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

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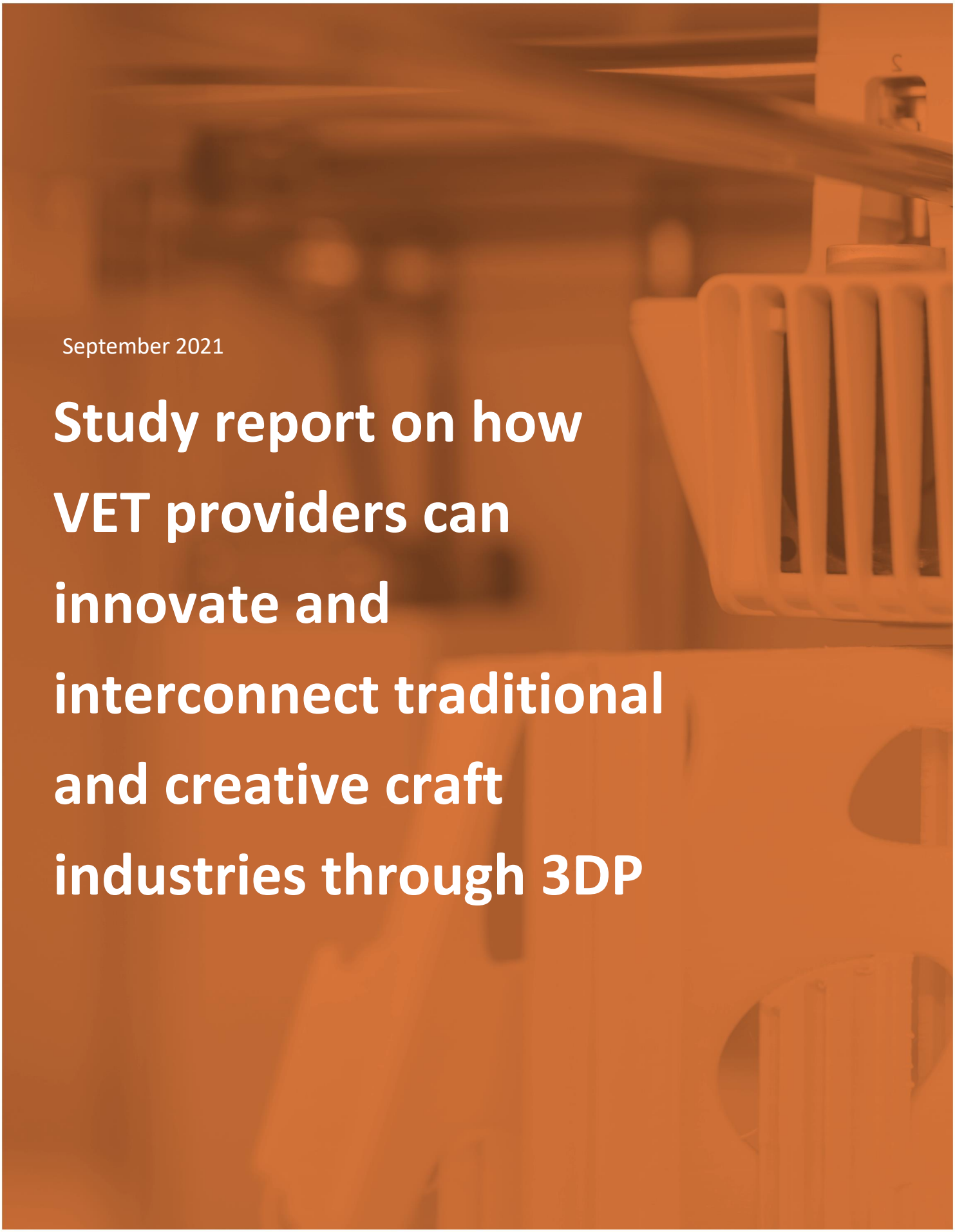

September 2021

Study report on how VET providers can innovate and interconnect traditional and creative craft industries through 3DP

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

STUDY REPORT ON HOW VET PROVIDERS CAN INNOVATE AND INTERCONNECT TRADITIONAL AND CREATIVE CRAFT INDUSTRIES THROUGH 3DP

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TABLE OF DOCUMENT VERSIONS AND CHANGES

Version	Date	Short description	Author(s)
1	06/05/2021	First draft of the report	CMA Lyon-Rhône
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GLOSSARY

- AI - Artificial Intelligence
- AIR - Advanced Industrial Robotics
- AM- Additive Manufacturing
- B2B – business to business
- C-TCI - Creative and Traditional Craft Industry
- HE – Higher education
- 3DP – 3D printing
- KET - Key Enabling Technology
- MOOC – Massive Open Online Course
- MSME – Micro Small and medium-sized enterprise
- SME – Small and medium-sized enterprise
- VET – Vocational Education and Training

1 DESCRIPTION OF THE PROJECT

Additive Manufacturing (AM) (or 3DP) is one of the technologies under the umbrella of AM which has been identified by the European Commission as one of the Key Enabling Technologies (KETs).

The creative industries are core elements of the European economy. The people active in its development are talented and flexible with a range of core capabilities that can be developed and improved naturally through practice in their field's activities and lifelong learning. Enterprises in the creative industries are usually small, and often micro, enterprises. They find work with clients in sectors that have been traditionally connected to the creative industries for some time, using their flexibility to add value to their products by applying their ability to realize innovative ideas through their work.

Increasingly, these capacities are becoming more relevant to the European economy as new sectors find out that they are needing the skills provided by creative enterprises and their workers. At the same time new, often disruptive, technologies come to light and consequently require highly skilled creative labour to allow maximum exploitation of capital based thanks to the tools and machines provided by these technologies.

Such technologies are often adoptable by relatively traditional sectors in the economy. However, these sectors often need workers who are ready and competent enough to use the new technologies. On the other side, when they do have a high level of technical skills, workers often lack the core capacities for creativity, innovation, and an entrepreneurial approach to use technologies such as AM/3DP. These are working capacities that new technologies require if the capital in the form of tools and machines are to be exploited to the maximum of their potential.

ACCESS-3DP brings together an innovative consortium of 5 partners with experts in 3DP and design from the Vocational Education and Training (VET), Higher Education (HE) world and business organisations from creative industries from 5 EU countries. The partners jointly embrace the following objectives:

- Identification of skills mismatched between the craft and traditional industries with additive manufacturing technologies;
- Use of the skills needs to develop and tailored VET curricula according to EU standards to foster the mobility and employability in craft sectors in Europe;
- Improve the competitiveness and efficiency of the traditional sector enterprises through the use of 3DP technology;
- Improve the entrepreneurship in craft sectors and Additive Manufacturing sector through better understanding of the 3DP value chain;
- Evaluate the impact of tailored training about 3DP in entrepreneurs and craftsmen;
- Sustain the project results, in the course of time, through the development recommendations for certification.

To achieve such objectives, the partners will develop the following intellectual outputs:

- A report on how VET providers can connect creative and traditional-craft industries;
- A joint VET curriculum according to national and EU standards;

- Learning Modules based on the VET curriculum supported by a Massive Open Online Course (MOOC) platform;
- A course assessment and qualification resource package in order to support the certification of the ACCESS-3DP Learning Modules and Course;
- A pilot implementation and study of the Learning Modules and Course.

A workshop in the form of a short-term joint staff training event (L/T/T) focusing on innovating crafts through 3DP technology will take place during the last project period and will involve Associated Partners. At the same time, 5 Multiplier Events will be organized in order to enhance the impact of the ACCESS-3DP project through the dissemination of the project results.

A partnership composed by HE, Business representatives and research will develop approaches to training people in the creative industries that promote that creativity, alongside entrepreneurial thinking and skills for applying innovative ideas in practice. It is vital for anyone working industries that may apply 3DP, to understand the “value chain of 3DP” and how it may evolve over time. An ACCESS-3DP needs to be given on where in the chain value is added, and how. ACCESS-3DP training materials will empower students to successfully enter the market, and/or to successfully sustain their business.

Increasingly, these capacities are becoming more relevant to the European economy as new sectors find they are needing the skills provided by enterprises in creative industries and their workers, and new, often disruptive, technologies come to light that require highly skilled creative labour for there to be maximum exploitation of capital based in the tools and machines of these technologies. Additive manufacturing will be an asset to the factors of competitiveness, such as flexibility and time to market, among others for the craft and creative industries.

2 EXECUTIVE SUMMARY

The study report aims to respond to the first objective of the ACCESS 3DP project, which is to identify the skills mismatched between the craft and traditional industries in relation to AM technologies. The report consists of three complementary parts, providing training recommendations on how to innovate and interconnect creative and traditional craft industries (C-TCIs) through 3DP.

The first part of the report illustrates a preliminary study carried out by the project partners, which shows the interest of adopting 3DP and the opportunities that this technology presents for all types of industrial and craft businesses. It also provides concepts and guidelines to consider in the following sections of the study, including:

- A definition of creative craft businesses (innovative and users of 3DP) and traditional craft businesses (with reference to the manual know-how passed down through generations and to the business sector), agreed by the partners of ACCESS 3DP and adopted in the scope of the project;
- The various sectors concerned (furniture, jewellery, woodworking, leather, footwear, metal, etc.) that give the opportunity to target a development approach for the skills by focusing on the activities.
- Examples of inspiring creative businesses for traditional craft businesses;
- Specificities by country, in the use of 3DP and in national support programmes, which need to be considered.

The second part of the report illustrates a benchmark analysis of 3DP and Advanced Industrial Robotics (AIRs) training courses available in Europe and targeting, amongst other sectors, also the craft one. The analysis reviews the offer proposed by 64 training organizations based in 27 European countries and covers, in total, 70 training courses. This European benchmark highlights possible and desirable adaptations of the training programmes for a greater diffusion of the technology in the craft sector.

One notable result of the benchmark is that there is a great diversity of 3DP training courses, both in terms of technological content (i.e. software, 3D printers, materials), as well as duration, costs, and target audiences. Nevertheless, almost 90% of them are not offering trainings on AIRs. Another important point to notice is that 57% of the training courses are partly appropriate to the craft sector and almost 6% are not appropriate at all to the craft sector.

There is therefore a strong potential for the development of courses that are more suited for craftsmen and a strong potential as well to link the experience of creative craft companies with traditional craft industries. A new offer of training on AM for craft entrepreneurs should address some identified deficiencies.

It has been noticed that the training programmes are not very detailed, and it might be helpful to develop a new format for the training programmes to identify easily, for example, what technology or software is adapted to the project. It may be also interesting to develop new contents about different materials used in AM such as their applications, the specificities of each material, the limits, the difficulties, the costs related to their use in 3DP and others.

As there are many courses already covering technical subjects and skills in their training programmes, there is a noticeable lack of training courses covering other related topics, such as

transversal skills. Based on the example of the trainings addressing these types of skills, it appears interesting to develop a training offer that focuses on critical and innovative thinking, project management and organizational skills, to stimulate creativity and facilitate the adoption of a new technology, like the 3DP technology.

The majority of the courses usually aims to provide general and basic knowledge about 3DP and its complete digital chain, applied in all of the sectors. Thus, for ACCESS 3DP is would be interesting to develop a training format where the learner has the possibility to choose the training modules and adapt the level of the training to their level of knowledge of the technology and to their 3DP project.

As for the prerequisites, when they are necessary, they seem to mainly relate to simulation software, digitization, and prototyping. Introducing additional prerequisites might be helpful for potential users, like craftsmen. For example, for the ones that are not completely at ease with the English language (which is dominant for using 3DP technology), a glossary of key terms translated in the languages of the partner countries can be developed.

Finally, access to 3DP and the experiences of creative companies can be facilitated for craft companies by free access to content, illustrated by examples of peers and with possibilities of direct exchanges between creative and traditional craft entrepreneurs through business to business (B2B) meetings, networking events or online chats, which facilitate the development of key competences on AM by sharing best practices.

The third and final part of the report presents an analysis of the use and the needs about 3DP, which has been carried out by directly questioning the final beneficiaries of the training offer on 3DP and AIRs. The replies were provided by 46 European businesses, based in 7 European countries, which either are already using this technology or are potentially interested in adopting it, but also by other types of organizations such as training providers on 3DP and AIRs and similar stakeholders. Considering their feedbacks, the main recommendations and proposals to consider in the development of the ACCESS-3DP Joint curriculum are as follows:

A) Regarding the **content of the training**:
- Explain and show the added value brought by 3DP and its applications to businesses and provide information to give visibility to the network of actors who can be mobilized to use 3DP;
- Rely on the concrete and varied uses of 3DP already existing to arouse interest and show the possible opportunities for traditional companies;
- Rely on the needs identified by companies to build the content of training modules: design and software modelling, 3DP as a source of creativity, multifactorial approach to their business project and the technology available (market-uses / technical / financial), choice of the right material for their 3DP project;
- Raise awareness and inform on the security issues related to the use of 3DP equipment.

B) Regarding the **form of the training**:
- Raise awareness on the training providers offering trainings on issues related to 3DP and AIRs and facilitate the link between craft entrepreneurs and the actors of the local economic and innovation ecosystem that can support the development of a 3DP project;
- Give examples of best practices from the craft sector 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 benefits of associating 3DP and AIR;

- Integrate practical workshops into the training programme;
- Raise the level of awareness and skills on AM by favouring highly operational trainings including scenarios, as well as 3DP practical examples and/or exercises.

C) Regarding the **access of the training:**

- Allow for the choice on different levels of trainings, with a focus on the basic and intermediate levels.

3 PRELIMINARY STUDY

The objective of this section is to present the preliminary work carried out by the project partners, which aimed to understand:

- The usefulness of 3DP and the opportunities offered by this technology;
- Its adoption by companies - whether they are industrial based, creative and/or craft companies - which have different levels of integration of 3DP in their production process;
- The barriers and levers identified to increase the adoption of 3DP in the craft sector and to improve the exchange of information and contacts between creative and traditional craft businesses.

This work is based on a desk research about relevant studies and reports on 3DP as well as on the knowledge and expertise of the partners on this technology. In addition, to enrich the study and make sure to take into account the specificities related to the adoption of the technology in each partner country, the partners prepared a short overview on the use of 3DP by craft enterprises in France, Spain, Portugal, Slovakia and Slovenia, which provided some of the first indications to be considered in the rest of the study.

3.1 CONTEXT AND GENERAL OVERVIEW

Emerging as a real revolution in the 1980s, the 3DP has since developed with different technologies, being the main ones Fused Deposition modelling (FDM), Stereolithography (SLA), Direct Metal Laser Sintering (DMLS), Selective Laser Sintering (SLS). Despite the first AM technology being developed over 30 years ago, most of the development and improvement has been done over the time and it remains, for many, a technology to be discovered and understood.

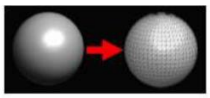
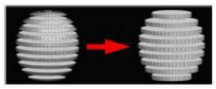
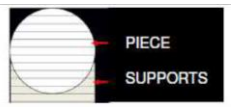
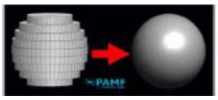
Its development is carried out in different countries with various uses (3DP for prototyping, 3DP as a service, 3DP to make goods for sale or for internal use) but less than 10% of companies in Europe have adopted this technology[1], leaving therefore the possibility of a more massive deployment.

While the technology has reached a certain level of maturity with the production of manufactured parts in the 2010s, its development continues: there are innovations in terms of the technology (printing with metals for example) or related to new purchasing or production models, which require consequently a regular monitoring and renewed skills by the users of 3DP.

Finally, 3DP must be considered as a digital chain and a succession of different actions.

[1] Eurostat statistics on 3D printing and robotics
https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=isoc_eb_p3d&lang=en

Figure 1 – 3DP Digital chain and actions

Digital data for product design (CAD 3D – STL)	
Preparation of the printing file (correction, orientation, location of the pieces, slicing etc.)	
Manufacturing	
Finishing touches (cleaning, removal of supports, sandblasting, machining, etc.)	

Source: Cetim, fabrication additive, décryptage d'une technologie de fabrication à fort potentiel - 2017

For the purposes of ACCESS-3DP, and in the current study, it is therefore important to consider the complete digital chain.

3.2 INTEREST AND OPPORTUNITIES

3DP is of interest and provides opportunities for all types of industrial and craft businesses.

3.2.1 Challenges and growth driven by the industry

By 2022, the US firm International Data Corporation (IDC) forecasts an average annual growth rate of 3DP expenses of 19%, taking into account not only the purchase of machines and materials, which constitutes two thirds of the expenditure, but also the purchase of software and services (January 2019 report)[2].

This growth is primarily driven by manufacturers, whose spending will represent in the near future 95% of the market. Manufacturing parts and prototypes for the industry remains the most common application for AM. However, it is the bioprinting of tissues, organs and bones that is expected to experience the strongest growth, with an average annual rate of 49.9% until 2022.

By 2021, the combined developments of 3DP, artificial intelligence (AI) and robotics, will incite 40% of manufacturing industries to almost fully automate their production lines to optimize yields. In addition, by the same year, about 40% of the top 2,000 factories around the world are expected to

[2] Source : «Worldwide Spending on Artificial Intelligence Is Expected to Double in Four Years, Reaching $110 Billion in 2024, According to New IDC Spending Guide", International Data Corporation (IDC), August 2020 , https://www.idc.com/getdoc.jsp?containerId=prUS46794720

use 3DP technology combined with intelligent machines, which will reduce the waste of raw materials by 25%.

3.2.2 Multiple applications in the industrial sector

3DP combined with AI offers many potential applications in the military industry, in aircraft construction and for electronics manufacturers. 3DP is used to manufacture printed circuit boards and other electronic components, in response to the ever more challenging demand for flexible and expandable electronics, in its various fields of application such as electromechanics, robotics, home automation, IT, etc.

In 2022, 20% of 3D printer manufacturers will offer 3DP "as a service"[3] and the share of equipment will allow the diffusion of the technology to be extended and therefore to achieve economies of scale.

By 2023, 50% of the industrial and professional sectors will use 3DP and AI. In 2024, the blockchain will protect 35% of the 3DP files. Today, many solutions exist in terms of sharing share cloud-computing resources. They allow the enterprises to reduce their operating costs and consequently optimize their profits. It is in this context that technologies resulting from 3DP are developing.

3.2.3 A development tool for craft companies

As a consequence of the fact that the 3DP technology is reaching a level of maturity that allows the acquisition of 3D printers at more affordable prices, and that it allows for an increased performance in terms of productivity, quality, resistance of parts, compatibility with new materials, 3DP is now a **key technology for craftsmen**. Its advantages offer many possibilities to the craft sector:

- ***Specialist in low-cost prototypes, unique parts, and small series***: 3DP allows the desired part or mould to be produced directly, without going through manufacturing processes (for example with dedicated tools) that are only profitable for large-scale production. 3DP gives the possibility of performing functional tests (assembly).
- ***Reactivity/flexibility***: the seamless transition from digital design to manufacturing reduces time to market to a minimum. Direct manufacturing of parts and assemblies for end-use in plastic and metallic materials enables design changes to be implemented, even during the production phase.
- ***Infinite variations***: the AM process allows the realization of any geometry, knowing that a simple modification of the digital file generates a new model, thus leaving an important place for creativity.
- ***A participative experience***: 3DP paves the way for personalization and interaction with the customer, who can combine the different elements of the object to be manufactured.
- ***Reduction of manufacturing waste***: 3DP only uses raw material where it is needed, saving money in upstream purchasing and downstream waste management.

[3] "IDC 2019 predictions attributes $2 billion in new spending related to 3D printed products", 3D printing industry, December 2018, https://3dprintingindustry.com/news/idc-2019-predictions-attributes-2-billion-in-new-spending-related-to-3d-printed-products-145138/#:~:text=Finally%2C%20the%20tenth%20prediction%20(10,and%20maximize%20their%20market%20potential.

- ***Zero surplus, zero stock, limited transport***: 3DP is all of that, an optimization of the entire production chain.
- ***New business possibilities***: AM should, for example, revive the businesses for the repair and manufacturing of spare parts. Thanks to new consumption habits, it is possible to imagine 3DP services in local shops, similarly to the model of "parcel pick-up point".

3.3 INTEGRATION FOR CRAFT BUSINESSES

The current study aims to rely on creative craft businesses to upgrade the skills of more traditional craft businesses. Thus, first and foremost it is essential to define these 2 types of companies in the scope of the project, and to illustrate with examples the uses of 3DP in craft companies.

