



# CLLAIM

**Project Partner: Fraunhofer IGCV**

**Title: Profile “Operator PBF - LB” Piloting selected Competence Units at  
Fraunhofer IGCV, Augsburg, Germany**

*Matthias Schneck; Dr.-Ing. Vera Böhm*

Project title: **C**reating know**L**edge and skill**L**s in **A**dditive **M**anufacturing

Reference number: 2017-3309/591838-EPP-1-2017-1-ES-EPPKA2-SSA



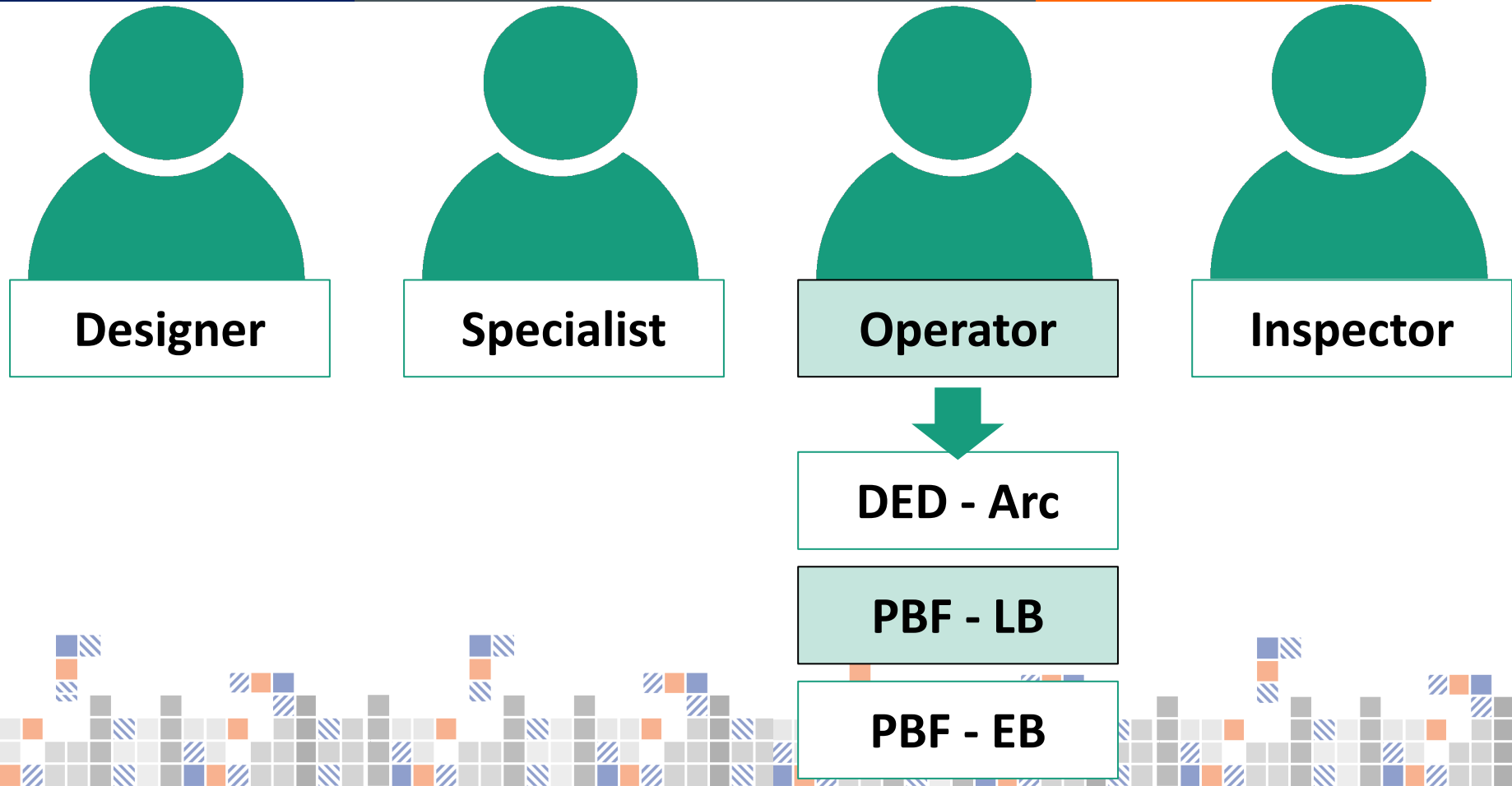
This project has been funded with support from the European Commission. This communication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.



