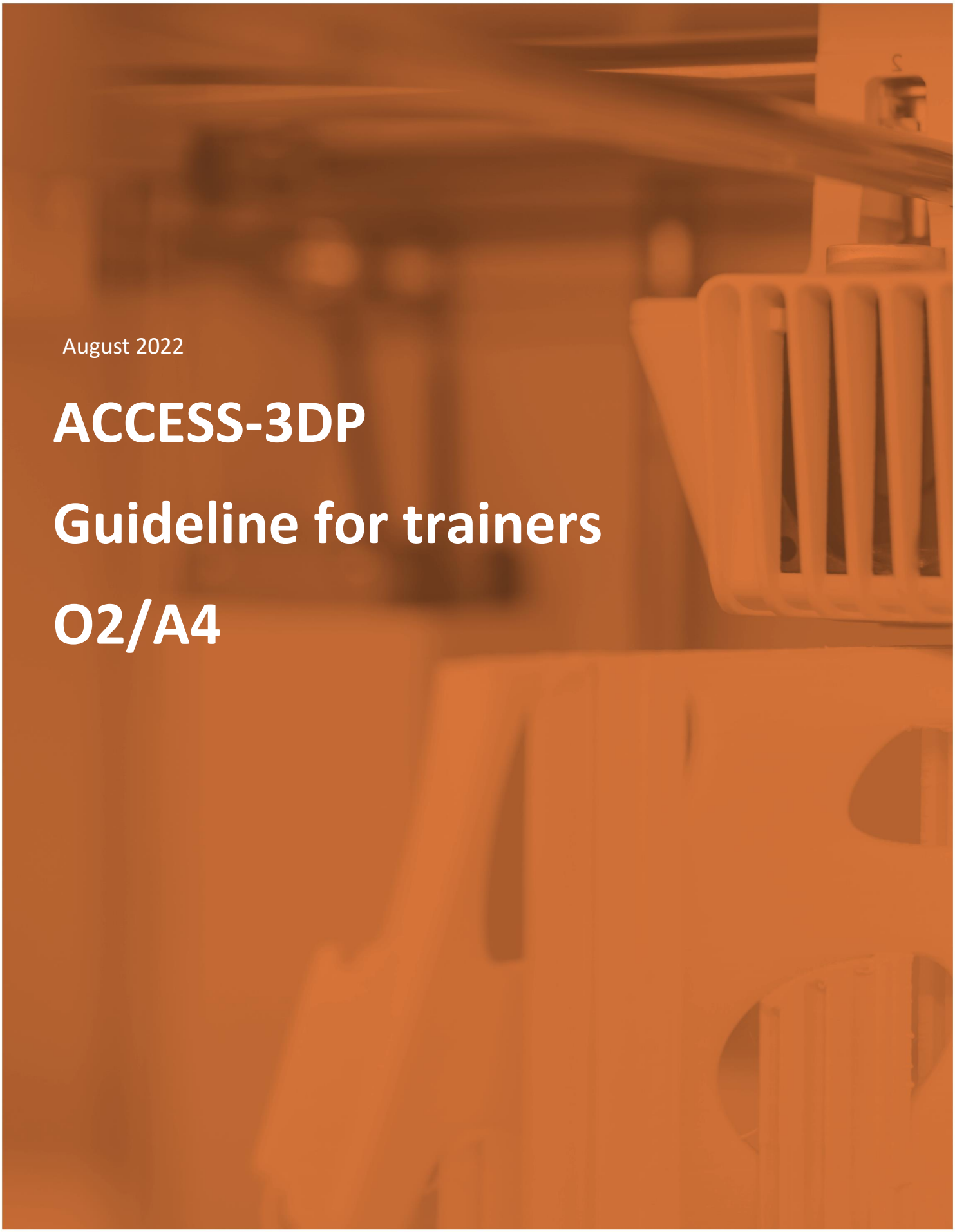
access-3DP
Art & Creative Craft Enterprises for Successful Streaming of 3D Printing

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



August 2022

ACCESS-3DP

Guideline for trainers

O2/A4

Art & Creative Craft Enterprises for Successful Streaming of 3D Printing

GUIDELINE FOR TRAINERS: O2/A4

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Version	Date	Short description	Author(s)
1	12/10/2021	First draft	CMA Lyon Rhône
2	OCT2021	Revisions and comments	All partners
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1 INTRODUCTION

The project "ACCESS-3DP Art & Creative Craft Enterprises for Successful Streaming of 3D Printing«, co-funded by the European Commission Erasmus+ KA2 program, focuses on establishing the VET curriculum that combines identified skills mismatched between the craft and traditional industries with additive manufacturing technologies.

The training path developed with the collaborative work of 5 partner organizations was established and implemented to correspond to the needs and skills of different target groups. With this document, the training paths are explained to support the trainers using the training modules and clarify the goals and aims of the established training material.

2 LEARNING NEEDS AND OUTCOMES

The main needs identified into the research report[1] carried out under first project activity, can be summarized as follows:

- To develop a new format for the training programme on additive manufacturing, including information a comprhensive programme with information on the technology, software, or materials addressed, so to make the information easier to get and clearer for the potential participants;
- To raise the level of awareness and skills on 3DP and show the added value that it can bring to craft activities by providing concrete examples of applications, best practices and practical case studies issued by creative entrepreneurs who have already adopted it;
- To explain and show the different production processes and materials used in AM, by illustrating exemples of their applications, the specificities of each material, the limits, the difficulties, the costs, as well as provide information on the security issues related to the use of 3DP machines, which are often absent in the current training offer;
- To develop skills and competences on non-technical subjects, which nevertheless are important to appreciate the value-added of the technology and assess the economic viability of an investment in additive manufacturing;
- To favour the development of transversal skills such as, critical and innovative thinking, project management and organizational skills, so to stimulate creativity and facilitate the adoption of AM by craft entrepreneurs;
- To support the introduction of innovative processes into the activities of traditional craft enteprises, by favoring the adoption of an innovative approach in terms of design thinking as well as design and software modelling;
- To give visibility to the network of partners available in the local innovative innovation ecosystem, which can offer expertise and support to develop a 3DP project;
- To show to the enterprises how 3DP can be coupled with robotic technologies to generate new solutions and application for production automation and highlight the

[1] The full study report on how VET providers can innovate and interconnect traditional and creative craft industries through 3D is available online on the ACCESS 3DP project's website: https://access3dp.eu/

benefits of associating 3DP and AIR trough examples of best practices from the craft sector;
- To allow for the choice on different levels of trainings, with a focus on the basic and intermediate levels;
- To develop a diploma which valorise the learnings outcomes achieved, based on the ECVET system.

3 OVERVIEW OF THE MODULES

Followin the results of need analysis carried the partnership has decided a training path including 6 different training modules.