3.3.1 Traditional craft companies

The craft sector is very often identified as a traditional sector, even though some companies are technologically advanced. Traditional craft companies have very specific characteristics. The ones common to the various partner countries are:

- An extensive experience with production techniques;
- Outputs made thanks to manual skills;
- A handcraft know-how acquired and passed down through the company or within the same family;
- Products which, in the past, met daily needs.

Traditional craft businesses are also characterized with reference to the materials they use to make their product: wood, leather, textiles, metal, stone, ceramics, glass, etc. which are then transformed into furniture, shoes, clothing, jewellery, ornamental products, decoration, etc. In addition, some traditional craftsmen can also carry out service activities as, for instance, in the repair sector (cycles, household appliances, computer hardware, etc.)

Finally, in most of the cases, craft companies are micro-organizations, or even one-person businesses, though this is not a common feature for all the partner countries. In Portugal, for example, craft companies can be larger, such as a designer's atelier, and can count more than 10 employees, which is unusual in other countries.

Consequently, it is the sectors of activity as well as the manual know-how, passed down through generations, that characterize traditional craft businesses, regardless of the size of the company: one person company, micro-enterprise, or SME.

3.3.2 Creative craft businesses

Creative craft, just like traditional craft, is characterized by an historical handicraft know-how, passed through generations, but has its own specificities, which are, most notably:

- The proposal of products in unique or very small series, original, exclusive.
- Products created with a strong aesthetic, cultural, artistic and historical value.
- A high level of skills with a strong creativity and with the use of digital technology, such as 3DP, which allows for the creation of new shapes and personalization.

Creative crafts are generally considered innovative, offering higher added value products designed with cutting-edge technologies, such as 3DP.

The creative craft activities common to the various project partners are in the wood, textile and footwear sectors and therefore do not differ from traditional sectors.

Thus, it seems entirely appropriate for traditional craft businesses to draw inspiration from the practices of creative craft to increase their skills and create more differentiating products / services. (see annex 1).

3.3.3 Examples of the use of 3DP by creative craft businesses

To illustrate the creative potential implemented through 3DP by craft businesses, we have selected and detailed in the annex a few examples, taken from each partner country (see annex 2).

The diversity of these examples highlights the following points:

- Numerous business sectors already benefit from 3DP, such as the medical sector (manufacture of medical instruments, prostheses, orthotics), food sector, bedding sector/ mattress, metal manufacturing, shoe sector (manufacture of soles and safety shoes), etc.
- 3DP offers opportunities for the development or repositioning of an activity:
    - For example, as a service provider and no longer just as a manufacturer, with after-sales service, prototyping service / as a design office;
    - With a niche positioning, very differentiating with more original products, with complex shapes;
    - With rapid design and manufacture of new products to meet new demands (e.g. masks);
- Opportunities for collaboration with schools / universities / technical centres / designers, etc. for easier access to new markets;
- Relevant integration of technology into manufacturing automation and robotization processes (e.g. 3DP robotic hands to incorporate smart assembly).

3.4 IDENTIFIED OBSTACLES AND LEVERS

While they get inspired by creative craft businesses, traditional craftsmen must also consider other important factors: for some companies, such factors may limit the access to 3DP, but for others on the contrary, they are likely to foster its adoption.

The analysis of the main obstacles and levers has been conducted by each project partner (see annex 3) and can be summarized as follows:

→ there are 3 types of potential obstacles that must be considered:

- **The technology itself and its accessibility**: the multiplicity of techniques, hardware, materials, and software make technological choices more difficult, with also significant purchase costs and return on investment, especially for small businesses. Therefore, some craft managers are wondering if 3DP should really be considered as an option.
- **Skills and knowledge**: a minimum level of skills and knowledge is essential to test the technology even before being able to use it on a regular basis. They include more specifically skills and knowledge on 3DP techniques, but also on computer-aided design, 3D modelling, materials, etc.
- **Standards and norms**: AM standards are intended to guarantee products, services, and systems. They aim to promote knowledge of the sector, stimulate research, and encourage the implementation of the technology. They set rules in a specific sector. They represent a

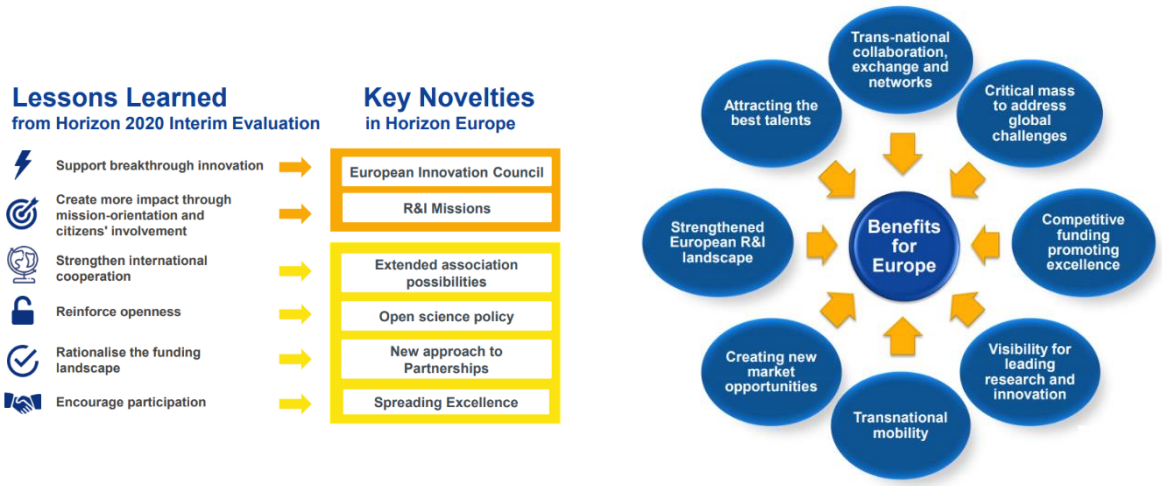
consensus between the actors of the sector. Standardization is essential for the introduction of the technology at a large-scale.
Currently, many experts agree that AM standards are a major barrier to the adoption of this technology. The need for reproducibility is a real obstacle to its use. There are many processes and materials, and many companies are developing their own set of technologies. But these are essentially obstacles for industrial applications. The specific standards to AM mainly relate to three fields of application: aeronautics / space, medical and electronics.
Finally, by funding the SASAM project, through CEN/TC 438 and its cooperation with ISO TC 261 and ASTM F42, Europe has shown its support for the development of standards in the additive manufacturing sector.

→ In contrast, 3DP benefits from 3 levers for its development:

- **European and regional support programmes for the investment and development of 3DP technologies**:

The European Union funds research projects in the field of 3DP since the end of the 1980s. It has granted more than 320 million euros in funding between 2007 and 2019, and notably through "Horizon 2020", its European framework programme for research and innovation, between 2014 and 2020.

Figure 2 - Added value through "Horizon Europe"



Source: The next EU research & innovation investment programme (2021 – 2027)

This support programme continues from 2021 to 2027 as part of "Horizon Europe", and with the adoption on March 17, 2021 of the new EU investment programme: InvestEU. It should allow to mobilize more than 370 billion euros of additional investments over the next seven years, with a quarter dedicated to the section "Research, innovation and digitization" in which 3DP has its place.

Simultaneously, the Erasmus+ programme stimulates the development of skills individuals to keep pace with the changing needs of the labour market and society. As AM is considered as a leading sector for industrial competitiveness, since 2019 Erasmus + supports the Skills Alliance "Sector Skills Strategy in Additive Manufacturing" and sets up a platform for AM skills at European, National and Regional levels. Its aim is to provide data on current and

future skills needs for the AM sector, support the definition of an AM European qualification system, and contribute therefore to foster and support the growth, the innovation and competitiveness of the sector.

In addition, several European countries, most often with the support from the EU, have adopted national innovation, investment, or digitalization programmes to promote the development of 3DP (see annex 2) and to develop skills related to this technology. For example:

- In Slovakia: The regional Innovation Strategy for Kosice Region
- In Slovenia: The Slovenian Enterprise Fund
- In Portugal: COMPETE and PORTUGAL 2020
- In Spain: Empresa4.0 projects and the Industrial Innovation support
- In France: "Alliance du future", a programme for future investments and AM platform in Auvergne Rhône Alpes

- **Development of training programmes and training organizations in recent years**:

Although differences between the 5 partner countries have been noted, in all countries it has been observed an increase in the training offers in the field of 3DP and digital design. In addition, these training courses are provided by an increasing number of different types of organizations: universities, schools but also technical centres, incubators, private companies, etc. Provided that the offer will remain readable, suitable for all audiences and accessible, it will contribute to a better adoption of this technology, which requires specific knowledge and the acquisition of 3DP-related skills.

- **A mature technology:**

Due to the use of an increasingly number of various materials and thanks to the development of different techniques, 3DP is reaching maturity: the technology being known, a new phase of integration, adoption and wider dissemination can begin.

In Europe, the market is driven by metal printing and the production of finished parts, mainly in the industrial sector of the aeronautics or energy sectors, with the 3D manufacturing of more and more small and medium-sized parts, previously produced in a foundry. 3DP in the automotive industry is also experiencing strong growth with investments from manufacturers and companies such as Audi, BMW, Bugatti, Michelin, etc., thus demonstrating that a new level has been reached in the use of this technology.

3DP, which can be produced in plastic, metal, ceramic, concrete and even sugar, is also making its way into the daily lives of SMEs and craftsmen: jewellers, goldsmiths, watchmakers, printers, toy manufacturers, ceramists, dental prosthetists, etc. Indeed, an increasing of craft enterprises are currently betting on this type of equipment.

The present time offer favourable conditions to craft businesses to adopt 3DP, because the acquisition of 3D printers is more affordable and the technology offers increased performance in terms of productivity, quality, strength of parts, compatibility with new materials.

Finally, more generally, it should be noted that the Covid-19 crisis, by its magnitude, its duration,

and its impact on economic activities, is an additional obstacle that inevitably delays the development of projects related to this technology in MSMEs.

But it can also ultimately be an accelerator of new directions given to projects, to provide interesting solutions to major climate and ecological issues by questioning the circular economy issues offered by AM and the recycling of materials.

3.5 PRELIMINARY CONCEPTS TO CONSIDER IN THE REST OF THE STUDY

- **Type of companies concerned by the project:** a creative company is a craft company that uses 3DP, with no reference to the business sector or the size of the company. As for traditional craft companies, they are characterized by their handicraft know-how, passed down through generations, and their business sector.
- **Creative business practices as a source of inspiration:** examples of creative businesses using 3DP can be useful to illustrate the interest and opportunities of the technology, but also the skills that need to be developed, for traditional craft businesses.
- **Variety of the business fields covered:** by considering different types of activities and business fields, the study includes guidelines and recommendations on a training programme that can target different needs. Consequently, the new offer will cover a variety of skills that can be developed according to the needs of the final learner.
- **Country specificities:** the country focus carried out by the partners (Annex 3) during the preliminary study have highlighted a number of specificities in terms of the use of the 3DP by the craft enterprises and in terms of national support programmes that will be taken into account in the next steps of the study report.

4 BENCHMARKING OF 3DP AND AIR TRAINING COURSES ADDRESSING THE CRAFT SECTOR IN EUROPE

The purpose of the benchmarking of the 3DP and AIRs training courses carried out by the partners during the first phase of ACCESS 3DP was to better understand the training offer available in Europe, which potentially targets, amongst others sectors, also the craft one. The intent of the exercise was not to be exhaustive, but to get a general overview and the major trends of the offer available on the market at the time of the project.

The partners reviewed the offer provided by 64 training organizations based in 27 European countries, including the data concerning as well one training course in the UK.

The sample covered in total 70 training courses, most of which proposed by organizations based in Belgium, Greece, Italy, Portugal, and Sweden (between 3 and 4 courses per country).

The questionnaire was split in two parts:

- The first part collected the information on the organizations offering trainings on AM, their type, the ability to address the craft sector, the extent of the offer (one or more courses), the general topics proposed by the programmes as well as the availability of an offer addressing also AIR;
- The second part went more into details of the training courses, providing information on their objectives, prerequisites, contents, duration, costs and the type of valorisation offered at the end of the course, if any.

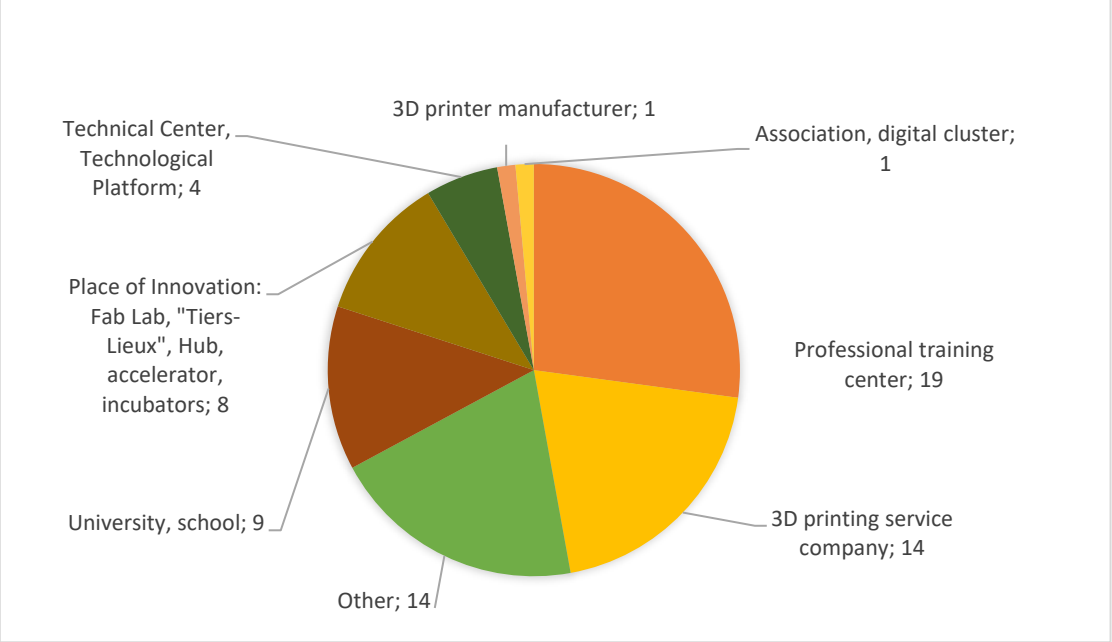
The following sections present the analysis of the data collected for the benchmarking and illustrate in the end the recommendations and proposals to consider for the development of the ACCESS-3DP Joint Curriculum issued from this first activity.

4.1 THE TRAINING OFFER IN EUROPE - A GENERAL OVERVIEW

4.1.1 Types of training organizations

When considering the organizations providing training courses on 3DP, the first interesting result to highlight is that there is the variety of the training centres. More specifically, most of the offer comes from professional training centres (19) and 3DP service companies (14), but there is also an interesting number of "less conventional" training providers, such as retailers, a chamber of craft, and as well as two project consortia, resulting from of Erasmus + projects[4]. The offer also comes from universities, incubators, accelerators, and technological centres.

Figure 3 - Types of training organization



Source: Internal elaborations

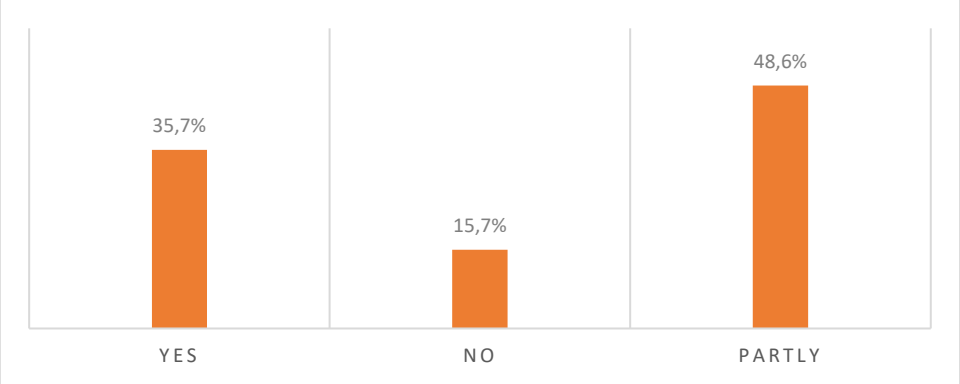
This variety of the training providers ensure multiple approaches, to the benefit of the learner which can choose the one which suit the most its needs.

4.1.2 Suitability for the craft sector

Most of the training offer reviewed seems to target the needs of craft sector, if not completely (35.7%), at least partly (48.6%), while 15.7% is not adapted for craft entrepreneurs. Though these figures are encouraging, there is still a margin of progress that can be achieved to propose a more complete offer that suits the needs of all sectors.

[4] Respectively, project n. 2016-1-RO01-KA202-024578 - Training in 3DP to foster EU innovation & creativity" and project n. 2017-2-PL01-KA205-039021 "3D LAB: Making with brain, technology and hands".

Figure 4 - Does the training offer targets the needs of the craft sector?



Source: Internal elaborations

4.1.3 General topics addressed by the programmes

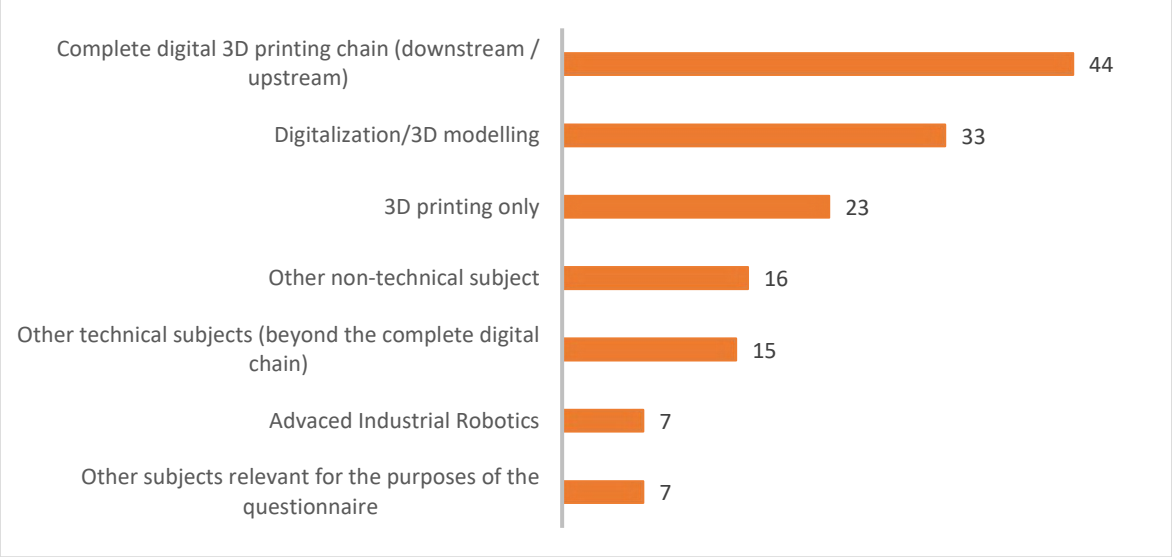
When it comes to the topics addressed, the survey highlights that the technical subjects related to AM are relatively well covered. More than half of the organizations proposes programmes covering the complete digital 3DP chain (downstream and upstream), or at least topics such as the digitalization and 3D modelling. 23 organizations provide a training offer focused on 3DP only, and 15 centres cover also other technical aspects beyond the complete 3DP digital chain (such as, for instance, the machine cost, part production and the cost of integration into the manufacturing process).

Non-technical subjects seem less frequently addressed by the current training offer. A relatively low number of organizations (15) include in their programmes topics such as:

- information on the additive market (users, worth)
- business models for AM,
- current AM trends in the country, worldwide and projected future
- European and country-related standards and regulations
- design and web communication
- health, safety, and environment-related issues

Future training programmes on AM for the craft sector should pay more attention to similar non-technical subjects, which are essential to assess the economic viability of a project. Courses targeting the craft sector should also develop more contents or concrete examples of applications that highlight the added value that 3DP can bring to craft activities as well as its power to create different elements on similar products rapidly, reducing the time-to-market and the costs linked to such variations.