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



## Overview of profiles in Additive Manufacturing (defined by CLLAIM)





## Competence profile “Operator PBF-LB”

<b>CU 00</b>	<b>Additive manufacturing Process Overview</b>
<b>CU 15</b>	<b>PBF-LB Process</b>
CU 16	Quality Assurance (QA) in PBF-LB
<b>CU 17</b>	<b>Health, Safety and Environment (HSE) in PBF-LB</b>
CU 18	Hardware, software and build file set-up for PBF-LB
CU 19	Monitoring and managing the manufacturing of PBF-LB parts
CU 20	Post-processing of PBF-LB parts
CU 21	Maintenance of PBF-LB systems
CU 48	Powder Handling
CU 49	Laser Beam Characterization

→ CU 00, CU 15 and CU 17 were tested in a pilot training at Fraunhofer IGCV, Augsburg, Germany.



## Pilot-Training “Operator PBF-LB” (CU 00, 15, 17) – Agenda

Day	Time (hours)	CU	Content
<b>1<sup>st</sup> day</b> (22.10.19)	08:35 AM – 12:00 AM	00 Additive Manufacturing Process Overview	Introduction to AM and Metal-AM; ISO 52900; Overview raw materials (powder; wire...); Definitions, Overview Process Chain (pre/in/post); AM market overview and standardization
	13:00 PM – 17:00 PM	15 PBF-LB Process	physical principle, laser, limitations, limitations, powder properties, business models
<b>2<sup>nd</sup> day</b> (23.10.19)	08:30 AM – 12:00 AM	17 Health, Safety and Environment (HSE) in PBF-LB	Work safety & powder handling, LPBF Materials, machine Equipment (Theory and Lab)
	13:00 PM – 17:30 PM	15 PBF-LB Process	Implementation, Costs, Design-Rules, Powder Analysis Workshops



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

Project title: **C**reating know**L**edge and skill**S** in **A**dditive **M**anufacturing  
Reference number: 2017-3309/591838-EPP-1-2017-1-ES-EPPKA2-SSA



