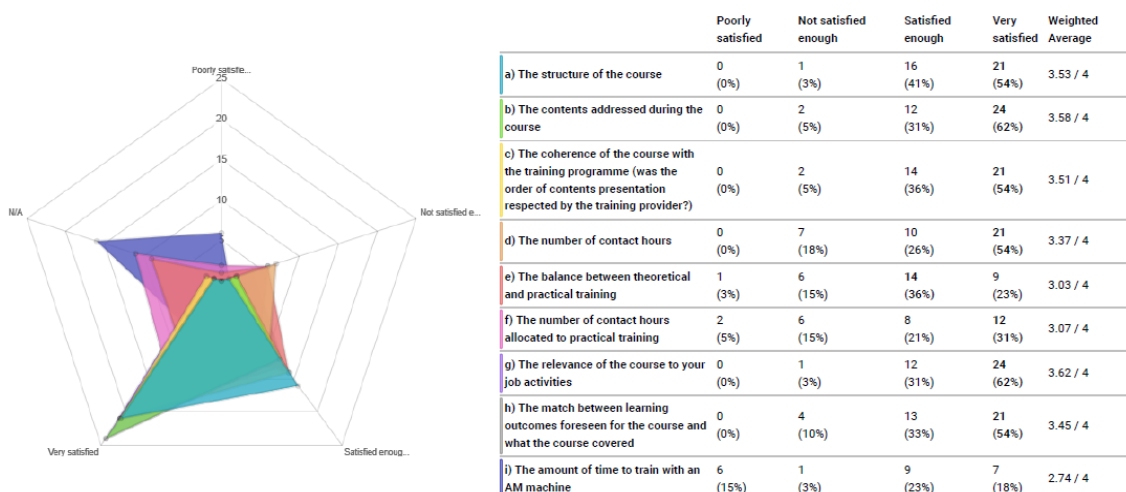*Project No. 601217-EPP-1-2018-1-BE-EPPKA2-SSA-B*

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There was a good balance of knowledge among the participants and no big discrepancies in the background knowledge were noticed	2	7	14	16	3.13
The trainer(s) showed a good performance (good time management, ability to communicate clearly)	1	1	16	21	3.46
The trainer(s) was well prepared and showed a good understanding of the subject	0	2	13	24	3.56
The support provided by the trainer(s) was good and a good management of questions and answers was done	0	2	13	24	3.56

The level of satisfaction was rated from 1 to 4 as "poorly satisfied", "not enough satisfied", "enough satisfied" and "very satisfied". The results were quite high in the course regarding the three different aspects, as can be seen in Figure 14: The level of satisfaction in CU30.

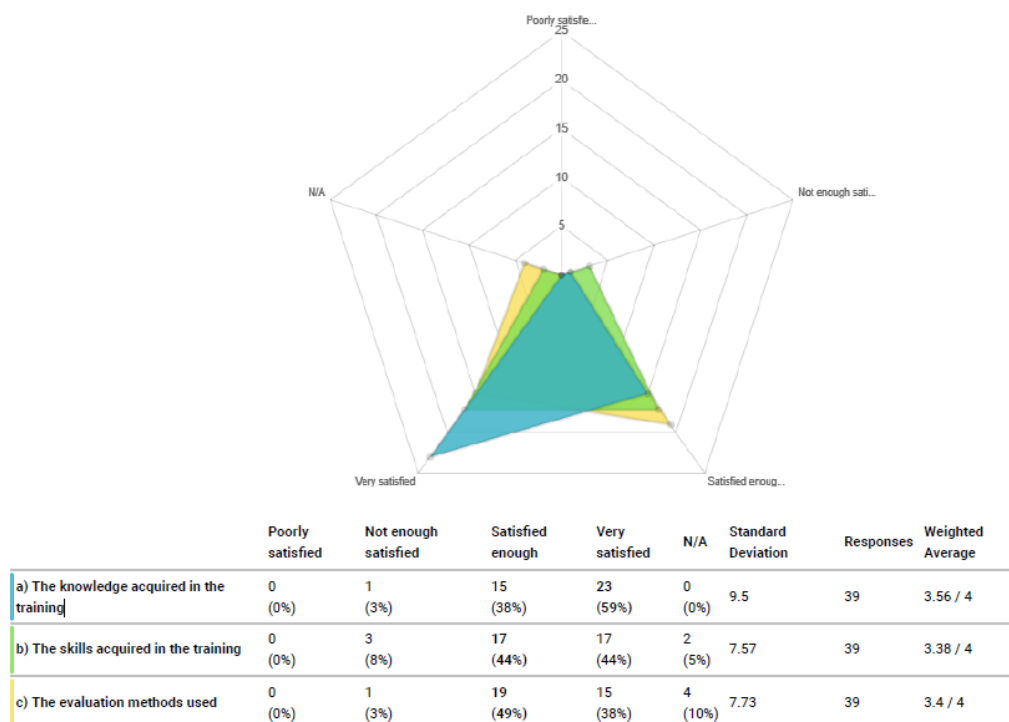|	Poorly satisfied	Not enough satisfied	Satisfied enough	Very satisfied	N/A	Standard Deviation	Responses	Weighted Average
a) The knowledge acquired in the training	0 (0%)	1 (3%)	15 (38%)	23 (59%)	0 (0%)	9.5	39	3.56 / 4
b) The skills acquired in the training	0 (0%)	3 (8%)	17 (44%)	17 (44%)	2 (5%)	7.57	39	3.38 / 4
c) The evaluation methods used	0 (0%)	1 (3%)	19 (49%)	15 (38%)	4 (10%)	7.73	39	3.4 / 4

Figure 14: The level of satisfaction in CU30

The expectations of the students were mostly satisfied in course CU30. 90% of the students replied that course has met their expectations, and 97% of the students replied that they would recommend the course to others.

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Three **lecturers** of the course CU30 have participated in the feedback survey. Regarding general aspects, all three lecturers say that they are very satisfied by the training provider staff, and the infrastructure conditions provided by the training institution (Figure 15: The level of satisfaction of trainers in CU30).
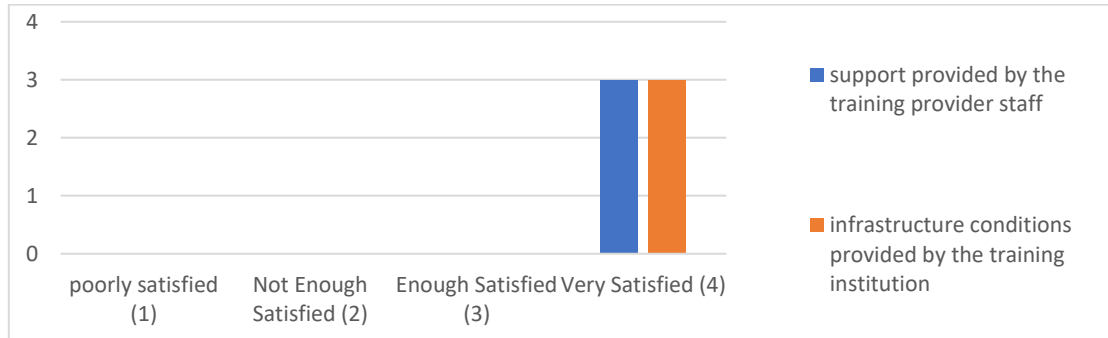

Figure 15: The level of satisfaction of trainers in CU30

Concerning the training programme, the lecturers were most satisfied with the established contact hours and least satisfied with the balance between theoretical and practical training (Figure 16: The level of satisfaction of trainers about the training program in CU30).
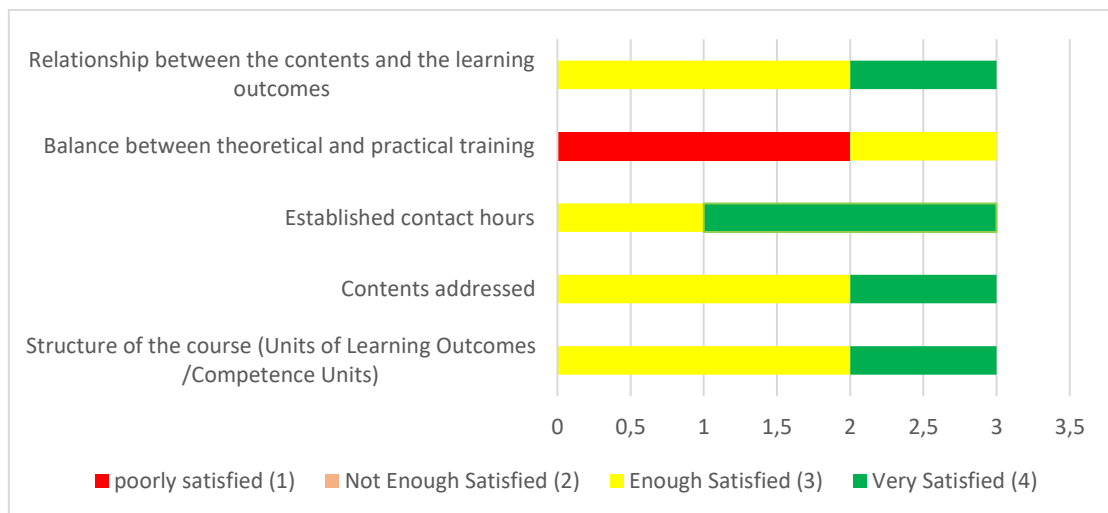

Figure 16: The level of satisfaction of trainers about the training program in CU30

The lecturers were asked to remark 3 positive aspects of the training course. The responses of each trainer is given below in Table 3: The positive aspects in CU30 according to the trainers.

Ozgur Poyraz	"The online course made it easy for participants from different countries to access the course."	"The time planned for the course was sufficient for the subjects on additive manufacturing of nickel alloys."	"In all sessions of the course on AM of nickel alloys, the participants were interested and contributed to the topic with interesting questions."

Caner Simsir	"The trainings are, in general, well-oriented and well-organized."	"The participation and the reaction of the participants to the training was quite positive."	"The time spent on each module is well balanced."
Evren Yasa	"The audience was a very targeted group of people really interested in AM of nickel superalloys with some background. This increased the quality of the questions asked in the training course."	"It was a pity that the course had to be given as online sessions but I believe this increased the interest and attendance from many different countries."	"The time spent on each module is well balanced."

Table 3: The positive aspects in CU30 according to the trainers

The lecturers were asked to declare what other aspects of the course learning programme that could be improved. Individual answers are as follows:

Trainer 1:

"Due to the fact that the course program was determined before the training materials were prepared, the preparation process of the training was somewhat limited."
"In the planning of the course, welding of nickel alloys was taken as a basis, and some topics that were not so priority for additive manufacturing were included in the plan."

Trainer 2:

"If all courses related with AM of steels (including stainless steels) are conducted by the same instructors in the same package, the consistency of the training can be improved. This will also reduce repetitions."

Trainer 3:

"The content of the courses given by the module description was targeted towards welding but a bit misoriented towards additive manufacturing. Although there are many similarities between welding and AM, there are also differences as well. Thus, the content should take AM aspects more into account."
"Regarding the assessment, I personally believe 3 chances are too many. After the assessment, one chance for a make-up is reasonable."

The lecturers were asked to grade their level of satisfaction concerning the training sessions and achieved results. The level of satisfaction is rated from 1 to 4 as "poorly satisfied", "not enough satisfied", "enough satisfied" and "very satisfied". The results are shown below in Figure 17: The satisfaction level of trainers on the training sessions and achieved results:
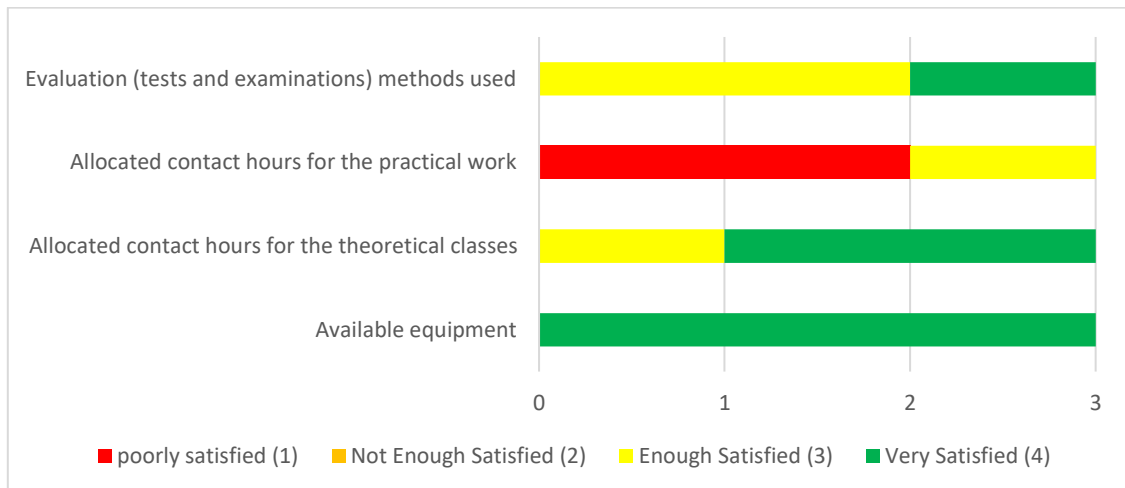
Figure 17: The satisfaction level of trainers on the training sessions and achieved results

Finally, trainers were asked for any other aspects that they would like to refer. Two trainers have given a response. Their individual answers are as follows.

"The course did not include any practical work. In this regard, my answers should be as -not applicable- with respect to some of the questions."