Figure 5 - Number of courses addressing the following training topics

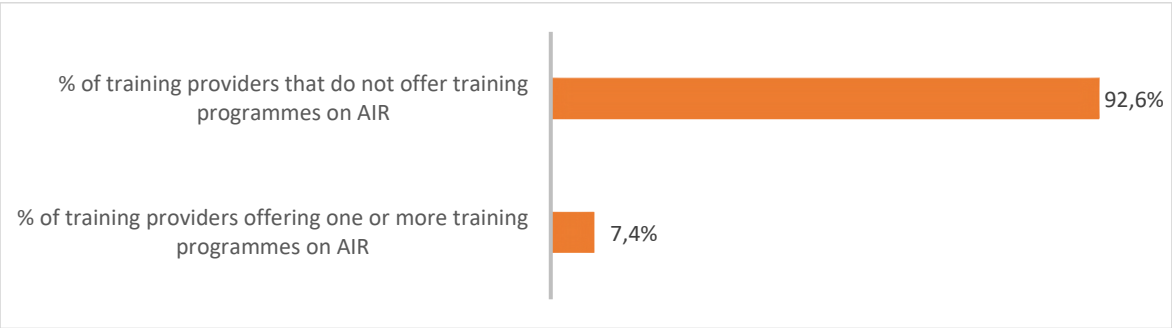


Source: Internal elaborations

4.1.4 Offer on Advanced Industrial Robotics

Finally, while the large majority of the training providers offer at least a training programme on AM, almost none has a similar offer on AIR (92,6%). Thus, there is a real potential for improvement of the training offer of the latter.

Figure 6 - Advanced Industrial Robotics (AIR)



Source: Internal elaborations

4.2 TRAINING COURSES – AN INSIGHT

4.2.1 Objectives

When exploring more in depth the specificities of the training courses available in Europe, as far as it concerns their objectives, a number of similarities can be observed in almost all the programmes analysed. Most of the courses are aiming to provide learners with general and basic knowledge about 3DP and 3D modelling, from the complete digital 3DP chain, and that can be applied in all sectors. More specifically, most of the training are aiming to:

- Present 3DP technology, how it works, its advantages and limits.
- Present the different uses of 3DP technology / professional applications.
- Teach how to use 3D modelling tools and basic techniques and programmes to be able to design and print object.

There are only a few courses (around 12 courses over more than 200 analysed) that are focusing their goals toward the craft sector. These trainings usually target a specific field (ceramic, furniture, textile, metallurgy and forging, wood, jewellery) and are aiming as well to provide basic knowledge about 3DP and 3D modelling applied to the field.

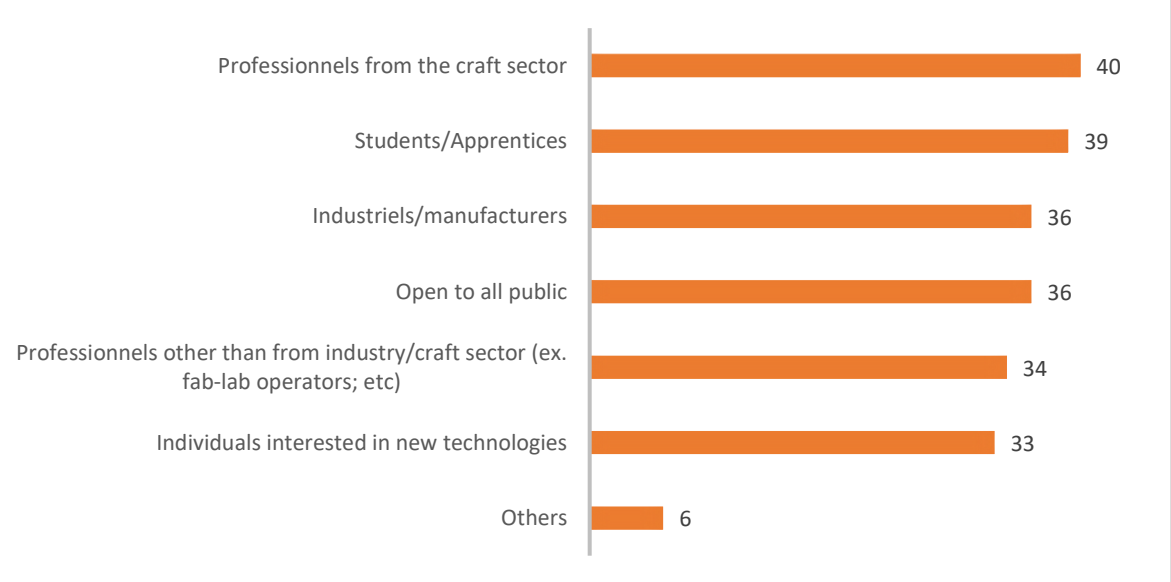
Most of the courses are aiming to target an audience with a beginner level.

Finally, it is interesting to notice that there are only a few trainings (4) that are focusing on the creative and innovative aspects of 3DP uses. These courses offer, for example, to provide innovative applications of 3DP or the creation of added value in a company through 3DP.

4.2.2 Target audience, sectors of application, duration and costs

The target audience is very variable and there is not a particular public that seems to be targeted more than others. In general terms, training courses on AM are quite open to all types of public, (professionals from different economic sectors - craft, manufacturing, technicians and operators from innovative centres, fab-lab, living labs; students/apprentices, individuals interested in new technologies, etc. When the training course is particularly focused on a specific sector (medical), the target audience is also more restrained.

Figure 7- Target audience

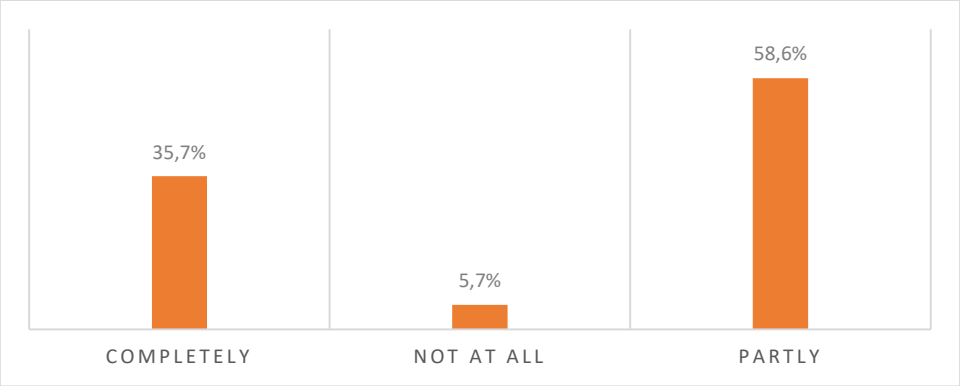


Source: Internal elaborations

Around 36% of the training courses analysed are appropriated to the craft sector, and 59% only partly. The courses which are considered as not appropriated for the craft sector often demand a theoretical pre-knowledge on topics such as materials engineering, materials chemistry and/or mechanical engineering, which are too technical for the average craft enterprise. In addition, though training courses applied to different sectors may have inspiring good practices, these are not evident for the traditional craft sectors. Consequently, there is room for improvement in terms of examples of application taken from different sectors (such as medical, manufacturing), which may be adopted by traditional craft enterprises and which need to be more visible. Traditional craft entrepreneurs need examples of applications taken also from creative enterprises in the craft sector, which have

already adopted 3DP. By illustrating what peer entrepreneurs have already realised through 3DP and what benefits they have realised, traditional entrepreneurs may be inspired in testing the technology and be interested in adopting it in their current activity.

Figure 8 - Does the training offer targets the needs of the craft sector?

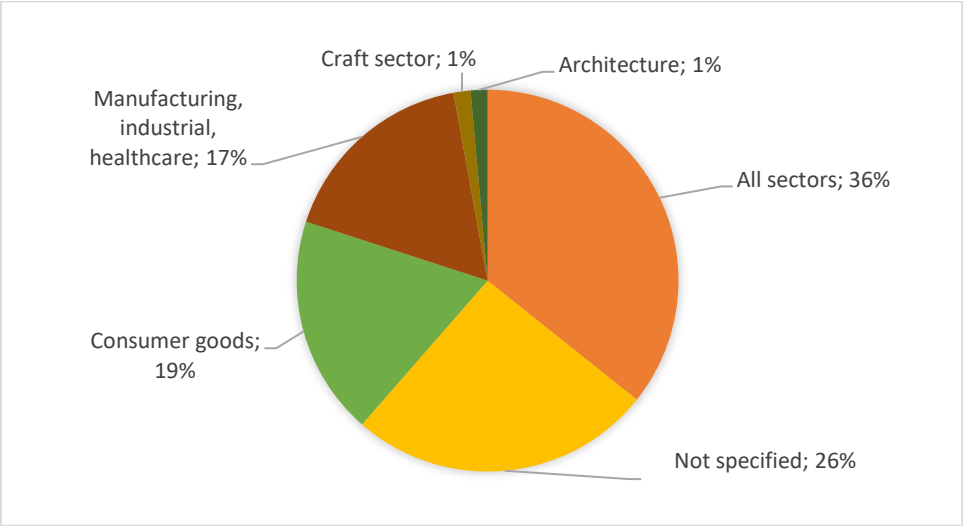


Source: Internal elaborations

There is a wide offer of training courses which offer general contents and do not target any particular sector of application (36%), but for many the information is not clearly reported (26%).

When they do, training courses target mainly the industrial/manufacturing/healthcare sector (17%) and consumer goods (19%), with the latter focusing clearly on ceramics and decorating objects. Additional applications may include furniture, lighting, textile and jewellery. There is only one course that targets the general "craft sector". The same is the case also for the architectural sector.

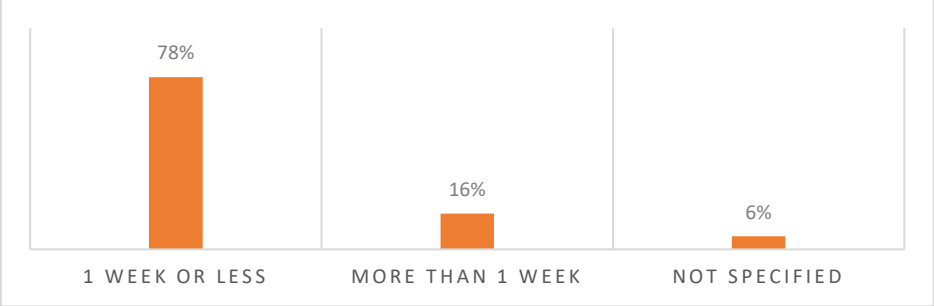
Figure 9 - Main sector of application targeted by the training course



Source: Internal elaborations

The training offer in terms of duration of the course is very variable. Trainings last rarely less than one day and it seems not to be common to split the programme in several training sessions. University degrees last more than one year.

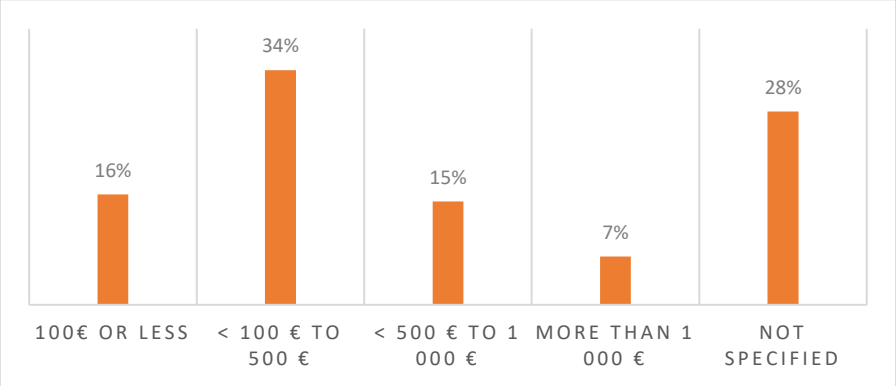
Figure 10 - Duration of the courses



Source: Internal elaborations

The offer in Europe is very wide also in terms of training costs. Providers may charge from few to thousands of euros for a training course, depending on the duration and the target level of skills (beginner/intermediate/advanced). A course is rarely provided for free, but very often the information on the costs is only on request.

Figure 11 - Training costs of the courses (in euros)



Source: Internal elaborations

4.2.3 Prerequisites

Amongst the prerequisites needed to attend a training course in 3DP, almost all courses demand a basic computer knowledge (ex. working with a web browser, installing software). This may be considered as the only compulsory prerequisite for enterprises who intend to train in this technology. Most of the trainings do not demand a pre-knowledge on 3DP, but several courses at basic and/or intermediate level may require notions on technical design, technical drawing and/or on 3D modelling software (ex. CAD), and/or notions related to materials used by the 3DP.

Almost half of the training courses requires a basic knowledge of English, which may be linked to the fact that most of the software used by the technology are only available in this language. Thus, craft entrepreneurs which are not familiar with English may encounter more difficulties in attending a course on 3DP. For this reason, it may be useful to prepare a glossary of key terms, which any actor interested in providing a training course on 3DP may easily translate in a language other than English.

Finally, in general terms, there is no need for technical knowledge on any specific software for modelling and printing. However, when it is required, it usually easily accessible and a trial version

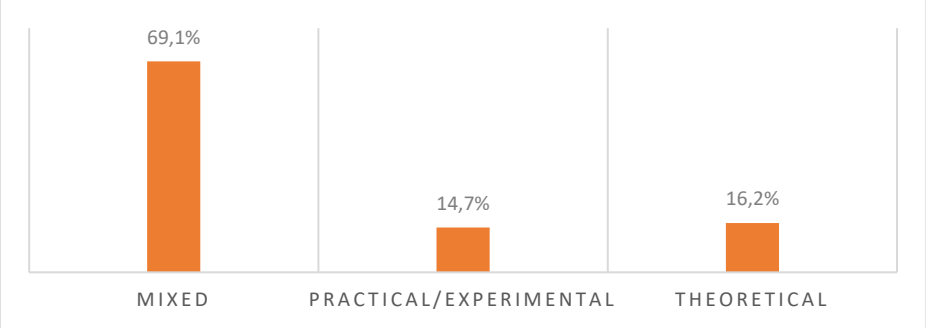
for free is often available.

More advanced courses require more pre-knowledge, such as on the 3DP approach to build parts and assemblies, 3DP technology steps, 3DP types of processes. An in-depth knowledge of technical software is also required (as, for instance, Autodesk Fusion 360)

4.2.4 Training approach and format

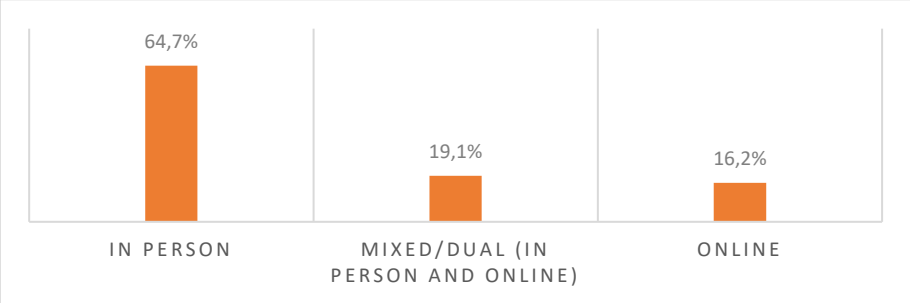
Most of the training courses propose a mixed approach (69,1%), providing theoretical contents and practical experiences. For this reason, the large majority of the courses is still organized only in person (64,7%). Trainings adopting a mixed approach (online and in person) or provided only online are still quite limited (respectively 19.1% and 16.2% of the total offer). Considering the booming of digital education following the COVID-19 pandemic, the training offer on AM needs to adapt and more courses needs to consider the possibility to be delivered remotely, at least partly.

Figure 12 - Type of content



Source: Internal elaborations

Figure 13 - Format of the training course



Source: Internal elaborations

4.2.5 Training contents

4.2.5.1 Main topics

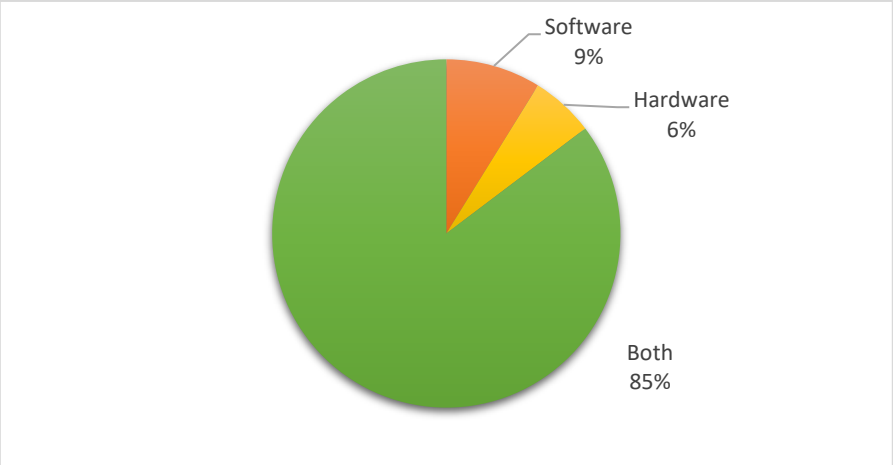
The large majority of the training courses addresses topics related to both the hardware and the software related to 3DP (85.3%).

Among the courses, there is also a great diversity in terms of contents and the trainings cover the entire digital value chain with a great variety of subjects.

For example, regarding the objectives of the trainings, a majority of them offers to provide an overview of 3DP technology, from its history to its advantages, limits, examples of uses and

information about the 3DP procedures, trends and outlook. Some trainings provide learners with practical exercises, that are sometimes applied to a specific area of activity (e.g. wood sector or fashion industry) or get into details about the different types of materials that can be used and their application. While some others can focus more on the process monitoring and control, on design and edition, on qualification and certification or on lifecycle assessment and recycling.

Figure 14 - Focus of the training course

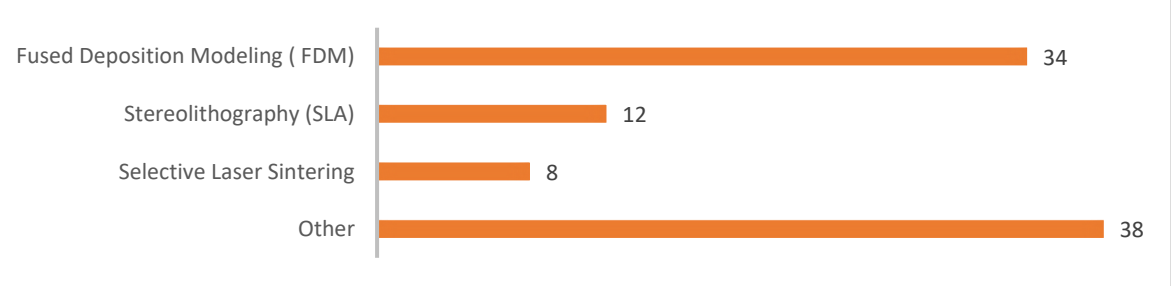


Source: Internal elaborations

4.2.5.2 Technologies and software

The most common technology addressed by the trainings is the Fused Deposition Modelling (FDM), adopted by 34 courses. The Stereolithography (SLA) (12 courses) and the Selective Laser Sintering (8 courses) are also quite frequently used. Less common technologies targeted by the courses are also the 3DP/Binder jetting; Material Jetting (MJ); Manufacture of laminated objects (LOM); Laser Metal Sintering (SLM) or open sources for printers related to one specific material (ex. for ceramics).

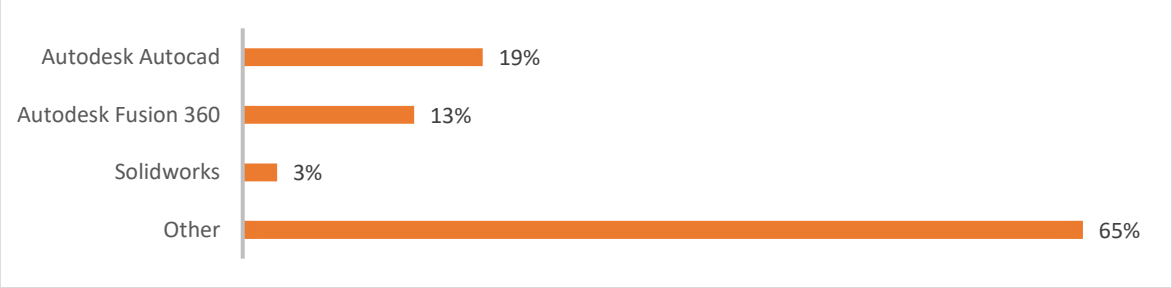
Figure 15 - 3DP technology addressed by the training course



Source: Internal elaborations

As for the modelling or scan software used during the trainings, the most common seems to be Autodesk Fusion 360 and Autodesk Autocad (more than 30% of courses use them). The offer is nevertheless very wide, as quite common tools are also Google SketchUp, Rhinoceros 3D, Blender, 3DS MAX, TinkerCAD, Solidworks, 3DXExpert, Inkscape (for vectorial drawing), FreeCAD, Ultimaker Cura, Makerbot Print software, (to prepare the printing file, .gcode).