## Pilot-Training “Operator PBF-LB” (CU 00, 15, 17)



**Pilot-Training at Fraunhofer  
IGCV in Augsburg, Germany**

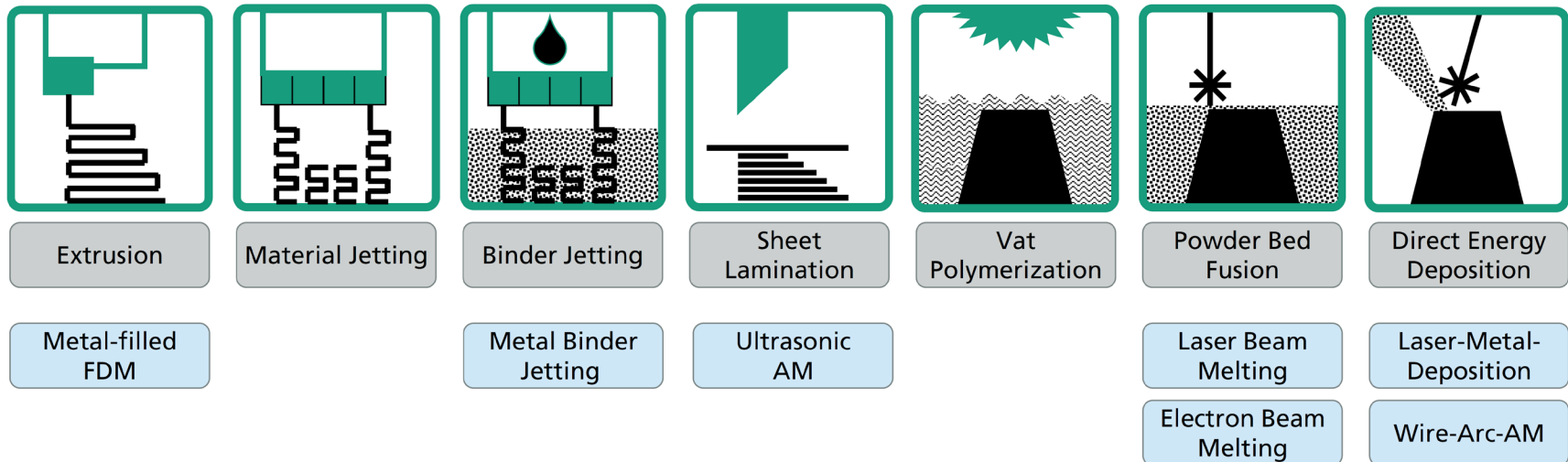
**10 participants from different  
branches were trained and  
provided feedback.**





## Training insight: AM processes (CU 00)

### Additive Manufacturing Technology: A variety of processes Overview of process categories based on DIN EN ISO ASTM 52900



- A variety of manufacturing processes is summarized in the term "Additive Manufacturing" or "3D printing"
- Systematic evaluation of application potential necessary





## Training insight: AM processes (CU 00)

### Additive Manufacturing Technology: A variety of processes

#### Metal-based Additive Manufacturing: Dimension of parts

Screw nut  
(Digital Metal)



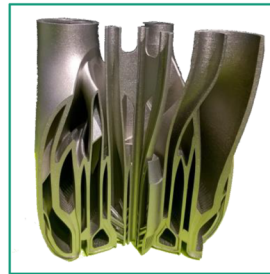
< 5 mm

Fastener Aerospace  
(LZN)



100 mm

Burner tip  
(Siemens)



400 mm

WAAMPeller  
(RamLab)



1200 mm

Structural part  
(Sciaky)



> 1500 mm

Multistep (FDM / BJ)

Powder bed fusion (PBF)

Direct energy deposition (DED)


Complexity / Filigree


Dimension / Weight

# Feedback from participants – Evaluation sheet

## Evaluation based on standardized CLLAIM-Evaluation sheet

Project CLLAIM  
Pilot-Course - Survey

 Funded by the  
Erasmus+ Programme  
of the European Union

 CLLAIM

Evaluation of Pilot-Courses

Dear Trainer,

Thank you very much for taking the time to fill out this survey.  
Please fill out every question by selecting one box.  
Please justify any less positive ranking and if possible add suggestions for improvement

Thank you!

**Trainer Information – please fill out the following aspects**

In which country did you conduct the pilot-course?

England ☐ Germany ☒ Portugal ☐ Spain ☐

Other: \_\_\_\_\_

Date of pilot: 22 - 23.10.2019

Which pilot-course did you conduct?

Operator ☒ Designer ☐ Inspector ☐ Supervisor ☐

Which Competence Unit did you pilot?

CU\_00 ☐ CU\_15 ☐ CU\_17 ☐ CU\_18 ☐

How would you rate your experience of performing trainings?