Training module	Short description
Module 1 – Innovation process applied in traditional sector as design and 3DP	The module is dedicated to provide training on innovation process and managament and its application to 3DP projects, the craft sector. It is split into 4 learning objects (LO)[2], which aim is favour the introduction of innovative processes into the activities of traditional craft enteprises. The module is enriched with exemples of issues from craft enteprises which have used 3DP as a source of innovation in their product or production rpocesses.
Module 2 - Design Thinking & Skills	The module aims to facilitate the adoption of design thinking as a source of creativity for traditional craft entrepreneurs, interested in additive manufacturing. Module 2 is split in 7 LO, with the aim to provide specific training on the concept, steps and benefits of design thinking, to favour the developemnt of critical skills and to show how 3DP can contribute to the adoption of design thinking.
Module 3 – 3D printing & production processes	The module introduce to the concept of 3DP and illustrate the different production processes and available software for 3DP as well as the materials used by the different technologies. Module 3 also present the potential risked associated with the use of 3DP machines and prodiucts. Finally, somme notions are provided on the impact of additive manufacturing on the supply chain. Module 3 includes 6 LO.
Module 4 - The current processes, different fields of application	This module is dedicated to illustrate the most common 3DP technologies and the relative

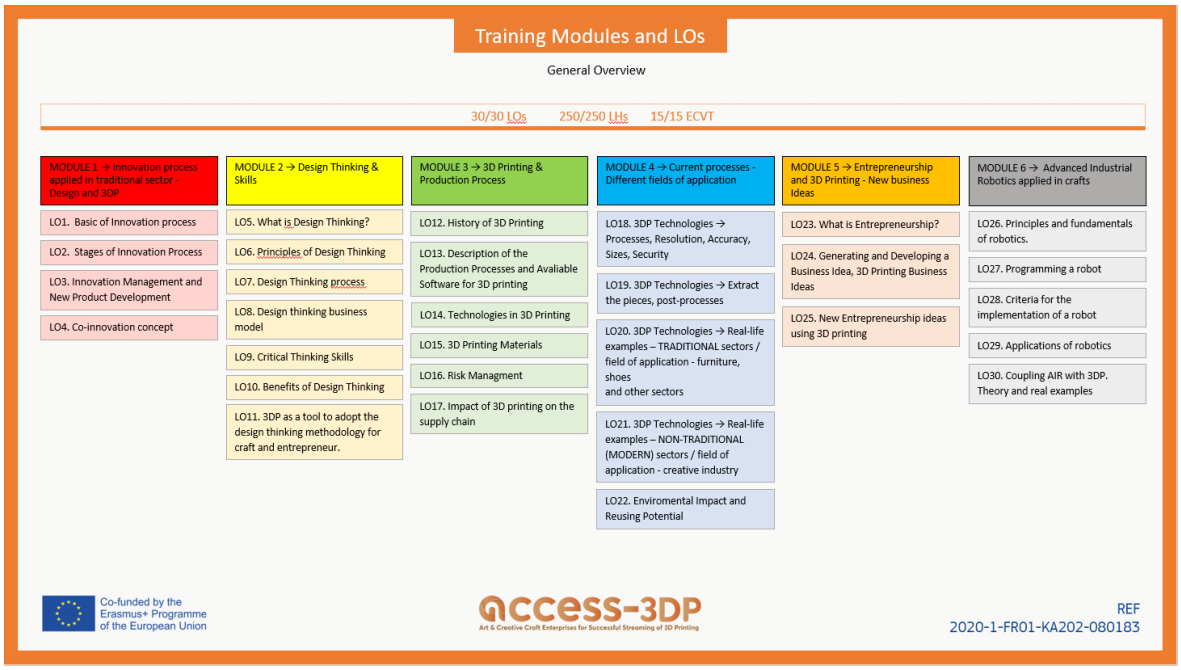
[2] Each leanring objective correspond to the relative learning unit of the ACCESS 3DP course.

	production processes in detail. Module 4 includes 5 LO and provides several exemples of concrete applications of 3DP from different craft sectors (ex. furniture, footwear, clothing, jwellery, etc).
Module 5 - Entrepreneurship and 3D Printing, new business ideas	This module is dedicated to provide specific training on entrepreneuship, business development, marketing strategies and business promotion, particularly in 3DP projects in the craft sector. The module includes 3 LO , whose goal is to train on non-technical skills, which nevertheless are important to assess the economic viability of a bussiness project involving additive manufacturing.
Module 6 - Advanced Industrial Robitics appliced in crafts	The module is dedicated to illustrate how 3DP can be coupled with robotic technologies. It includes 5 LO and provide basic training on robotics, its accessories and programming. The module is enriched with basic theoretical concepts and concrete exemples of robotics applied to additive manufacturing in the craft sector so to show the potentials of the association.

4 HOW TO USE THE TRAINING PATH

4.1 OVERVIEW OF THE OVERALL ACCESS 3DP TRAINING PATH

The overal training path developed by the ACCESS 3DP is incudes 6 traning modules, including all together 30 learning objectives, corresponding to the learning units of the course.



The overall path covers in total 250 learning hours, which correspont to 15 ECVET points[3].

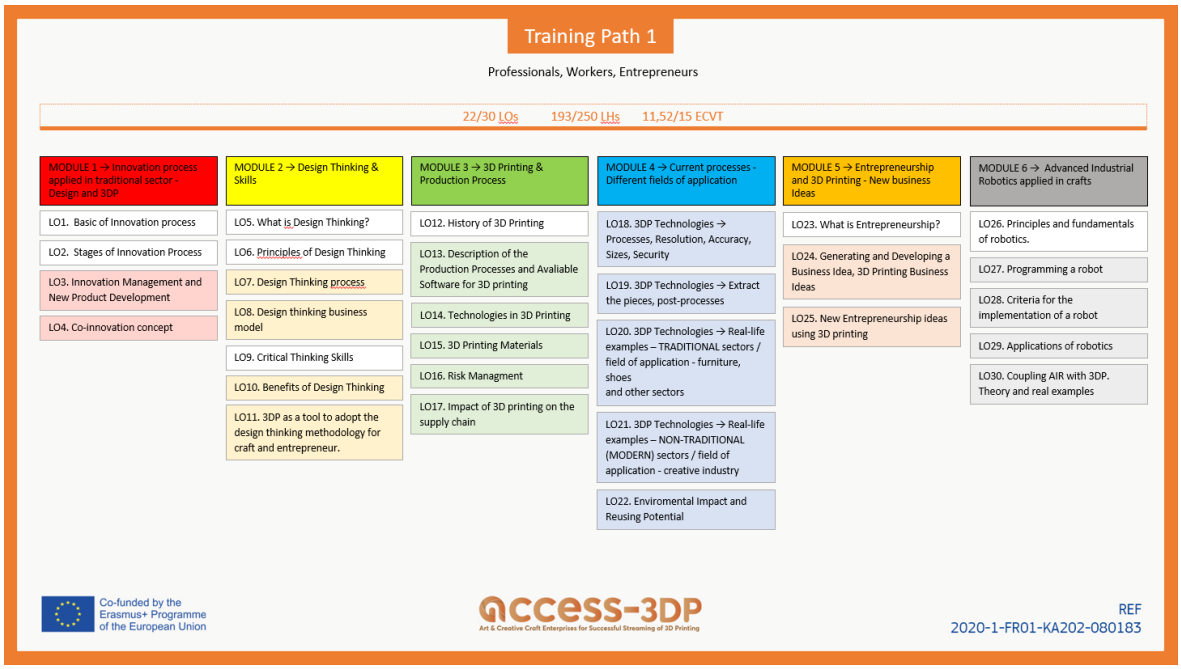
In line with the recommendations issued by the need analysis and in order to facilitate the use and understanding of learning contents to the public targeted by this new training offer, the ACCESS-3DP Consortium has developed three different training paths. Every path targets a different target group, for which the learninh units, hours and ECVET points achieved at the end of the path are different.