Figure 16 - Modelling or scan software addressed by the training course



Source: Internal elaborations

However, both for in the case of the technology addressed and the software used during the courses, the information is very often not clearly reported in the training programme. There is a need therefore for more accurate programme on these topics.

Considering the wide offer available to craft entrepreneurs, traditional craft entrepreneurs approaching 3DP may be easily lost. They need some guidance in the choice of the best tools which suit their needs the most. Thus, it might be interesting to provide a general overview on the most common software and technologies available on the market, as well as on the actors which may help entrepreneurs in adopting the ones that are most appropriated for their project.

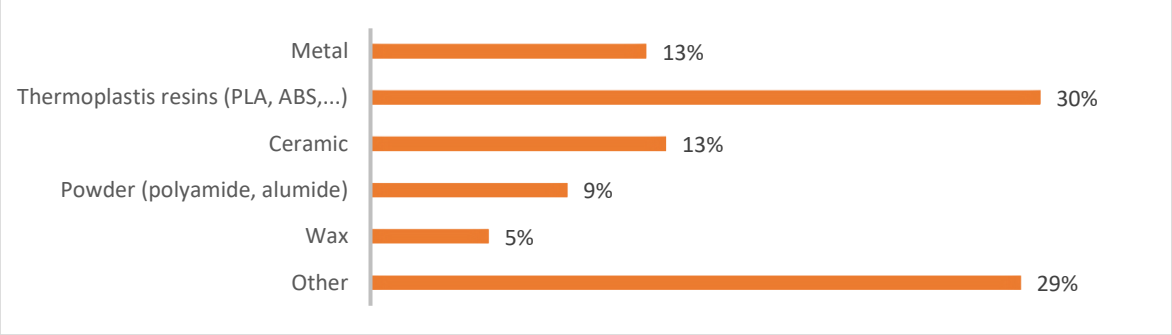
Topics that could be targeted by the overview could be, for instance:

- What are the most common software available on the market (focusing most notably on the ones that are for free), advantages/disadvantages of each tool, prerequisites, costs, etc.
- What are the most common printer's technologies, what are the advantages/disadvantages of each technology;
- What are the professional actors/organizations that can help craft entrepreneurs to choose the best tools for their projects, what are their sectors of the activity; what are the types of support and services that they offer to craft entrepreneurs, whether they provide financial support for projects implying AM, or whether they are able to support the entrepreneurs in seeking financial support from different sources, etc.

4.2.5.3 Materials

Regarding the materials on which the courses are focusing the most, the most common seems to be the thermoplastics resins (PLA, ABS,…), which is addressed by 30% of the courses, i.e. 34 courses. Ceramic and metal are also quite common (13%), followed by the powder (polyamide, alumide) (9%) and wax (5%).

Figure 17 - Material addressed by the training course



Source: Internal elaborations

Among our sample, the materials that are less frequently used, as they are used by only one or two courses, are clay, glass, sugar, meringue, different filaments, hybrid WoodFil and silicone.

However, one of the most outstanding observation is that, here as well, there is often a lack of clarity in the training programmes. The information on the materials used during the courses is frequently missing (around 29 courses do not give details on the materials). Thus, once again, there is a need to improve the information reported in the programmes and to provide more details on the materials used during the trainings.

In addition, considering the large choice of materials available in AM, traditional craft entrepreneurs may be interested in having an overview of the most common ones used in their sector of activity. In this respect, it may be interesting to develop a training course including new contents about different materials used in AM, their applications, the specificities of each material, the limits, the difficulties, the costs related to what they use in 3DP, etc. An approach by sector may be more interesting for craft entrepreneurs, so to give an overview of the possible applications of different materials, according to the different uses that can be done in the same field of activity (ex. what are the most common materials used by jewellers, for what use, what are the specificities to consider for each material, etc.)

4.2.5.4 Additional remarks

Amongst all courses reviewed in the questionnaire, only two offer an online and free access to all contents and materials. Both the courses are the result of an European projects supported by the Erasmus+ programme ("Training in 3DP to foster eu innovation & creativity" and "3D Lab"). The review of their programmes may be inspiring for any new course addressing AM in the craft sector.

The clear lack of free access to the content of courses on 3DP can be considered as a barrier to the diffusion of this technology in the craft sector. The analysis shows that there is a strong need to provide quality content, adapted to the needs of craft companies and available for free.

4.2.6 Transversal skills

More than 70% of the courses (53 courses) do not address transversal skills in their training programmes and 17% of them are not specifying if they are included or not.

There are only 7 training courses addressing transversal skills and the most common skills are project management, coordination, and monitoring skills. Less commonly, a couple of courses also

focus on developing critical and innovative thinking by addressing creative skills to "*understand the interrelationships and future trends of the creative society*" or to be able to "*adapt to the changing creative economy and new models*" of a specific industry/sector.

Transversal skills[5] can be defined as the skills that are not specifically related to a job, a task, or an area of knowledge, but that can be used in a wide range of situations and work settings (e.g. inter/intra-personal skills, critical and innovative thinking, organizational skills, etc). Thus, they appear to be very useful to successfully adapt to changes, and, for example, to adopt a new technology.

A new training offer should give more attention to such topics. Traditional craft entrepreneurs interested in AM should be supported, for instance, in developing creative approaches to develop their products based on the use of the final customers. This is quite uncommon in the craft sector. Thus, it would be interesting to create links, for instance, with designers, and develop this type of transversal skills during trainings on AM.

4.2.7 Competences achieved and skills acquired at the end of the courses

Generally speaking, most of the training courses intend to provide an overview of the possibilities and technologies of 3DP, presenting the whole process from modelling to the actual printing of objects. At the end of the course the participants are often able to fabric a simple object/good, so that they have a concrete example of creation in their hands.

The most common competences achieved at the end of a training course on 3DP are the following:

- Notions on how to create an object with 3DP / design a first proposal for 3DP application (search for ideas/sketches, design, 3D modelling, print design, manufacture, and postproduction, technical skills un 3D drawing and 3DP, creation of digital models and printing of physical 3D prototypes);
- Notions on 3D modelling and tools for it (ex. Google SketchUp);
- Notions on the various modelling methods;
- Notions on the basic principles of 3DP;
- Notions on 3DP software (for creation, edition, repair and production of 3D parts);
- Notions on how to calibrate and use a 3D printer;
- Notions on the different 3DP technologies (e.g. understanding of the different existing production systems) and raw materials, their advantages and disadvantages. (e.g. develop a sensitivity linked to the behaviour of the material printed in 3D, in order to understand the possibilities and limitations of its use/ you will know which technology is worth using for what and in which industry they are used);
- Notions to develop design skills to enhance project creativity.

Most of these competences can be useful and well suited for craft companies.

Creative companies which have already adopted AM could play an important role in supporting the development of skills of traditional craft entrepreneurs who wants to adopt AM. More experienced

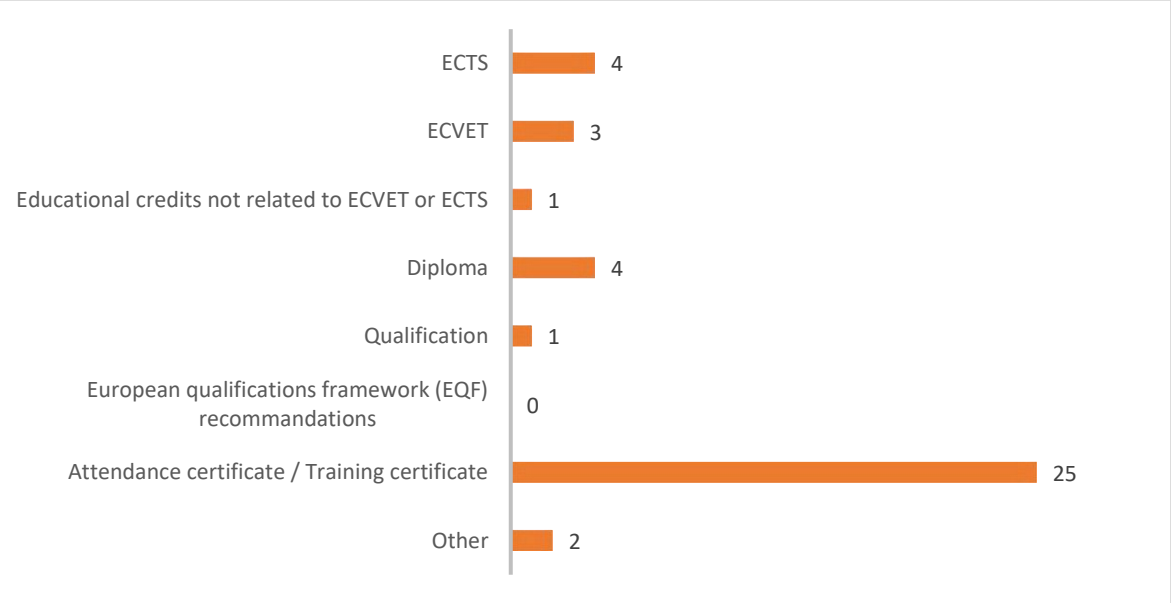
[5] Centre for technical and vocational education and training (TVET), UNESCO-UNEVOC https://unevoc.unesco.org/home/TVETipedia+Glossary/filt=all/id=577

craft entrepreneurs could share their knowledge, for instance, on the choice of the right software for a specific project; the choice of the best technology for a specific activity; the warnings on 3D modelling or printing, etc. It could be interesting, for instance, to organize B2B meetings or online chats between creative and traditional craft entrepreneurs to share best practices on AM. The exchanges could be guided by a list of questions/topics to address, prepared on the base of the key competences to achieve at the end of the training course on AM.

4.2.8 Certification/diploma

Though most of the trainings provide a kind of certification or diploma at the end of the course (40 in total), there is still a considerable number of them which do not deliver any form of recognition or valorisation of the learnings outcomes achieved. The most common is a certification of attendance (28 courses). The sample of courses analysed include only two trainings that provide a diploma adopting the ECVET approach. In this respect, the development of a new course that offers such recognition is warmly encouraged.

Figure 18 - Certification / Diploma issued



Source: Internal elaborations

4.3 CONCLUSIONS FROM THE BENCHMARKING ANALYSIS

The benchmark of 3DP and AIRs training courses for the craft sector has evidenced that in Europe there is a not only great diversity of training providers, but also of programmes both in terms of technological content (i.e. software, 3D printers, materials), as well as duration, costs, and target audiences.

Regarding the training organizations, most of them offer only one training course on 3DP and target an audience with a beginner level. By contrast, almost none proposes an offer on AIRs. In terms of objectives, most of the courses usually aim to provide general and basic knowledge about 3DP and its complete digital chain, applied in all sectors. Moreover, the majority aim as well to acquire technical skills and to allow participants to be able at the end of the training to design and to fabric a simple object. The most common technical skills developed are the ones related to 3DP

technologies, 3D modelling and 3DP software and materials.

Though there are many trainings covering technical subjects and skills in their training programmes, there is a noticeable lack of courses covering other related topics, such as transversal skills. Based on the example of the trainings addressing these types of skills, it appears interesting to develop a training offer that focuses on critical and innovative thinking, project management and organizational skills, to stimulate creativity and facilitate the adoption of a new technology, like the 3DP technology.

Most of the training programmes are poorly detailed, and it is difficult to identify, for example, what technology, software, or materials they address. In this regard, there is a need develop programmes which are easier to understand and clearer for the potential participants. As for the prerequisites, when they are necessary, they seem to mainly relate to simulation software, digitization, and prototyping. Introducing additional prerequisites might be helpful for potential users, like craftsmen. For example, for the ones that are not completely at ease with the English language (which is dominant for using 3DP technology), a glossary of key terms can be develop for them to translate it easily.

When it comes to the training approach and format, it seems evident that there is a need to develop an offer based at least on more mixed approach, including modules delivered online or remotely and classroom or practical training in person. This is particularly recommended also taking into consideration the booming of digital education tools following the COVID-19 pandemic.

The benchmarking has also evidenced that the majority of the training courses are considered as being only partly appropriate to the needs of companies from the sector of craft. Indeed, the results indicate that 57% of the training courses are partly appropriate to the craft sector and almost 6% are not appropriate at all to the craft sector. There is therefore a strong potential for the development of courses that are more suited to craftsmen and to their needs.

In addition, a new offer of training on AM for craft entrepreneurs should illustrate more examples of applications, best practices and practical case studies issued by creative entrepreneurs who have already adopted this technology. Traditional craft entrepreneurs are likely to be more interested to discover this new technology if they are given concrete examples of its use in the same sector of activity. Direct exchanges between creative and traditional craft entrepreneurs should also be fostered as much as possible through B2B meetings, networking events or online chats, which facilitate the development of key competences on AM by sharing best practices.

A strong majority of the courses do not give a free access to the content of their trainings, which can be an obstacle for encouraging the adoption of 3D printing technology by craftsmen. In this respect, the ACCESS-3DP project will be thus to support craftsmen for using 3DP and stimulate their creativity by providing them with a free access to an adapted content.

Finally, the development of new a new training offer on 3DP should also pay more attention to the valorisation of the learnings outcomes achieved. Since the current offer recurs largely to certificate of attendance, more valuable forms of recognitions based on the ECVET approach for instance are warmly encouraged.

4.4 RECOMMENDATIONS AND FIRST PROPOSALS FOR THE ACCESS-3DP JOINT CURRICULUM

Based on the benchmarking analysis carried out, the following recommendations and proposals should be considered for the development of the **ACCESS-3DP Joint Curriculum**

#1	**Develop a** new format for the training programmes**, including information on technology, software, or materials addressed, so to make the information easier to get and clearer for the potential participants.**
#2	Develop contents or **concrete examples of applications** that highlight the **added value that 3DP can bring to craft activities** as well as its power to create different elements on similar products rapidly, reducing the time-to-market and the costs linked to such variations.
#3	Develop contents that illustrate more **examples of applications, best practices and practical case studies issued by creative entrepreneurs** who have already adopted this technology
#4	Develop of **examples of applications and good practices taken from different sectors** (such as medical, manufacturing), and using fewer common materials, which may be inspiring for traditional craft enterprises
#5	Focus on a **mixed/online approach**, by involving for instance associated partners
#6	Develop contents related to the most **common prerequisites** as a glossary of key terms used in AM in English
#7	Develop **contents on non-technical subjects**, which nevertheless are important to appreciate the VA of the technology and assess the economic viability of an investment in AM (ex. business models for AM)
#8	Develop **transversal skills**, such as, critical and innovative thinking, project management and organizational skills, to stimulate creativity and facilitate the adoption of AM by craft entrepreneurs
#9	Develop **contents** about **different materials used in AM**, their applications, the specificities of each material, the limits, the difficulties, the costs, etc. An approach by sector may be more interesting for craft entrepreneurs, to give an overview of the possible applications of different materials for different use in the same field of activity
#10	Integrate **direct exchanges between creative and traditional craft entrepreneurs** through, for instance, B2B meetings, networking events or online chats, which facilitate the development of key competences on AM by sharing best practices.
#11	Develop a **diploma** which valorise the learnings outcomes achieved, based on the **ECVET**

	approach
#12	Develop contents on **AIRs applied to the craft sector**

5 COMPARATIVE STUDY OF THE C-TCIS MISMATCHED SKILLS AND NEEDS FOR APPLYING INNOVATIVE 3DP PRACTICES

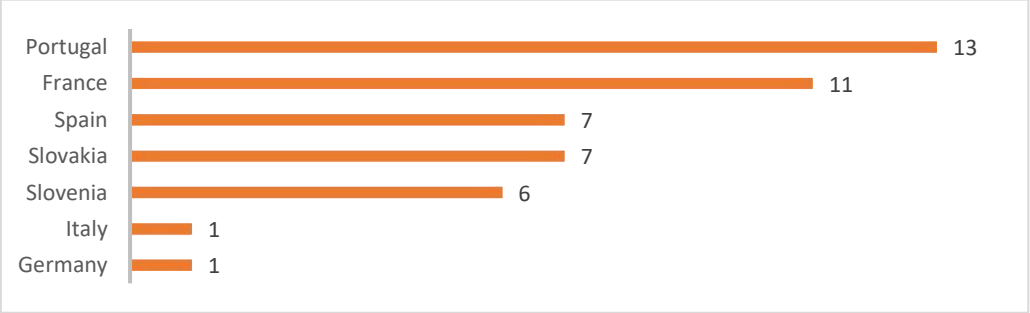
The final part of this study report is dedicated to the illustration of the results of a questionnaire carried out by the partners, which was addressed directly to the final beneficiaries of the training offer on the 3DP and AIRs in Europe for the craft sector, i.e. the businesses, which either are already using this technology, or are potentially interested in adopting it. The questionnaire submitted by the partners also included a section addressing training providers on 3DP and AIRs and similar stakeholders, to collect information on the experience of the enterprises asking to train on issues related to these technologies.

This section presents therefore the analysis of the data collected through the interviews and illustrate in the end the recommendations and proposals to consider for the development of the ACCESS-3DP Joint Curriculum coming directly from the beneficiaries of the training offer.

5.1 THE PROFILE OF THE RESPONDENTS

The following analysis reviews the replies provided by 46 European businesses and other types of organizations based in 7 European countries, which accepted to participate to the survey conducted by the project partners between February and March 2021. All actors were recruited within the networks of the project partners, which explain the relatively limited number of European countries covered by the survey.

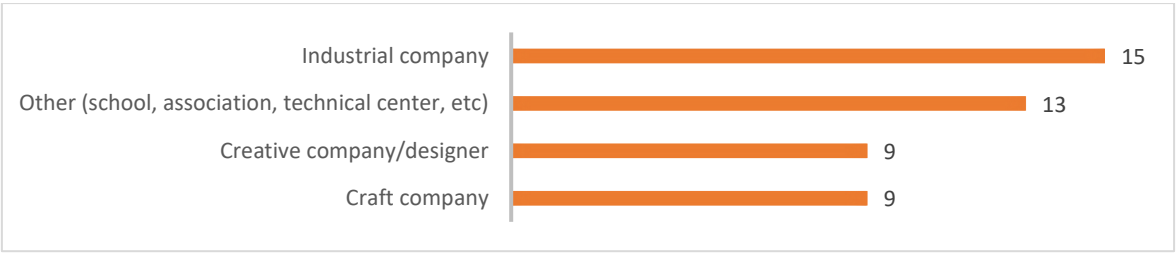
Figure 19 - Respondents per country



Source: Internal elaborations

The sample of the respondents offers a diverse spectrum both in terms of type of organizations and sectors of activity covered. Thus, 15 of the participating organizations are from the industry, 9 are from the sector of craft and another 9 are creative companies.

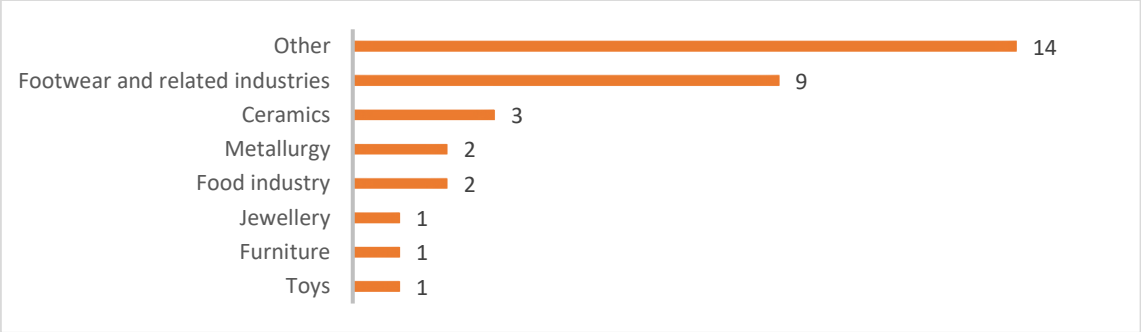
Figure 20 - Type of organization



Source: Internal elaborations

There is nevertheless a significant number of answers from “other” structures (13) such as schools, associations, technical centres, and 9 of the responses are from the footwear sector, which might orientate certain responses.