Newbie ☐ little experience ☐ medium experience ☐ high experience ☒

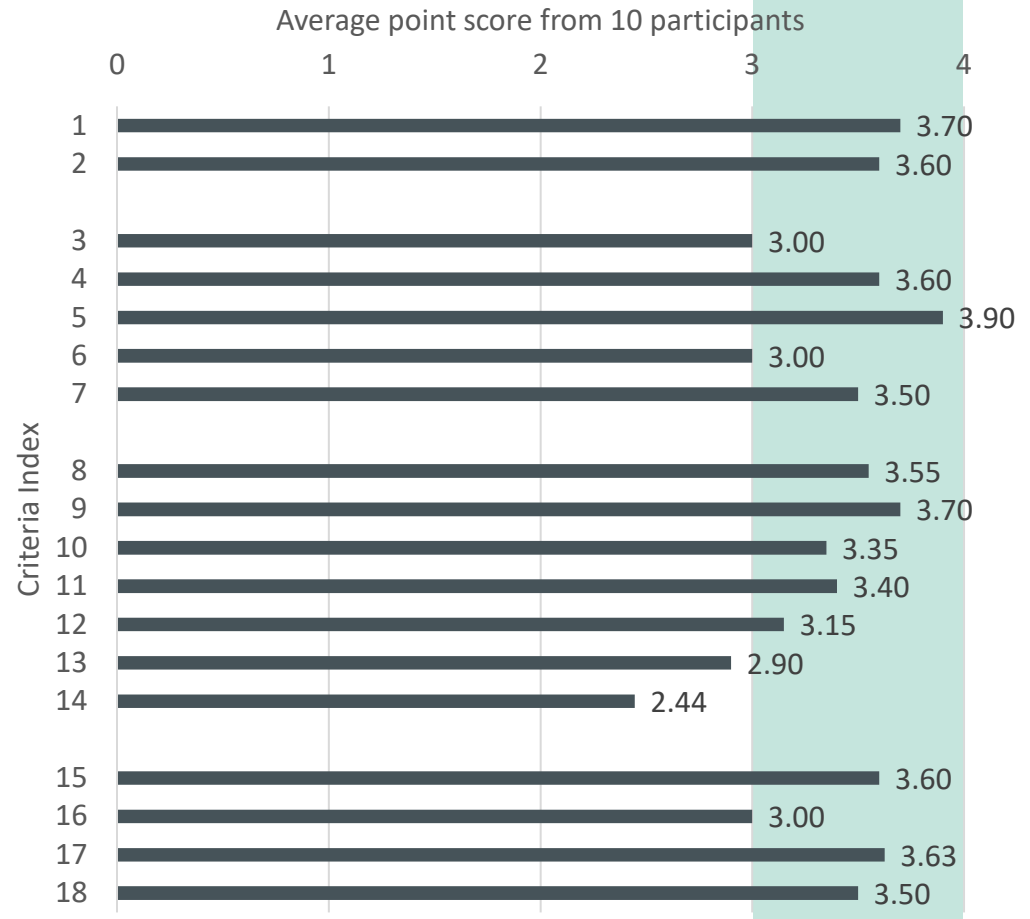
Comments: \_\_\_\_\_

**General Aspects – please rate the following aspects**

(1 = the worst rating, 4 = the best rating)

How satisfied are you with the:	1	2	3	4
support provided by the training centre staff (other than trainers)?				X
infrastructure conditions provided by the training institution (furnishing, heating, lighting, sanitation, etc.)?			X	
overall quality of the training?				X

**Very good**  
**Point score  $\geq 3$**



- The pilot training was evaluated “very good” with 3.4 / 4 points.
- All participants (10/10) recommend the training.