"Since the courses took place as online sessions, there was no practical work related to this module."

6.2.9. Feedback on CU31: Additive Manufacturing with Titanium Feedstock

Out of the 16 students, 3 were feminine (19%) and 13 masculine (81%). 94% of the students were younger than 26 years and 6% (1) was between age 26-35. All students are from Spain (100%). All students had a pre-education as Engineers (100%).

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5 ¿Cuál es el sector principal en el que se focaliza su organización?(más de una respuesta es posible)

13% (2) Aeroespacial	**25%** (4) Automoción	**0%** (0) Defensa	**0%** (0) Consumo
0% (0) Construcción	**13%** (2) Energía	**0%** (0) Salud	**13%** (2) Equipo y utillaje industrial
44% (7) En este momento, no estoy trabajando en ninguna organización	**38%** (6) Otro (por favor, especifique)		
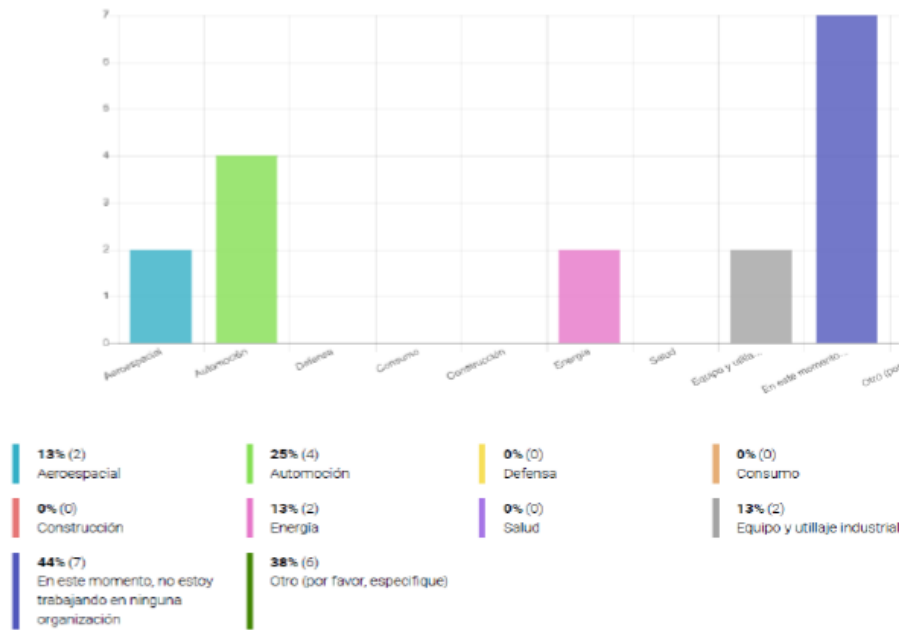
Ilustración 7 - Question for Students: In which sector is your company specialised?

As can be seen from question 5, 13% of the students have been involved in aerospace, another 13% have been involved in energy and another 13% in tooling/utilities manufacturing. 25% in automotive and 38% have stated that they are working in other sectors. 44% of the students have answered that they are currently not involved in any company.

The experience in AM of the students can be clustered as follows: 62,5% had no previous experience with AM. 6,25% had previous experience with valve manufacturing. Another 6,25% worked as a project engineer for industrial plants in water management. 6,25% worked as part of a Master project on surfboard manufacturing and 6,25% had experience from previous lectures throughout their mechanical engineering studies and practical work. 6,25% had worked in FDM investigation and worked 2 years in a company working with FDM.

The course was 94% in person. One person stated bi-learning. The students stated that they have been 11 hours in contact with the professor.

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Satisfaction with the training conditions:

	Nada satisfecho	Poco satisfecho	Suficientemente satisfecho	Muy satisfecho	N/A	Standard Deviation	Responses	Weighted Average
a) La infraestructura proporcionada por la entidad de formación	0 (0%)	0 (0%)	5 (31%)	11 (69%)	0 (0%)	4.35	16	3.69 / 4
b) El apoyo proporcionado por el personal (distinto de los formadores)	0 (0%)	0 (0%)	5 (31%)	10 (63%)	1 (6%)	3.87	16	3.67 / 4
c) La claridad/comunicación de los objetivos y resultados de aprendizaje del curso	0 (0%)	0 (0%)	5 (31%)	11 (69%)	0 (0%)	4.35	16	3.69 / 4
d) Los canales de comunicación usados durante la formación	0 (0%)	1 (6%)	4 (25%)	11 (69%)	0 (0%)	4.17	16	3.63 / 4
e) El equipo usado en la formación práctica	0 (0%)	5 (31%)	4 (25%)	7 (44%)	0 (0%)	2.79	16	3.13 / 4
								3.56 / 4

Ilustración 8 - Question for Students: Satisfaction with the training conditions

Out of 16 students, 10-11 (around 67%) were mostly very satisfied in terms of infrastructure, support via the trainer, communication between participants and trainer and communication channels. The rest of the students 4-5 (around 27%) were sufficiently satisfied. The only thing that participants noted is the lack of practical equipment in the sessions. Here, only 44% showed a high satisfaction, whereas 31% were only minor satisfied.

Satisfaction with the course:

	Nada satisfecho	Poco satisfecho	Suficientemente satisfecho	Muy satisfecho	N/A	Standard Deviation	Responses	Weighted Average
a) La estructura del curso	0 (0%)	1 (6%)	6 (38%)	9 (56%)	0 (0%)	3.66	16	3.5 / 4
b) Los contenidos abordados durante el curso	0 (0%)	0 (0%)	6 (38%)	10 (63%)	0 (0%)	4.12	16	3.63 / 4
c) La coherencia del curso respecto el programa de formación (¿el formador respetó el orden de presentación de los contenidos?)	0 (0%)	0 (0%)	4 (25%)	12 (75%)	0 (0%)	4.66	16	3.75 / 4
d) El número de horas de contacto	0 (0%)	3 (19%)	10 (63%)	3 (19%)	0 (0%)	3.66	16	3 / 4
e) El equilibrio entre formación teórica y práctica	2 (13%)	9 (56%)	3 (19%)	1 (6%)	1 (6%)	2.99	16	2.2 / 4
f) El número de horas de contacto asignadas a la formación práctica	3 (19%)	6 (38%)	4 (25%)	2 (13%)	1 (6%)	1.72	16	2.33 / 4
g) La relevancia del curso para sus actividades laborales	0 (0%)	2 (13%)	8 (50%)	6 (38%)	0 (0%)	3.25	16	3.25 / 4
h) La correspondencia entre los resultados de aprendizaje previstos para el curso y lo que cubrió el curso	0 (0%)	1 (6%)	8 (50%)	7 (44%)	0 (0%)	3.54	16	3.38 / 4
i) La cantidad de tiempo para formarse con una impresora 3D	4 (25%)	7 (44%)	3 (19%)	1 (6%)	1 (6%)	2.23	16	2.07 / 4
								3.01 / 4

Ilustración 9 - Question for students: Course satisfaction

In terms of satisfaction with the overall course, 9 (56%) to 10 (63%) of the participants stated that the course structure has been appropriate as well as the contents. With regards of coherence of the course 75% were very satisfied.

However, the number of contact hours only medium satisfied 63% of the students, with 19% stating that it was too low. This result is further expanded when looking at the equilibrium between theory and practical work (d)) and the assigned hours for practical work (e)): 69% were only little or not satisfied with the equilibrium. 57% were unhappy with the assigned hours. Again, 69% were also not satisfied with the time spend on a printer (question i)).

In terms of relevance for working life and balance between pre-knowledge and coverage of topics, nearly all students 88% and 94% were medium or very satisfied.

Satisfaction with the training sessions:

	Totalmente en desacuerdo	Relativamente en desacuerdo	Relativamente de acuerdo	Totalmente de acuerdo	Standard Deviation	Responses	Weighted Average
a) Los materiales de aprendizaje (es decir, presentaciones de diapositivas, manuales, videos, muestras) fueron útiles	0 (0%)	0 (0%)	9 (56%)	7 (44%)	4.06	16	3.44 / 4
b) Las sesiones de formación fueron bastante dinámicas, (en el sentido de que fueron atractivas e involucraron actividades interactivas, en lugar de ser solo expositivas)	1 (6%)	2 (13%)	8 (50%)	5 (31%)	2.74	16	3.06 / 4
c) Las jornadas de formación promovieron el uso de herramientas digitales	0 (0%)	2 (13%)	9 (56%)	5 (31%)	3.39	16	3.19 / 4
d) Hubo espacio para metodologías de aprendizaje activo, como el aprendizaje basado en problemas, el aprendizaje basado en proyectos, la gamificación, la realidad aumentada, la realidad virtual, el aprendizaje colaborativo, etc.	2 (13%)	4 (25%)	8 (50%)	2 (13%)	2.45	16	2.63 / 4
e) Las horas presenciales asignadas al curso fueron adecuadas a la cantidad y naturaleza de los contenidos del curso	0 (0%)	2 (13%)	7 (44%)	7 (44%)	3.08	16	3.31 / 4
f) Hubo un buen equilibrio de conocimientos entre los participantes y no se notaron grandes discrepancias en los conocimientos previos	0 (0%)	1 (6%)	10 (63%)	5 (31%)	3.94	16	3.25 / 4
g) El (los) formador(es) se desempeñó/ desempeñaron adecuadamente (buena gestión del tiempo, capacidad para comunicarse con claridad)	0 (0%)	0 (0%)	8 (50%)	8 (50%)	4	16	3.5 / 4
h) El (los) formador(es) estaba(n) bien preparados y mostraron una buena comprensión del tema	0 (0%)	0 (0%)	5 (31%)	11 (69%)	4.53	16	3.69 / 4
i) El apoyo brindado por el(los) formador(es) fue bueno y se realizó una buena gestión de preguntas y respuestas	0 (0%)	0 (0%)	7 (44%)	9 (56%)	4.06	16	3.56 / 4

3.29 / 4

Ilustración 10 - Question for Students: Satisfaction for the training

All participants were medium to very satisfied with the learning material used in this CU and 14 participants were also satisfied with the digital content. In terms of dynamics of the lesson, 50% were medium satisfied and 19% (3 students) were not or little satisfied.

For question d) in which active learning should be rated, only 50% were medium satisfied and 38% were little or not satisfied.

In terms of rating the trainer, participants were medium or very satisfied (up to 69% acceptance in terms of knowledge and 56% for learning support).

Overall efficiency of the course provided:

	Nada satisfecho	Poco satisfecho	Suficientemente satisfecho	Muy satisfecho	N/A	Standard Deviation	Responses	Weighted Average
a) El conocimiento adquirido en la formación	0 (0%)	0 (0%)	7 (44%)	9 (56%)	0 (0%)	3.97	16	3.56 / 4
b) Las habilidades adquiridas en la formación	0 (0%)	1 (6%)	7 (44%)	8 (50%)	0 (0%)	3.54	16	3.44 / 4
c) La metodología de evaluación utilizada	0 (0%)	0 (0%)	7 (44%)	9 (56%)	0 (0%)	3.97	16	3.56 / 4
								3.52 / 4

Ilustración 11 - Question for Students: overall efficiency of the provided course?

All three questions above (learning outcomes, competencies and evaluation method) have been rated medium and very satisfying (94%).

Expectations and recommendation:
- 100% were satisfied with the course (question 15) and also 100% would also recommend this course.

What were the most positive aspects?
- Knowledge about Titanium and its alloys in AM, usage and applications.
- Quality.
- Course coverage.
- New topics.

What were the most negative aspects?
- No time to do practical work.
- Amount of hours theoretical/practical.
- Lack of samples.
- Very theoretical.
- Lack of practical work.

Additional comments:
- None

Analysis of the results:

The participants were in total very happy with the course structure and stated that all important aspects of Titanium and its alloys were covered. Hence, 100% would recommend this course. What has been seen for CU00, can be seen here as well: the lack of hours assigned for practical work has been too low as well as the utensils used in the course in order to let participants see real-world examples. In terms of the utensils used, that really is a lesson-learned for the teacher and can be easily fixed. Here, it is interesting to the see the forces due to heat input on a titanium part or the ripping of support structure as well as the different surfaces. With respect to practical

work, it would be interesting to see what participants want. Watching a PBF machine building a part in titanium is not the most interesting thing to see and it has been seen a lot that learners are somewhat disappointed because the process in itself is not the most excited process. However, expanding the hours in order to include active engagement of the group such as the design of a part as well as the usage of utensils may decrease the lack of practical work.

6.2.10. Feedback on CU34: Process Selection

This course had 13 students that all answered this survey. Most of the students were male (92%) and they were between 26 and 35 years old. All were Master students of Industrial Engineering, most of them (85%) were not working at any organization when this pilot study was conducted. All had only basic or no knowledge on AM when entering this course.

In overall, the result showed a high level of satisfaction with the trainers, the "training conditions", "course", and "training session", also the evaluation score of "course effectiveness" was high. The students had a slightly lower level of satisfaction according to the "balance between theoretical and practical training" and "The amount of time to train with an AM machine", which might be caused by the virtual piloting event (due to COVID-19). The course included several videos and some examples and case studies of AM applications and process. Anyhow, it could not satisfy the expectations of students, observing different real AM processes and practicing with AM machines, as they identified a "lack of practical activities" as aspect to improve for future implementations.

However, the results indicated that students were more satisfied with knowledge they had learnt than skills they had acquired. They highlighted the gained knowledge and the expertise trainers as most positive aspect of the course. This course met the expectations of 12 students (92%); the one who answered "No" to this item explained that he/she expected an in-person course, having hands on experience and practical activities.

