Global Scientific JOURNALS

GSJ: Volume 10, Issue 5, May 2022, Online: ISSN 2320-9186

www.globalscientificjournal.com

3D PRINTING TECHNOLOGY: CHANGING THE MANUFACTURING INDUSTRY'S NARRATIVE.

BY:

MANGAI SAGAI BITRUS

AND

DAMLA MADOR SUNDAY

ABSTRACT

Science and technology are transforming our daily lives with ground-breaking technologies that make what was previously thought to be science fiction or inconceivable futuristic a reality, making our lives much easier and more interesting. One of these technologies is 3D Printing Technology. It is a rapidly developing technology that involves the layer-by-layer addition of material (plastic, metal, nylon, and over a hundred other materials) to create three-dimensional physical items from a geometrical representation using a computer-aided design program (CAD). Currently, this technology is revolutionizing the manufacturing industry by allowing for mass customisation and the creation of any form of open-source design. This technology has proven to be both fast and cost-effective. This paper provides an overview of the various types of 3D printing technologies, as well as their applications and contributions in the fields of agriculture, healthcare, automotive, locomotive, and aviation technology manufacturing industries, as well as the materials used and, finally, the disadvantages of this technology in the manufacturing industry.

TABLE OF CONTENTS

1.1 INTRODUCTION

3D printing Technology also referred to digital fabrication technology or additive manufacturing, is a process of making a three-dimensional solid object of virtually any shape from a digital model (Thabiso, Cephas, & Macdonald, 2012). This technology is based on the digital model file, bonding some adhesive materials together in powder form such as metals or plastics. And then through the layer-by-layer printing method, it is possible for two-dimensional data to transform into 3D materials. This is one of the best process to create any complex objects in minimum time without complex process and large machines.

3D printing technology was invented by Chuck Hull in 1984, who invented a process known as stereolithographic, in which layers are added by curing photopolymers with UV lasers. After that, in 1990, layer-by-layer technology was used, with each layer having 0.1mm depth. In 1999, this technology was first used in the medical sector to create the first parts of the human body, such as ears and fingers. In 2005, 3D printing technology became open source, allowing users, to use and research the technology more freely. In 2009, the first self-replication printer was introduced, allowing the printer to print most of its own components (Samer, Saed Makhool, & Qais, 2015).

The 3D printing technology shows the characteristics of zero-release and zero-waste, because of its various construction forms, its application is widespread around the world. In the fields of agricultural, healthcare, automotive, and aerospace, 3D printing technology is rapidly being used for mass customization and manufacture of any form of open-source design. Although much of the research is still in its early stages, experts believe that the use of 3D printing as a tool will change every sector in the future.

However, there are several drawbacks to using 3D printing technology in manufacturing industry. This include its effect in reducing the use of manufacturing labour, leading to unemployment, which will have a significant impact on the economies of countries that rely heavily on low-skill job. Also, this technology if not properly managed can be a tool in the hands of criminals, enabling them print object such as knives, guns and other dangerous items without the regulatory body's knowing. One of the challenges to also address is copyright; with the development of this technology, anybody who has a blueprint would be able to quickly

counterfeit products without the permission of the original owners (Pirjan & Petrosanu, 2013). This technology has been widely adopted in many nations, particularly in the manufacturing sector, heralding a significant advancement in the manufacturing sector.

1.2 BACKGROUND OF THE STUDY

Manufacturing industries and investors are continuously looking for new methods to reduce costs, save energy, and increase their capabilities in production. However, the traditional manufacturing technique does not allow it to be possible, due to its main subtractive manufacturing processes (CNC Machining, Injection Moulding, Plastic Forming and Plastic Joining), Which takes a longer time, as moulds are required to facilitate the process. At times, they may take up to months to prepare, costing up to thousands for a single mould. It takes 15-60 days (and sometimes more) to have the first part in hand (Asia, 2014).

The emergences of the 3D printing technology, has revolutionised the manufacturing industries in diverse ways, due to the fact that it is an additive manufacturing process which involves depositing material layer by layer on the printing bed. Lead time can be as short as a few days, while observing a significant reduction in cost as there is no need for moulds. Hence this paper focus on the overview of the 3D printing Technology, and its effect in the manufacturing industry.

1.3 SIGNIFICANT OF THE STUDY

3D printing is inexpensive prosthetics, creating spare parts, rapid prototyping, creating personalized items and 3D printing has a positive impact on the environment: it reduces manufacturing waste, lowers the carbon footprint and supports the circular economy. Because the advent of this technology has significantly changed the manufacturing industry, this paper provides an overview of 3D printing technology and its contribution to the manufacturing.