Figure 21 - Activity area



Source: Internal elaborations

In line with the structure of the survey, the analysis of the replies has been split in two parts:

- The first one presents the results of the analysis on the 33 responses from craft, industrial and creative/designer companies.
- The second one refers to the replies given by the 13 other type of structures interviewed.

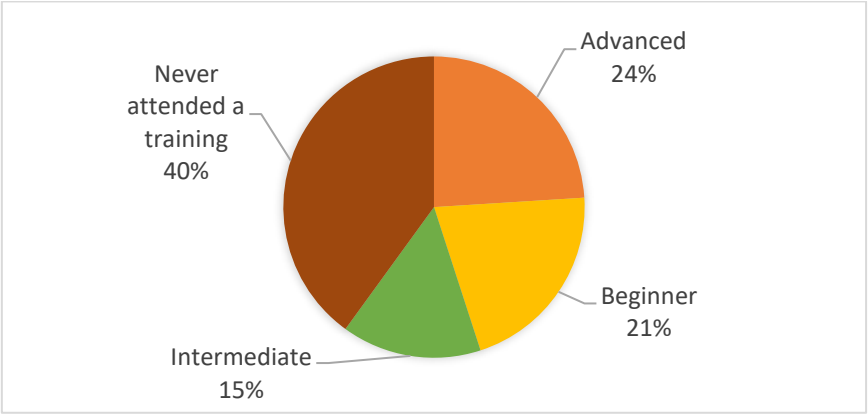
5.2 ANALYSIS OF THE REPLIES FROM COMPANIES

5.2.1 The experience and appreciation of the current training offer in 3DP

The overall opinion on 3DP is very positive: 58% of the companies interviewed consider 3DP as being very useful and 42% as being useful.

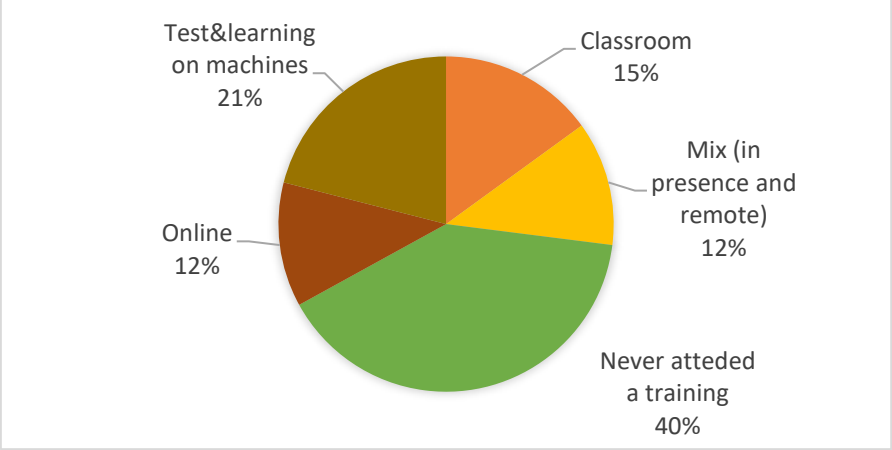
More than half of them (19) have already participated in a 3DP training programme which has enabled them to acquire skill levels from beginner to advanced depending on the programmes followed. The survey highlights that the advanced level has been reached mainly thanks to very operational training (on machines) of “test and learn” type or by combining face-to-face time and online courses. The beginner's knowledge was acquired mainly in classical theoretical face-to-face lessons.

Figure 22 - Level of knowledge and skills gained in a 3DP training



Source: Internal elaborations

Figure 23- Format of the training attended by the enterprises



Source: Internal elaborations

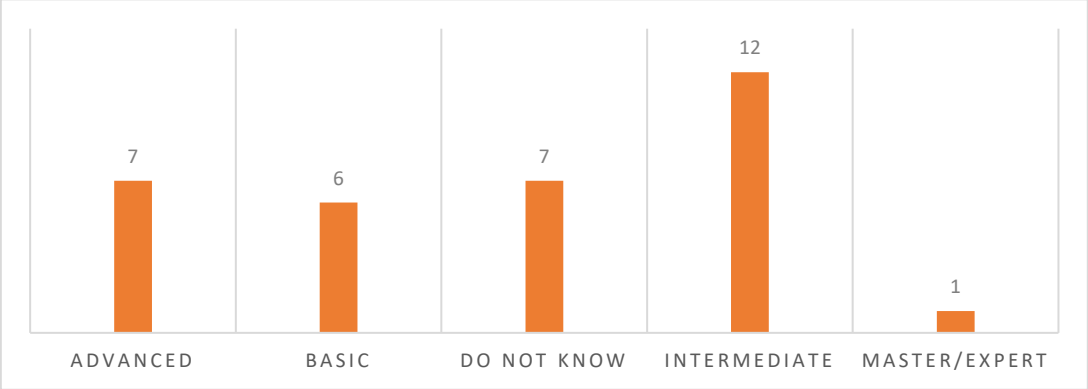
Considering the high appreciation of the technology, in order to raise the level of awareness and skills on 3DP and expand even further its adoption, it seems important to favour highly operational trainings with scenarios and 3DP practical examples.

Finally, since two thirds of the respondents have little or no knowledge of the 3DP training offer, even though the offer continues to grow[6], there is a strong need for improving the awareness on the existing training offer.

5.2.2 The level of training offer

The majority of the companies interviewed (12) consider that intermediate-level training should be further developed and are interested in testing this level of courses. However, training at a basic or more advanced level would also be of interest for respectively 24% and 27% of the companies surveyed. A new training offer on 3DP should therefore let the beneficiary the possibility to choose different levels of trainings, with a focus on the basic and intermediate levels.

Figure 24 - What level of knowledge offer in 3DP is missing and/or should be improved the most?



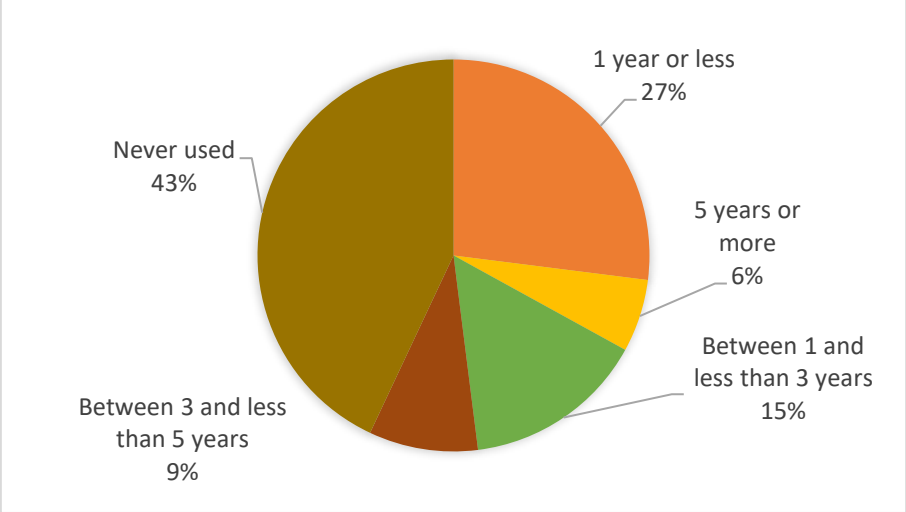
Source: Internal elaborations

[6] See section 4.1.

5.2.3 The experience of companies on advanced industrial robotics

When it comes to AIRs, half of the companies who have replied to the survey have already used robotic technologies and in most of the cases, the experience is quite recent (less than 3 years old).

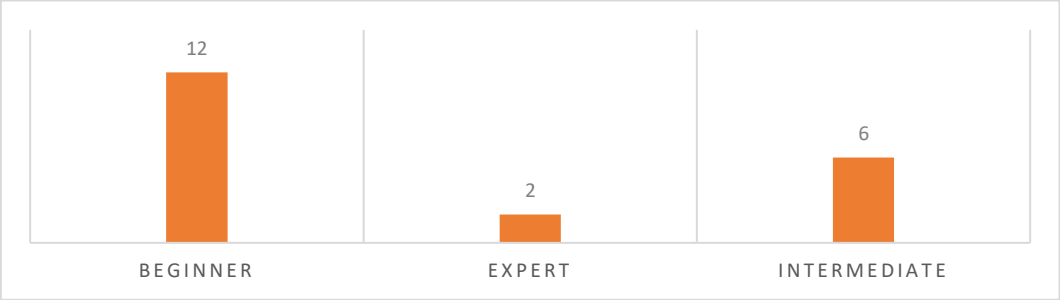
Figure 25 - Experience on AIRs



Source: Internal elaborations

Amongst the enterprises with an experience with AIR, most of them (12) believe to have beginner's knowledge on the subject, with certain difficulties encountered in programming, in the adaptation of the technology to their job/professional activity or due to a lack of knowledge in electronics.

Figure 26 - How would you qualify your current knowledge and skills on robotics technology?



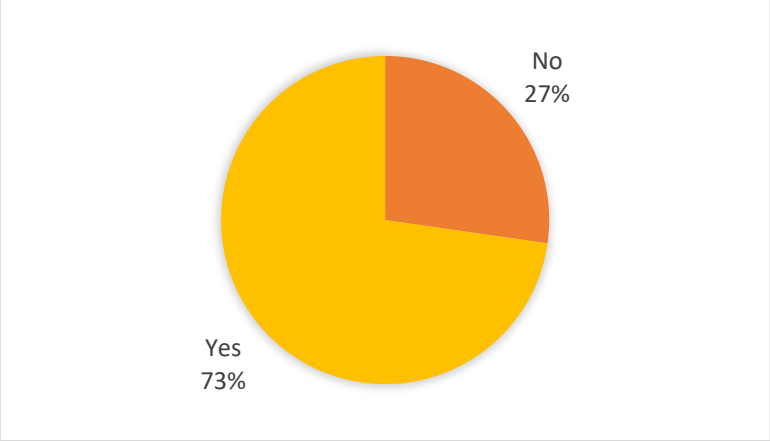
Source: Internal elaborations

The replies to the survey, together with the qualitative information gathered during the interviews show that the enterprises need to better understand how 3DP can be coupled with robotic technologies to generate new solutions and application for production automation. To raise a real interest from traditional craft entrepreneurs, the benefits of associating 3DP and AIRs should be emphasised by providing, for instance, inspiring examples of best practices already adopted in the craft sector.

5.2.4 The experience of companies on 3DP

Most of the enterprises interviewed (73%) have already some experience on 3DP.

Figure 27 - Have you ever used 3DP?



Source: Internal elaborations

5.2.4.1 From the point of view of the ones who have not yet used 3DP…

9 out of 33 companies who have replied to the questionnaire have no experience in additive manufacturing and 3 of them have never followed a training programme of the subject. Almost all companies (8) are unfamiliar with the trainings available.

The lack of interest for 3DP is directly correlated to the lack of technical knowledge, to the lack of financial resources but also to the lack of visibility on what this can bring to their business (in financial and economic terms / ROI, advantage / handmade, ...). These replies show therefore that there is a need to provide more information to show the added value brought by 3DP and its applications for businesses.

Despite the lack of knowledge on the technology, a third of the companies who have never used 3DP have declared that they would be interested in using 3DP in the future to customize products or make a 1st prototype.

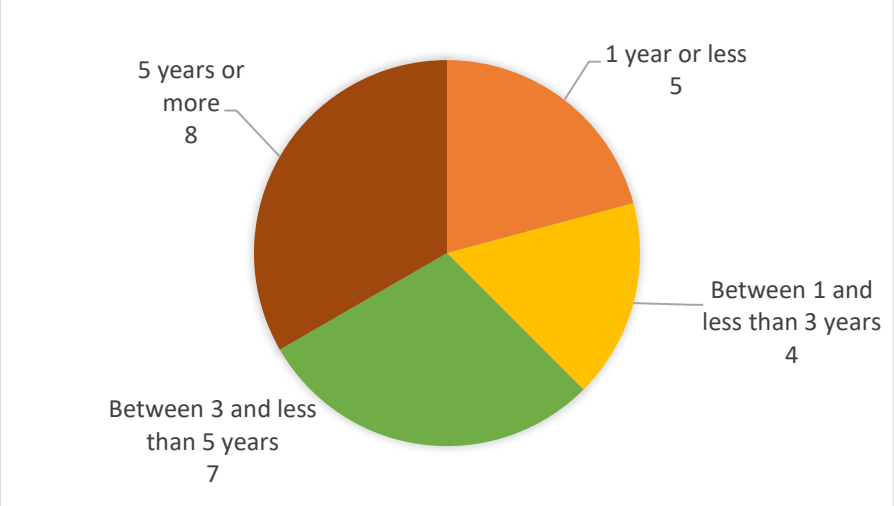
To do this, they refer to need more information on the technologies / materials / limits of 3DP applicable / adapted to their profession. More information on the technical centres / schools / partners that can be mobilized to advance in their project would be useful to them are also asked. Consequently, to give more visibility to the network of partners who can be mobilized to use 3DP is also a priority for future trainings on additive manufacturing.

Finally, 2 companies accept to test the training modules developed under the ACCESS 3DP project.

5.2.4.2 … and from the ones who have already used 3DP

24 out of the 33 companies who have replied to the questionnaire have some experience in terms of 3DP. Two thirds of them have used this technology for more than 3 years, while for 5 of them, the adoption is very recent (less than a year).

Figure 28 - Experience in the use of 3DP

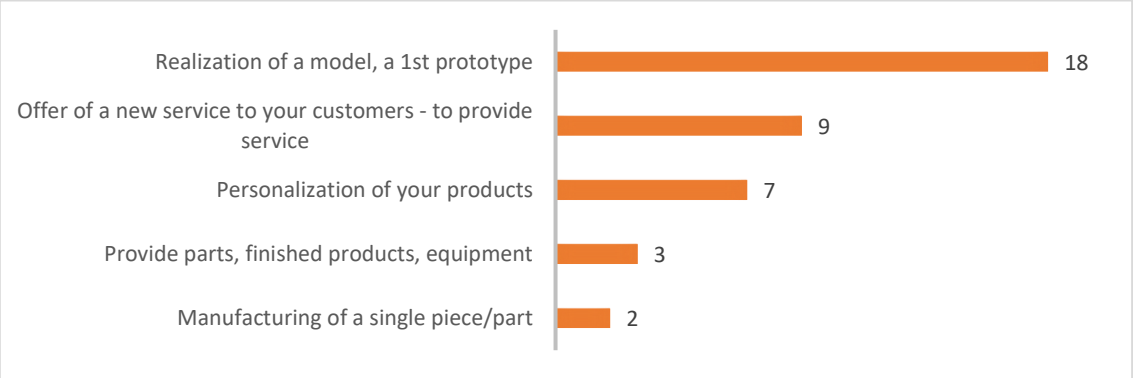


Source: Internal elaborations

The main reasons which led these companies to use 3DP are the realization of a 1st model or prototype, the development of a new service or the personalization of products.

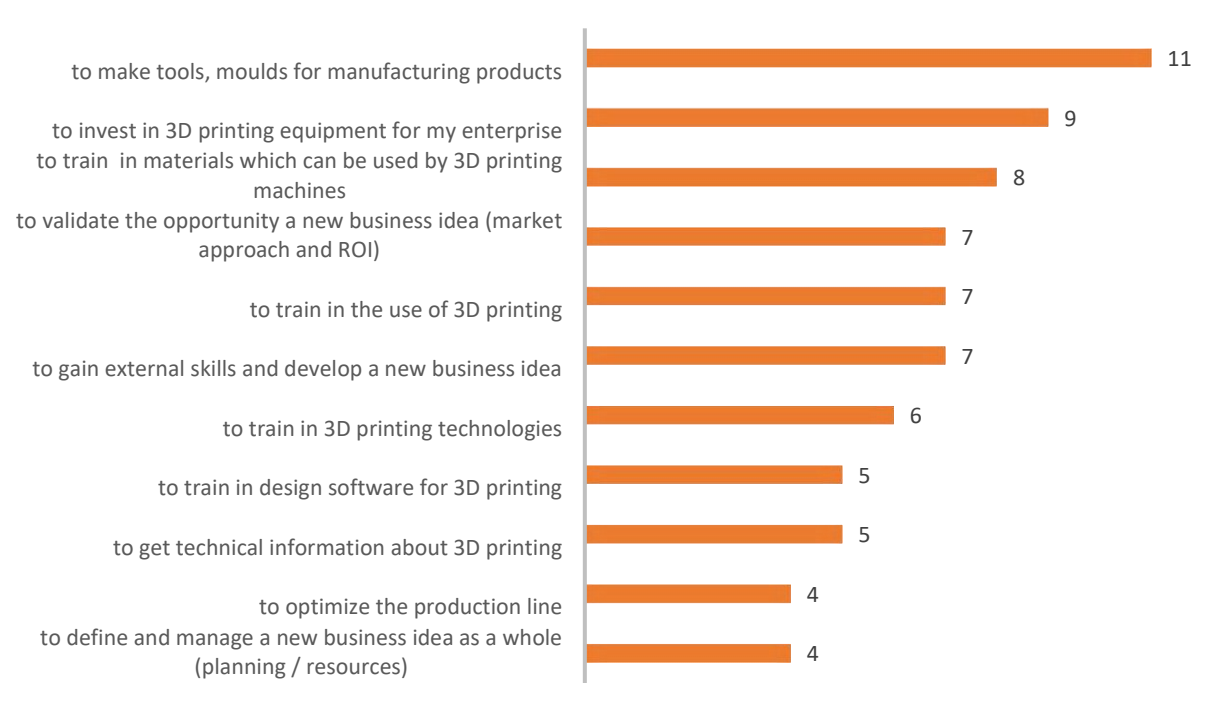
Some more avant-garde companies have started to use 3DP for direct manufacturing of parts or finished products.

Figure 29 - For what purpose(s) have you ever used 3DP?



Source: Internal elaborations

Figure 30 - Why have you used 3DP?



Source: Internal elaborations

More specifically, most of the companies have declared to use 3DP to make tools or moulds, to invest in equipment for their company, or to train themselves to the various usable materials.

The acquisition of new skills, the possibility of testing and validating product / process / business innovations are also common reasons to the use of this technology.

More marginally, 3DP has allowed some companies to train in modelling software and to acquire information on printing technologies.

We can therefore easily observe that companies have employed 3DP for a great variety of uses. Having access to these concrete and varied examples could help traditional companies to arouse their interest and to have a better understanding of the possible opportunities offered by 3DP technology.