## Feedback from participants – Comments

**Please, indicate why you would recommend / not recommend the training:**

- Very good introduction to the world of Additive Manufacturing
- Program offers comprehensive introduction at the topic and provides detailed background knowledge
- Wide range of topics addressed; high information density; high knowledge of trainers
- Familiar with basic concepts and relevant working; Insights for practical design
- Important and useful information of AM processes and materials are given
- The course provides a good overview over the different aspects of AM and enables researchers to talk to colleagues in the field of AM on a professional level
- Offers a good overview of AM; State of technology development, existing challenges and cost are addressed



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

Project title: **C**reating know**L**edge and skills in **A**dditive **M**anufacturing  
Reference number: 2017-3309/591838-EPP-1-2017-1-ES-EPPKA2-SSA



# New building of Fraunhofer IGCV: Opportunity for trainings in AM



**Up-to-date Green Factory  
Building in Augsburg, Germany;  
In operation since 02/20**

**One of the most advanced labs  
for metal-based AM in Germany!**

**You are welcome  
for a visit!**

**Metalverarbeitende Systeme**

- Aconity One  
Ø 400 mm x 400 mm<sup>3</sup>
- EOS M290  
250 x 250 x 325 mm<sup>3</sup>
- EOS M400  
400 x 400 x 400 mm<sup>3</sup>
- Concept Laser M1 Cusing  
150 x 150 x 250 mm<sup>3</sup>
- SLM Solutions 125 HL  
125 x 125 x 125 mm<sup>3</sup>
- SLM Solutions 250 HL  
250 x 250 x 350 mm<sup>3</sup>
- Trumpf TruPrint 1000 GREEN  
Ø100 x 100 mm<sup>3</sup>
- Trumpf TruPrint 2000 Dual  
Ø200 x 100 mm<sup>3</sup>
- 14-Axes High-Pressure  
Cold Spray System
- 2 Wire-arc DED

**Directed Energy  
Deposition  
(DED)**

**Metal AM: 9 systems**

**Kunststoff- / Sandverarbeitende Systeme**

- Voxeljet VX1000  
500 x 400 x 300 mm<sup>3</sup>
- Voxeljet VXC800  
800 x 500 x continuous
- Voxeljet VX500  
500 x 400 x 300 mm<sup>3</sup>
- Voxeljet Testachse  
110 x 250 x 95 mm<sup>3</sup>
- EOS Formiga P100  
200 x 250 x 330 mm<sup>3</sup>
- Stratasys F270  
305 x 254 x 305 mm<sup>3</sup>
- 3D Systems ProJet HD3000  
298 x 185 x 203 mm<sup>3</sup>
- Markforged Marc Two  
575 x 332 x 360 mm<sup>3</sup>
- RepRap X400 Pro V3  
390 x 400 x 330 mm<sup>3</sup>
- Sintratec Kit,  
Zortrax M300  
Ultimaker 3 (3 pieces),  
Makerbots (15 pieces)

**Prototyping-  
Systeme**

**Other AM: 10 systems**



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

Project title: **C**reating know**L**edge and skill**S** in **A**dditive **M**anufacturing  
Reference number: 2017-3309/591838-EPP-1-2017-1-ES-EPPKA2-SSA



Please feel free to contact us anytime!

**Dr.-Ing. Vera Böhm**

Group leader  
Additive Manufacturing

**Fraunhofer IGCv**

Am Technologiezentrum 10  
86159 Augsburg, Germany  
Phone +49 821 90678-150  
[vera.boehm@igcv.fraunhofer.de](mailto:vera.boehm@igcv.fraunhofer.de)  
[www.igcv.fraunhofer.de](http://www.igcv.fraunhofer.de)  
[www.amlab.de](http://www.amlab.de)

**Matthias Schneck, M. Sc.**

Research Associate  
Additive Manufacturing

**Fraunhofer IGCv**

Am Technologiezentrum 10  
86159 Augsburg, Germany  
Phone +49 821 90678-140  
[matthias.schneck@igcv.fraunhofer.de](mailto:matthias.schneck@igcv.fraunhofer.de)  
[www.igcv.fraunhofer.de](http://www.igcv.fraunhofer.de)  
[www.amlab.de](http://www.amlab.de)

Project title: **C**reating know**L**edge and skill**S** in **A**dd**I**tive **M**anufacturing  
Reference number: 2017-3309/591838-EPP-1-2017-1-ES-EPPKA2-SSA



# Thank you for your attention



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



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