2.1 LITERATURE REVIEW

Researchers in (Rogers & N. Baricz, 2016) conducted a survey with 404 European firms from different countries, related to the 3D printing industry. They mainly focused on 3D printing as service, detailing the process of how this service works. They introduced three different categories of 3D printing services, which are generative services, facilitative services and selective services. According to their results, 3D printing is an evolving industry with many potentials for future growth during the next decade. In (Ajay et al, 2020) identify the materials used in 3D printing, with plastic being one of the most used materials. They went on to say how crucial this technology is in our daily lives.

Binding jetting, directed energy deposition, material extrusion, material jetting, powder bed fusion, sheet lamination, and vat photopolymerization are among the seven 3D printing technologies classified by Shahrubudin, Lee, and Ramlan, (2019). They also recognize the significance of this technology in the food industry, which produces healthy food by allowing consumers to change the ingredients of materials without affecting nutrients or taste.

Samer,Makhool and Qais,(2015), identified three components of a 3D printer that work together to generate the required result. They also stated the 3D printer's working principle. Zhang,Wu and Jiajun, (2016), emphasize the significance of this technology in educational military equipment, as well as analyze the issues that have arisen in the use of 3D printing in military equipment education and also provide potential solutions. Savonen et. al., (2018) developed a resilient 3D printer for humanitarian crisis response. The researchers proposed a modular machinery, with low cost, commercially available parts as a response to humanitarian situations. The machine is capable of producing vast number of orthopedic devices, therapy tools and replacement parts of medical machinery.

Our research will build on previous research on 3D printing technology, with a particular focus on the influence this technology has on the manufacturing industry and also offer a future recommendation for this technology.

2.2 MANUFACTURING PROCESS

Manufacturing is the process of transforming raw materials or parts into finished goods using tools, human labor, machinery, and chemical processes. This can be accomplished by following a set of designed procedures known as the "manufacturing process "Manufacturing processes can be broadly classified into three categories, which are carried out as a unit of operation. These include shaping, joining, and finishing processes.

The shaping processes relate to the act of taking a raw material and forming it into a finished item. It is implemented in a variety of methods such as molding, rolling, forging, and so on. Adhesive, welding, riveting, screws, and nut assembly are some of the methods used to join the various shapes cast to make a single component. Finishing is the last phase in the manufacturing process; it is the process of packaging the product so that it is ready for final consumers. One of the main goals of this process is to beautify the product. This is done by polishing, electroplating, and enameling.

For a product to be ready for use, it must go through these processes, which take time, more resources, and a lot of effort to complete. This process also has the potential to harm the environment by releasing toxic substances into the atmosphere. As a result, 3D printing is helping to change a lot in the manufacturing sector.