Training path number	Target public	Number of Leaning Units	Overall Learning hours	ECVET points
#1	Professionals, Workers, Entrepreneurs	22	193	11,52
#2	Students, VET providers, Universities, Unemployed	30	250	15
#3	Relevant Stakeholders	17	150	9

4.2 TRAINING PATH 1 : PROFESSIONALS, WORKERS, ENTREPRENEURS

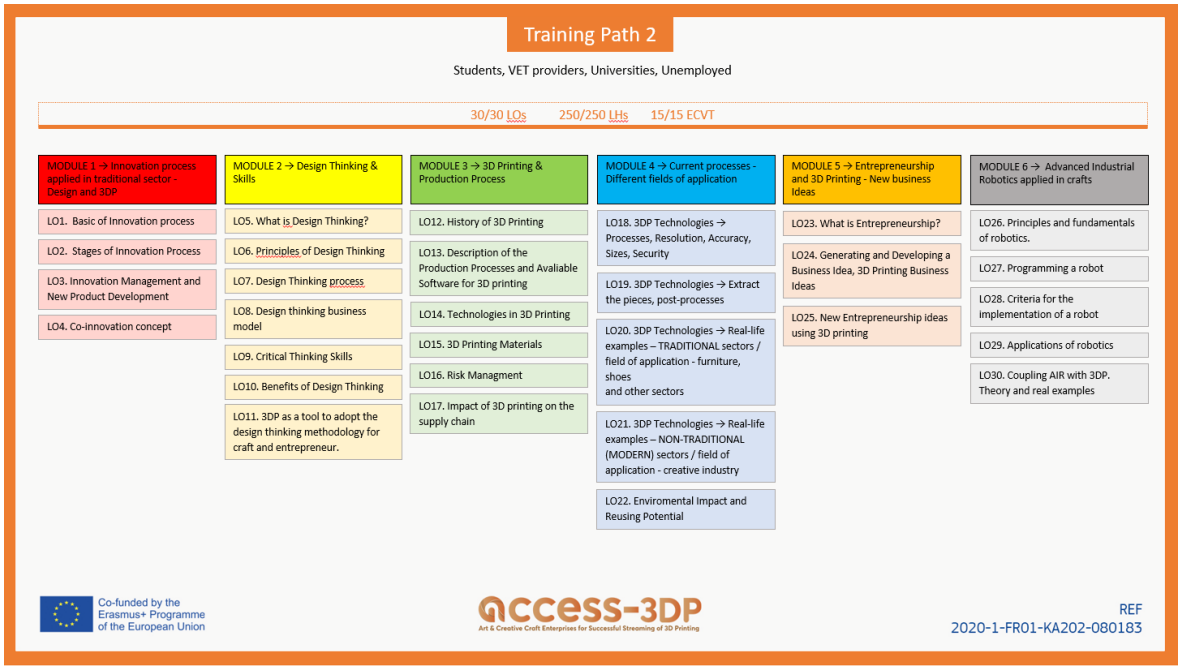
The first training path targets individuals who already have a basic understanding of the main areas of knowledge related to additive manufacturing and the relative non-technical topics which are essential to understand the potensials of this technology (such as innovation, design thinking, entrepreneuship, robotics). The path is intended for professionals of innovative technologies, such as (1) Designers, (2) 3D printing manufacturers, as well as (3) those interested in grasping business opportunities into these sectors and (4) Entrepreneurs who want to set up a creative business in traditional craft sectors, adopting 3D printing technologies. Therefore, the objective of this path is to rise the interest of the traditional craft sectors for additive manufacturing, promote creativity, innovation, and competitiveness, and get highly skilled workers, without burdening them with basic LOs that are intended to explain the fields they have practical experience in (e.g. What is Creative thinking?). This training path is focused on the practical exemples of application, to push inspiration from peers (e.g. Real life example).

[3] See Chapter 6 for for details about the conversion.



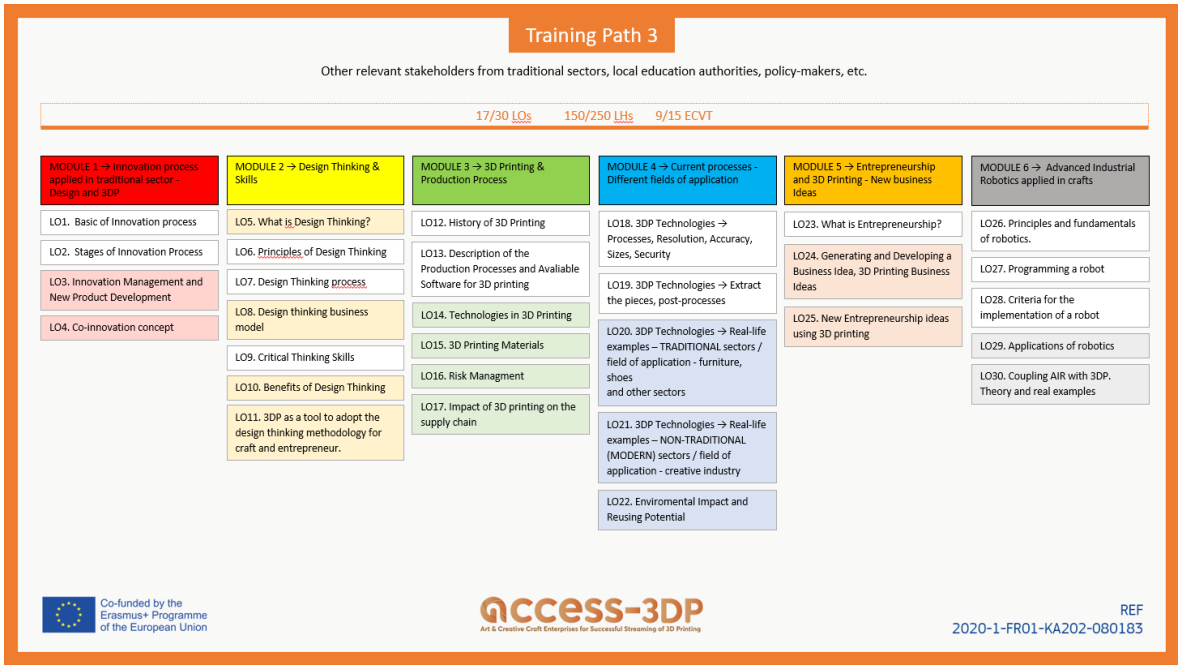
4.3 Training path 2: Students, VET providers, Universities, Unemployed

The second target group consists of students, including VET providers on manufacturing in traditional sectors or new technologies, Universities on CAD Design and 3D printing technology, unemployed and other students interested in industrial CAD design, manufacturing processes in 3D printing, and craft industries. As this group includes people that may have no previous knowledge of any of the topics covered in the training path, they are offered the full spectre of LOs. This approach ensures that the target group will understand what the basics of running a business, innovation etc. before learning specific knowledge connected to the 3DP and AM.



4.4 TRAINING PATH 3: RELEVANT STAKEHOLDERS

The third target group is very mixed and involves "Other Relevant Stakeholders" that vary from educational authorities, support environment, to decision makers. The purpose of the training for this target group is different from the first two groups, as in this case it is not expected that the learners will apply the knowledge gained in the practical fields. However, in the scope of their work, they can contribute to the development of the sector, but only if they possess enough understanding of it. Therefore, the main objective of training this target group is not just the dissemination of knowledge, but also awareness raising and general advancement of 3DP and AM.



4.5 SPECIAL TRAINING PATH : OPEN-ACCESS

A special training path completes the training offer and targets all types of public. Indeed, in order to consider the different profiles of individuals who are part of the same target group and that may be not interested in completing all the modules proposed, the partners have decided to open a training path "on the menu". In this training path, learners are invited to complete a short questionnaire on their pre-knowledge on each module. According to the replies, the training path is then personalized.

