Introduction to 3D Printing

Executive Summary

March 2021

March 2021

This THREE-D-PRINT project (2020-1-UK01-KA204-078911) has been funded with support from the European Commission. This publication and all its contents reflect the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

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

EXECUTIVE SUMMARY

The aim of this Report is to produce an introduction to 3D printing, what it is, the opportunities and potential for its use, the impact on society, the prospects for employment, how to introduce 3D printing in training establishments, including the type of hardware and software required, and a few general 'tips/tricks'.

The full Report can be downloaded from https://3dprint-training.com/guide

The THREE-D-PRINT project will create a training programme on 3D printing for trainers, to provide them with the knowledge and tools to develop a teaching programme on 3D printing in adult education.

THREE-D-PRINT will also develop a teaching pack to enable educators to learn how to teach the 3D printing programme and provide course materials for their students e.g., assignments, quizzes, general learning materials.

Worldwide pandemic multiplies the problems in supply chains, especially in sectors such as manufacturing and logistics. The spread of coronavirus has caused disruptions in many plants, disrupted supply chains and prevented production at many industrial factories. This time of global crisis forces most companies to review their current working methods and consider implementing new tools and technologies: such as 3D printing (Additive Manufacturing (AM)).

3D printing refers to the process of additively building a three-dimensional physical object from a digital model data (Computer Aided Design or scanned object) file by depositing and forming successive layers of material under computer control.

Since its beginning, the 3D printing industry has experienced significant growth, evident in Wohlers Associates' yearly reports (Wohlers Report 2019 ISBN 978-0-9913332-5-7). Behind this growth is a talented workforce. But, as with most disruptive technologies, the sector growth happens much quicker than the pace of learning, leading to a talented workforce.

This lag has created what is commonly known as the 'Additive Manufacturing (AM) Skills Gap'; the notion that there are simply not enough talented people to fill jobs and thus meet the needs and demand from the AM employers.

> *"For educators, having an understanding of 3D modelling and 3D printing techniques will be invaluable, as the culture of fab labs is starting to gain support as an important aspect of education. Teachers with 3D modelling and fabrication experience have a range of opportunities open to them within educational programs looking to incorporate this new technology," (Erol Gunduz, a professor at New York University's School of Continuing and Professional Studies (NYU-SCPS)).*

Regarding the skills that will be needed by workers in new age technology fields, there are four basic skill fields.

First, there are **cognitive skills**, which include digital literacy, as well as advanced problem-solving and creative and critical thinking skills.

Second, there are **social and behavioural skills** like conscientiousness, grit, and openness to experience.

Third, there are **educational skills** like cooperative learning, peer education, metacognitive attitude, an optimal proximal learning environment developing a group identity and prosocial values attitude.

Fourth, there are job- or occupation-specific **technical skills**, in this case related to robotics systems and 3D printing.

In THREE-D-PRINT we see the knowledge and use of 3D printing as a tool that can motivate, enable, and empower. In terms of motivation and inspiration, **it allows the user/learner to experience a rapid and easy materialization of the envisioned objects,** it enables the production of parts that can be used in robotics training and ultimately empowers the user to master the skills that will be relevant and needed in numerous commercial, manufacturing and even healthcare settings.

Finally, it can be used to foster creativity, innovation, experimentation and a DIY "maker mentality" that can be usefully employed in an entrepreneurial as well as an industrial setting.

There are also enabling interconnections between the fields of robotics and 3D printing, for example printing robot parts with 3D printers, without the technology engineers would be unable to construct certain components for (for instance) a soft legged robot that can navigate difficult terrain and could be used in search and rescue operations.

The possibilities and opportunities that 3D printing is creating are endless.

For example, 3D printing has been used successfully to make both standard and customized hearing aid shells, dental implants, and prosthetic limbs, sometimes within 24 hours. Previously, implants had to be validated before being used clinically, which is very time-consuming. Today, 99% of hearing aids are 3D printed. 3D printed anatomical models allow surgeons to properly understand organs' internal structure.

In addition, surgical guides with a better visualization assist surgeons to plan detailed surgical procedures. As a result, it increases the clinical efficacy, lowers the surgical risk from errors, and produces better outcomes for patients. More than 70,000 surgical guide units were produced in 2013 using 3D printing.