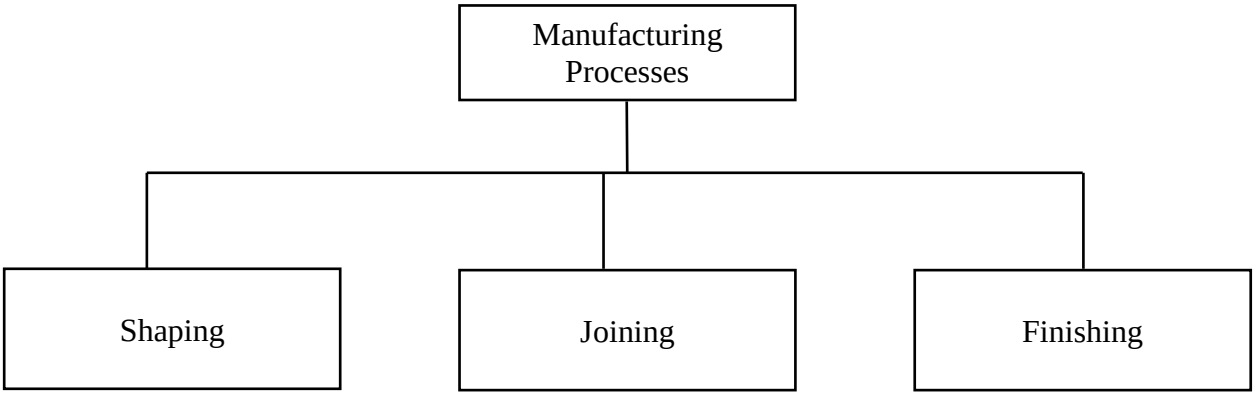

Figure 1. Manufacturing Processes

2.2.1 3D PRINTING TECHNOLOGY, WORKING PRINCIPLE

Making a model of the object you want to manufacture is the first step in 3D printing. The model design serves as a blueprint for the physical object which will be manufactured. The object to be manufactured can be prototyped on the computer from the scratch using a 3D modelling program known as CAD (Computer Aided Design) which convert 3D objects file to STL file format. There are many software's available in market which can be used for drafting and modeling also. Some of these are fusion360, Solid Works, Auto CAD etc. If, it was previously prototyped by someone else, it could be downloaded to the computer or if the part to be produced is an existing object, it can be produced after scanning, using 3D Scanner. This scanner makes a 3D digital copy of an object and puts it into a 3D modelling program.

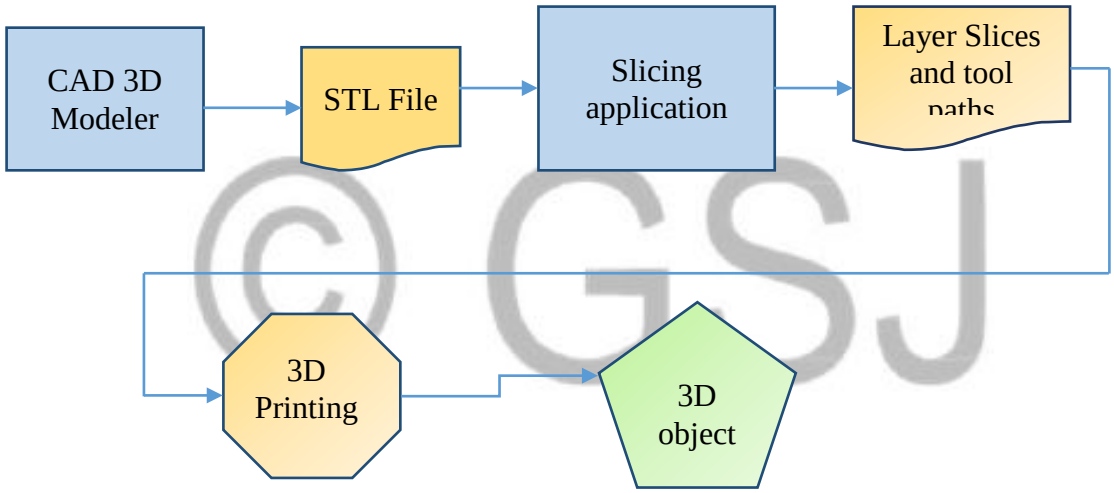

Figure 2. work-flow of 3D printing process

The model is then sliced into hundreds or thousands of horizontal layers in preparation for printing. This prepared file is thus uploaded in the 3D printer, Materials begin to heat up in the extruder, and the filament begins to melt. This melting material is deposited on the print bed as programmed in the CAD, and the object is created by depositing components layer by layer on top of one another. The layers in a horizontal, cross, or zigzag pattern, as well as in a hexagonal or honey comb structure. Because of this technology, prototyping, which takes several months using traditional manufacturing methods, may be reduced to a few days or hours, saving time and money.