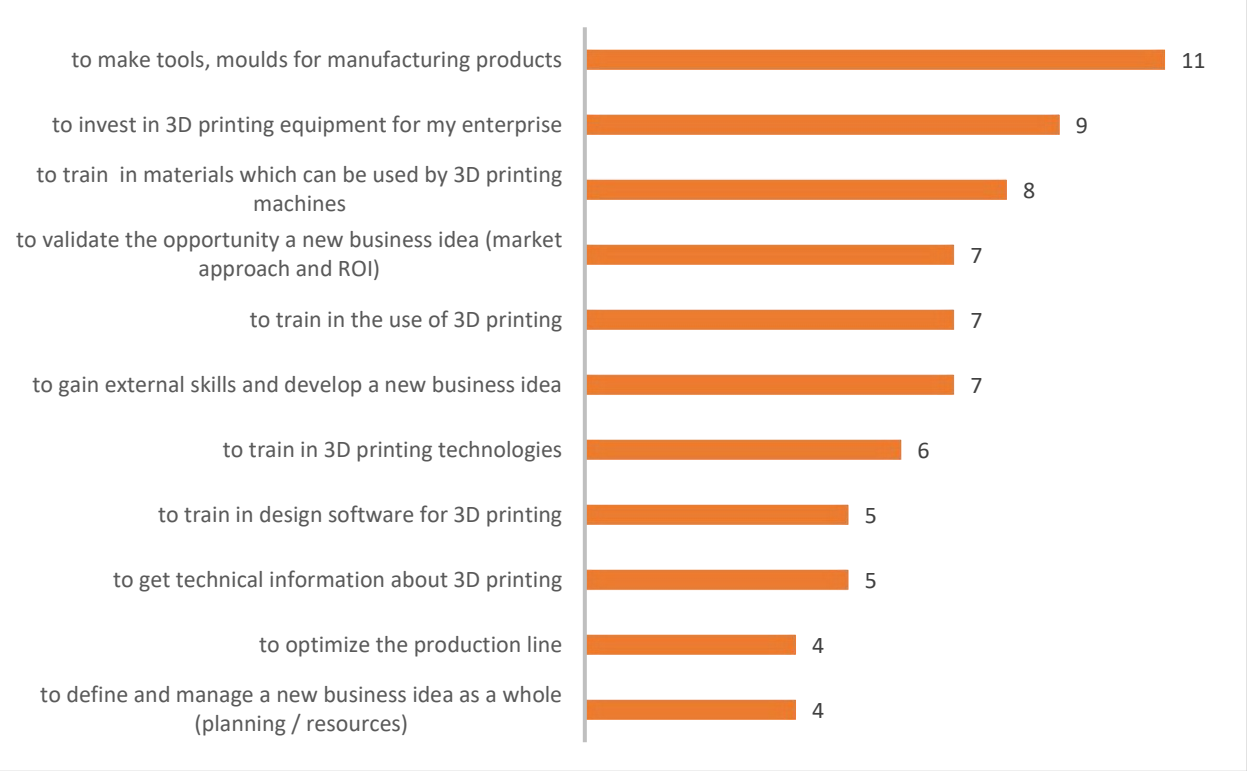
Moreover, when using 3DP, it should be noted that these companies mainly highlight difficulties due to the lack of technical knowledge, whatever their initial level of knowledge, in particular in terms of design software. This therefore reinforces the importance of training programmes for a more massive use of this technology, whatever the type of organization (craft company, industry, and design company).

It is also interesting to note that it is among the companies that have been using 3DP for several years that we see the greatest number of companies with an advanced or expert level of mastery. Practical workshops integrated into the training should help to accelerate the acquisition of knowledge and skills and should thus be integrated, as much as possible, into ACCESS-3DP's training programme.

Retrospectively, these user companies have expressed what would have been useful for them to get

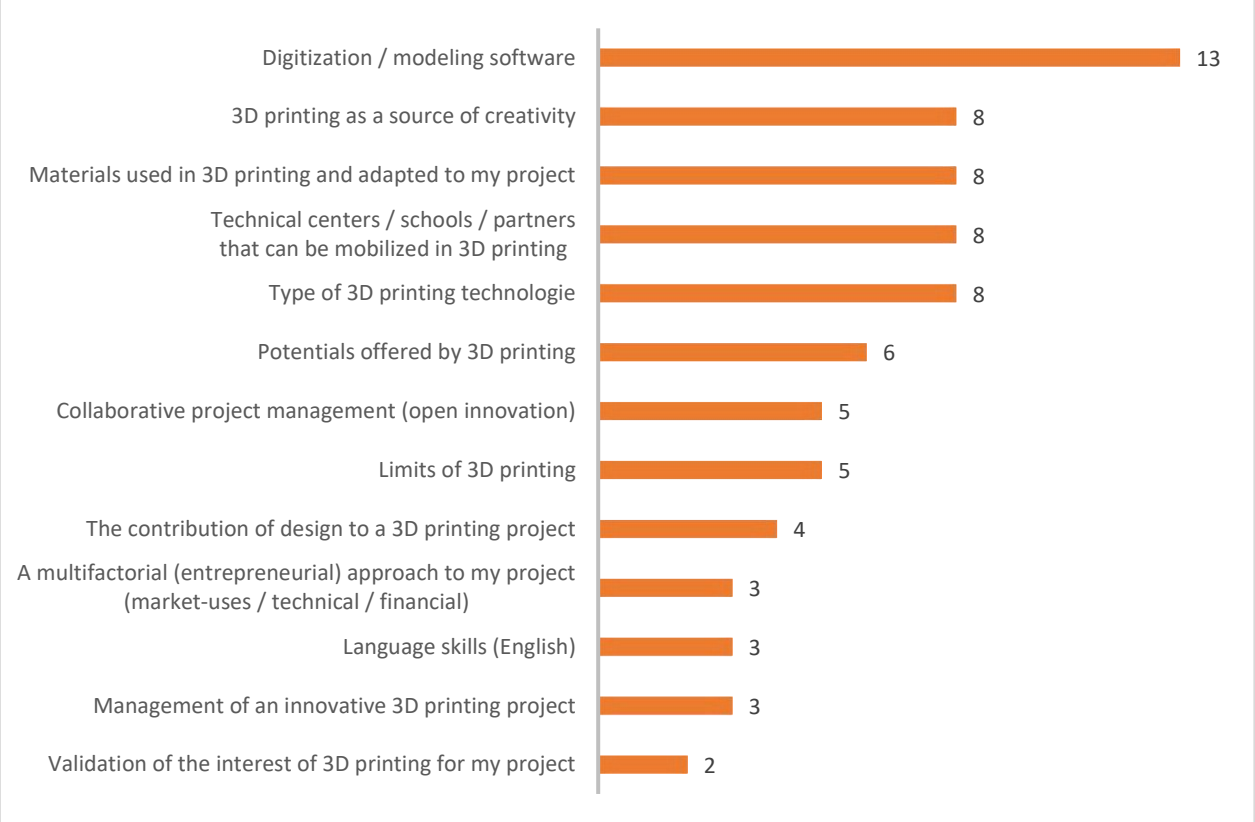
started with 3DP. A great majority of them (13) highlight that it would have been useful for them to have trainings on design and software modelling, but also in the theme of 3DP as a source of creativity (for 8 of them).

Figure 31 - Why have you used 3DP?



Source: Internal elaborations

Figure 32 - Needs identified by user companies



Source: Internal elaborations

Some additional needs are similar to the ones expressed by companies that are not yet users of 3DP, for example, regarding the need of trainings to inform on the materials (mentioned by 8 companies), on skills centres that can be mobilized (mentioned by 8 companies), or even on the types of existing technologies (8) with their potential (6) and their limits (5).

Finally, some of them also have subjects of interest that are less technical for trainings related to the thematic of collaborative project management or of a multifactorial approach to the project (market-uses / technical / financial).

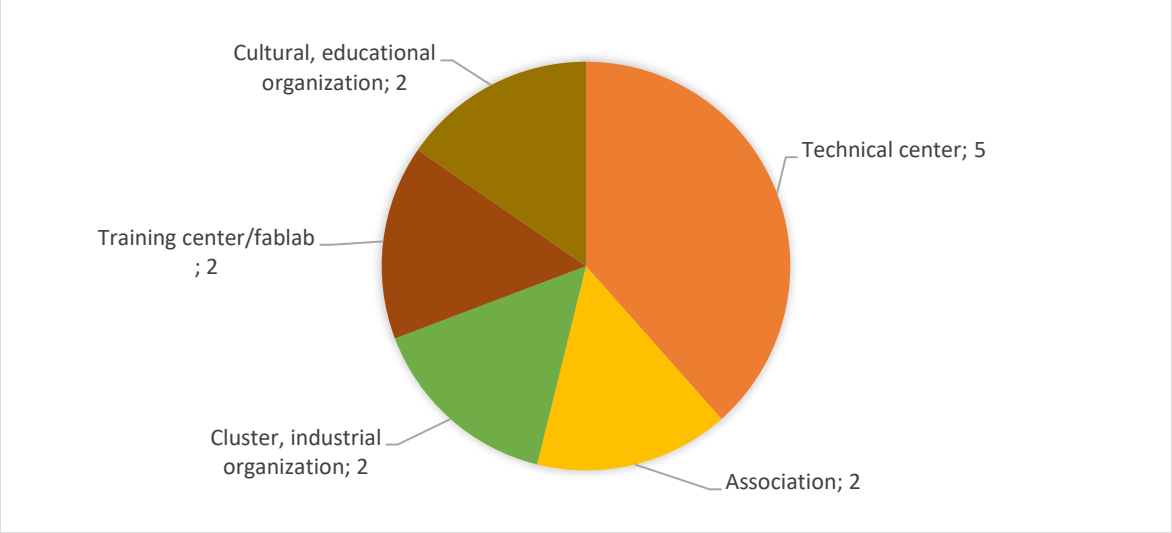
During the next phase of the project, the partnership will give the utmost importance to these identified needs to build the content of the project's training modules.

5.3 ANALYSIS OF THE REPLIES FROM OTHER STRUCTURES

In addition to the businesses, the survey on the current 3DP and/or AIRs training offer for the craft sector collected the responses of 13 organizations other than businesses. While the type of these organization varies, they all have in common the fact that they all propose a training offer on additive manufacturing. However, half of them propose only one training programme on 3DP.

Out of the total, 2 organizations target specifically micro enterprises, 2 additional target students and the rest of the respondents target SMEs from the industry or the craft sector.

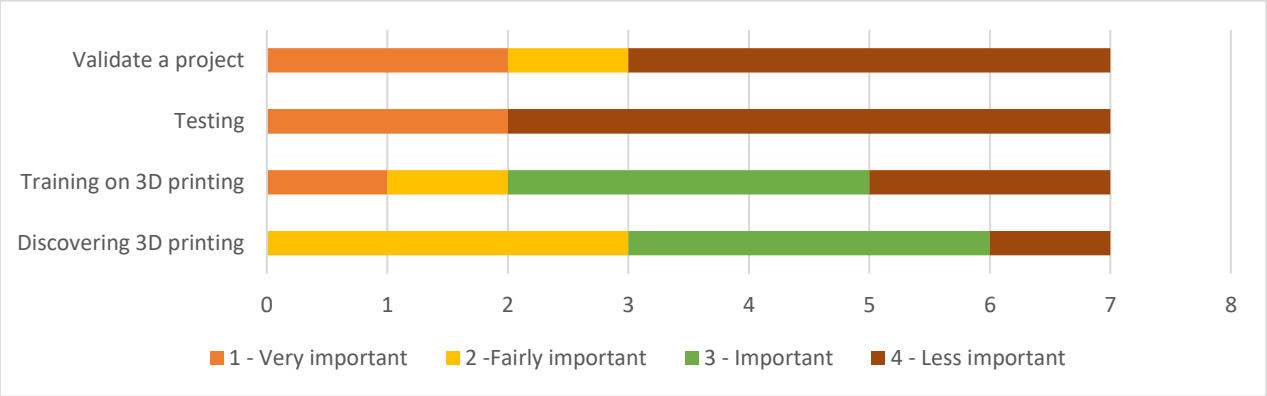
Figure 33 - Types of respondents other than enterprises



Source: Internal elaborations

The enterprises trained come from different sectors of activity (furniture, footwear, jewellery, metallurgy, leather goods, automotive industry, plastics, ceramics) and the majority ask to train to validate or test a project. They also use the training to discover AM as a new way of production.

Figure 34 - What does the enterprises are mainly looking for in a 3DP training?

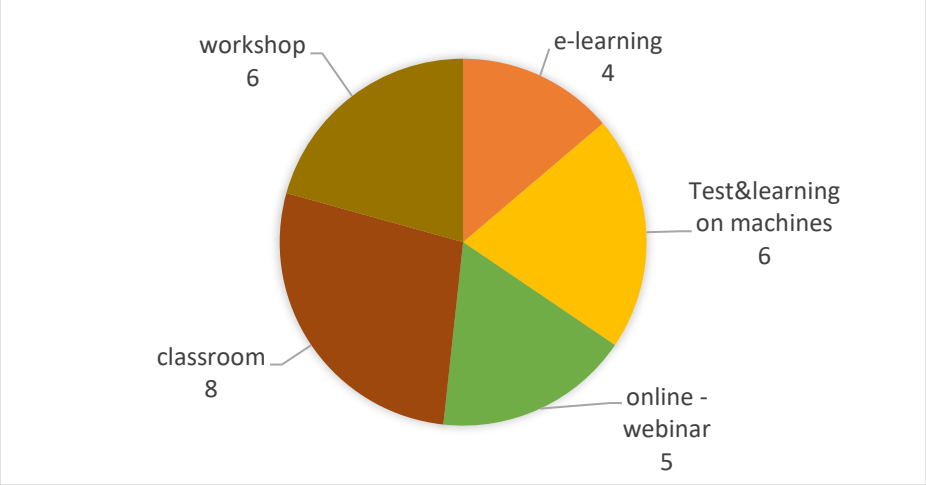


Source: Internal elaborations

The average knowledge about 3DP is variable (from beginner to master) and in terms of needs, the respondents report the same ones expressed by the enterprises who have replied directly to the survey (see Figure 2.10 - Needs identified by user companies)

As far as it concerns the format of the trainings, there are different types which are proposed with a slight preference for the classroom. However, the remaining types are also quite common.

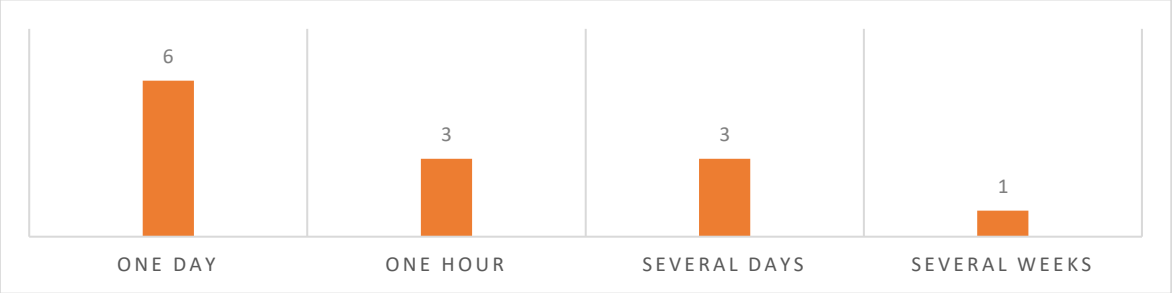
Figure 35 - Formats of the training proposed



Source: Internal elaborations

In most of the cases, the duration of the course is relatively short (from one hour to one day).

Figure 36 - Duration of the training(s)



Source: Internal elaborations

When considering the skills that are missing to the enterprises interested in elaborating a 3DP project, in addition to the technical ones, the organizations interviewed remark a general lack of competences in terms of project management. The enterprises need also to develop a multifactorial approach to their business project and the technology available (market use/technical/financial issues). Security issues related should also be deepen, to make sure that the dangers and risks related to the use of 3DP machines are well understood by the entrepreneurs. Finally, there is a general need to strengthen the importance of the choice of the material for a 3DP project.

5.4 CONCLUSIONS FROM THE INTERVIEWS

Thanks to the great diversity of responses gathered from varied organizations, it is possible to observe that most of the companies (58%) believe that 3DP is very useful.

In this regard, more than half of them have already participated to a training programme in 3DP and, when it comes to the ones targeting an advanced level, they are mostly very operational training (on machines). The majority of companies ask to get trained on 3DP to validate or test a project or to discover AM as a new way of production.

It thus appears important to continue to raise the level of awareness around 3DP, a technology

which is very much appreciated but from which the training offer is not very well known by the respondents. More specifically, to help the adoption of 3DP y, in the next phases of ACCESS-3DP project, it is important to favour a training programme that includes operational trainings, with scenarios and 3DP practical examples. The use of practical examples from craft companies that are already using 3DP will help showing the added value brought by 3DP and its applications for businesses to craft companies that are more traditional and that have not used 3DP yet.

It appears important as well to develop further a training offer focusing on basic and intermediate levels, because they are the ones for which companies have a stronger interest.

Concerning the use of 3DP coupled with robotic technologies, once again it will be key to provide inspiring examples from the craft sector to help companies to have a better understanding of the benefits of associating these technologies and to increase the interest of traditional craft businesses.

Finally, when it comes to the missing skills and the needs expressed by companies in terms of training content, it has been observed that there is a lack of information on the materials, on the skills centres that can be mobilized and on the types of existing technologies with their potential and their limits. All such topics should be considered during the development of the ACCESS 3DP training modules. Finally, there is an evident need for to develop contents on less technical subjects related to the development of transversal skills on project management and to have a multifactorial approach to their 3DP project (market-uses / technical / financial), but also to help entrepreneurs understanding security issues and the risks related to the use of 3DP machines.

5.5 RECOMMENDATIONS FOR THE ACCESS-3DP JOINT CURRICULUM

Based on the analysis carried out on the replies collected through the interviews, the following recommendations and proposals should be considered for the development of the ACCESS-3DP Joint Curriculum:

#1	**Raise the level of awareness and skills on additive manufacturing by favouring highly operational trainings with scenarios and 3DP practical examples and/or exercises**
#2	**Raise the awareness** on the existing training offer
#3	Allow for the **choice on different levels of trainings**, with a focus on the **basic** and **intermediate** levels
#4	Explain and show the **added value brought by 3DP and its applications to businesses** and provide information to give **visibility to the network of partners** who can be mobilized to use 3DP
#5	Rely on the **concrete and varied uses of 3DP already existing to arouse interest** and show the possible opportunities for traditional companies
#6	Integrate **practical workshops** into the training programme

#7	Rely on the **needs identified by the user companies** to build the content of training modules
#8	Develop **transversal skills** such as on project management and support to develop a multifactorial approach to their business project and the technology available
#9	Raise the **awareness on the security issues** to the use of 3DP machines
#10	Develop modules or contents that support the enterprises in their choice of the **right material** for their 3DP project.
#11	Show to the enterprises **how 3DP can be coupled with robotic technologies** to generate new **solutions and application for production automation** and highlight the **benefits** of associating 3DP and AIR trough **examples** of **best practices** from the craft sector.

6 FINAL CONCLUSIONS

3DP is a technology that has reached its maturity and whose usefulness and benefits have already been confirmed for the sector of craft (i.e. in terms of reactivity, flexibility, new business possibilities, etc.).

This technology has now become more accessible for traditional craft businesses, who can benefit from lower investment costs, be inspired by the examples of successful applications from creative craft peers, but also get access to a great diversity of training courses at a European level, both in terms of the format of the courses and in terms of their content.

However, the adoption of 3DP may remain a challenge for some traditional craft businesses, notably for the ones who have gaps in the skills and technical knowledge required to exploit this technology, or when they are unfamiliar with the norms and standards related to use of 3DP (including security issues related to the use of 3DP machines).

Conceiving a new, open and free of charge training programme on 3DP, which is tailored to the needs expressed by the craft sector, is therefore an important step to support the diffusion of the technology and its adoption by traditional craft entrepreneurs.

The benchmark analysis has evidenced indeed that, although the training offer on 3DP is large and diversified, companies have limited knowledge of it. Training programmes are very often not detailed, which makes it difficult for a craft entrepreneur to identify the training course that can be best adapted to his/her level of knowledge and skills, and that it is the most indicated to his/her 3DP project (from a technical point of view, regarding the material and the software used). The analysis revealed also that there is room for improvement in terms of adapting the training offer to the needs of the craft sector, and that in this respect, it is important to diversify the contents of the trainings, which at the present time are focused on mostly technical contents.

Based on the recommendations made following the benchmark, it appears essential to develop a new offer targeting a basic and medium level with a clear and detailed training program, mixing operational units and practical examples. The interconnection between creative and traditional craft industries should also be fostered, by favoring as much as possible direct contacts, peer meetings or workshops, which will allow to present the added value of 3DP as an innovative technology for traditional craft companies.

To make the most of the use of 3DP, it also appears important to provide tools to traditional businesses to help them applying innovative processes into their activities, by favoring the adoption of an innovative approach in terms of design thinking and by developing training contents focused on design and software modelling.

The analysis of the needs expressed by the final beneficiaries of the training courses highlights as well that there is need to develop modules or contents that provide inspiring examples on concrete applications and on the different materials that can be used with 3DP equipment. Additional modules or supporting documents should be also developed to fill the lack of content among the current training offer on transversal skills. This mostly target subjects related to project management, the adoption of a multifactorial approach to a business project, an approach based on the market-use, technical and financial issues related to a 3DP project, but also to a better

understand the investment risk related to the adoption of this technology.

In addition, it seems important as well to develop informative documents or training contents that help the craft entrepreneurs to identify the closest actors, which are part the local innovation ecosystem and which can offer expertise and support to develop a 3DP project.

Finally, the new training offer provided by ACCESS 3DP should also be conceived in way that enables craft companies to discover a wider field of possibilities offered by advanced technologies by, for instance, introducing training contents that raise awareness on the potential offered by the link between 3DP and AIRs technologies.