Question	If the reply is **YES**, the learning unit recommended is	If the reply is **NO**, the learner is recommended to go trough
Do you know what innovation means	Unit 1.3 Innovation Management and New Product Development Unit 1.4 Co-innovation concept	All units of module 1
Are you familiar with the concept of design thinking and its different steps?	Unit 2.4 Design Thinking and Business Models Unit 2.6 Benefits of Design Thinking	All units of module 2

	Unit 2.7 3DP as a tool to adopt the design thinking methodology for craft entrepreneur	
Do you have a basic knowledge on how to use software for designing (modelling and reverse engineering) and 3D printing technologies?	Unit 3.4 3D printing materials Unit 3.5 Risk Management Unit 3.6 Impact of 3D printing on the supply chain	All units of module 3
Do you know the different 3DP technologies characteristics (resolution, accuracy, sizes, security, etc.)?	Unit 4.3 3DP Technologies. Real-life examples in traditional sectors Unit 4.4 3DP Technologies. Real-life examples in non-traditional sectors Unit 4.5 Environmental impact and reusing potential	All units of module 4
Have you ever set up a business (any sector of activity)?	Unit 5.2. Generating and Developing a Business Idea, 3D Printing Business Ideas Unit 5.3. New Entrepreneurship ideas using 3D printing	All units of module 5
Are you familiar with robotics?	Unit 6.3. Criteria for the implementation of a robot Unit 6.4. Application of robotics Unit 6.5. Coupling AIR with 3D printing. Theory and real examples	All units of module 6

This latter training path is particularly interesting for entrepreneurs and stakeholders have a limited time available for the ACCESS 3DP e-learning MOOC and are not interested in final certification.

5 LEARNING OUTCOMES , LEARNING OBJECTS AND LEARNING UNITS

5.1 "LEARNING OUTCOMES": A GENERAL DEFINITION

According to Recommendation of the European Parliament and of the Council of 23rd April 2008 on the establishment of the European Qualifications Framework for Lifelong Learning, "Learning outcomes" means statements of what a learner knows, understands and is able to do on completion of a learning process, which is defined in terms of knowledge, skills and competence.

These terms have been defined as follows in the same Recommendation:

- "knowledge" means the outcome of the assimilation of information through learning. Knowledge is the body of facts, principles, theories, and practices that is related to a field of work or study; for example, the Earth spins around its axis;
- "skills" means the ability to apply knowledge and use know-how to complete tasks and solve problems. In the context of the European Qualifications Framework, skills are

described as cognitive or practical; for example, the ability to know where are east and west;

- "competence" means the proven ability to use knowledge, skills, and personal, social, and/or methodological abilities, in work or study situations and professional and personal development; for example: know how to make a sun dial.

The overall ACCESS 3DP training course targets in total 30 learning outcomes, which in turn correspond to 30 LO and corresponding mearning units. The latter are gathered into the 6 learning modules, which make up the course.

5.2 MODULE 1 - INNOVATION PROCESS APPLIED IN TRADITIONAL SECTOR AS DESIGN AND 3DP

5.2.1 Overview of the learning units of Module 1

The module is dedicated to illustrate innovation and its application to 3DP applied to the craft sector.

Module 1 is split in 4 different LO (from LO1 to LO4), corresponding to the relative learning units detailed as follows:

1) Unit 1.1 Basic of the Innovation process
   a) What is innovation?
   b) The different types and intensities of innovation
   c) Innovation as a state of mind
   d) Objectives and challenges of an innovation process
   e) The innovation process
2) Unit 1.2 Stages of Innovation Process
   a) Preliminary step
   b) The stages: from the search of ideas to the promotion of innovation
   c) Good practices from creative companies
3) Unit 1.3 Innovation Management and New Product Development
   a) Innovative project management
   b) Risk management
   c) Key success factors: management of technical and financial resources
4) Unit 1.4 -innovation concept
   a) The interest for open innovation
   b) Different practices
   c) Opensource resources
5) The overal Module 1 last 28 hours and its completion entitels to 1,68 ECVET points.

5.2.2 Learning outcomes from Module 1

KNOWLEDGE	SKILLS	COMPETENCES
Have knowledge about Innovation concepts and objectives, and challenges through the innovation process	Be able to describe the different types of innovation, the benefits, and key factors of success of an innovative approach, in connection with 3D printing	Ability to identify an innovative project thanks to 3D printing, that will benefit the business/business project of the learner

Have the knowledge about stages of the Innovation Process with examples of good practices	Be able to explain the different stages of an innovative project and the relative points of warning	Ability to be autonomous in the identification of the innovation potential of its own project with 3D printing Ability to define an innovative project related to 3D printing and meet the conditions that are needed for its success
Understand the Co-Innovation Concept	Be able to identify good co-innovation practices related to 3D printing	Ability to federate and cooperate with different actors in the implementation of an innovative project related to 3D printing

5.2.3 Training methods recommended for Module 1

The training methods recommended for this module are slides and text. Link to interesting videos are proposed within the documents.

5.2.4 Assessment methods recommended for Module 1

The assessment method recommended for this module is a set of close questions (quiz test).

5.3 Module 2 - Design Thinking & Skills

The module is dedicated to devlopt skills and knowledge concerning design thinking.

It is split into 7 different LO (from LO5 to LO11), corresponding to the relative learning units detailed in the overwiev below.

The overal Module 2 last 38 hours and its completion entitles to 2,28 ECVET points.

5.3.1 Overview of the learning units of Module 2

1) Unit 2.1 – What is Design Thinking?
   a) History of Design Thinking
   b) What is Design Thinking
   c) Why Design Thinking is the Key to 3D Printing
2) Unit 2.2 – Principles of Desing Thinking
3) Unit 2.3 – Design Thinking Process
   a) What Is the Design Thinking Process and Why Is It Necessary?
   b) Design Thinking Stage 1: Empathy
   c) Design Thinking Stage 2: Define
   d) Design Thinking Stage 3: Ideate
   e) Design Thinking Stage 4: Prototype
   f) How Design Thinking Improves the Creative Process
4) Unit 2.4 – Design Thinking and Business models (name change)
   a) Why Design Thinking Appeals to Businesses?
   b) Industries in design thinking
   c) Design Thinking and Business Models Innovation
   d) Business Model Canvas
   e) Lean Startup Canvas

f) Stanford D.School Design Thinking
g) How to Apply Design Thinking models

5) Unit 2.5 – Critical thinking skills
   a) Critical Thinking and Design Thinking
   b) Stages of Critical Thinking
   c) What Is Critical Thinking Skills?
   d) How to Improve Critical Thinking?
6) Unit 2.6 – Benefits of design thinking
7) Unit 2.7 – 3DP as a tool to adopt the Design Thinking

5.3.2 Learning outcomes from Module 2

KNOWLEDGE	SKILLS	COMPETENCES
Know the History of Design Thinking, its definition, and its use in the 3DP	To gain knowledge about the development of design thinking and to recognize opportunities for applying design thinking as a problem-solving approach and innovation accelerator in production processes by using 3DP	Linking previous working experience with skills for optimization and innovation of production processes by using design thinking methods and applying 3DP tools in practice.
Understand the principles of Design Thinking	Be able to define and explain basic principles of design thinking- the rules that should guide the design process as a toll for innovation of products in traditional craft sectors	Autonomous ability to use design thinking principles to research and improve the product/process using 3D technology based on the satisfaction of its users. Ability to recognize the many generated ideas and determine which ones are likely to produce specific, desired outcomes
Understand the Design Thinking Process and its stages	Be able to identify and specify the various stages of the design thinking process and explain the mutual sequences in the design thinking process. Be able to explain the value of the Design Thinking process, its benefits to improve the creative process of product-advantages of using technology of 3D in this process.	Ability to apply Design Thinking techniques to support the innovation of products/services - to test innovative ideas through a fast iteration cycle. Ability to use Design Thinking mindset in approaching tasks that require "out the box thinking" as a tool to solve complex problems to creatively improve products/processes