The results of the feedback survey of the three trainers showed, that they were satisfied with the course in general. They valued the diversity of content, the students' engagement und the broad overview on the AM process and decision-making processes. It was suggested to increase the amount of practical activities and group discussions for future implementations as the engagement and attention of students seemed decreased as well as to allocate the contact hours and the evaluation method.

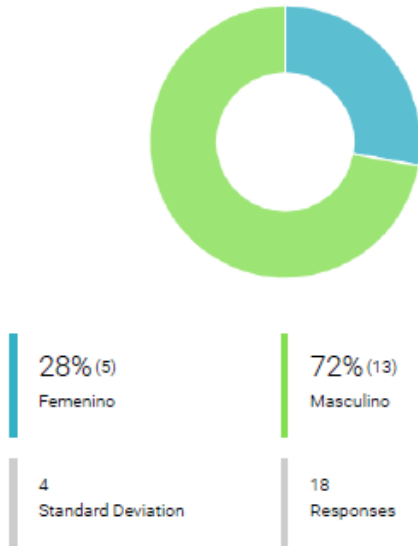### 6.2.11. Feedback on CU35: Metal AM integration

Results:

2. Please select the gender you identify better with (for gender balance reporting duties, only)

3. Please select the age range you are in
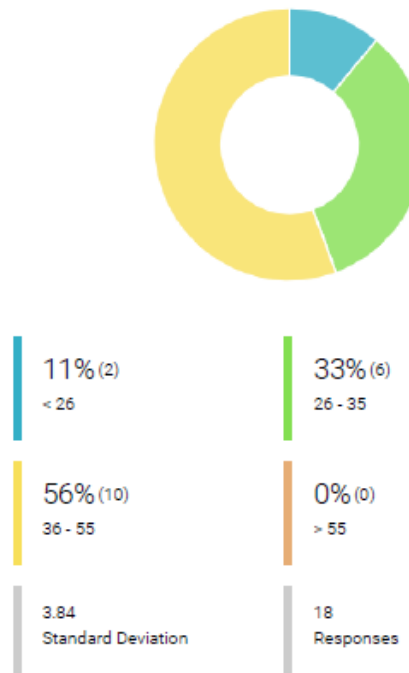
WP5 Pilot Activities Report
Qualification/Professional Profile: Process Engineer PBF-LB | 2 Competence Units: Metal AM Designer
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2 Por favor, seleccione el género con el que se identifica (únicamente debido a la obligación de informar sobre el equilibrio de género)
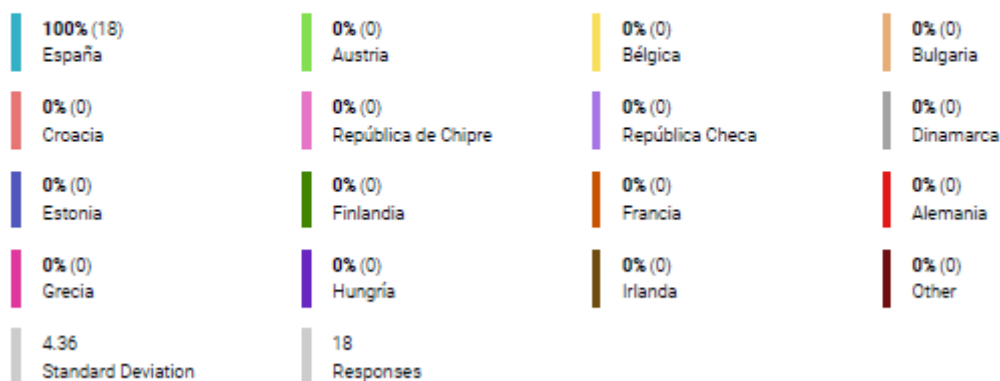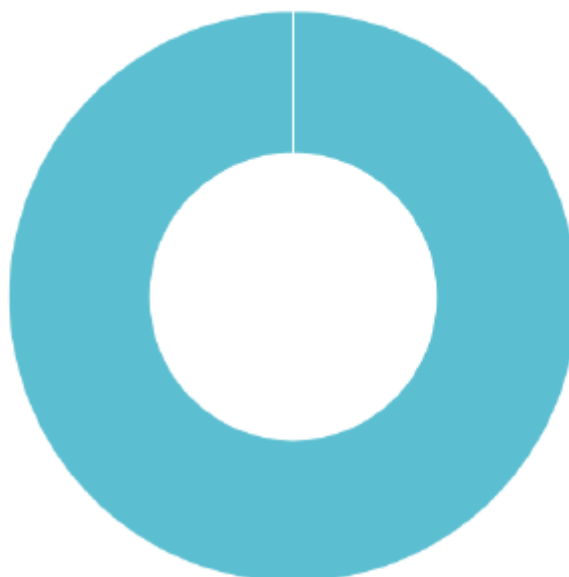
3 Por favor, seleccione su rango de edad:

28% (5)
Femenino

72% (13)
Masculino

4
Standard Deviation

18
Responses

11% (2)
< 26

33% (6)
26 - 35

56% (10)
36 - 55

0% (0)
> 55

3.84
Standard Deviation

18
Responses

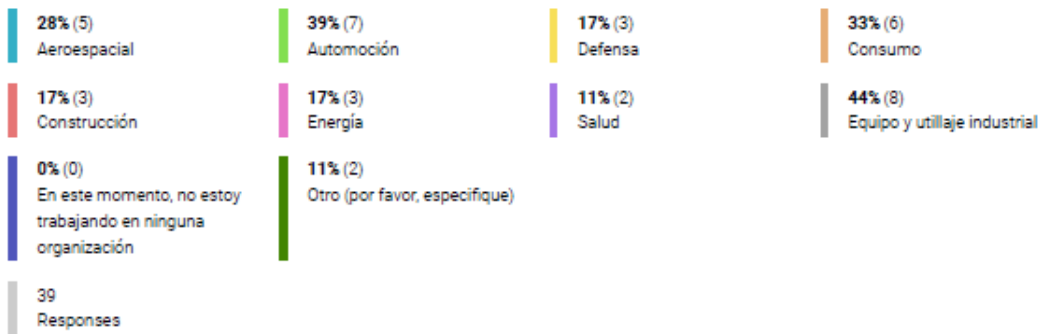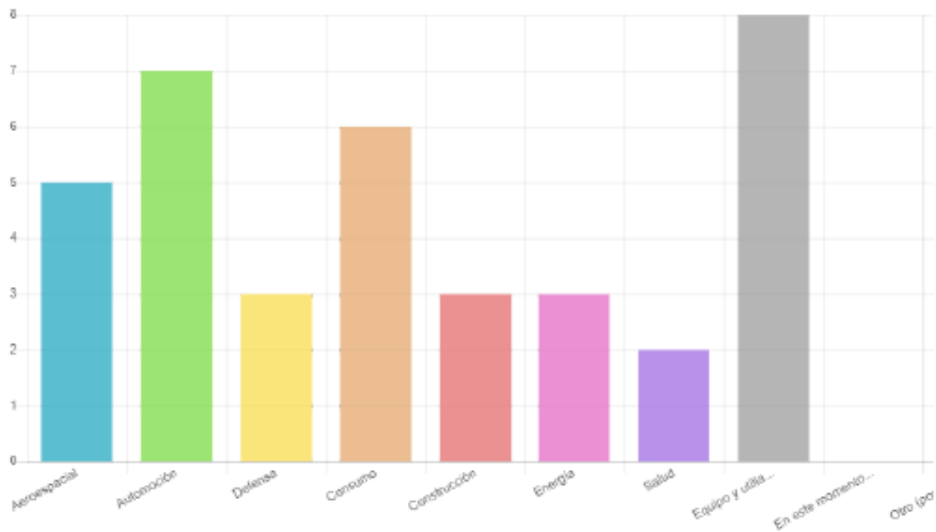4. In which country is your AM training course taking place?

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4 ¿En qué país ha tenido lugar su actividad formativa en FA?

100% (18) España	**0%** (0) Austria	**0%** (0) Bélgica	**0%** (0) Bulgaria
0% (0) Croacia	**0%** (0) República de Chipre	**0%** (0) República Checa	**0%** (0) Dinamarca
0% (0) Estonia	**0%** (0) Finlandia	**0%** (0) Francia	**0%** (0) Alemania
0% (0) Grecia	**0%** (0) Hungría	**0%** (0) Irlanda	**0%** (0) Other
4.36 Standard Deviation	18 Responses		

5. What is the main activity/sector of your organisation?

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5 ¿Cuál es el sector principal en el que se focaliza su organización?(más de una respuesta es posible)

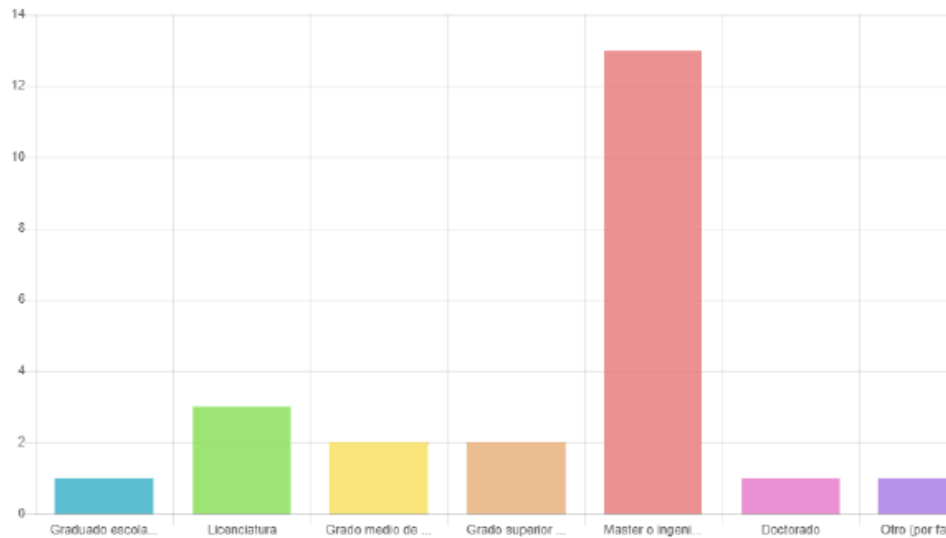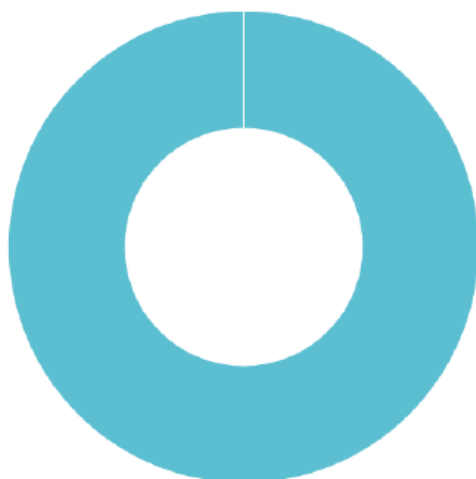|	
28% (5) Aeroespacial	**39%** (7) Automoción
17% (3) Defensa	**33%** (6) Consumo
17% (3) Construcción	**17%** (3) Energía
11% (2) Salud	**44%** (8) Equipo y utillaje industrial
0% (0) En este momento, no estoy trabajando en ninguna organización	**11%** (2) Otro (por favor, especifique)

39
Responses

Food packaging

Robotica

6. What is your Education background?

6 ¿Cuál es su formación académica?

6% (1) Graduado escolar	**17% (3)** Licenciatura	**11% (2)** Grado medio de Formación Profesional	**11% (2)** Grado superior de Formación Profesional
72% (13) Master o ingeniería	**6% (1)** Doctorado	**6% (1)** Otro (por favor, especifique)	
23 Responses			

Estudiando el doctorado

7 ¿Cuál es su experiencia profesional previa en Fabricación Aditiva?/ What is your professional background/previous additive manufacturing experience?

- Ninguna/None
- Impresoras libres y de Stratasys/ Free and Stratasys printers
- Post procesado de piezas de Impresión 3D/Post processing of 3D printing parts
- Mi empresa ha comprado una máquina SLM/ My company has purchased an SLM machine
- Una witbox./ a witbox
- No tengo/ None
- MUY POCA EXPERIENCIA PREVIA/ VERY LITTLE PREVIOUS EXPERIENCE
- Impresión 3D en plástico/Plastic 3D printing
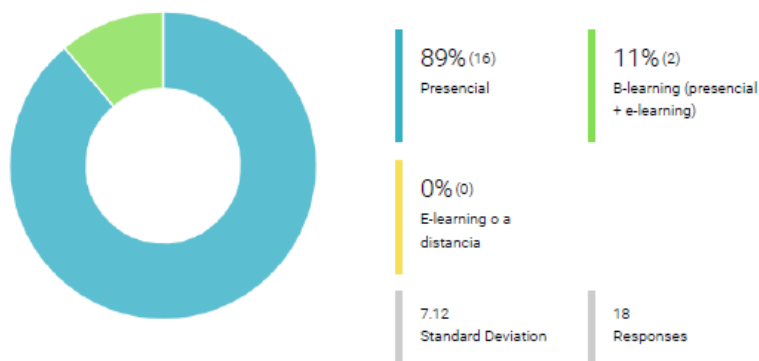- Ninguna/ None

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- Ninguna/ None
- Diseño de utillajes para realizar mediante fabricación aditiva/Design of tooling to be made by additive manufacturing
- Fabricación de utillajes/Tooling manufacturing
- Proyectos de robótica y aeroespacial para la CE/Robotics and aerospace projects for the EC
- USUARIO/User
- Conocimientos generales/General knowledge
- Poca experiencia previa/ Little previous experience
- He trabajado con impresoras 3D con termoplasticos/ I have worked with 3D printers with thermoplastics.
- Apoyo en diversos proyectos europeos/ Support in several European projects

8. Which pilot course did you attend?

8 ¿A qué curso piloto ha asistido?