In conclusion, the ACCESS 3DP training offer should provide the target beneficiaries with new skills and competences issued from the main following areas: 3DP production process (types of software, technologies and applications to different materials), managements of health, safety, and environment-related issues for projects involving 3DP, innovation process, management and local actors to support 3DP projects, design thinking, business management adapted to innovative projects, basics on AIRs associated with 3DP and the craft sector. All theoretical concepts should be coupled, as much as possible, with concrete examples issued from the craft sector.

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- www.3dnatives.com

- www.usinenouvelle.com

8 ANNEXES

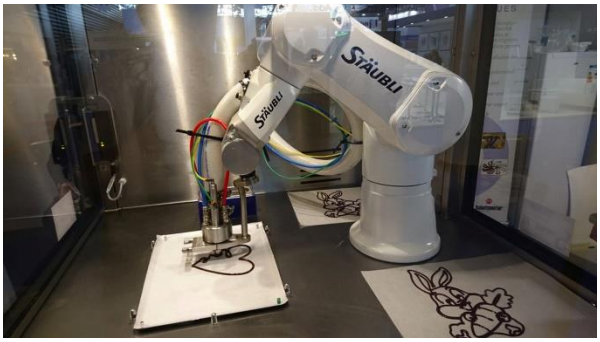
8.1 ANNEX 1: CREATIVE AND CRAFT INDUSTRY

	Characteristics				
	Slovakia	Slovenia	Portugal	Spain	France
Traditionnal CI	Traditional craft represents the performance of the skilled work leading to the development of the products/services while such a production requires the unique (hand)skill which is historically distinguished For the traditional craft is typical to create their own products/services which have been covering daily needs in the past Examples : woodcarving, beekeeping, pottery	Wooden, stone, textile, ceramics products.	In Portugal the term "craft" is related to traditional manufacturing sectors, which even for the time being are very advanced, are yet referred as traditional sectors. Those sectors are mainly Footwear/components/leather goods, Leather (tanning), Textile/Cloths, Cork, Ceramics/Glass, Wood/Furniture, Moulds, Rocks/Ornamental Rocks, Gold/Jewellery, Metals. It's related to the type of manufacturing, the sector, not to the size of the company. For instance, a IT micro company, although employing less than 10 people is not of the craft sector. A designer's atelier, even with more than 10 employees, of course always a SME and never a larger company belongs to craft industry. The term "creative" is, by its turn, very much involved with fashion and communication/marketing such as TCLF industries and ICT/Multimedia strand.	The craftsmen have extensive experience in production techniques and use them to develop the manual work that is inherited from generation to generation, generally passed on from parents to children. Some of the most popular handcrafted products are jugs, tapestries, carpets, furniture, chairs, plates or musical instruments among others. The most representative activities of Spanish crafts are ceramics, glass, wood, leather, footwear, metals or textiles.	Creative/ artistic crafts with recognized know-how (cutler, ceramist, instrument maker, metalworker, ...) - Jewelry maker - Craftsmen of the repair sector (cycles, household appliances, computer hardware, ...) - Craftsman of food (pastry chef / chocolate maker) - Crafts in the textile, leather, metallurgy sectors
Créative CI	Creative craft represents the performance of the skilled work leading to the development of the products/services while such a production requires the unique (hand)skill For the creative craft is typical to create their own products/services which are unique and they can be rearded as the art products Examples : painting, artistic woodcarving	In general, the creative craft sectors in Slovenia are mainly dealing with wooden, stone, textile, ceramics products and jewellery. The usage of 3D printing technology is highest in the sector of wooden products, but this differs from small, medium and large companies.	Manufacturing of products – manipulation of materials and means/tools - that correspond to aesthetic values, incorporate emoticons, history, feelings, culture. Some characteristics of creative crafts: .manuality .high level of skills required .creativity .originality /uniqueness / exclusivity .relation to heritage / history .finetuned aesthetic aspects	The Creative Craft are a contemporary form of artistic expression, with a greater knowledge of applied techniques, with own and evolved designs and with an implication also in the process and final end. These "Makers" normally use 4.0 technology tools such as 3D printing or cutting-engraving lasers. In general, they are more creative, innovative and dynamic than traditional craftsmen. Examples include the company VOJD Studios, which manufactures high-end fashion with 3D printing, the manufacture of shoe soles using 3D printing or the creation of jugs and other decorative elements that incorporate this laser engraving and cutting technology for prints.	Craft companies that invest in 3DP as a product/service offered: e.g. chocolate robot (3Dessert graphique) - prototyping service (Materya) - 3D printing service, 3D modeling and 3D digitization (additive3D) Manufacturing of products in fab additive (rheve3D) - use to personalize products (see chocolatiersdart.com-Drôme) - artist / designer / creator (e.g.yann bajard 3d designer for jewelry and high jewelry)

8.2 ANNEX 2: EXAMPLES OF 3DP USES IN EUROPE

8.2.1 Examples from France

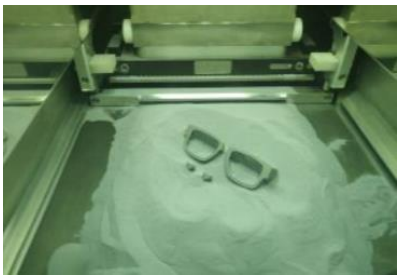
Name of craft company	3DESSERTS GRAPHIQUES
City, country	Lyon, France
Website*	www.3dessertsgraphiques.fr
Contact details*	https://www.3dessertsgraphiques.fr/contact/
Sector of activity	Agrifood
Material	Chocolate
3DP technology used	Specific development: robotic arm with digital 3DP sleeve pocket
Product/good manufactured with 3DP	Decoration, chocolate product
How the use of these technologies has enhanced the craft/ business	The 3DP technology is the core of the business: 3Desserts Graphics designs and distributes CE-certified food-grade 3D printers. That allow to create patterns in chocolates to infinity and to elaborate decors in relief, allowing a personalisation of the products demanded by the consumers



Name of craft company	RHEVE 3D
City, country	Vénissieux, France
Website*	https://rheve3d.com/
Contact details*	https://rheve3d.com/nous-contacter
Sector of activity	Additive Manufacturing
Material	(57 materials)
3DP technology used	FDM/SLA/SLP/CFF/Colorjet
Product/good manufactured with 3DP	Any type of product: prototyping, small and medium series
How the use of these technologies has enhanced the craft/ business	RHEVE 3D is a craft company with an industrial additive manufacturing activity: it offers services from design to 3DP through 3D scanning, consulting and training.

8.2.2 Examples from Portugal

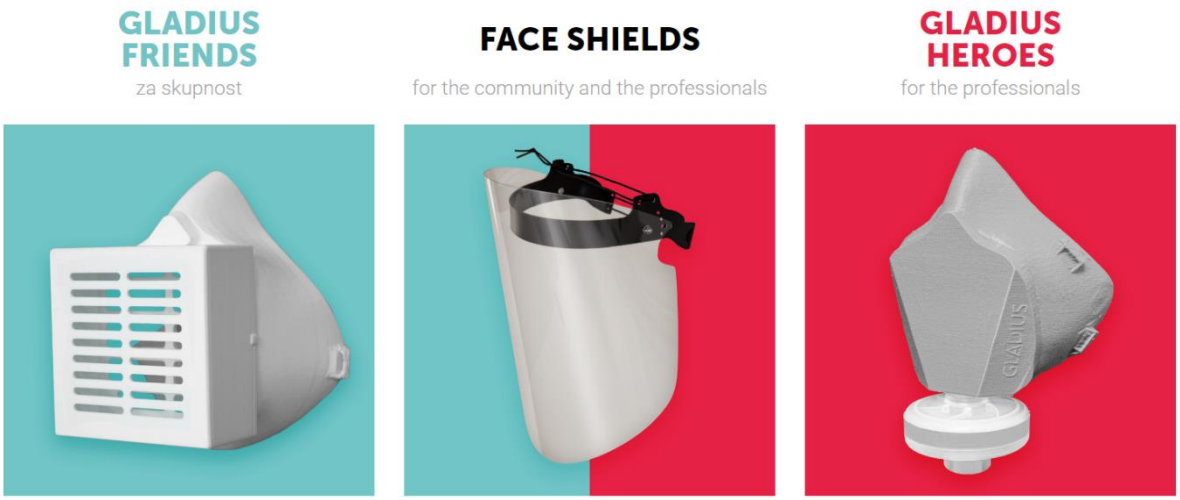
Name of craft company	Hypermetal
City, country	Vila Nova de Gaia, Portugal
Website*	https://hypermetal.eu/
Contact details*	info@hypermetal.eu / +351 220 135 162
Sector of activity	Additive manufacturing
Material	Metal (aluminium, tool steel, stainless stell, Inconel, cobalt, chromium and titanium)
3DP technology used	Laser Powder Bed Fusion
Product/good manufactured with 3DP	Prototypes and functional parts/tools for all sectors
How the use of these technologies has enhanced the craft/ business	Their whole production is based on 3DP and CNC machining. They use both technologies to develop and fabricate specific parts according to the needs of each client which would be impossible to fabricate by other technologies. Some examples are tools to optimize the production line, other kind of tools, moulds for manufacturing products and functional products (other than tools).

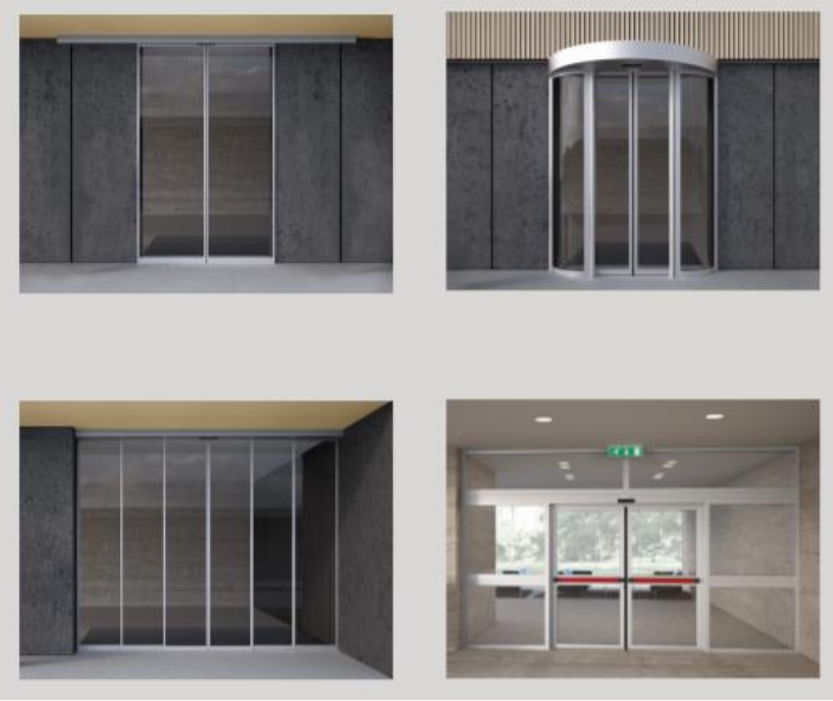
Name of craft company	AMF, LDA
City, country	Guimaraes, Portugal
Website*	http://www.amfshoes.com/
Contact details*	info@amfshoes.com / +351 253 527 163
Sector of activity	Safety shoes
Material	N/A
3DP technology used	N/A
Product/good manufactured with 3DP	Creation of a new model, prototyping.
How the use of these technologies has enhanced the craft/ business	AMF is a safety shoes manufacturer. The 3DP technology allow them to gain external skills and develop a new business idea, to train in design software for 3DP and to make tools and moulds for manufacturing products.

8.2.3 Examples from Slovenia

Name of craft company	Zaščitimo Slovenijo
City, country	Ljubljana, Slovenija
Website*	https://zascitimo.si/en/
Contact details*	info@zascitimo.si
Sector of activity	n/a
Material	Plastic
3DP technology used	n/a
Product/good manufactured with 3DP	Protective face masks and shields
How the use of these technologies has enhanced the craft/ business	3DP was at the core of their business – without 3DP, they would not start producing.
A group of companies and individuals (https://zascitimo.si/en/about/partners-and-supporters/) started producing 3D printed facemasks and protective shields for personal use during the Covid pandemic.	



Name of craft company	Doorson
City, country	Maribor, Slovenija
Website*	www.doorson.si
Contact details*	(02) 460 55 60 info@doorson.si
Sector of activity	71.129 Other technical consultancy
Material	Currently not available (website under construction)
3DP technology used	Currently not available (website under construction)
Product/good manufactured with 3DP	Mechanisms for sliding doors.
How the use of these technologies has enhanced the craft/ business	They have raised the quality of their products and replacement parts for mechanisms connected to their sliding doors, making them more adaptable to various surfaces.
Doorson produces sliding doors. They incorporate 3DP technology in their development and also provide small scale production of elements or products with 3DP.	



8.2.4 Example from Spain

Name of craft company	Gomarco Descanso S.L.
City, country	Yecla- Murcia (Spain)
Website*	https://gomarco.com/es/
Contact details*	Bedding Sector
Sector of activity	Mattresses
Material	Silica powder and a binder.
3DP technology used	Rapid prototyping machine, specifically using a machine with 3DP technology (Three-Dimensional Printing)
Product/good manufactured with 3DP	Manufacture of pre-moulds to obtain structural models to define the design for the manufacture of innovative mattress cores taking into account ergonomic factors. These moulds were created during the research part of R&D&I which had the objective of developing a non-continuous flexible internal structure with a high capacity for transpiration and with optimum properties for use as a core in the manufacture of mattresses.
How the use of these technologies has enhanced the craft/ business	During the research, the intermediate step of building or manufacturing a pattern or model, allowed the company to ensure the production of strong and sufficiently robust parts. It was also possible to verify whether the behaviour of the structural models was in line with what was initially defined and whether this structural morphology was viable for subsequent industrialisation of the process.

Moulds created by 3DP technology

Series of mattresses incorporating this innovative system, called the Nucol

8.3 ANNEX 3: FOCUS PER COUNTRY

8.3.1 France

INFORMATION FROM FRANCE	
BUSINESSES INVOLVED	
Creative craft: characteristics – examples ***What is your definition of creative craft? What are the characteristics of creative craft? Can you give some examples?***	Craft companies that invest in 3DP as a product/service offered: e.g. chocolate robot (3Dessert graphique) - prototyping service (Materya) - 3DP service, 3D modelling and 3D digitization (additive3D) Manufacturing of products in fab additive (rheve3D) - use to personalize products (see chocolatiersdart.com-Drôme) - artist / designer / creator (e.g.yann bajard 3d designer for jewellery and high jewellery)
Traditional craft (TCIs): characteristics – examples ***What is your definition of traditional craft industry? What are the characteristics of traditional craft? Can you give some examples?***	Creative/ artistic crafts with recognized know-how (cutler, ceramist, instrument maker, metalworker, ...) - Jewelry maker - Craftsmen of the repair sector (cycles, household appliances, computer hardware, ...) - Craftsman of food (pastry chef / chocolate maker) - Crafts in the textile, leather, metallurgy sectors
Examples of 3DP use by craft companies	For prototyping, for product manufacturing, to develop company's own service, to differentiate / personalize products.
Obstacles already identified to the use of 3DP ***Are you already aware of existing obstacles that you could already identified for using 3DP?***	Technological obstacle/barrier (ignorance / choice) - skills gap (is it for me?)
3DPRINTING	
Figures about the use of this technology and its evolution	Regular development of this technology since 10 years with a maturity acquired in recent years and a diversification in the usable materials, and limits of use identified Ultimaker Study Nov 2019 France ranked 4th on the knowledge, use and potential development of 3DP (behind USA, UK, Germany) Source: Ultimaker study Nov 2019 - With 3% of the world's 3D printer fleet, France ranks 7th behind Japan and China - 9% each - and far behind the United States, 1st in the ranking with 38% of machines installed. Source: Economic, Social and Environmental Council, March 2015. (+ see project response)

Identified aid/support (local/national/European support) for the use of 3DP ***Existing support to invest in materials/equipment** ***Existing support to invest in skills/competences**	Framework Programme "Horizon 2020" then "Horizon Europe" In France in 2017, the public authorities made the subject of additive manufacturing one of their priorities to support the modernization of French industry. In this context, the government relied on a roadmap drafted under the leadership of the "Alliance Industrie du futur" -> Future investment program (PIA): e.g. support of BPI France for innovative investments and R&D, plan for fiscal advantages in investment amortization ("dispositif de suramortissement" in French), loan Regional actions: ex Additive manufacturing platform in Auvergne Rhône Alpes with financial support for Additive Manufacturing services + a training component
Opportunities and strategic stakes/issues for craft companies ***What are the opportunities a craft company can benefit from the use of 3DP? What are the strategic stakes/issues for a craft company using 3DP?***	3DP offers opportunities for the local craft sector to manufacture unique pieces or limited editions at a reasonable cost. Technology that reaches maturity allows the acquisition of 3D printers with increased performance in terms of productivity, quality, resistance of parts, compatibility with new materials and all at more affordable prices. AM should revive repairing jobs and jobs for manufacture of spare parts. We can consider the development of 3DP services in local shops or parcel relay points. Among its many qualities - low cost prototypes, responsiveness, customization and interaction with the customer - 3DP adds one: it only uses the material where it is needed and does not generate manufacturing waste. Source: avise-info.fr, 02/27/2019
What vision of the complete chain (upstream and downstream of 3DP) ***According to you, what steps have to be integrated/considered by companies before and after using a 3DP? And should we take them into consideration in the project?***	Digital files -> Preparation of usable files -> 3DP -> finish touch (cleaning, removal of supports, sandblasting, machining, etc.)
TRAINING VET PROVIDERS AND LEARNERS (Introduction)	
List of the different types of structures offering 3DP training	"Universities, school ... Professional training centre Technical Centre, Technological Platform Place of Innovation: Fab Lab, "Tiers-lieux"[7], Hub, accelerator, incubators

[7] *Third places ("Tiers-lieux" in French): it is a place of innovation providing access to technologies (like a Fab Lab, Incubator, Hub, etc.) and providing complementary services

	Association, digital cluster 3D printer manufacturer 3DP service company Other business "
List of useful and complementary trainings to 3DP trainings (preliminary draft of the subject - only if already identified)	CAD (Computer Aided Design), Design / uses, innovative project management, creativity, Sustainable development / circular economy, …
Different learner profiles already identified (craftsmen-future craftsmen)	Formal education (e.g. designer, industrial designer, artistic education, engineer, etc.) Profile maker…

for companies by giving them, for example, the possibility to establish themselves physically in their offices.