Have knowledge about Design thinking in relation to the Business Model	Be able to identify and describe the influence of design thinking on the innovation of traditional business models - generating new business models. Be able to recognize and identify the variety of design thinking business process models, their different approaches to problem solving and putting product innovations into practice.	Ability to choose a suitable business model of design thinking process for own business/product in order to innovate them. Autonomous ability to use a suitable business model using 3D printing methodology as a tool for prototyping and innovation of the final product.
Understand the approach of Critical Thinking and its stages	Be able to identify and describe the critical skills needed for the critical thinking process as a catalyst of changes in design and way for solving problems and innovate products Be able to identify core methods, tips for improving critical thinking skills used in critical thinking process	Ability to recognize the most important critical thinking skills, develop them, improve them - their use in product innovation process, to innovate products reflexing the users needs. The ability to recognize and use the most appropriate method to improve critical skills in order to innovate, improve the product
Understand the benefits of Design Thinking	Be able to identify and describe how design thinking benefits an organization, identify the main benefits of using Design Thinking methods in the production process.	Ability to use and apply design thinking methods as problem-solving methods and innovation accelerators in production processes Ability to use design thinking to implement culture change within the organization. Ability to reduce risk of the product, not meeting customer needs, to reduce dependency on individual knowledge, hunches, and opinions.
Understand how to adopt Design Thinking methodology with the 3DP for craft and entrepreneurs	Be able to recognize and explain how 3D printing can contribute to adopting of Design thinking, the advantages of using 3D printing in product innovation, in prototyping, and product production itself	Ability to use and apply design thinking methods as a problem-solving methods and innovation accelerator of craft and entrepreneurs production processes by using 3DP

5.3.3 Training methods recommended for Module 2

The training methods recommended for this module are slides and text. Link to interesting videos are proposed within the documents.

5.3.4 Assessment methods recommended for Module 2

The assessment method recommended for this module is

5.4 MODULE 3 - 3D PRINTING & PRODUCTION PROCESSES

The module is dedicated to explain and show the different production processes and materials used in AM, as well as the risks connected with the use of the 3DP machines. It also include informotaion of the impact 3D printing on the supply chain.

It is split in 6 different LO (from LO12 to LO17), corresponding to the relative learning units detailed in the overwiev below.

The overal Module 3 last 60 hours and its completion entitle to 3,6 ECVET points.

5.4.1 Overview of the learning units of Module 3

1) Unit 3.1 History of 3D printing
   a) History of 3D printing
   b) What is 3D printing or Additive Manufacturing?
2) Unit 3.2 Description of the production processes and available software for 3D printing
   a) Production process in 3D printing
   b) Needed software for 3D printing
3) Unit 3.3 Technologies in 3D printing
   a) Introduction
   b) FDM
   c) SLA
   d) SLS
4) Unit 3.4 3D printing materials
   a) Overview
   b) FDM printing materials
   c) SLA printing materials
   d) SLS printing materials
5) Unit 3.4 Risk Management
6) Unit 3.6 Impact of 3D printing on the supply chain

5.4.2 Learning outcomes from Module 3

KNOWLEDGE	SKILLS	COMPETENCES
Knowledge about the origin of 3DP	Recognizing opportunities for applying 3DP technology in production processes	Linking previous working experience with skills for optimization of production processes with skills for applying 3DP in practice

Understand the Production Process and available Software	Be able to identify the different types of Software used in 3D printing	Autonomous ability to determine what kind of program is needed for each step of the 3D printing process, ability to make decisions within the printing process, solve printing problems
Know about different technologies in 3DP. Knowledge of the various technologies, their advantages and disadvantages, their main applications, and post-processing in each one of them.	Ability to identify what type of technology is needed and used. Be able to identify the different types of technologies. Expand knowledge of the most usable 3D Printing technologies. Go deeper with the current processes, different fields of application for the most usable 3D Printing technologies.	Autonomous ability to decide among technologies and be able to predict what the result will be with each technology. Solve printing problems.
Knowledge about different 3DP materials, characteristics of every material	Describe the most commonly used 3D printing materials, as well as their characteristics. Appreciate the main differences between materials, choosing the appropriate material depending on the final object purpose	Autonomous ability to identify the most suitable material for the process and solve printing problems
Know possible hazards by using the 3DP	Describe the possible risks, increased awareness of potential hazards, and taking action to avoid it	Ability to evaluate and identify the environment of the 3DP process for a wide range of risks and dangers
Understand the Impact of 3DP on the Supply Chain	Explain the advantages of 3DP impact on supply chain	Autonomous ability to recognize the possible reduction of the supply chains with the elimination of unnecessary procedures along the process

5.4.3 Training methods recommended for Module 3

The training methods recommended for this module are slides and text. Link to interesting videos are proposed within the documents.

5.4.4 Assessment methods recommended for Module 3

The assessment method recommended for this module is a set of close questions (quiz test).

5.5 MODULE 4 – THE CURRENT PROCESSES, DIFFERENT FIELDS OF APPLICATION

The module is dedicated to illustrate the most comm 3D printing technologies and relative production processes. The module is enriched with real-life exemples, issued from several craft sectors (furniture, footwear, clothing, Jwellery, ceramics and others).

It is split into 5 different LO (from LO18 to LO22), corresponding to the relative learning units detailed in the overwiev below.

The overal Module 4 last 60 hours and its completion entitles to 3,6 ECVET points.

5.5.1 Overview of the learning units of Module 4

1) Unit 4.1 3DP technologies :Processes, Resolution, Accuracy, Sizes, Security
   a) FDM. Process, resolution, accuracy, sizes, security
   b) SLA (and derivatives as for example CLIP). Process, resolution, accuracy, sizes, security
   c) SLS. Process, resolution, accuracy, sizes, security
   d) Binder jetting. Process, resolution, accuracy, sizes, security
   e) Other technologies. Process, resolution, accuracy, sizes, security
2) Unit 4.2 3DP technologies : Extract the pieces, post-processes
   a) Extracting the piece and applying post-processes with FDM
   b) Extracting the piece and applying post-processes with SLA (and derivatives)
   c) Extracting the piece and applying post-processes with SLS
   d) Extracting the piece and applying post-processes with Polyjet
   e) Extracting the piece and applying post-processes with Binder jetting
   f) Extracting the piece and applying post-processes with other technologies
3) Unit 4.3 3DP Technologies : Real-life examples – TRADITIONAL sectors / field of application – furniture, shoes, and other sectors
   a) Furniture sector
   b) Footwear sector
   c) Clothing
   d) Jewellery and other fashion acessories
   e) Ceramics
   f) Other industries
4) Unit 4.4 3D printing Technologies : Real-life examples – NON TRADITIONAL (MODERN) sectors / field of application – creative industry
   a) Medical sector
   b) Orthodontics and dental sector
   c) Manufacturing industry
   d) Consumer goods
5) Unit 4.5 Environmental impact and reusing potential