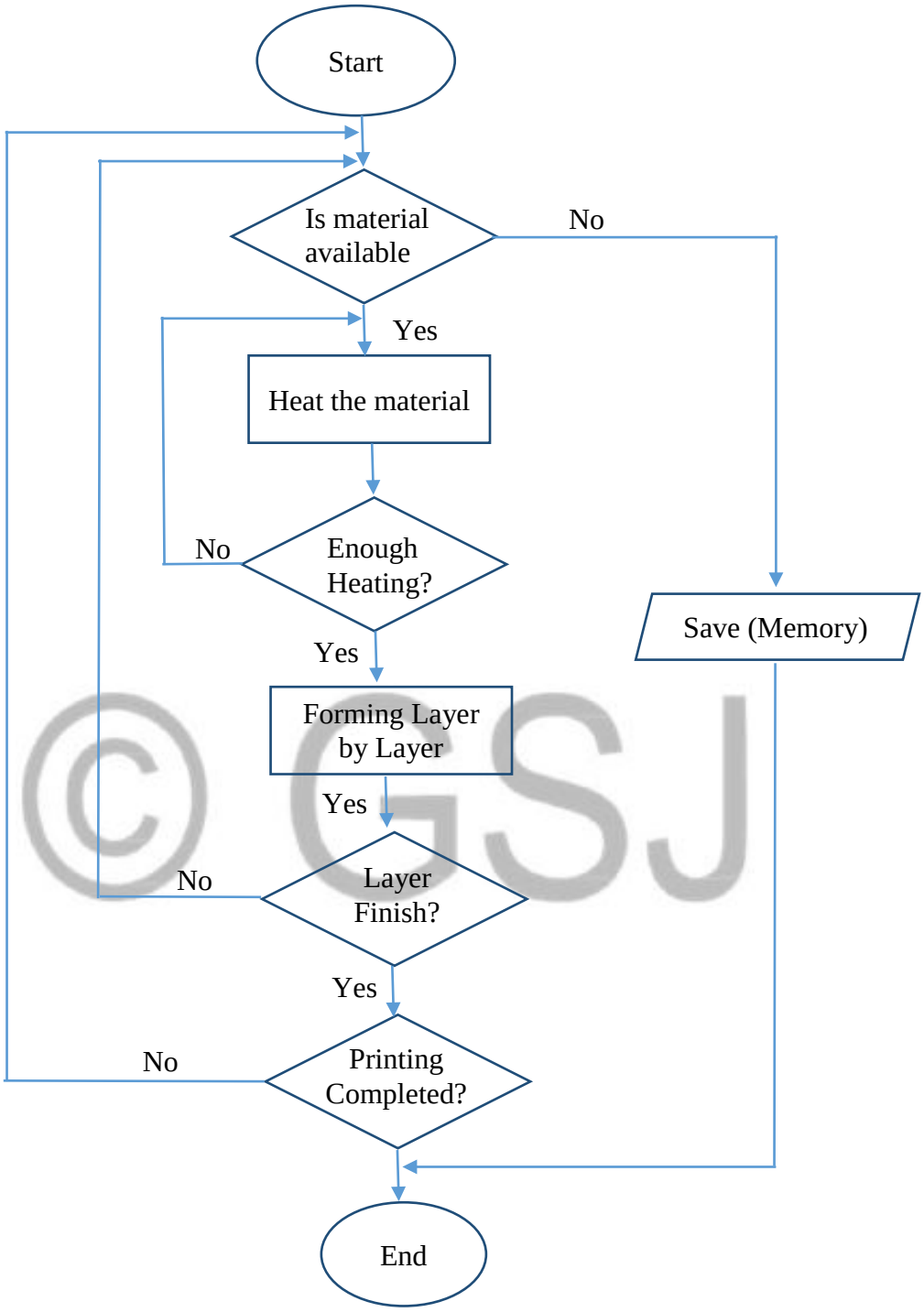

Figure 3. Flow chart of 3D printing operation

2.3 APPLICATIONS OF 3D PRINTING IN MANUFACTURING

3D printing technology has been applied in various and varied Manufacturing sectors. which include research, artistic items, visual aids, presentation models, device covers, custom parts, functional models, and patterns as well as series production.

2.3.1 AUTOMOBILE MANUFACTURING INDUSTRY

3D printing has introduced an era of rapid manufacturing. The prototyping phase is now able to be skipped and go straight to the end product. Car parts are being printed using 3D printing technology. The printing of parts is being done in a fast and efficient manner thus contributing immensely to the value chain.

In May, 2013, the first 3D-printed vehicle, the Urbee 2, was launched, paving the way for the application of 3D printing technology in the area of automotive manufacture. Ford is also championing the building of prototypes and engine parts using this technology. Adopting 3D printing technology in the automobile sector allows companies to experiment with different options and implement them early in the development process, resulting in a perfect and successful vehicle design. Furthermore, 3D printing technology has the potential to minimize material waste and consumption. In comparison to the traditional way, 3D printing technology may save production time and perform well when creating components with complicated structures. By using one-step molding technology, 3D printing may eliminate many traditional manufacturing process, that connect pieces or parts together, significantly reducing vehicle weight.

Figure 4. Urbee 2 vehicle, manufactured using 3D Printing Technology

2.3.2 FOOD INDUSTRY

Not only does 3D printing technology offer opportunities for the automobile business, but it also opens doors for the food industry. At the moment, there is a growing demand for the development of customized food for specialized dietary needs, such as athletes, children, pregnant women, and patients, who require a different amount of nutrients by reducing the amount of unnecessary ingredients and increasing the presence of healthy ingredients. Semisolid, powder, and viscous liquid types of food material may be mixed and processed into many complicated structures and shapes utilizing 3D printing technology, making it a very suitable option for giving fresh food to astronauts. Sugar, chocolate, pureed foods, and flat foods like spaghetti, pizza, and crackers may all be combined to create new food dishes with complex and attractive designs.