8.3.2 Portugal

INFORMATION FROM PORTUGAL	
BUSINESSES INVOLVED	
Creative craft: characteristics – examples ***What is your definition of creative craft? What are the characteristics of creative craft? Can you give some examples?***	Manufacturing of products – manipulation of materials and means/tools - that correspond to aesthetic values, incorporate emoticons, history, feelings, culture. Some characteristics of creative crafts: • .made using hands • .high level of skills required • .creativity • .originality /uniqueness / exclusivity • .relation to heritage / history • .fine-tuned aesthetic aspects
Traditional craft (TCIs): characteristics – examples ***What is your definition of traditional craft industry? What are the characteristics of traditional craft? Can you give some examples?***	In Portugal the term "craft" is related to traditional manufacturing sectors, which even for the time being are very advanced, are yet referred as traditional sectors. Those sectors are mainly Footwear/components/leather goods, Leather (tanning), Textile/Cloths, Cork, Ceramics/Glass, Wood/Furniture, Moulds, Rocks/Ornamental Rocks, Gold/Jewellery, Metals. It's related to the type of manufacturing, the sector, not to the size of the company. For instance, an IT micro company, although employing less than 10 people is not of the craft sector. A designer's atelier, even with more than 10 employees, of course always a SME and never a larger company belongs to craft industry. The term "creative" is, by its turn, very much involved with fashion and communication/marketing such as TCLF industries and ICT/Multimedia strand.
Examples of 3DP use by craft companies	Footwear: printing lasts, tools and components for prototypes, production of parts of shoes, specific components that normally need moulds to produce (small applications, heels, reinforcements, stiffeners, toe puffs, prototyping concept models. In the footwear industry, 3DP begins to be applied in the development of footwear sport. In the case of Adidas, the sole developed and applied in its recent model of sneakers, used as raw material plastic collected from the oceans. In the case of haute couture industry, 3DP has been applied, for example, in the development of dresses and swimming suits. It is expected that in the future, with the of 3DP technology and the reduction in the cost of acquisition of this equipment, that any person can print garments or shoes from their home. Architecture: prototyping

	Ceramics: prototypes, validation, preproduction Jewellery: pre-production Moulds: printing of injection moulds for prototypes, making it possible to achieve significant reductions in costs and production times. In a future scenario, we will be able to see the massification of 3DP in the development of injection moulds for the production of small lots of pieces. Assembly testing/form&fit Assembly of two or more components where the exact fit of the components determines the functionality of the assembly, e.g. sliding components, to validate the fit. Mechanical functional testing Physical testing of the mechanical functions of a part or component, e.g. mechanical load Durability testing Testing in harsh environments - under influence of heat, corrosive liquids or gases Aerodynamic testing: physical testing of aerodynamic properties of a model/assembly, typically carried out in a wind tunnel Fluid flow analysis: physical testing of design to determine flow rates and key figures, validation of efficiency, etc.. Typically carried out with transparent parts.
Obstacles already identified to the use of 3DP ***Are you already aware of existing obstacles that you could already identified for using 3DP?***	The limitations of 3DP are the high cost of purchasing printing equipment, as well as uneconomical production costs for large quantities of parts and a reduced choice of printing materials, colours, and surface finish. It also has relatively long printing times, just as parts tend to show non-uniform resistance. The materials are still a problem for the final use of produced shaped by 3DP technology. In footwear for instance, the result of 3DP is not functional at least till the moment. Footwear is an assembling of quite wide number of components, assembled around a tool – the last. A prototype shaped through 3Dprinting will not be possible to use of pass in tests of functionality, such as Comfort tests, usage/performance tests.
3DPRINTING	

Figures about the use of this technology and its evolution	Modern 3DP emerged in the 1980s with Stereolithography (SL). In 1987, the company 3D Systems, developed the first 3D printer for commercial purposes, under the name of SLA-1, the first model being sold in 1988. In 1986, started the patenting process for 3DP technology, Selective Layer Sintering (SLS), which was granted in 1989. In 1989, in the USA, starts the patenting process for a new 3DP process, called Fused Deposition Modelling (FDM). The printing process called Direct Metal Laser Sintering (DMLS) was patented in 1998. A new printing process called Selective Laser Melting (SLM) was patented in 1998
Identified aid/support (local/national/European support) for the use of 3DP ***Existing support to invest in materials/equipment** ***Existing support to invest in skills/competences**	There are a lot of National (with the EU support mainly) financing programmes to invest and evolve in the so-called features of i4.0. The same programmes associate the skills development investment. COMPETE and PORTUGAL 2020 programmes are some examples.
Opportunities and strategic stakes/issues for craft companies ***What are the opportunities a craft company can benefit from the use of 3DP? What are the strategic stakes/issues for a craft company using 3DP?***	3DP has advantages for craft companies as following: - It shortens the production cycle allowing the manufacture of products with few or no tools, using less material and parts, reducing time during the product design and development phases, making it economically viable to manufacturing of small quantities, allows to increase the complexity and detail of the design that through traditional manufacturing processes they are difficult or impossible to achieve. - It allows not only to reduce waste of raw material resulting from the production of components, resulting in substantial savings to those who work with valuable raw materials, but also allows the production of lighter and more resistant parts. - It requires less human control since the object's printing process is controlled by a computer. - Summing for micro craft companies, the opportunity to rapid prototype their ideas, i.e. to give a shape to their ideas, be able to deliver a prototype for commercial purposes in a short period of time and resources. Be able to have accessories, decorative pieces, small components to incorporate in the final products without moulds (economy of time and money) For bigger companies even in traditional sector: - Be able to test designs in early stages and extensively to avoid expensive changes later. For verification applications, the parts should provide a true representation of design performance. - Be able to produce concept models - concept models not only drives significant cost savings, but also they empower the products by comparing alternative design concepts side-by-side, improving early design

	decisions that impact every design and engineering activity that follows and reducing or eliminating costly design changes later. - It allows for design changes during and after product introduction, for minimal cost. Producing parts with classic production technologies like injection moulding means to invest in tooling. Traditional manufacturing must freeze the design at one point, typically right before the tool is being produced. After the design freezes, the cost of changing the tool is typically prohibitive to implement further functional or design improvements. The direct manufacturing of end-use parts and assemblies in plastic and metal materials allows to implement design changes, even during production phase. Thus, staying flexible even during manufacturing, being able to respond to changed market requirements and making the best out of the product.
What vision of the complete chain (upstream and downstream of 3DP) ***According to you, what steps must be integrated/considered by companies before and after using a 3DP? And should we take them into consideration in the project?***	The 3DP process starts from a 3D digital model, which can be created using a variety of CAD software, or through 3D scanners. The 3D digital model is generally recorded in an agreed format. The software converts the file into multi-layer format, translating the initial design into a accessible reading for the 3D printer. The material processed by the 3D printer is deposited according to the printing process and technology that process different materials in different ways giving rise to the intended object. Subsequently, some finishing activities, such as polishing, sanding and painting the material needs to be considered.
TRAINING VET PROVIDERS AND LEARNERS (Introduction)	
List of the different types of structures offering 3DP training	Fab Labs (example: ShoeFabLab in CTCP) Technological centres/institutes Universities Industry of components (in case of footwear soles and heels) used to do reverse engineering. Start with prototype to reach the mould
List of useful and complementary trainings to 3DP trainings (preliminary draft of the subject - only if already identified)	3D design and modelling / 3D scanning Knowledge on Materials and types of equipment Finishing processes
Different learner profiles already identified (craftsmen-future craftsmen)	Creatives, Artists, Designers, Architects, Engineers.

8.3.3 Slovenia

INFORMATION FROM SLOVENIA	
BUSINESSES INVOLVED	
Creative craft: characteristics - examples ***What is your definition of creative craft? What are the characteristics of creative craft? Can you give some examples?***	In general, the creative craft sectors in Slovenia are mainly dealing with wooden, stone, textile, ceramics products and jewellery. The usage of 3DP technology is highest in the sector of wooden products, but this differs from small, medium and large companies.
Traditional craft (TCIs): characteristics - examples ***What is your definition of traditional craft industry? What are the characteristics of traditional craft? Can you give some examples?***	Wooden, stone, textile, ceramics products.
Examples of 3DP use by craft companies	Prototyping and customization.
Obstacles already identified to the use of 3DP ***Are you already aware of existing obstacles that you could already identified for using 3DP?***	Lack of knowledge and skills, not enough developed in Slovenia
3DPRINTING	
Figures about the use of this technology and its evolution	In Slovenia, 3DP is one of the technologies enabling digital transformation of work processes and automation in companies and robotization. Robots (for industrial or service purposes) are used by 7% of all companies with at least 10 employees. In 2017, 3DP was used by 4% of companies with at least 10 employees. Among these, 77% used 3DP to print prototypes or models for internaluse, 41% to print prototypes or models for sale, 37% to develop products to be used in the production process and 22% to develop products for sale (i.e., for manufacturing moulds, tools, product parts, semi-finished products and other products). In 2019 statistics showed that the usage of digitalisation enabling technology is increasing, with 8% of robots and 5% of 3DP technology being used by Slovenian companies. Source: stat.si
Identified aid/support (local/national/European support) for the use of 3DP ***Existing support to invest in**	The Slovenian Enterprise Fund is the major financial institution providing effective financial aid and support to SMEs, notably in the field of digitalisation. This also includes the adoption of new emerging technologies like 3DP or in general under Advanced Manufacturing. The institution issues vouchers for different kind of purposes

materials/equipment ***Existing support to invest in skills/competences**	(building up digital competencies, digital strategy)
Opportunities and strategic stakes/issues for craft companies ***What are the opportunities a craft company can benefit from the use of 3DP? What are the strategic stakes/issues for a craft company using 3DP?***	One of the core opportunities identified for the usage of 3DP technology in Slovenia is the fact that it allows to shorten the time to develop and manufacture products. In 2017 the technology was mainly used by large companies in Slovenia (21%) and medium-sized companies (6%), while the small and micro enterprises represent 3%. Mostly its usage was related to the manufacturing sectors (7%), while only 2% for services. Moreover, in Slovenia there is a low number of companies, that own their own printers. A bigger number is hiring 3DP services from external companies. In the upcoming months, the EU will invest in the DIGITAL EUROPE Programme through the establishment of European Digital Innovation Hubs aiming at supporting the adoption of new, digital technologies, including 3DP across Europe.
What vision of the complete chain (upstream and downstream of 3DP) ***According to you, what steps have to be integrated/considered by companies before and after using a 3DP? And should we take them into consideration in the project?***	n/a
TRAINING VET PROVIDERS AND LEARNERS (Introduction)	
List of the different types of structures offering 3DP training	- Universities - Professional training centres - FabLabs and 3DP specialised centres - Digital innovation hubs
List of useful and complementary trainings to 3DP trainings (preliminary draft of the subject - only if already identified)	3DP in general (tools, design, modelling, post-processing, problem solving, good practices)
Different learner profiles already identified (craftsmen-future craftsmen)	In formal education, 3DP is offered especially to students of mechanical engineering, biotech, civil engineering and design.

8.3.4 Spain

INFORMATION FROM SPAIN	
BUSINESSES INVOLVED	
Creative craft: characteristics – examples ***What is your definition of creative craft? What are the characteristics of creative craft? Can you give some examples?***	The Creative Craft are a contemporary form of artistic expression, with a greater knowledge of applied techniques, with own and evolved designs and with an implication also in the process and final end. These "Makers" normally use 4.0 technology tools such as 3DP or cutting-engraving lasers. In general, they are more creative, innovative and dynamic than traditional craftsmen. Examples include the company VOJD Studios, which manufactures high-end fashion with 3DP, the manufacture of shoe soles using 3DP or the creation of jugs and other decorative elements that incorporate this laser engraving and cutting technology for prints.
Traditional craft (TCIs): characteristics – examples ***What is your definition of traditional craft industry? What are the characteristics of traditional craft? Can you give some examples?***	The craftsmen have extensive experience in production techniques and use them to develop their work with hands that is inherited from generation to generation, generally passed through from parents to children. Some of the most popular handcrafted products are jugs, tapestries, carpets, furniture, chairs, plates or musical instruments among others. The most representative activities of Spanish crafts are ceramics, glass, wood, leather, footwear, metals or textiles.
Examples of 3DP use by craft companies	Creating parts from scratch (design); Actual development of the piece; Continue with the accessibility and legacy of a traditional but reinvented sector; Creation of products never traditionally available (e.g. rough or striped finishes on parts).
Obstacles already identified to the use of 3DP ***Are you already aware of existing obstacles that you could already identified for using 3DP?***	Turnaround time, price, quality of the print, materials, low quantity series, feasibility testing of the product, low level of printing technologies skills gained during education, lack of investment (specifically for the hardware). In general, low specific skills in 3DP and its applications- lack of technology know-how)
3DPRINTING	
Figures about the use of this technology and its evolution	3DP is new but not recent. The beginnings of this technique date back to 1984 when the stereolithography method was created. Since then, 3DP has advanced greatly, creating a multitude of techniques for printing 3D objects. This trend became more relevant with the "Maker" community and the RepRap movement. Since then, there are more than 12,000 professionals working in 3DP in Spain with two of the main additive manufacturing centres located in Madrid and Barcelona. Manufacturing with 3DP is becoming increasingly important in the creation of shoes, toys, broken pieces, etc. So far, industrial design, architecture, cinema or health are the sectors that have benefited most from this technology. [Source: https://www.interempresas.net/Fabricacion-aditiva/Articulos/251885-El-

	mercado-de-talentos-de-la-impresion-3D-en-Espana.html]. According to the Eurostat data, only a 3% of enterprises in Spain uses 3DP being 7% the maximum in Europe, concretely in Finland and followed by a 6% in countries like Malta, Belgium or Denmak. [Source: https://appsso.eurostat.ec.europa.eu/nui/submitViewTableAction.do]. However, the emergence of COVID-19 and the lack of respirators and other medical equipment specially in countries like Spain, has put a premium on this technology for the manufacture and production of objects.
Identified aid/support (local/national/European support) for the use of 3DP ***Existing support to invest in materials/equipment** ***Existing support to invest in skills/competences**	EXISTING SUPPORT TO INVEST IN MATERIALS/EQUIPMENT The Regional Promotion Institute has a programme for the acquisition and consolidation of technological infrastructures by the Technology Centres of the Region of Murcia, for the development of R&D&I lines of action by and for companies, in the fields of activity or technological domains prioritised in the Research and Innovation Strategy for the Intelligent Specialisation of the Region of Murcia (RIS3Mur). At the same time, it helps business and innovation incubators by providing funding to ensure that these bodies have modern spaces with all the appropriate infrastructure to enable them to carry out their activities. The "Empresa 4.0" projects were also launched, projects for the implementation of technologies for digital transformation, which impact on the company's key business processes and has as one of their objectives the personalisation of products and services, adapting them to the needs of each client, making the means of production, logistics and distribution more flexible and more efficient, improving the client's experience, improving relations with suppliers, the public administration and other entities or, finally, analysing and exploiting the information available in order to make better decisions. The National Government approves 173.5 million euros to support industrial innovation and the financing of SMEs and entrepreneurs and creates three calls for proposals, two of which are related to the project's topic: - The thematic areas of the Manufacturing Industry call will be the automotive sector, aeronautics and space, and the other manufacturing industries (food industry, textiles, chemicals, graphic arts, pharmaceuticals, manufacture of computer products, electronics, etc). - The Connected Industry 4.0 call is focused on supporting digital transformation through the implementation in industrial establishments of digital enablers related to sensorization, advanced and collaborative robots, advanced printing, data analysis, machine learning, deep learning, collaborative platforms, etc. In addition, the 2019 call was solved for the acquisition of scientific and technical equipment for universities and research centres has been granted. On the other side, The Expansion Hotline will also provide aid for initial investment in new economic activity to promote the growth of innovative companies.

	At European level, SMEs Instrument (the new EIC Accelerator), apart from the different call and support through Horizon 2020 or the upcoming framework, Horizon Europe. EXISTING SUPPORT TO INVEST IN SKILLS/COMPETENCES The Regional Employment and Training Service promotes free courses for active and especially unemployed people in new technologies such as 3DP (e.g. "3DP and additive manufacturing. The industry 4.0 applied to the furniture sector"). Likewise, the School of Industrial Organisation also promotes, together with other public bodies, courses such as "Makers Course: 3DP Technologies". As for the national government, it has prepared publications to establish knowledge such as "Digital Manufacturing: Introduction to 3D modelling and printing. Aula y Mentor Collection". In addition, the National Distance Learning University also promotes free courses such as "Introduction to 3DP". At a European level, it is worth highlighting the Erasmus + projects related to creative crafts on the one hand and to 3DP on the other.
Opportunities and strategic stakes/issues for craft companies ***What are the opportunities a craft company can benefit from the use of 3DP? What are the strategic stakes/issues for a craft company using 3DP?***	Among the opportunities or advantages of a craft company that wants to apply 3DP technology, we can highlight: • Risk reduction in the manufacture of new products (validation of the prototype before investment in final manufacture) • Reduced manufacturing costs • Reduction of production times • Reduction of the time to market of the final product • Realization of short production series • On-demand manufacturing without material waste All this will give them a competitive and distinctive advantage, offering a unique product that will bring them added value. Indirectly this will again improve the positioning of the traditional industry allowing to modernize the sector and strengthen it.
What vision of the complete chain (upstream and downstream of 3DP) ***According to you, what steps must be integrated/considered by companies before and after using a 3DP? And should we take them into consideration in the project?***	1. Product design 2. Product design in CAD 3. Choice of 3D technology 4. Conversion of the design document to the correct 3DP format (usually STL) 5. Selecting the right materials 6. 3DP 7. Piece improvement (cleaning and surface treatment, by hands or automatic) All of them must be considered during the project but I believe that, as craftsmen, the product conception and design part is fundamental. In general, these types of professional profiles must have extensive skills in design

	programmes such as CAD.
TRAINING VET PROVIDERS AND LEARNERS (Introduction)	
List of the different types of structures offering 3DP training	Some examples are detailed below. From Universities: Nebrija Formación Continua (3D design and printing course), Oviedo University (Expert in creative 3DP), Salamanca University (Master Degree in technologies applied to 3D design and printing), Polytechnic University of Catalonia (Master Degree in design and engineering for additive manufacturing) // Incubators: CEEIM (3DP technologies), CEEIC (3DP course), MadridEmprende (3DP technology and entrepreneurship) // Technological Centres: EURECAT (online training in 3D technologies), AITIIP (3DP, basic concepts and application sectors) // Fablabs: 3D School of Malaga Fatlab, Fablab Valencia of 3DP process in ceramic, Fablab Alicante (3D printers course) // Cluster: CEAGA (Introductory course of 3DP) // Public Bodies: ADDIMAT - Spanish Association of 3D and Additive Manufacturing Technologies // Private companies related to education: EDMM (Master in 3DP and advanced manufacturing), MasterD (online course of 3DP) // Private companies related to 3DP as manufacturers or service company: Trimaker or BQ education
List of useful and complementary trainings to 3DP trainings (preliminary draft of the subject - only if already identified)	Tecnical training: CAD software, Installation and calibration of 3D printers, Bioprinting, 3D modelling, 3DP post-treatments.// Transveral training: entrepreneurship, generation of business ideas, sustainability, creativity, innovation, circular economy
Different learner profiles already identified (craftsmen-future craftsmen)	Qualified engineer; professor/educator/teacher; researcher; students; designers; architect; plastics arts education; sculptors; technical assistant; hobbyist; artist;

8.3.5 Slovakia

INFORMATION FROM SLOVAKIA	
BUSINESSES INVOLVED	
Creative craft: characteristics – examples ***What is your definition of creative craft? What are the characteristics of creative craft? Can you give some examples?***	What is your definition of creative craft? • Creative craft represents the performance of the skilled work leading to the development of the products/services while such a production requires the unique (hand)skill What are the characteristics of creative craft? • For the creative craft is typical to create their own products/services which are unique and they can be regarded as the art products Can you give some example? • painting, artistic woodcarving
Traditional craft (TCIs): characteristics – examples ***What is your definition of traditional craft industry? What are the characteristics of traditional craft? Can you give some examples?***	What is your definition of traditional craft? Traditional craft represents the performance of the skilled work leading to the development of the products/services while such a production requires the unique (hand)skill which is historically distinguished What are the characteristics of creative craft? For the traditional craft is typical to create their own products/services which have been covering daily needs in the past Can you give some example? woodcarving, beekeeping, pottery
Examples of 3DP use by craft companies	• https://www.sashe.sk/layerica • https://www.sashe.sk/supolka • https://tvaroch.sk/en/applications/ • https://n-e-r-v-o-u-s.com/cellCycle/ • - https://www.go3d.sk/category/nasa-praca/
Obstacles already identified to the use of 3DP ***Are you already aware of existing obstacles that you could already identified for using 3DP?***	• low level of skills needed to implement 3DP printing • a few practical examples In 3DP, more than 90% of production problems arise due to inappropriate design and inappropriate setting of

	production parameters. (stepanek3d)
3DPRINTING	
Figures about the use of this technology and its evolution	https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=isoc_eb_p3d&lang=en https://www.idc.com/getdoc.jsp?containerId=US45586119
Identified aid/support (local/national/European support) for the use of 3DP ***Existing support to invest in materials/equipment** ***Existing support to invest in skills/competences**	Regional Innovation Strategy for Kosice Region (2015): 3D print identified as one of 10 core technological trends Funding opportunities: Horizon2020, Erasmus+, Interreg(s)?
Opportunities and strategic stakes/issues for craft companies ***What are the opportunities a craft company can benefit from the use of 3DP? What are the strategic stakes/issues for a craft company using 3DP?***	n/a
What vision of the complete chain (upstream and downstream of 3DP) ***According to you, what steps must be integrated/considered by companies before and after using a 3DP? And should we take them into consideration in the project?***	n/a
TRAINING VET PROVIDERS AND LEARNERS (Introduction)	
List of the different types of structures offering 3DP training	• Private companies active in the field of 3DP • Business Support Organisations • NGOs - incubators, accelerators, training centres
List of useful and complementary trainings to 3DP	Two type of trainings were identified: 3D modelling and the use of 3D printer

trainings (preliminary draft of the subject - only if already identified)	
Different learner profiles already identified (craftsmen-future craftsmen)	n/a