100% (18)	0% (0)	0% (0)	0% (0)
CU 35: Metal AM integration	CU 00: Additive manufacturing Process Overview	CU 01: DED-Arc Process	CU 08: DED-LB Process
0% (0)	0% (0)	0% (0)	0% (0)
CU 15: PBF-LB Process	CU 25: Post Processing	CU 34: Process selection	CU 36: Coordination activities
0% (0)	0% (0)	0% (0)	0% (0)
CU 43: Production of PBF-LB parts	CU 44: Conformity of PBF-LB parts	CU 45: Conformity of facilities featuring PBF-LB	CU 26: Introduction to materials (optional)
0% (0)	0% (0)	0% (0)	0% (0)
CU 27: AM with steels feedstock (excluding Stainless Steel)	CU 28: AM with Stainless Steel feedstock	CU 30: AM with Nickel feedstock	Other
4.36	18		
Standard Deviation	Responses		

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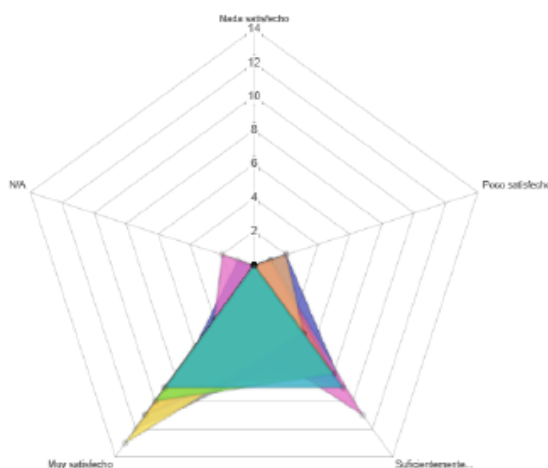*Project No. 601217-EPP-1-2018-1-BE-EPPKA2-SSA-B*

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9 ¿Cuántas horas presenciales incluía su curso? (es decir, cuántas horas ha estado en contacto directo con su profesor?/ How many contact hours were there in your course? (i.e., how many hours were there of contact with your trainer(s)?)

21

10. What was the regime in your course?

10   ¿Qué tipo de curso era?

89% (16)
Presencial

11% (2)
B-learning (presencial + e-learning)

0% (0)
E-learning o a distancia

7.12
Standard Deviation

18
Responses

11. How would you rate your level of satisfaction with...

11   Valore su nivel de satisfacción respecto a las siguientes condiciones

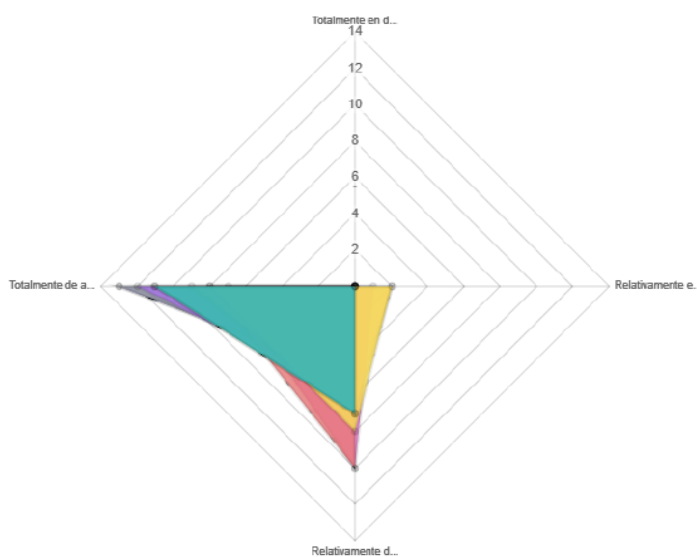|	Nada satisfecho	Poco satisfecho	Suficientemente satisfecho	Muy satisfecho	N/A	Standard Deviation	Responses	Weighted Average
a) La infraestructura proporcionada por la entidad de formación	0 (0%)	0 (0%)	4 (22%)	14 (78%)	0 (0%)	5.43	18	3.78 / 4
b) El apoyo proporcionado por el personal (distinto de los formadores)	0 (0%)	0 (0%)	8 (44%)	10 (56%)	0 (0%)	4.45	18	3.56 / 4
c) La claridad/comunicación de los objetivos y resultados de aprendizaje del curso	0 (0%)	0 (0%)	6 (33%)	12 (67%)	0 (0%)	4.8	18	3.67 / 4
d) Los canales de comunicación usados durante la formación	0 (0%)	0 (0%)	5 (28%)	13 (72%)	0 (0%)	5.08	18	3.72 / 4
e) El equipo usado en la formación práctica	0 (0%)	0 (0%)	6 (33%)	11 (61%)	1 (6%)	4.32	18	3.65 / 4
								3.67 / 4

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How would you rate your level of satisfaction with…	1. Poorly satisfied	2. Not satisfied enough	3. Satisfied enough	4. Very satisfied	n.a.
a) The infrastructure conditions provided by the training provider	❏	❏	❏	❏	❏
b) The support provided by the staff (other than trainers)	❏	❏	❏	❏	❏
c) The transparency/communication of the learning outcomes associated to the course	❏	❏	❏	❏	❏
d) The communication channels used during the training	❏	❏	❏	❏	❏
e) The equipment used in the practical training	❏	❏	❏	❏	❏

12. How would you rate your level of satisfaction with…

12 Valore su nivel de satisfacción respecto a…

	Nada satisfecho	Poco satisfecho	Suficientemente satisfecho	Muy satisfecho	N/A	Standard Deviation	Responses	Weighted Average
a) La estructura del curso	0 (0%)	0 (0%)	9 (50%)	9 (50%)	0 (0%)	4.41	18	3.5 / 4
b) Los contenidos abordados durante el curso	0 (0%)	0 (0%)	8 (44%)	10 (56%)	0 (0%)	4.45	18	3.56 / 4
c) La coherencia del curso respecto el programa de formación (¿el formador respetó el orden de presentación de los contenidos?)	0 (0%)	0 (0%)	5 (28%)	13 (72%)	0 (0%)	5.08	18	3.72 / 4
d) El número de horas de contacto	0 (0%)	2 (11%)	5 (28%)	11 (61%)	0 (0%)	4.13	18	3.5 / 4
e) El equilibrio entre formación teórica y práctica	0 (0%)	1 (6%)	8 (44%)	9 (50%)	0 (0%)	4.03	18	3.44 / 4
f) El número de horas de contacto asignadas a la formación práctica	0 (0%)	1 (6%)	11 (61%)	4 (22%)	2 (11%)	3.93	18	3.19 / 4
g) La relevancia del curso para sus actividades laborales	0 (0%)	1 (6%)	6 (33%)	11 (61%)	0 (0%)	4.32	18	3.56 / 4
h) La correspondencia entre los resultados de aprendizaje previstos para el curso y lo que cubrió el curso	0 (0%)	0 (0%)	6 (33%)	12 (67%)	0 (0%)	4.8	18	3.67 / 4
i) La cantidad de tiempo para formarse con una impresora 3D	0 (0%)	2 (11%)	9 (50%)	6 (33%)	1 (6%)	3.38	18	3.24 / 4
								3.49 / 4

How would you rate your level of satisfaction with...	1. Poorly satisfied	2. Not satisfied enough	3. Satisfied enough	4. Very satisfied	n.a.
a) The structure of the course	❏	❏	❏	❏	❏
b) The contents addressed during the course	❏	❏	❏	❏	❏
c) The coherence of the course with the training programme (was the order of contents presentation [foreseen in the ULO] respected by the training provider?)	❏	❏	❏	❏	❏
d) The number of contact hours	❏	❏	❏	❏	❏
e) The balance between theoretical and practical training	❏	❏	❏	❏	❏
f) The number of contact hours allocated to practical training	❏	❏	❏	❏	❏
g) The relevance of the course to your job activities	❏	❏	❏	❏	❏
h) The match between learning outcomes foreseen for the course and what the course covered	❏	❏	❏	❏	❏
i) The amount of time to train with an AM machine	❏	❏	❏	❏	❏

13. What is your opinion regarding the following statements?

13 ¿Cuál es su opinión respecto a las siguientes afirmaciones?
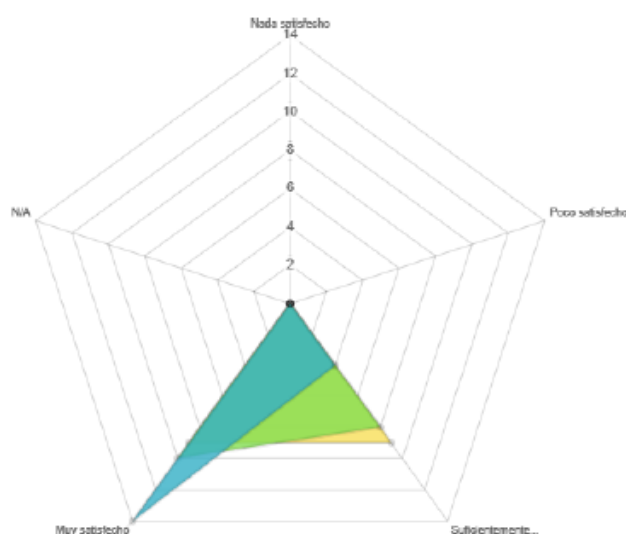
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	Totalmente en desacuerdo	Relativamente en desacuerdo	Relativamente de acuerdo	Totalmente de acuerdo	Standard Deviation	Responses	Weighted Average
a) Los materiales de aprendizaje (es decir, presentaciones de diapositivas, manuales, videos, muestras) fueron útiles	0 (0%)	0 (0%)	7 (39%)	11 (61%)	4.72	18	3.61 / 4
b) Las sesiones de formación fueron bastante dinámicas, (en el sentido de que fueron atractivas e involucraron actividades interactivas, en lugar de ser solo expositivas)	0 (0%)	0 (0%)	7 (39%)	11 (61%)	4.72	18	3.61 / 4
c) Las jornadas de formación promovieron el uso de herramientas digitales	0 (0%)	2 (11%)	8 (44%)	8 (44%)	3.57	18	3.33 / 4
d) Hubo espacio para metodologías de aprendizaje activo, como el aprendizaje basado en problemas, el aprendizaje basado en proyectos, la gamificación, la realidad aumentada, la realidad virtual, el aprendizaje colaborativo, etc.	0 (0%)	2 (11%)	7 (39%)	9 (50%)	3.64	18	3.39 / 4
e) Las horas presenciales asignadas al curso fueron adecuadas a la cantidad y naturaleza de los contenidos del curso	0 (0%)	0 (0%)	10 (56%)	8 (44%)	4.56	18	3.44 / 4
f) Hubo un buen equilibrio de conocimientos entre los participantes y no se notaron grandes discrepancias en los conocimientos previos	0 (0%)	1 (6%)	10 (56%)	7 (39%)	4.15	18	3.33 / 4
g) El (los) formador(es) se desempeñó/ desempeñaron adecuadamente (buena gestión del tiempo, capacidad para comunicarse con claridad)	0 (0%)	0 (0%)	6 (33%)	12 (67%)	4.97	18	3.67 / 4
h) El (los) formador(es) estaba(n) bien preparados y mostraron una buena comprensión del tema	0 (0%)	0 (0%)	5 (28%)	13 (72%)	5.32	18	3.72 / 4
i) El apoyo brindado por el(los) formador(es) fue bueno y se realizó una buena gestión de preguntas y respuestas	0 (0%)	0 (0%)	5 (28%)	13 (72%)	5.32	18	3.72 / 4

3.54 / 4

What is your opinion regarding the following statements?	1. Strongly disagree	2. Somewhat disagree	3. Somewhat agree	4. Strongly agree
a) The learning materials (i.e. slide shows, handbooks, videos, samples) were useful	❏	❏	❏	❏
b) The training sessions were quite dynamic, in the sense that they were engaging and involved interactive activities, instead of being just expositive)	❏	❏	❏	❏
c) The training sessions promoted the use of digital tools	❏	❏	❏	❏
d) There was space for active learning methodologies, such as problem-based learning, project-based learning, gamification, augmented reality, virtual reality, collaborative learning, etc.	❏	❏	❏	❏
e) The contact hours allocated to the course was adequate to the amount and nature of the course contents	❏	❏	❏	❏
f) There was a good balance of knowledge among the participants and no big discrepancies in the background knowledge were noticed	❏	❏	❏	❏
g) The trainer(s) showed a good performance (good time management, ability to communicate clearly)	❏	❏	❏	❏
h) The trainer(s) was well prepared and showed a good understanding of the subject	❏	❏	❏	❏
i) The support provided by the trainer(s) was good and a good management of questions and answers was done	❏	❏	❏	❏

14. How would you rate your level of satisfaction with…

14 Defina su nivel de satisfacción con respecto a…

	Nada satisfecho	Poco satisfecho	Suficientemente satisfecho	Muy satisfecho	N/A	Standard Deviation	Responses	Weighted Average
a) El conocimiento adquirido en la formación	0 (0%)	0 (0%)	4 (22%)	14 (78%)	0 (0%)	5.43	18	3.78 / 4
b) Las habilidades adquiridas en la formación	0 (0%)	0 (0%)	8 (44%)	10 (56%)	0 (0%)	4.45	18	3.56 / 4
c) La metodología de evaluación utilizada	0 (0%)	0 (0%)	9 (50%)	9 (50%)	0 (0%)	4.41	18	3.5 / 4
								3.61 / 4

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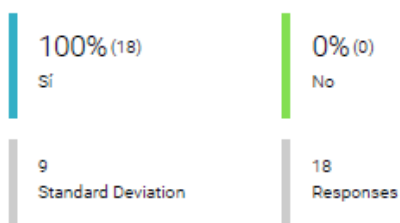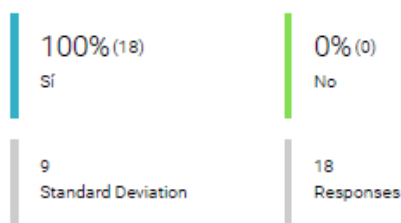Qualification/Professional Profile: Process Engineer PBF-LB | 2 Competence Units: Metal AM Designer
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How would you rate your level of satisfaction with...	1. Poorly satisfied	2. Not enough satisfied	3. Satisfied enough	4. Very satisfied	n.a.
a) The knowledge acquired in the training	❑	❑	❑	❑	❑
b) The skills acquired in the training	❑	❑	❑	❑	❑
c) The evaluation methods used	❑	❑	❑	❑	❑

15 ¿Ha satisfecho el curso sus expectativas?   **16** ¿Recomendaría este curso

100% (18) Sí	0% (0) No
9 Standard Deviation	18 Responses

100% (18) Sí	0% (0) No
9 Standard Deviation	18 Responses

15. and 16. Closure	YES	NO
a) Did the course meet your expectations?	❑	❑
b) Would you recommend this course to others?	❑	❑

17 ¿Cuál fue el aspecto más positivo del curso? ¿Por qué?/ What was the most positive aspect of the training course? Why?