Food Ink, the world first food printing restaurant was launched in July 2016 in London, serving 3D-printed food with 3D-printed utensils at 3D printed tables, allowing customers print their own food. 3D printing technology is a high-energy efficiency food manufacturing technology that is environmentally friendly, has higher quality control, and is affordable in cost. Because it introduces a new procedure for food customization and can adjust to individual tastes and demands, 3D-food printing can be healthful and beneficial to humans. By allowing food preparation and ingredients to be automatically altered based on consumer input, it is also feasible to cook food without touching, hence improving hygiene standards. This technology is changing the dimensions of food in terms of taste, texture, and appearance.

Figure 5. Food Ink 3D Printing

2.3.3 HEALTHCARE AND MEDICAL INDUSTRY

3D printing technology can be used to create 3D skin, drug and pharmaceutical research, bone and cartilage, replacement tissues, organ printing, cancer research models, and models for visualization, teaching, and communication. Organ printing or body part printing is being printed and some parts being used as implants of actual body parts. Body parts such as titanium pelvic, plastic tracheal splint, titanium jaws to mention but a few have been printed. People are getting 3D printed teeth customized for the individual. Dental Implants are being made on a commercial level and making the whole process faster and more efficient.

Although most of the work is still in the experimental stage, additive manufacturing of stem cells has led to a variety of possibilities in printing artificial organs. Professor Tal Dvir, an Israeli researcher, has created the world's first 3D-printed heart made from human cells and patient-specific biological materials. The heart does not beat and is too small to be used in humans; it is approximately the size of a rabbit's heart. However, the small organ is regarded as a significant step forward in the ongoing search for new treatments for heart diseases.

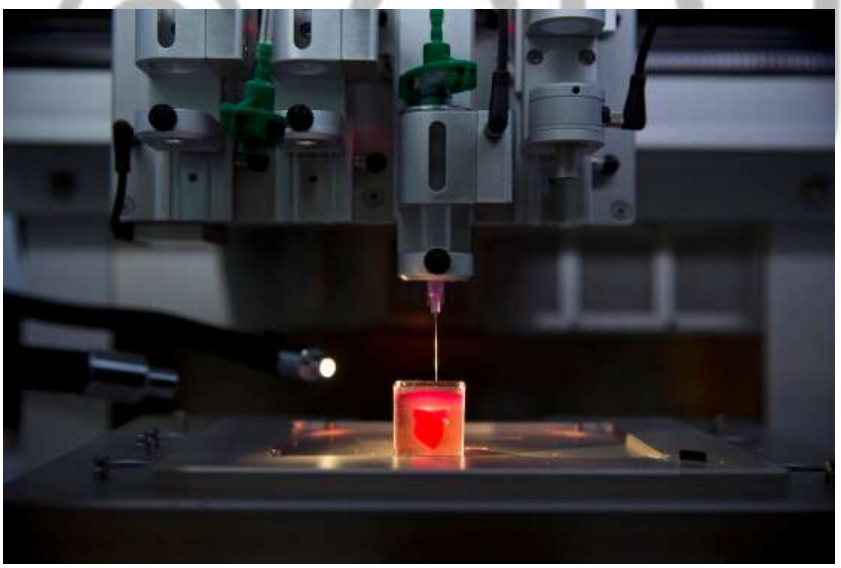

Figure 6 A 3D printer builds a heart with human tissue during a presentation at the University of Tel Aviv on April 15.

2.3.4 HOUSING AND CONSTRUCTION

Massive 3D printers are used to build a house from the ground up. In the future, this technology will be a viable alternative to the traditional technique of building. China has reported the construction of ten houses in a single day using 3D printing. The first 3D-printed house in Germany was just formally opened, and it has since been the talk of the town. This is due to the fact that the 160-square-meter structure is not only an architectural marvel, but it has also been granted the "German Innovation Award" 2021.

For building co (Yahya Bozkurt, 2021) (Yuan1, 2014) (Jatin A. Savaliya, 2021) (Tanisha Pereiraa, 2018) (Khayal, 2019) instruction, many 3D printing techniques like as Big Area Additive Manufacturing (BAAM), 3D Curve Printing, and Scaffolding are used. All of these strategies aid in the construction of buildings in order to save time and money. Using 3D printing technology in this industry, a huge number of houses for the poor may be built in a short amount of time and at a low cost. It is a quicker and more precise building approach for complicated parts, with reduced labor costs and zero waste created.