5.5.2 Learning outcomes from Module 4

KNOWLEDGE	SKILLS	COMPETENCES
Describe the most commonly used 3D printing technologies and their technical aspects (processes, resolution, accuracy, sizes, security, etc.).	Identify and differentiate the different types of technologies. Identify and interpret the main technical aspects of each technology.	Analyse and differentiate the main 3D printing technologies used. Outlet the main technical aspects of each technology. Ability to decide which technology is the most suitable for printing a 3D model. Be able to identify in advance the result to be obtained with each technology. Be sensitized to solve 3D printing problems in advance.
Describe the extraction of parts and post-treatments applied to different 3D printing technologies.	Outline and understand the extraction process of the main 3D printing technologies. Outline and understand the subsequent treatments of the main 3D printing technologies. Differentiate between the processes of extraction of parts and the subsequent treatments of the main 3D printing technologies.	Be sensitized with the different processes of extraction of parts and subsequent treatments of the main 3D printing technologies. Ability to analyze and understand in detail which technology is most appropriate depending on the final application of the printed model.
Get familiar with the real-life examples in traditional sectors	To gain in-depth knowledge of the different fields of application of the main 3D printing technologies in traditional sectors. Identify the most suitable technology depending on the final application.	Outlet the main 3D printing technologies and their processes in order to apply them in different traditional sectors. Outlet the best technology to manufacture prototypes, moulds, etc. for applications in traditional sectors.
Get familiar with the real-life examples in the non-traditional sector	To gain in-depth knowledge of the different fields of application of the main 3D printing technologies in non-traditional sectors. Identify the most suitable technology depending on the final application.	Outlet the main 3D printing technologies and their processes in order to apply them in different non-traditional sectors. Outlet the best technology to manufacture prototypes, moulds, etc. for applications in non-traditional sectors.

Understand the Environmental Impacts and Reusing Potential	To gain an in-depth understanding of the environmental impact of the application of 3D printing technologies. Identify possible processes to make this technique greener, such as the use of biodegradable materials.	Recognise the environmental impact of 3D printing technologies and their application for different applications. Demonstrate knowledge about different techniques for making 3D printing greener.

5.5.3 Training methods recommended for Module 4

The training methods recommended for this module are slides and text. Link to interesting videos are proposed within the documents.

5.5.4 Assessment methods recommended for Module 4

The assessment method recommended for this module is a set of close questions (quiz test).

5.6 Module 5 – Entrepreneurship and 3D Printing, new business ideas

The module is dedicated to provide concepts and tools related to entrepreneurship, so to support the development of solid business projects involving additive manufacturing.

It is split into 3 different LO (from LO23 to LO25), corresponding to the relative learning units detailed in the overwiev below.

The overal Module 5 last hours and its completion entitles to 2,28 ECVET points.

5.6.1 Overview of the learning objects of Module 5

1) Unit 5.1 What is Entrepreneurship?
   a) The different profiles of an entrepreneurs: qualities and motivation
   b) What type of entrepreneur are you?
2) Unit 5.2 Generating and Developing a Business Idea, 3D Printing Business Ideas
   a) Reasons to start a 3DP Business
   b) How to start a 3DP Business
   c) The marketing process
   d) How to finance a business in 3DP
   e) How to develop a business network
   f) How to ensure a long-lasting business
3) Unit 5.3 New Entrepreneurship ideas using 3D printing

5.6.2 Learning outcomes from Module 5

KNOWLEDGE	SKILLS	COMPETENCES
Understand the Entrepreneurship and Entrepreneurs, their types	Be able to identify the different entrepreneurial profiles	Ability to identify the type on entrepreneur which suits the best to the learner Be able to o work on and

		analyse the motivations behind an entrepreneurial project
Understand the development of a business idea with knowing how to start it with the marketing process, financial point, and networking	to know the key steps that lead to the definition of a successful entrepreneurial project to get a deep knowledge of the different areas that are related to an entrepreneurial project: (including management, marketing, finance, network development, etc.) to get the methodology to develop an entrepreneurial project	Ability to draft a business plan Ability to analyze the economic sustainability of a business project involving 3D printing Ability to understand the different challenges related to the set up of an enterprise
Familiarizing with examples of new entrepreneurship ideas using 3DP	to gain knowledge about different approaches of entrepreneurship in 3D printing and new trends	Ability to identify potential business opportunities in the 3D printing sector Be able to identify the key factors that lead to a successful entrepreneurial project involving 3D printing and take inspiration for its own project

5.6.3 Training methods recommended for Module 5

The training methods recommended for this module are slides and text. Link to interesting videos are proposed within the documents.

5.6.4 Assessment methods recommended for Module 5

The assessment method recommended for this module is a set of close questions (quiz test).

5.7 Module 6 - Advanced Industrial Robitics applied in crafts

The module is dedicated to explore the potential of appling robotic technologies and 3D printing. It provide basic concepts and concrete exemples, which show the potentials of the association of these two advanced technologies.

It is split into 3 different LO (from LO26 to LO30), corresponding to the relative learning units detailed in the overwiev below.

The overal Module 5 last hours and its completion entitles to 1,56 ECVET points.

5.7.1 Overview of the learning objects of Module 6

1) Unit 6.1 Principles and fundamental of robotics
   a) History of robotics

b) What is Robotics?
c) Categories of Robots
d) Basic concepts
e) Accessories for robotics applications
f) Sensors
g) Effectors
h) Other accessories

2) Unit 6.2 Programming a robot
   a) Principles of programming languages
   b) Computer numerical control programming
   c) Collaborative robots programming
3) Unit 6.3 Criteria for the implementation of a robot
4) Unit 6.4 Application of robotics
5) Unit 6.5 Coupling AIR with 3D printing. Theory and real examples

5.7.2 Learning outcomes from Module 6

KNOWLEDGE	SKILLS	COMPETENCES
Know the principles of robotics with its history, categories, and basic concept	Be able to identify the different elements (accessories) that can be attached to robotic applications.	Autonomous ability to determine which accessories are needed in a robotic application. Be capable of idenitify which elements of a robotics application could allow them to interact with a specific environment and improve the usefulness of the robot.
Familiarizing with accessories for robotics applications	To gain in depth-knolwedge about the creation of software programs to create a robot.	Be capable of creating a software programms to command machinery and perform useful automated tasks.
Understand the principles of programming the robot	To gain in-depth knowledge of the different fields of application of robotics. Identify the most suitable robotic cell and components depending on the final application.	Outlet the main robotic cell and components in order to apply them in different sectors. Outlet the main application of robotics to optimise production and subsequently, the financial results of an organisation.
Understand the different applications of robotics	Identify the procedure behind coupling AIR with 3DP. - Get familiar with different examples of applications with AIR and 3DP coupled.	Build capacity for generating coupling between AIR and 3D printing. Illustrate different examples of cases that couple AIR with 3DP.
Know principles of Coupling Air with 3DP with examples	Be able to identify the different elements (accessories) that can be attached to robotic	Autonomous ability to determine which accessories are needed in a robotic application.

	applications.	Be capable of identifying which elements of a robotics application could allow them to interact with a specific environment and improve the usefulness of the robot.

5.7.3 Training methods recommended for Module 6

The training methods recommended for this module are slides and text. Link to interesting videos are proposed within the documents.

5.7.4 Assessment Methods Recommended for Module 6

The assessment method recommended for this module is a set of close questions (quiz test).

6 TRAINING TIMESHEETS AND ECVET POINTS

6.1 THE OVERALL ACCESS 3DP TRAINING PATH

The overall ACCESS 3DP training path requires 250 hours of work from the learner, which are split differently according to the different modules. The working hours have been distributd taking into account not only the learning needs expressed by the craft entrepreneurs and stakeholders involved in the first phase of the project, but also the complexity of each subject and the expertise of the project partners. Thus, the heavier modules to complete are the ones focused on the process and the technologies of 3D printing (module 3 and 4), which, altogether, cover 120 hours of work (around half of the training path). Modules on design thinking and entrepreneurship are also important in terms of working hours and represent together around a third of the overall working time. Finally, some less attention is give to innovation and AIRs technologies, for which only basic concepts will be provided to the learners.