- Contenido/ Contents
- Las actividades en grupo. Aprendes y son más entretenidas/ Team activities. You learn more and are more entertaining
- Es un tema diferente al de cursos anteriores y eso es interesante/ It is a different topic from previous courses and that is interesting
- Que es presencial, y eso ayuda mucho para cuestiones muy tecnológicas/ That it is face-to-face, and that helps a lot for very technological issues
- La visita a las instalaciones/ The visit to the facilities.
- No conocía estas aplicaciones de impresión 3D/ I did not know about these 3D printing applications
- Adentrarme en un ámbito totalmente desconocido, pero tan relevante de cara al futuro de la industria/ Knowing a totally unknown field, but so relevant for the future of the industry
- Presencial/On site
- La combinación teórico-práctica/ The theoretical-practical combination.
- El nivel del profesorado/ The level of the teachers

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- TEMARIO Y PROFESORADO/ AGENDA AND TEACHERS
- Curso muy práctico, con muchos ejemplos/ Very practical course, with many examples
- El profesorado/Teachers

18 ¿Cuál fue el aspecto menos positivo del curso? ¿Por qué?/ What was the less positive aspect of the training course? Why?

- Falta de horas practicas/ Lack of practical hours
- Es más aburrido que el otro o a mi me interesa menos/ It is more boring than the other course or I am less interested Algunos aspectos son aburridos/ Some aspects are boring
- A veces se hacen muy largos/ Sometimes the contents get very long
- Un poco demasiado teórico/ A little too theoretical.
- Veo el otro curso más adecuado para mi trabajo/ I see the other course more suitable for my job.

19. Comentarios adicionales y sugerencias/ Further comments and suggestions:

- ¿Se podrían hacer visitas a otras empresas?/ Would it be possible to visit other companies?
- Realizar prácticas reales con máquinas industriales/ Carry out real practices with industrial machines.
- Recomendable para todas aquellas personas que quieran profundizar en conocimientos específicos sobre la Fabricación Aditiva/ Recommended for all those who want to deepen in specific knowledge about Additive Manufacturing.
- RECOMENDABLE/Highly recommended

Analysis of results:

In the CU35 course take part 28% women (5) and 72% **men** (13). 89 % of participants are in the **age range** 26-55. The course was done in **Spain**, in AITIIP facilities. The most of participants defined their company's sector as **Industrial equipment** and tooling (44%) and **automotive** (39%). Jointly the sector mentioned in the questions, participants also mentioned robotics. The **education background** is mainly master or engineering (72%). Regarding the **AM experience** varies between general knowledge and expertise in plastic AM. Two of them are expertise in metal AM. Two of them are confusing about the **regime** of the session, probably because the session was face to face but the certification was online and some information was sent previously to the course. The satisfaction about the **course conditions** (facilities, supporting, communication, etc.) is high, especially in infrastructures (3.78/4). About course **characteristics** (structure, contents, etc.) the results are high too (3.49 average) Regarding materials, training sessions, etc. the participants value everything in a positive way. The best results are for **trainers** (3.72). The satisfaction with **course effectiveness** is 3.61 average. A 100% is satisfied with the course and would recommend it. The participants value **positively** the environment and the course contents. The main **negative** aspects is the duration and the balance between theory and practice.

6.2.12. Feedback on CU36: Coordination of AM

30 of the 31 students of this pilot course replied to the feedback questionnaire and have evaluated the training as follows:

Section1 – Background of Participants

1.1 Demographics of participants:

- Only 13% of attendees were female
- 76% of attendees were 26-55
- 93% of the attendees were from the UK with the remaining 7 % split evenly between Portugal and Ireland

1.2 Participants links to industrial sectors (Question 5): Enabled companies to select more than one sector (i.e. the total score can exceed 100%) – in terms of sector engagement 50% had aerospace links, 33% defence, 23% from automotive, 20% from industrial equipment and tooling, 17% with other sectors and only 3% from the consumer goods sector.

1.3 Educational background (Question 6): The answers given seem contrary with 43% holding an engineer or Masters degree but only 17% holding a degree (usually a prerequisite to take a Masters degree). 17% held a PhD which is more than those holding vocational training qualifications.

1.4 Industrial experience in the AM field: Most attendees had several years of experience in the AM field although a small number had no direct experience and a couple had only recently graduated.

Section 2 – Participants views on the course

2.1 Training conditions (Question11): Most people were satisfied or very satisfied with the training conditions– infrastructure used (3.54/4), support given (3.68/4), communication of the learning outcomes (3.57/4), communication during training (3.6/4). The lowest score was for equipment in the practical training (3.11/4), as there was no practical training.

2.3 Course structure & content (Question 12): In terms of the course structure and content the scores were generally good but there was clearly a diversity of opinion with some attendees giving high scores and other very low – this indicates that some attendees were expecting a different type of course (possibly one more focused on the technical aspects of AM).

Structure scored 3.33/4 with 97% being "satisfied enough" /"very satisfied". Contents scored slightly lower at 3.27/4 but with 90% being "satisfied enough" /"very satisfied". Course coherence scored 3.63/4 with 99% being "satisfied enough" /"very satisfied". Nos of contact hours scored 3.37/4 with 87% being "satisfied enough /very satisfied".

The lowest scores relate to the lack of practical training (the nature of the course subject together with the impact of covid19 meant that a practical training aspect was not undertaken) – with balance between practical and theoretical training scoring just 2.59% number of contact

hours for practical training scoring 2.29 and amount of time to train with AM machines just 2.1/4 (67% answered not applicable).

The issue of practical training has been highlighted and although, given the focus on the course, which is more about the management of the AM process (there will always be a bias towards theory) it should be possible to introduce some practical elements to the course.

On a more positive note the score for relevance of the course to job activities scored 3.46/4 with 100% being "satisfied enough /very satisfied" and match between the foreseen and actual learning outcomes scoring 3.4/4 with 96% being "satisfied enough /very satisfied".

2.4 Training material and delivery (Question 13): The scores for training material, performance of trainers (including time management), preparation/knowledge of the trainers, and support given by the trainers were all good.

However, there were low scores for level of engagement/interactivity (2.57/4) use of digital tools (2.77/4), space for active learning methodologies (2.07/4) show that the course needs to be modified to improve interaction, although it may be better when delivered in a conventional face-to-face scenario. The score for allocation of contact hours was also relatively low (2.82/4) and this confirms that the course content is probably too much for a one day course.

2.5 Knowledge, skills gained (Question14): 97% of participants were "satisfied" /"very satisfied" with the knowledge they gained from the course, although the same question for "skills" scored slightly lower. Most of the participants were "satisfied" /"very satisfied" with the evaluation methods used, however, this was scored before the assessment had taken place and so should be disregarded

2.6 Overall impression (Question 15): 97% of the attendees felt the course met their expectations and 100% would recommend it to others.

Feedback and recommendations from participants:

The feedback on the course was excellent with many positive aspects, including; "knowledge of the trainers" and "friendly atmosphere". Negative aspects included;

- Too much material to cover in a single day.
- Too many words on slides, not enough illustrations or real world examples.
- Need to have some practical interactive sessions.

The recommendations given mirror the previous points;

- Too much information for one day so reduce the topics or delivery it over two days.
- Include more real world examples.
- Make it more interactive, interesting and engaging using voting systems (such as mentimeter) to encourage audience participation and trigger debate.

Three of four trainers replied to the feedback survey. The organiser noted regarding the questionnaire for the trainers that some of them are not applicable due to Covid 19 restrictions.

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Only 3 of the 4 people involved with training completed the questionnaire. One only attended and presented for 30mins out of the 7 hours of contact time and so was not asked to complete the questionnaire.

Generally speaking the course structure, content and contact hours were judged to be acceptable (scored 3 out of 4). However, there was concern about the broad and intensive nature of the course. The course went into too much detail for some of the subjects. The surplus material could be removed from the presentations and supplied separately just for reference. Another clear frustration was the lack of interactivity, due to time restrictions (too much material / short duration), exacerbated by the remote teaching environment. The course, including the assessment, was entirely theoretical and if possible (not easy given the subject) a practical element should be included. The content and duration of the assessment needs to be revised, including simplification/clarification of questions and extended the duration to 20mins (see section on assessment).

6.2.13. Feedback on CU43: Production of PBF-LB parts

Overall, 35 students answered the survey, with the following composition:

- 26 males and 9 females
- 22 of them were less that 26 years old, whereas 13 of them were in the range 26 – 35 years old.
- 20 of them had a BSc degree, whereas the remaining had a MSc degree; one of them had a PhD degree
- Almost all of them are not working at the moment in any organization, although a few of them have current working activities in different sectors

Results:

Satisfaction with the training conditions

The radar plot shows that almost all students were very satisfied or satisfied enough with the infrastructure conditions, the support provided by the staff, the transparency/communication of the learning outcomes and the communication channels. Regarding the practical training, the remote learning mode and the impossibility to let large groups accessing the training facilities did not allow hands-on group activities related to AM SW tools, which could have further increased the satisfaction.

11 Satisfaction with the training conditions

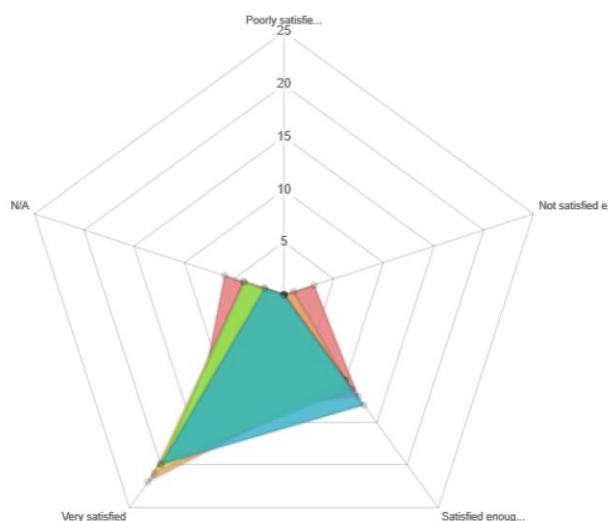|	Poorly satisfied	Not satisfied enough	Satisfied enough	Very satisfied	N/A	Standard Deviation	Responses	Weighted Average
a) The infrastructure conditions provided by the training provider	0 (0%)	0 (0%)	13 (37%)	**20 (57%)**	2 (6%)	8.1	35	3.61 / 4
b) The support provided by the staff (other than trainers)	0 (0%)	0 (0%)	11 (31%)	**20 (57%)**	4 (11%)	7.64	35	3.65 / 4
c) The transparency/communication of the learning outcomes associated to the course	0 (0%)	0 (0%)	10 (29%)	**21 (60%)**	4 (11%)	7.9	35	3.68 / 4
d) The communication channels used during the training	0 (0%)	1 (3%)	10 (29%)	**22 (63%)**	2 (6%)	8.29	35	3.64 / 4
e) The equipment used in the practical training	0 (0%)	3 (9%)	12 (34%)	**14 (40%)**	6 (17%)	5.29	35	3.38 / 4
								3.59 / 4

Satisfaction with the course structure and organization

The radar plot shows that almost all students were very satisfied or satisfied enough with basically all the aspects of the course organization. Only two aspects received lack of satisfaction by some students:

- The amount of time to train with an AM machine: indeed, this was not possible due to COVID restrictions to lab accessibility. However, the full scale implementation of this CU shall include some hands-on activity on AM systems, as this is felt as a very important aspect by students.
- The number of contact hours allocated to practical training: some theoretical aspects could be made more concise, leaving more time to practical classes devoted to design for AM, topology optimization and build design for AM.

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12 How would you rate your level of satisfaction with...