Figure 7 First 3D House in Germany

3.1 CONCLUSION

3D printing technology is playing an essential role in industrial growth. Because of its high efficiency and cheap cost, 3D printing technology has had a significant impact on traditional manufacturing, and it may be viewed as a driving force of economic and social growth. However, there are several issues with 3D printing that must be addressed, such as the lack of a guarantee of production quality, high production technology requirements, difficult personnel training and copyright issues, and so on. Although there is still a technical barrier, the technology has a bright future; 3D printing technology will usher in a new era of manufacturing. Some experts believe that these technologies will be the catalyst for a new revolution that will transform the face of the world.

REFERENCES

(n.d.). Retrieved April 09, 2022, from Special Broadcasting Service (SBS): https://www.sbs.com.au/food/article/2018/02/12/are-you-ready-eat-worlds-first-3d-printed-restaurant

Ajay, Anil Shinde, R., Patil, A., Dandekar, N., & Dhawale. (2020, July). 3D Printing Technology, Material Used For Printing and its Applications. *nternational Journal of Scientific and Engineering Research*.

Asia, A. 3. (2014). *news: traditional-manufacturing-3d-printing*. Retrieved April 06, 2022, from Additive 3D Asia: https://additive3dasia.com/

Jatin A. Savaliya, H. N. (2021, may 05). 3D Printing Technology: A Future Perspective . *International Journal of Engineering Research in Electronics and Communication Engineering (IJERECE)*.

Khayal, D. O. (2019). Review of Manufacturing Processes. *Research Gate*.

Mohammed, O. (2019, November 08). Review of Manufacturing Processes. *Research Gate*.

NBC News. (n.d.). Retrieved April 09, 2022, from https://www.nbcnews.com/mach/science/israeli-scientists-create-world-s-first-3d-printed-heart-using-ncna996031

Pirjan, A., & Petrosanu. (2013). The impact of 3D printing technology on the society and economy. *Journal of Information Systems & Operations Management,*, 1-11.

Rogers, & N. Baricz, K. P. (2016). 3D printing services: classification, supply chain implications and research agenda. *nternational Journal of Physical Distribution & Logistics Management* .

Samer, M., Saed Makhool, & Qais, S. (2015). *3D Printing Technology.* https://www.researchgate.net/publication/272789911_3D_printing?enrichId=rgreq-dcc050724333a0963690df7396ffe244-XXX&enrichSource=Y292ZXJQYWdlOzI3Mjc4OTkxMTtBUzoyMDc3Mjg1ODE1ODI4NTZAMTQyNjUzNzc2MTU3NQ%3D%3D&el=1_x_2&_esc=publicationCoverPdf.

Savonen, B., T. M., M. C., J. S., J. G., & J. P. (2018). Development of a Resilient 3-D Printer for Humanitarian Crisis Response, Technologies.

Shahrubudin, N., T. L., & R. R. (2019). An Overview on 3D Printing Technology: Technological, Materials, and Applications. *2nd International Conference on Sustainable Materials Processing and Manufacturing.*

Tanisha Pereiraa, J. V. (2018). A comparison of traditional manufacturing vs additive manufacturing, the best method for the job Manufacturing Engineering Society International Conference 2017, MESIC 2017, 28-30 June manufacturing, the best method for the job. *14th Global Congress on Manufacturing and Management (GCMM-2018).*

Thabiso, P. M., Cephas, M., & Macdonald, M. (2012). The Impact and Application of 3D Printing.

What Do We Know About the First 3D-Printed House Inaugurated in Germany? . (n.d.). Retrieved April 09, 2022, from 3D Natives: https://www.3dnatives.com/en/insights-into-germanys-first-3d-printed-house-050820214/#!

Yahya Bozkurt, E. K. (2021). 3D printing technology; methods, biomedical applications, future opportunities and trends. *journal of materials research and technology*.

Yuan1, Y. (2014). Research Status and Development Trend of 3D Printing Technology. *OP Conf. Series: Materials Science and Engineering* .

Zhang, Z., wu, X., & Jiajun, Z. (2016). Research related to application of 3D printing technique in educational military equipment. *International Conference on Advances in Management, Arts and Humanities Science.*