The five stages of 3D Printing

1. The image to be printed in 3D format needs to be designed using relevant software and saved as the STL [1] file format.
2. The STL file becomes the blueprint which is used by the machine to recreate the design in physical form.
3. The STL file is then uploaded into the 3D printer and the computer changes its settings according to the output needed to be extracted.
4. The next stage involves the selection of materials where the layers of the 3D object need to be embedded.
5. Once the print work starts, the 3D printer deposits layer upon layer of material filaments over the print board to get a final 3D product.

The jobs that are emerging and opening with the development of 3D printing are in the areas of 3D design, 3D computer-aided design (CAD) modelling, research, and development (R&D), biological and scientific modelling, architecture/construction modelling, education, law and legal professions, new business opportunities, 3D-Printing-as-a-Service franchises and operations and administrative positions.

Jobs for designers who can translate a product idea into 3D printed objects will be opening in 3D printing firms, as part of 3D design teams in companies and as freelancers. Such job seekers will be most competitive if they acquire hands-on experience with the latest 3D printing technologies and stay up to date with how 3D printing is used in companies and work processes. Job seekers skilled in 3D CAD modelling will support the work of 3D designers, both for mass 3D printing and for custom designed 3D prototyping and manufacturing.

To help fill the skills gap 3D printing programmes at all grade levels need to be developed and widely offered. This will open jobs for educators who can teach the technical and business aspects of 3D printing.

Training institutions are looking to 3D printing as a point of exposure for students within the Arts as well as scientific areas of study. Teachers will need to have a background in the 3D printing industry. They will also need specific skill sets to teach specialized courses and stay current on the latest trends.

3D printing presents new business opportunities as well as new (including social) entrepreneurial models based on transforming digital data into physical objects in remote locations, independent of centralized production and industrial areas by using "printing hubs".

Skills and knowledge at the intersection of 3D printing will be in future demand.

In terms of education, jobs for educators who can teach such skills, both in respect of 3D printing itself and interdisciplinary connection and intersections with other fields and

[1] STL (an abbreviation of " stereolithography ") is a file format native to the stereolithography CAD software created by 3D Systems. STL has several backronyms such as "Standard Triangle Language" and "Standard Tessellation Language". This file format is supported by many other software packages.

subject areas, will become another emerging job opportunity. Such teachers will be needed in the Arts as well as the Sciences and stay current with the latest trends and technologies that the various industries and fields will adopt. Many legal questions related to intellectual property rights of 3D printed designs and products will emerge with the possibility of copying, modifying, and selling 3D designs that infringe on existing patents, copyrights, and brands.

3D printing fits neatly with the current trend for STEAM education (Science, technology, engineering, arts and mathematics). STEM is an interdisciplinary approach to educating children from an early age with knowledge and skills in these four key disciplines which drive much of the economic development and innovation in the modern world. By enabling students to engage with STEAM concepts from a young age, STEAM education aims to adopt a new learning approach that goes beyond the ability to remember facts and procedures. STEAM encourages people to use their creativity, critical thinking, knowledge, and skills in real-world situations.

This is a unique opportunity to give students the expertise and competencies needed for societal development and individual development.

3D printing technology will undoubtedly shape the future, so it makes sense that it should be a key component in adult education curriculum. With the introduction of more trials across adult education institutions and increased awareness that this technology exists, the education sector will undoubtedly begin to reap the many benefits of 3D printing and inspire artists, architects, and engineers in the years to come.

The main case for 3D printing in educational settings include:

- Teaching students about 3D printing, how 3D printing technology works, and its applications in real-world scenarios.
- Training the trainers in how to teach 3D printing so it can be incorporated into the curriculum.
- Improving student creativity and design skills and the use and value of new age technologies.
- Preparing the students for employment in the 3D printing industry.

The objective of this Report has been to give an understanding of 3D printing, its origins and opportunities and its potential for use.

Although there are many benefits of using 3D printing, it is important to recognise its limitations to make the most of the technology.

Having a significant understanding of the potential of what printers can and cannot do is important and result in better-informed choices and decisions and what challenges they can reliably solve.