	Poorly satisfied	Not satisfied enough	Satisfied enough	Very satisfied	N/A	Standard Deviation	Responses	Weighted Average
a) The structure of the course	0 (0%)	2 (6%)	14 (40%)	**17 (49%)**	2 (6%)	7.04	35	3.45 / 4
b) The contents addressed during the course	0 (0%)	1 (3%)	14 (40%)	**19 (54%)**	1 (3%)	7.92	35	3.53 / 4
c) The coherence of the course with the training programme (was the order of contents presentation respected by the training provider?)	0 (0%)	2 (6%)	15 (43%)	**17 (49%)**	1 (3%)	7.4	35	3.44 / 4
d) The number of contact hours	0 (0%)	3 (9%)	13 (37%)	**15 (43%)**	4 (11%)	5.9	35	3.39 / 4
e) The balance between theoretical and practical training	2 (6%)	5 (14%)	**14 (40%)**	10 (29%)	4 (11%)	4.38	35	3.03 / 4
f) The number of contact hours allocated to practical training	1 (3%)	7 (20%)	**12 (34%)**	9 (26%)	6 (17%)	3.63	35	3 / 4
g) The relevance of the course to your job activities	0 (0%)	4 (11%)	**13 (37%)**	13 (37%)	5 (14%)	5.18	35	3.3 / 4
h) The match between learning outcomes foreseen for the course and what the course covered	0 (0%)	1 (3%)	16 (46%)	**17 (49%)**	1 (3%)	7.77	35	3.47 / 4
i) The amount of time to train with an AM machine	6 (17%)	**13 (37%)**	5 (14%)	6 (17%)	5 (14%)	3.03	35	2.37 / 4
								3.22 / 4

Satisfaction with training material and training methods

The radar plot shows that all the students were satisfied or very satisfied with the training material, training methods and the performance of the trainers. Only a few students pointed out that active learning methodologies could be used more during the training and that a different balance of contact hours could have improved the course.

These are relevant suggestions for the full scale implementation of the CU.

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13 What is your opinion regarding the following statements?

	Strongly Disagree	Disagree	Agree	Strongly Agree	Standard Deviation	Responses	Weighted Average
a) The learning materials (i.e. slide shows, handbooks, videos, samples) were useful	0 (0%)	3 (9%)	**16 (46%)**	16 (46%)	7.33	35	3.37 / 4
b) The training sessions were quite dynamic, in the sense that they were engaging and involved interactive activities, instead of being just expositive)	1 (3%)	5 (14%)	**21 (60%)**	8 (23%)	7.5	35	3.03 / 4
c) The training sessions promoted the use of digital tools	0 (0%)	4 (11%)	15 (43%)	**16 (46%)**	6.91	35	3.34 / 4
d) There was space for active learning methodologies, such as problem-based learning, project-based learning, gamification, augmented reality, virtual reality, collaborative learning, etc.	3 (9%)	7 (20%)	**16 (46%)**	9 (26%)	4.71	35	2.89 / 4
e) The contact hours allocated to the course was adequate to the amount and nature of the course contents	2 (6%)	5 (14%)	**21 (60%)**	7 (20%)	7.29	35	2.94 / 4
f) There was a good balance of knowledge among the participants and no big discrepancies in the background knowledge were noticed	0 (0%)	7 (20%)	**20 (57%)**	8 (23%)	7.19	35	3.03 / 4
g) The trainer(s) showed a good performance (good time management, ability to communicate clearly)	0 (0%)	2 (6%)	14 (40%)	**19 (54%)**	7.98	35	3.49 / 4
h) The trainer(s) was well prepared and showed a good understanding of the subject	0 (0%)	0 (0%)	14 (40%)	**21 (60%)**	9.09	35	3.6 / 4
i) The support provided by the trainer(s) was good and a good management of questions and answers was done	0 (0%)	1 (3%)	**17 (49%)**	17 (49%)	8.26	35	3.46 / 4
							3.24 / 4

Satisfaction with the learning outcome and the assessment method

The radar plot shows students were satisfied enough or very satisfied with the learning outcome in terms of acquired knowledge and skills. A few students were not fully satisfied with the assessment method. Open questions or an oral exam could be perceived as better methods to assess the learning outcomes.
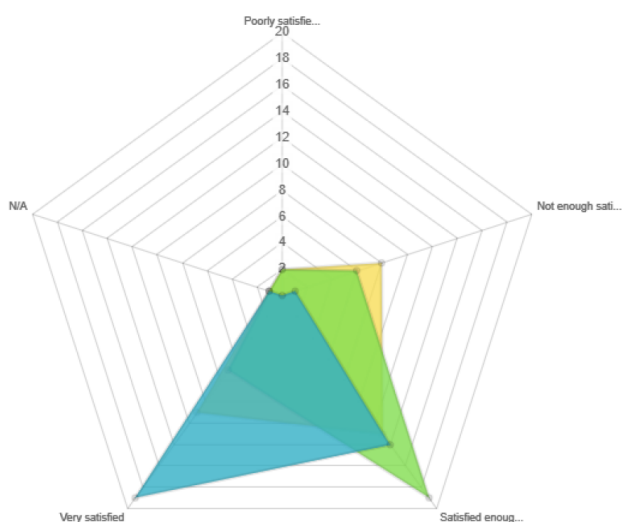
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14 How would you rate your level of satisfaction with…

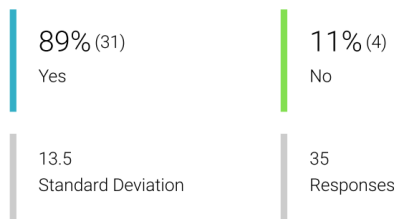|	Poorly satisfied	Not enough satisfied	Satisfied enough	Very satisfied	N/A	Standard Deviation	Responses	Weighted Average
a) The knowledge acquired in the training	0 (0%)	1 (3%)	14 (40%)	**19 (54%)**	1 (3%)	7.92	35	3.53 / 4
b) The skills acquired in the training	2 (6%)	6 (17%)	**19 (54%)**	7 (20%)	1 (3%)	6.42	35	2.91 / 4
c) The evaluation methods used	2 (6%)	8 (23%)	**13 (37%)**	11 (31%)	1 (3%)	4.77	35	2.97 / 4
								3.14 / 4

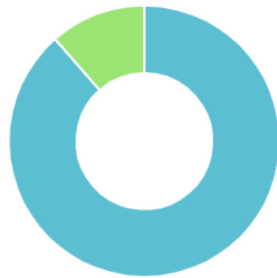**General satisfaction about the course**

The two pie charts show that the large majority of the students (89% - 91%) were satisfied by the course, which met their expectations, and they would recommend the same course to other people.
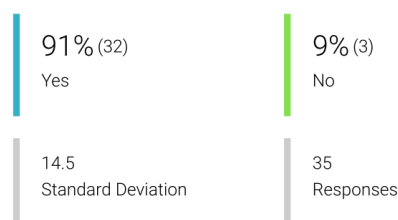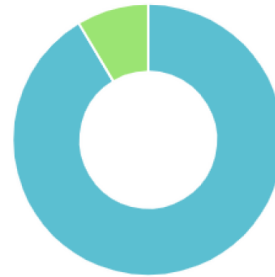
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89% (31)
Yes

11% (4)
No

13.5
Standard Deviation

35
Responses

91% (32)
Yes

9% (3)
No

14.5
Standard Deviation

35
Responses

The main issue pointed out by the students as less positive aspect and possible direction for improvement is the amount of time devoted to practical training. Since this module is strongly based on the comprehension of practical methods for part and build design and simulation, more contact hours and project activities devoted to these topics would have been appreciated.

Analysis of results:

Above results point out that the training was appreciated in all its aspects. The only fields of potential improvement pointed out by the students include the importance of including actual hands-on training on SW tools for AM and part design, and devoting more time to practical training classes, possibly with the use of more active learning methodologies.

This CU includes topics that deserve a good balance between theoretical and practical training, like topology optimization and design for AM. For process engineers working with PBF-LB processes it is of great importance to gather both practical and theoretical skills. The availability of AM machines and industrial SW suites in the labs owned by the training bodies is deemed of fundamental importance to deliver an effective training for this CU.

6.2.14. Feedback on CU44: Conformity of PBF-LB parts

Overall, 31 students answered the survey, with the following composition:

- 25 males and 6 females
- 17 of them were less that 26 years old, whereas 14 of them were in the range 26 – 35 years old.
- 17 of them had a BSc degree, whereas the remaining had a MSc degree; one of them had a PhD degree

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- Almost all of them are not working at the moment in any organization, although a few of them have current working activities in different sectors

Results:

Satisfaction with the training conditions

The radar plot shows that almost all students were very satisfied or satisfied enough with the infrastructure conditions, the support provided by the staff, the transparency/communication of the learning outcomes and the communication channels. Only a few students were not fully satisfied by the equipment used in the practical learning. The remote training mode and the impossibility to let large groups accessing the training facilities did not allow hands-on group activities related to AM systems, which could have increased the satisfaction with this last point.

11 Satisfaction with the training conditions
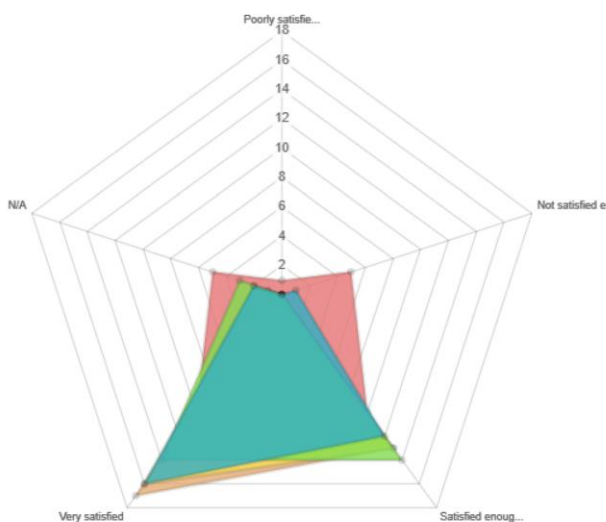
	Poorly satisfied	Not satisfied enough	Satisfied enough	Very satisfied	N/A	Standard Deviation	Responses	Weighted Average
a) The infrastructure conditions provided by the training provider	0 (0%)	1 (3%)	12 (39%)	**16 (52%)**	2 (6%)	6.52	31	3.52 / 4
b) The support provided by the staff (other than trainers)	0 (0%)	0 (0%)	**14 (45%)**	14 (45%)	3 (10%)	6.46	31	3.5 / 4
c) The transparency/communication of the learning outcomes associated to the course	0 (0%)	0 (0%)	13 (42%)	**16 (52%)**	2 (6%)	6.88	31	3.55 / 4
d) The communication channels used during the training	0 (0%)	0 (0%)	13 (42%)	**17 (55%)**	1 (3%)	7.3	31	3.57 / 4
e) The equipment used in the practical training	1 (3%)	5 (16%)	**10 (32%)**	10 (32%)	5 (16%)	3.43	31	3.12 / 4

3.45 / 4

Satisfaction with the course structure and organization

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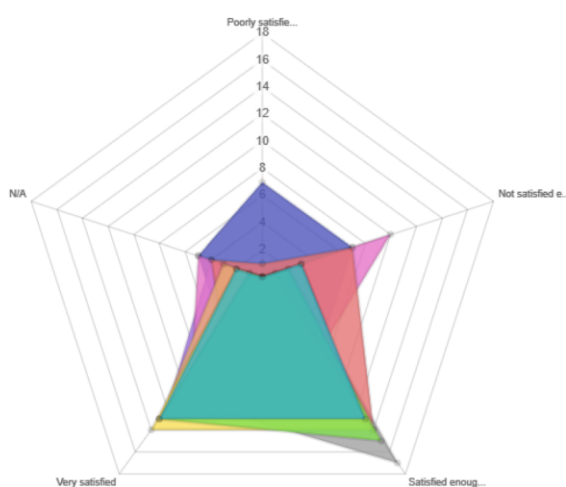*Project No. 601217-EPP-1-2018-1-BE-EPPKA2-SSA-B*

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The radar plot shows that almost all students were very satisfied or satisfied enough with basically all the aspects of the course organization. Only two aspects received lack of satisfaction by some students:

- The amount of time to train with an AM machine: indeed, this was not possible due to COVID restrictions to lab accessibility. However, the full scale implementation of this CU shall include some hands-on activity on AM systems, as this is felt as a very important aspect by students.
- The number of contact hours allocated to practical training: some theoretical aspects could be made more concise, leaving more time to practical classes devoted to inspection and material characterization methods.