Following the analysis of the qualifications and validations systems in the partner countries, as well as the overall guidelines issued at European level on the topic, the partners agreed to attribute 1 ECVET point to every 25 hours of work. The completion to the overall training path therefore entitles to 15 ECVET points.

The distribution of the working time and ECVET point through the overall path is represented in the table below:

M#	Module	Hours/ module	Weight/total hours	ECVET points	LO#	LO description	LO hours	LO weight	LO ECVET
1	Innovation process applied in traditional sector - Design and 3DP	28	11,20%	1,68	1	Basics of Innovation process	8,4	30,00%	0,5
					2	Stages of Innovation Process	7	25,00%	0,42
					3	Innovation Management and New Product Development	7	25,00%	0,42
					4	Co-innovation concept	5,6	20,00%	0,34
2	Design Thinking & Skills	38	15,20%	2,28	5	What is Design Thinking?	3,8	10,00%	0,23
					6	Principles of Design Thinking	7,22	19,00%	0,43
					7	Design Thinking process	5,7	15,00%	0,34
					8	Design Thinking and Business Models	8,74	23,00%	0,52
					9	Critical Thinking Skills	5,7	15,00%	0,34
					10	Benefits of Design Thinking	3,8	10,00%	0,23
					11	3DP as a tool to adopt the design thinking methodology for craft and entrepreneur	3,04	8%	0,18
3	3D Printing & Production Process	60	24,00%	3,6	12	History of 3D Printing	6	10,00%	0,36
					13	Description of the Production Process and Available Software	6	10,00%	0,36
					14	Technologies in 3D Printing	18	30,00%	1,08
					15	3D Printing Materials	18	30,00%	1,08
					16	Risk Management	6	10,00%	0,36
					17	Impact of 3D printing on the supply chain	6	10,00%	0,36
4	Current processes - Different fields of application	60	24,00%	3,6	18	3DP Technologies - Processes, Resolution, Accuracy, Sizes, Security	13,2	22,00%	0,79
					19	3DP Technologies- Extract the pieces, post-processes	13,2	22,00%	0,79
					20	3DP Technologies- Real life examples -TRADITIONAL sectors/field	13,2	22,00%	0,79
					21	3DP Technologies- Real life examples- NON-TRADITIONAL modern sectors	13,2	22,00%	0,79
					22	Environmental impact and Reusing Potential	7,2	12,00%	0,43
5	Entrepreneurship and 3D Printing - New business Ideas	38	15,20%	2,28	23	What is Entrepreneurship?	13,3	35,00%	0,8
					24	Generating and Developing a business ideas 3D Printing Business ideas	17,1	45,00%	1,03
					25	New Entrepreneurship ideas using 3D printing	7,6	20,00%	0,46
6	Advanced Industrial Robitics appliced in crafts	26	10,40%	1,56	26	Principles fundamentals of robotics	6,5	25,00%	0,39
					27	Programming a robot	3,9	15,00%	0,23
					28	Criteria for the implementation of a robot	3,9	15,00%	0,23
					29	Applications of robots	3,9	15,00%	0,23
					30	Coupling AIR with 3DP, Theory and real examples	7,8	30,00%	0,47
6	Total	250	100,00%	15	30		250		15

6.2 TRAINING TIMESHEETS AND ECVET POINTS PER TRAINING PATH

The distribution of the working time and the ECVET points per target group is presented in the tables below.

6.2.1 Professionals, Workers, Entrepreneurs

M#	Module	Hours/ module	Weight/total hours	ECVET points	LO#	LO description	LO hours	LO weight	LO ECVET
1	Innovation process applied in traditional sector - Design and 3DP	28	11,20%	1,68	1	Basics of Innovation process	0	0%	0,0
					2	Stages of Innovation Process	0	0%	0,0
					3	Innovation Management and New Product Development	7	4%	0,4
					4	Co-innovation concept	5,6	3%	0,3
2	Design Thinking & Skills	38	15,20%	2,28	5	What is Design Thinking?	0	0%	0,0
					6	Principles of Design Thinking	0	0%	0,0
					7	Design Thinking process	5,7	3%	0,3
					8	Design Thinking and Business Models	8,74	5%	0,5
					9	Critical Thinking Skills	0	0%	0,0
					10	Benefits of Design Thinking	3,8	2%	0,2
					11	3DP as a tool to adopt the design thinking methodology for craft and entrepreneur	3,04	2%	0,2
3	3D Printing & Production Process	60	24,00%	3,6	12	History of 3D Printing	0	0%	0,0
					13	Description of the Production Process and Available Software	6	3%	0,4
					14	Technologies in 3D Printing	18	9%	1,1
					15	3D Printing Materials	18	9%	1,1
					16	Risk Management	6	3%	0,4
					17	Impact of 3D printing on the supply chain	6	3%	0,4
4	Current processes - Different fields of application	60	24,00%	3,6	18	3DP Technologies - Processes, Resolution, Accuracy, Sizes, Security	13,2	7%	0,8
					19	3DP Technologies- Extract the pieces, post-processes	13,2	7%	0,8
					20	3DP Technologies- Real life examples -TRADITIONAL sectors/field	13,2	7%	0,8
					21	3DP Technologies- Real life examples- NON-TRADITIONAL modern sectors	13,2	7%	0,8
					22	Environmental impact and Reusing Potential	7,2	4%	0,4
5	Entrepreneurship and 3D Printing - New business Ideas	38	15,20%	2,28	23	What is Entrepreneurship?	0	0%	0,0
					24	Generating and Developing a business ideas 3D Printing Business ideas	17,1	9%	1,0
					25	New Entrepreneurship ideas using 3D printing	7,6	4%	0,5
6	Advanced Industrial Robitics appliced in crafts	26	10,40%	1,56	26	Principles fundamentals of robotics	0	0%	0,0
					27	Programming a robot	3,9	2%	0,2
					28	Criteria for the implementation of a robot	3,9	2%	0,2
					29	Applications of robots	3,9	2%	0,2
					30	Coupling AIR with 3DP, Theory and real examples	7,8	4%	0,5
6	Total	250	100,00%	15	30		192,08	1	11,5