12 How would you rate your level of satisfaction with…

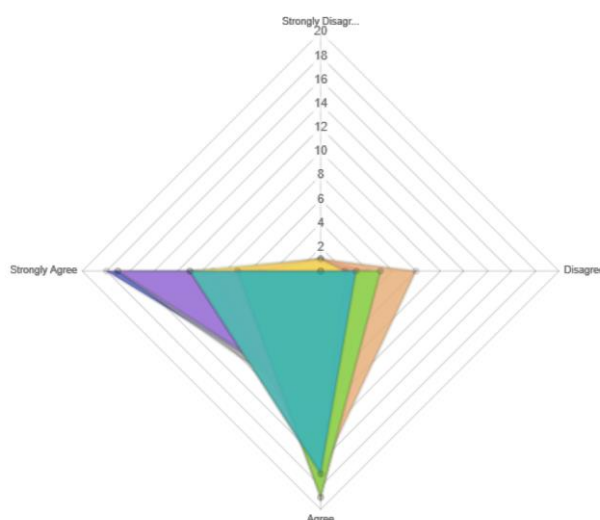|	Poorly satisfied	Not satisfied enough	Satisfied enough	Very satisfied	N/A	Standard Deviation	Responses	Weighted Average
a) The structure of the course	0 (0%)	3 (10%)	**13 (42%)**	13 (42%)	2 (6%)	5.64	31	3.34 / 4
b) The contents addressed during the course	0 (0%)	2 (6%)	**15 (48%)**	13 (42%)	1 (3%)	6.43	31	3.37 / 4
c) The coherence of the course with the training programme (was the order of contents presentation respected by the training provider?)	0 (0%)	1 (3%)	**14 (45%)**	14 (45%)	2 (6%)	6.4	31	3.45 / 4
d) The number of contact hours	0 (0%)	3 (10%)	12 (39%)	**13 (42%)**	3 (10%)	5.27	31	3.36 / 4
e) The balance between theoretical and practical training	1 (3%)	7 (23%)	**14 (45%)**	5 (16%)	4 (13%)	4.35	31	2.85 / 4
f) The number of contact hours allocated to practical training	0 (0%)	**10 (32%)**	7 (23%)	9 (29%)	5 (16%)	3.54	31	2.96 / 4
g) The relevance of the course to your job activities	0 (0%)	2 (6%)	**13 (42%)**	12 (39%)	4 (13%)	5.31	31	3.37 / 4
h) The match between learning outcomes foreseen for the course and what the course covered	0 (0%)	2 (6%)	**17 (55%)**	11 (35%)	1 (3%)	6.68	31	3.3 / 4
i) The amount of time to train with an AM machine	**7 (23%)**	7 (23%)	7 (23%)	5 (16%)	5 (16%)	0.98	31	2.38 / 4

3.15 / 4

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Satisfaction with training material and training methods

The radar plot shows that all the students were satisfied or very satisfied with the training material, training methods and the performance of the trainers. Only a few students pointed out that active learning methodologies could be used more during the training.

13 What is your opinion regarding the following statements?

	Strongly Disagree	Disagree	Agree	Strongly Agree	Standard Deviation	Responses	Weighted Average
a) The learning materials (i.e. slide shows, handbooks, videos, samples) were useful	0 (0%)	3 (10%)	**17** **(55%)**	11 (35%)	6.68	31	3.26 / 4
b) The training sessions were quite dynamic, in the sense that they were engaging and involved interactive activities, instead of being just expositive)	0 (0%)	5 (16%)	**19** **(61%)**	7 (23%)	6.98	31	3.06 / 4
c) The training sessions promoted the use of digital tools	1 (3%)	2 (6%)	**17** **(55%)**	11 (35%)	6.61	31	3.23 / 4
d) There was space for active learning methodologies, such as problem-based learning, project-based learning, gamification, augmented reality, virtual reality, collaborative learning, etc.	1 (3%)	8 (26%)	**17** **(55%)**	5 (16%)	5.89	31	2.84 / 4
e) The contact hours allocated to the course was adequate to the amount and nature of the course contents	0 (0%)	5 (16%)	**19** **(61%)**	7 (23%)	6.98	31	3.06 / 4
f) There was a good balance of knowledge among the participants and no big discrepancies in the background knowledge were noticed	1 (3%)	4 (13%)	**17** **(55%)**	9 (29%)	6.06	31	3.1 / 4
g) The trainer(s) showed a good performance (good time management, ability to communicate clearly)	0 (0%)	3 (10%)	11 (35%)	**17** **(55%)**	6.68	31	3.45 / 4
h) The trainer(s) was well prepared and showed a good understanding of the subject	0 (0%)	2 (6%)	12 (39%)	**17** **(55%)**	7.01	31	3.48 / 4
i) The support provided by the trainer(s) was good and a good management of questions and answers was done	0 (0%)	2 (6%)	11 (35%)	**18** **(58%)**	7.22	31	3.52 / 4
							3.22 / 4

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Satisfaction with the learning outcome and the assessment method

The radar plot shows students were satisfied enough or very satisfied with the learning outcome in terms of acquired knowledge and skills. A few students were not fully satisfied with the assessment method. Open questions or an oral exam could be perceived as better methods to assess the learning outcomes.

14 How would you rate your level of satisfaction with…
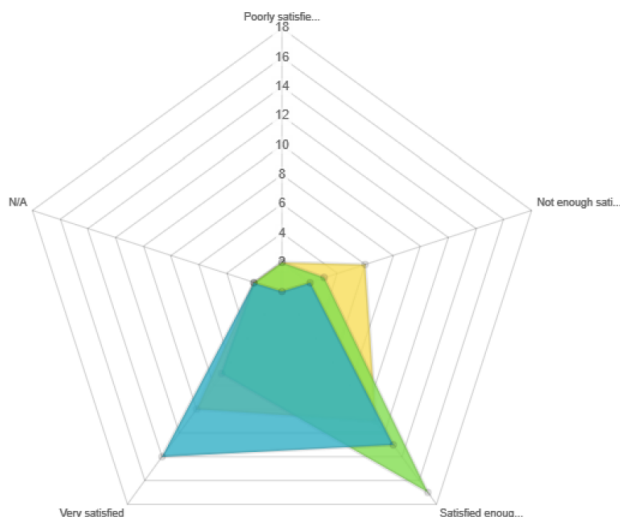
	Poorly satisfied	Not enough satisfied	Satisfied enough	Very satisfied	N/A	Standard Deviation	Responses	Weighted Average
a) The knowledge acquired in the training	0 (0%)	2 (6%)	13 (42%)	**14 (45%)**	2 (6%)	6.01	31	3.41 / 4
b) The skills acquired in the training	2 (6%)	3 (10%)	**17 (55%)**	7 (23%)	2 (6%)	5.71	31	3 / 4
c) The evaluation methods used	2 (6%)	6 (19%)	**11 (35%)**	10 (32%)	2 (6%)	3.82	31	3 / 4
								3.14 / 4

General satisfaction about the course

The two pie charts show that the large majority of the students (90% - 94%) were satisfied by the course, which met their expectations, and they would recommend the same course to other people.

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IN ADDITIVE MANUFACTURING

15 Did the course meet your expectations?

16 Would you recommend this course to others?

90% (28)
Yes

10% (3)
No

12.5
Standard Deviation

31
Responses

94% (29)
Yes

6% (2)
No

13.5
Standard Deviation
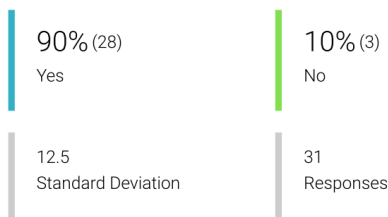
31
Responses

Comments and suggestions for the improvement of the course:

- More practical activities
- Should focus more on the basic principles of inspection and conformity and give a clear idea on how the instrumentation works. The materials used in slides usually included too many notions not being clearly explained. Also, some of the topics in the assessment were not mentioned neither at the lesson nor in the material provided.

Analysis of results:

Above results point out that the training was appreciated in all its aspects. The only fields of potential improvement pointed out by the students include the importance of including actual hands-on training on AM machines and devoting more time to practical training classes, possibly with the use of more active learning methodologies.

This CU includes topics that deserve a good balance between theoretical and practical training, like X-ray CT and NDE. For process engineers working with PBF-LB processes it is of great importance to gather both practical and theoretical skills. The availability of AM machines, metrology labs and material characterization facilities in the labs owned by the training bodies is deemed of fundamental importance to deliver an effective training for this CU.

6.2.15. Feedback on CU45: Conformity of facilities featuring PBF-LB

The pilot course started with 21 trainees and, at the end, there were 17. These 17 were the ones who did the exam and, immediately after, replied to the D2.7 evaluation questionnaire. The pilot course participants were mainly men, in the age range of 36 to 55 years.
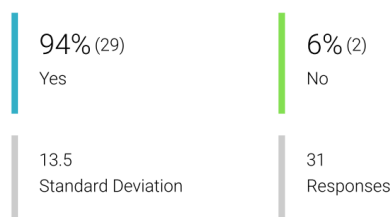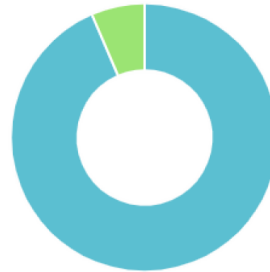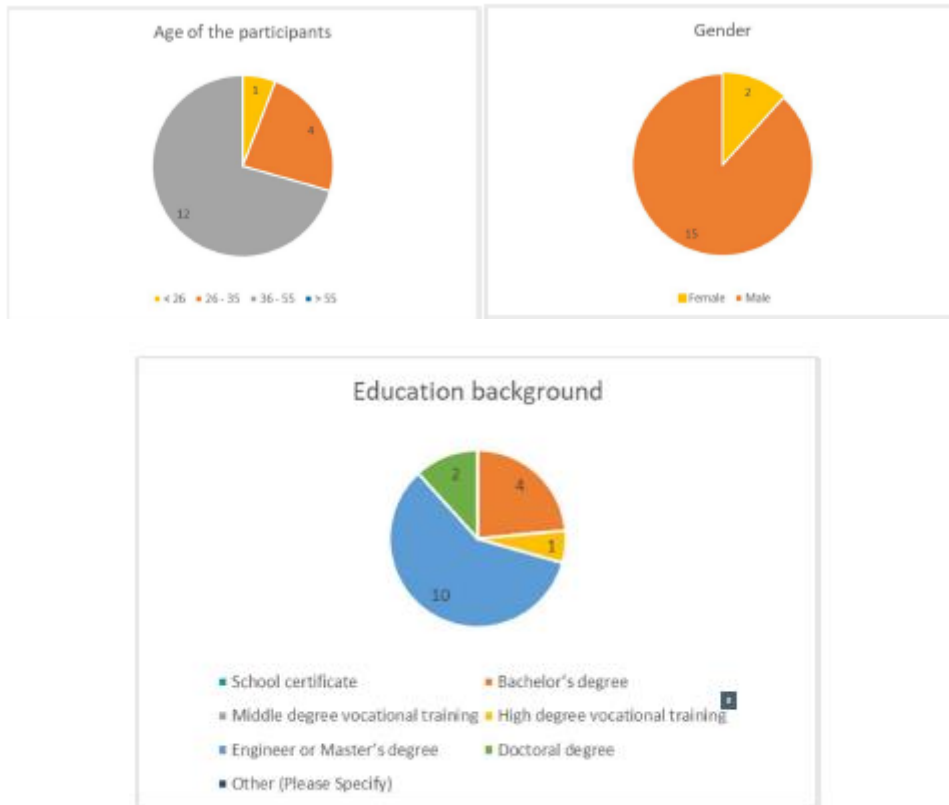
WP5 Pilot Activities Report
Qualification/Professional Profile: Process Engineer PBF-LB | 2 Competence Units: Metal AM Designer
Project No. 601217-EPP-1-2018-1-BE-EPPKA2-SSA-B

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Age of the participants

Gender

Education background

Their educational background was, in a large majority, an engineering or master's degree, although there were also some bachelor's degrees, a few others with a doctoral degree and one participant had a high VET degree.

Main activity/sector of participants' organisation

In this course, when asked to identify the sector they work in, about half of the participants selected the "Industrial equipment and tooling" option and a big part of the other half chose the "Other" option, indicating the following activities/sectors:

- Services

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- Additive Manufacturing
- Chemical industry
- Research and development
- Occupational Health and Safety
- Consulting, auditing and training in management systems

There were also two participants coming from the Energy sector, one from the aerospace sector, one from the health sector and one participant was unemployed. This was a b-Learning course, and there was no confusion about it among participants – all of them selected the e-Learning option. All participants also identified Portugal as being the country where the course was taking place. When asked about their previous experience or training on AM, eight participants stated they had none. The others gave the following answers:

- Machine inspection / audit
- Professional internship at a company where the main activity is AM
- Engineering Applications AM
- Development of LPBF additive manufacturing equipment
- Participation in AM projects with a view to applying industrial gases
- PhD with thesis in processing titanium alloys by PBF-LB
- 8 years of FDM and 2 years of SLA
- I had had no contact with this process or knowledge of its existence.
- Mechanical Engineering

In terms of the level of satisfaction with the training conditions, the results are mirrored in the next chart:
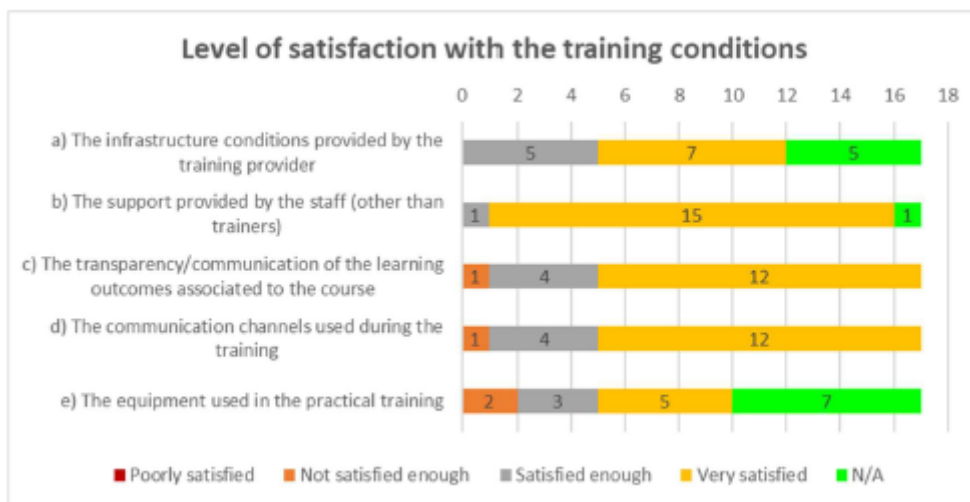
In this course there was no practical training. However, some trainees mistakenly rated question e). Regarding the level of satisfaction with the course itself, it is clear that some participants didn't quite understand that there was no practical training in this pilot course – it was not foreseen in the CU45.

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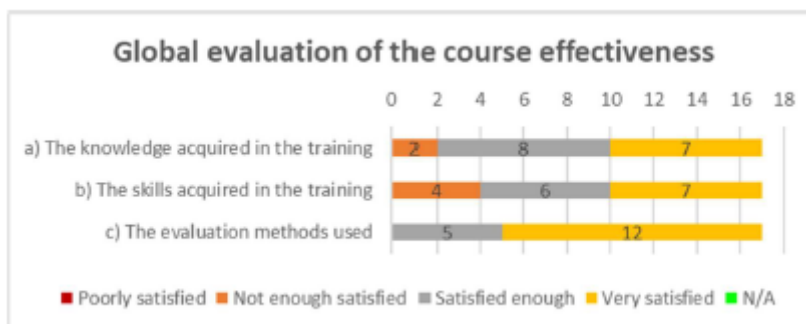of the European Union

SAM
SECTOR SKILLS STRATEGY
IN ADDITIVE MANUFACTURING

Level of satisfaction with the course

	Poorly satisfied	Not satisfied enough	Satisfied enough	Very satisfied	N/A
a) The structure of the course		3	6	8	
b) The contents addressed during the course	1	2	8	6	
c) The coherence of the course with the training programme (was…	1		6	10	
d) The number of contact hours	1		6	10	
e) The balance between theoretical and practical training		2	5	6	4
f) The number of contact hours allocated to practical training		3	4	4	6
g) The relevance of the course to your job activities		2	2	12	1
h) The match between learning outcomes foreseen for the course…	1	3	5	8	
i) The amount of time to train with an AM machine	4		3	10	

Regarding the level of satisfaction with the training sessions, the general results shown in the next chart are positive, although there were five participants that there was not so much space for active learning methodologies and that is, apparently, an aspect to improve in the future.

Level of satisfaction with the training sessions

The global evaluation of the course is also mainly positive, although a few participants didn't feel satisfied enough with the skills acquired in the training. Nonetheless, all participants felt the evaluation methods used were adequate.

Global evaluation of the course effectiveness

	Poorly satisfied	Not enough satisfied	Satisfied enough	Very satisfied	N/A
a) The knowledge acquired in the training		2	8	7	
b) The skills acquired in the training		4	6	7	
c) The evaluation methods used			5	12	

The course met the majority of participants expectations, but there were quite a few that felt disappointed. In that sense, some participants wouldn't recommend this course (CU) to others.

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It is easier to understand why, in the comments left by participants, when asked about what they thought could have been better:

- *Contents should be more adjusted to additive processes, in particular PBF.*
- *Maybe the duration of the course could be slightly increased, so that the objectives were better achieved.*
- *There could have been a greater exposure / explanation on video about the PBF process for a better knowledge / preparation for those who do not know the area.*
- *The number of hours per day could have been lower.*
- *The contents should have focused more AM*
- *The content was not adapted to the theme PBF, for the trainer did not have the necessary knowledge of this technology. The introduction to PBF technology should have been clearer and more objective to contextualize trainees who have no basis on the PBF technology. Training should have been provided in a more dynamic way.*
- *The course could be more adjusted to the context of additive manufacturing, specifically the PBF technique (risks associated with different types of powders, issues related to the post-treatment cycle, safety and environment, etc.)*
- *If there is no face-to-face component, where the contact with machines is possible, there should be more images or films of the way this type of equipment works.*
- *There should be videos of the process, of maintenance operations, of the installation of equipment, etc.*
- *Include more practical cases with real situations and real cases.*
- *The course should be more in depth about the technology, and not so general.*

But participants also left comments about what they thought was the most positive aspect of the course:

- *The diversity of trainees gave rise to an interesting exchange of information and experiences.*
- *The variety of participants with diverse knowledge (several times shared).*
- *Through the sharing of knowledge between trainers and participants, a good balance was achieved between theoretical / practical knowledge.*
- *The content provision, with a good adequacy of contents to the thematic.*
- *The presentation of the operation of the PBF-LB process in the 1st session.*
- *The way of presenting and demonstrating with examples.*

- *The diversity of information.*
- *Acquiring knowledge on an area that was unknown to me.*
- *To provide knowledge and be a source for consultation of legislation.*
- *Having participants that really work in the field and who could give their feedback on each subject.*
- *Hearing about new technologies.*
- *The disclosure of a little-publicised technology and process with clarity and detail.*
- *Participation and exchange of knowledge, as there were students and trainers from different areas, all of which are relevant to the theme, and a high encouragement to participate.*
- *Being able to deepen PBF-LB knowledge further.*

Other comments and suggestions made by participants were the following:

- *This course promised to be about Safety and Environment in Additive Manufacturing Facilities, more specifically in those using PBF-LB process. It ended up focusing generically on Safety and Environment in workplaces, depending on the intervention of trainees in the additive manufacturing area to give the context that was promised in the course objectives. If some trainees had no experience in the field it would be disastrous ... The initial part of the course was intended to contextualize the additive manufacturing technology, including PBF-LB, but it failed in the context of this course by going into too technical details, such as the influence of parameters in the process, when for this course it was critical to level the participants' knowledge about technology, raw materials, etc. I therefore consider that the course does not meet the proposed objectives and I cannot recommend it.*
- *The course content turns out to be too general in the area of safety and environment. The theory in this area is given while the possible applications in the AM processes are discussed with the participants. In this sense, the title of the course and the proposed objectives are too specific for its real content. It would be necessary to adapt the contents and that the trainers had more knowledge in this area, so that the course could meet the objectives initially proposed.*

Analysis of results:
About half of the participants knew the technology or at least had some knowledge in AM. The other half wasn't familiar with the technology, even though some were familiar with H&S issues. Among those who were familiar with AM, there was also a good balance between theoretical and practical knowledge, which ended up working in favour of the training experience. As to the trainers, one was totally familiar with the AM technology – even if its expertise was more in the DED process – and the other was an expert in H&S&E, although not familiar with the AM technology.

It is clear that some participants didn't quite understand that there was no practical training in this pilot course – it was not foreseen in the CU45 – maybe confusing it with a practical component which was included in the training through the use of exercises that they had to

solve by themselves and that were then discussed during the next class, in group. In terms of the training conditions, trainees were satisfied.

Regarding the level of satisfaction with the course, it was positive for most of the participants, but there were a few indications of dissatisfaction regarding the contents addressed during the course, the number of hours allocated to the course and the match between the learning outcomes and foreseen for the course and what the course covered.

As to the level of satisfaction with the training sessions, results show that, again, the great majority of participants was positively satisfied, but a significant part feels that there was not so much space for active learning methodologies and a few (three participants) think that the contact hours allocated to the course was not adequate enough to the amount and nature of the course contents. Three trainees also think that the trainers were not so well prepared nor showed a good understanding of the subject, which is probably related to the fact that one of the trainers was not so familiar with AM specificities.

The global evaluation of the course is also mainly positive, although a few participants didn't feel satisfied enough with the skills acquired in the training. Nonetheless, all participants felt the evaluation methods used were adequate. The course met the majority of participants expectations, but there were quite a few that felt disappointed. In that sense, some participants wouldn't recommend this course (CU) to others.

Picking on the comments left by trainees, it is easy to understand that a lot of trainees would refer to have contents that were totally adapted to the PBF-LB process instead of more general ones. They would also like to have videos of the process, real case scenarios, more exercises, events if that would mean increasing a bit the duration of the course.

The exchange between participants and trainers was an aspect seen as very positive and crucial for the course success. Also, the way of presenting the contents, even if not using a diversity of active learning methodologies, was seen as positive due to the *present-demonstrate* strategy used.

6.2.16. Feedback on CU61: Simulation Analysis

10 participants of the online piloting event answered to the feedback survey, the majority were men at an age between 26 and 30 with high education grades often in engineering. They work in various sectors and had different levels of knowledge on AM. There was a high level of satisfaction according to the conditions of realization of the training. 70% were satisfied with the structure, the learning results obtained and content of the course, the coherence of trainers and contact hours were valued positively. Various opinions were given on the balance between theoretical and practical training parts. The practical parts and the work with the machines were seen as to short, which was properly be affected by the remote training. 40% were not satisfied with the duration of the course, 60% stated it was adequate. Positive ratings were given for the learning materials and the usage of digital tools. 70% would recommend the course.

Caused by the online session, some participants stated that shorter sessions and more visual slides could help to maintain attention as well as the practical usage of the presented software

for a certain industrial application during the course. The participants highlighted the application approaches presented and valued the expansion of knowledge positively. The contents were seen as important for many industrial sectors.

The participants suggested to have more contact hours to present the tools or to work practically with the software. They expressed, that previous knowledge on FEM simulation and calculation and on ANSYS environment would be very useful in following the contents of the course.

The trainers had very positive ratings and were satisfied with the training, infrastructure and content. They highlighted the possibility to interact directly with the students and the introduction into FEM analysis, whereas they also stress the importance of practical working with the software.

CU 62 in addition is seen as very important to complement the topics that were demanded by the participants, though, to many overlaps according to the content should be avoided. The need to carry out the course remotely (due to the pandemic caused by the corona virus) caused a lack of interactivity and participation which can be improved by having in-person lectures in the future.

6.2.17. Feedback on CU62: Simulation Execution

The survey results are presented in the dedicated evaluation report combining participants responses. The key chart is presented below.

The students indicated as very positive the following items:

- Structure of the course – 53% very satisfied
- Content – 71% very satisfied
- Order of content 65% very satisfied
- Relevance to their jobs 76% very satisfied
- Match between LO and the course 65% very satisfied

The less positive items were noted as:

- Large no of hours. As the course included FEA fundamentals the hours were high to master the content. Removing FEA fundaments should be done for future.
- Lack of practical experience and using a machine. Due to COVID lockdown no access to labs could be arranged. Future course should allow lab access.
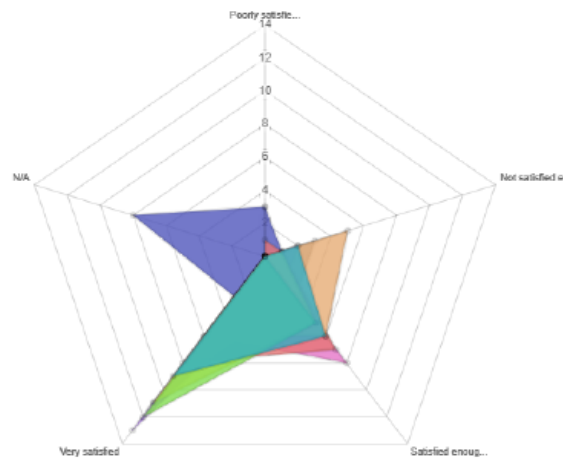
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12 How would you rate your level of satisfaction with...

	Poorly satisfied	Not satisfied enough	Satisfied enough	Very satisfied	N/A	Standard Deviation	Responses	Weighted Average
a) The structure of the course	0 (0%)	2 (12%)	6 (35%)	9 (53%)	0 (0%)	3.56	17	3.41 / 4
b) The contents addressed during the course	0 (0%)	0 (0%)	5 (29%)	12 (71%)	0 (0%)	4.72	17	3.71 / 4
c) The coherence of the course with the training programme (was the order of contents presentation respected by the training provider?)	0 (0%)	1 (6%)	5 (29%)	11 (65%)	0 (0%)	4.22	17	3.59 / 4
d) The number of contact hours	0 (0%)	5 (29%)	6 (35%)	6 (35%)	0 (0%)	2.8	17	3.06 / 4
e) The balance between theoretical and practical training	1 (6%)	1 (6%)	7 (41%)	8 (47%)	0 (0%)	3.38	17	3.29 / 4
f) The number of contact hours allocated to practical training	3 (18%)	0 (0%)	8 (47%)	6 (35%)	0 (0%)	3.2	17	3 / 4
g) The relevance of the course to your job activities	0 (0%)	2 (12%)	2 (12%)	13 (76%)	0 (0%)	4.88	17	3.65 / 4
h) The match between learning outcomes foreseen for the course and what the course covered	0 (0%)	3 (18%)	3 (18%)	11 (65%)	0 (0%)	4.03	17	3.47 / 4
i) The amount of time to train with an AM machine	3 (18%)	1 (6%)	2 (12%)	3 (18%)	8 (47%)	2.42	17	2.56 / 4
								3.3 / 4

In general, the participants were satisfied with the course, and it received excellent feedback. The main **positive feedback** from the participants is summarised below:

- *Environment*: Using Ansys software with Learning Hub, e-learning/self-paced opportunity, great flexibility to study, easy to reach trainers with questions
- *Content*: high quality, clear, well structured, good pace and manner, Q&A by the end of the week to introduce next module and take any doubts, AM learning opportunity (how to create more robust models, better understand the generated results and their validation). All the documentation and learning material provided was great in addition to the use of the complete package of Ansys tools. Practical applications part (design & simulation exercises).

The main less positive feedback and opportunity for development note from the participants were:

- Licensing process was noted difficult and experienced delays
- Large workload and short time of the course, especially for working participants that cannot dedicate full time
- More live, leacher led, dedicated lectures

Also, some aspects of the participant's survey were not relevant to the CU62 course for example, "amount of time to train with an AM machine" and other questions related to the experimental elements.