6.2.2 Students, VET providers, Universities, Unemployed

M#	Module	Hours/ module	Weight/total hours	ECVET points	LO#	LO description	LO hours	LO weight	LO ECVET
1	Innovation process applied in traditional sector - Design and 3DP	28	11,20%	1,68	1	Basics of Innovation process	8,4	30,00%	0,5
					2	Stages of Innovation Process	7	25,00%	0,42
					3	Innovation Management and New Product Development	7	25,00%	0,42
					4	Co-innovation concept	5,6	20,00%	0,34
2	Design Thinking & Skills	38	15,20%	2,28	5	What is Design Thinking?	3,8	10,00%	0,23
					6	Principles of Design Thinking	7,22	19,00%	0,43
					7	Design Thinking process	5,7	15,00%	0,34
					8	Design Thinking and Business Models	8,74	23,00%	0,52
					9	Critical Thinking Skills	5,7	15,00%	0,34
					10	Benefits of Design Thinking	3,8	10,00%	0,23
					11	3DP as a tool to adopt the design thinking methodology for craft and entrepreneur	3,04	8%	0,18
3	3D Printing & Production Process	60	24,00%	3,6	12	History of 3D Printing	6	10,00%	0,36
					13	Description of the Production Process and Available Software	6	10,00%	0,36
					14	Technologies in 3D Printing	18	30,00%	1,08
					15	3D Printing Materials	18	30,00%	1,08
					16	Risk Management	6	10,00%	0,36
					17	Impact of 3D printing on the supply chain	6	10,00%	0,36
4	Current processes - Different fields of application	60	24,00%	3,6	18	3DP Technologies - Processes, Resolution, Accuracy, Sizes, Security	13,2	22,00%	0,79
					19	3DP Technologies- Extract the pieces, post-processes	13,2	22,00%	0,79
					20	3DP Technologies- Real life examples -TRADITIONAL sectors/field	13,2	22,00%	0,79
					21	3DP Technologies- Real life examples- NON-TRADITIONAL modern sectors	13,2	22,00%	0,79
					22	Environmental impact and Reusing Potential	7,2	12,00%	0,43
5	Entrepreneurship and 3D Printing - New business Ideas	38	15,20%	2,28	23	What is Entrepreneurship?	13,3	35,00%	0,8
					24	Generating and Developing a business ideas 3D Printing Business ideas	17,1	45,00%	1,03
					25	New Entrepreneurship ideas using 3D printing	7,6	20,00%	0,46
6	Advanced Industrial Robitics applied in crafts	26	10,40%	1,56	26	Principles fundamentals of robotics	6,5	25,00%	0,39
					27	Programming a robot	3,9	15,00%	0,23
					28	Criteria for the implementation of a robot	3,9	15,00%	0,23
					29	Applications of robots	3,9	15,00%	0,23
					30	Coupling AIR with 3DP, Theory and real examples	7,8	30,00%	0,47
6	Total	250	100,00%	15	30		250		15

6.2.3 Relevant Stakeholders

M#	Module	Hours/ module	Weight/total hours	ECVET points	LO#	LO description	LO hours	LO weight	LO ECVET	LO hours	LO weight	LO ECVET
1	Innovation process applied in traditional sector - Design and 3DP	28	11,20%	1,68	1	Basics of Innovation process	8,4	30,00%	0,5	0	0%	0,0
					2	Stages of Innovation Process	7	25,00%	0,42	0	0%	0,0
					3	Innovation Management and New Product Development	7	25,00%	0,42	7	5%	0,4
					4	Co-innovation concept	5,6	20,00%	0,34	5,6	4%	0,3
2	Design Thinking & Skills	38	15,20%	2,28	5	What is Design Thinking?	3,8	10,00%	0,23	3,8	3%	0,2
					6	Principles of Design Thinking	7,22	19,00%	0,43	0	0%	0,0
					7	Design Thinking process	5,7	15,00%	0,34	0	0%	0,0
					8	Design Thinking and Business Models	8,74	23,00%	0,52	8,74	6%	0,5
					9	Critical Thinking Skills	5,7	15,00%	0,34	0	0%	0,0
					10	Benefits of Design Thinking	3,8	10,00%	0,23	3,8	3%	0,2
					11	3DP as a tool to adopt the design thinking methodology for craft and entrepreneur	3,04	8%	0,18	3,04	2%	0,2
3	3D Printing & Production Process	60	24,00%	3,6	12	History of 3D Printing	6	10,00%	0,36	0	0%	0,0
					13	Description of the Production Process and Available Software	6	10,00%	0,36	0	0%	0,0
					14	Technologies in 3D Printing	18	30,00%	1,08	18	12%	1,1
					15	3D Printing Materials	18	30,00%	1,08	18	12%	1,1
					16	Risk Management	6	10,00%	0,36	6	4%	0,4
					17	Impact of 3D printing on the supply chain	6	10,00%	0,36	6	4%	0,4
4	Current processes - Different fields of application	60	24,00%	3,6	18	3DP Technologies - Processes, Resolution, Accuracy, Sizes, Security	13,2	22,00%	0,79	0	0%	0,0
					19	3DP Technologies- Extract the pieces, post-processes	13,2	22,00%	0,79	0	0%	0,0
					20	3DP Technologies- Real life examples -TRADITIONAL sectors/field	13,2	22,00%	0,79	13,2	9%	0,8
					21	3DP Technologies- Real life examples- NON-TRADITIONAL modern sectors	13,2	22,00%	0,79	13,2	9%	0,8
					22	Environmental impact and Reusing Potential	7,2	12,00%	0,43	7,2	5%	0,4
5	Entrepreneurship and 3D Printing - New business Ideas	38	15,20%	2,28	23	What is Entrepreneurship?	13,3	35,00%	0,8	0	0%	0,0
					24	Generating and Developing a business ideas 3D Printing Business ideas	17,1	45,00%	1,03	17,1	11%	1,0
					25	New Entrepreneurship ideas using 3D printing	7,6	20,00%	0,46	7,6	5%	0,5
6	Advanced Industrial Robitics applied in crafts	26	10,40%	1,56	26	Principles fundamentals of robotics	6,5	25,00%	0,39	0	0%	0,0
					27	Programming a robot	3,9	15,00%	0,23	0	0%	0,0
					28	Criteria for the implementation of a robot	3,9	15,00%	0,23	0	0%	0,0
					29	Applications of robots	3,9	15,00%	0,23	3,9	3%	0,2
					30	Coupling AIR with 3DP, Theory and real examples	7,8	30,00%	0,47	7,8	5%	0,5
6	Total	250	100,00%	15	30		250		15	150	1	9,0

6.2.4 Special training path : open-access

The distribution of the working time for the training path “open-access” will depend on the choices of the final learner. As there is no certification issued for this path, the ECVET points are not relevant.

7 THE FORMAT OF THE ACCESS 3DP TRAINING

7.1 THE MOOC

ACCESS 3DP is a massive open online course (MOOC), meaning that the training course is developed on an online platform that delivers learning content online to any person who wants to take a course, with no limit on attendance.

7.2 THE E-LEARNING COURSE

The training course is hosted by the e-learning platform "H5P", a portal for educational content and resources that offers the learner all the tools neeed to complete the course online.

The training course is conceived and provided through distance learning, a method of education which allows to gather learners from different geographical areas. In addition, the ACCESS 3DP is offered in a asychonous way, meaning that the learner can access to the training at his/her opace and convenience, independently from the trainer.

7.3 THE TRAINING MATERIAL

The different training materials (coursebooks, videos, links to external resources, etc) will be available on e-learning platform (https://3dp.learning-platform.eu/), and stocked in a specific library. Learners will also be able to download the material for individual offline study, if needed.

7.4 LICENSE

All training contents are available under the creative common licence "CC-BY-BC". This license lets others remix, adapt, and build upon the work of the ACCESS 3DP non-commercially. New works must acknowledge the author and be non-commercial, but they don't have to license their derivative works on the same terms.

8 CONCLUSIONS AND RECOMMENDATIONS

ACCESS 3DP is a complete training course, which will offer to the learners the possibility to develop the knowledge, skills and competences that are needed to make additive manufacturing technologies closer to traditional craft activities. The flexiblibility of the course, which can be adaptd to the needs of the different taget publics, is one of its main adavntages and will contribute to disseminate the knowledge on additive manufacturing technologies applied to craft activities to a large public. Finally, to fully appreciate the potential of the technology, in addition to the concrete case studies and practical exemples that enrich the training course, the trainers should recommend to the learners to experience directly 3DP thouugh participation to practical workshops. In this respect, the ACCESS 3DP partnars can be contacted to support the organisation of a practical experience.