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A Review: History of 3D Printing

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Abstract:- However, the term 3D printing is commonly used to describe an assembling process whereby the final shape of the object results from the addition of several layers of build for the skeleton of the object. This process is better described as additive manufacturing and also referred to as rapid prototyping. After all, the term 3D printing, on the whole, is relatively new, and has been an active part of the current developments in Dentistry. Much publicity encompasses the evolution of 3D printing which is pro-claimed as an innovation that will change CAM manufacturing perpetually, including in the dental sector. This review is the first in a 3D Printing series that gives the history of 3D Printing, the technologies available, and reviews the literature regarding the accuracy of such technologies. Conclusion: The recent evolution of digital dentistry to introduce the methods has indeed revolutionized dental practice through paving. The road for CAD technology and rapid prototyping. With the advent of 3D printing, it is now possible to have 3D digital models created with an intraoral scanner that could then be easily manipulated for diagnosis, treatment planning, mockups, and countless other applications. Combining 3D Printing with a 3D intraoral scan eliminates the need for physical storage but makes it difficult to retrieve a 3D model for use within all dental modalities.

Keywords:- *3D Printing, Intraoral Scanners, Digital Dentistry, Trueness, Precision, Accuracy, History.*

I. INTRODUCTION - THE HISTORY OF 3D PRINTING TECHNOLOGIES

The term 3D printing is a more commonly used expression to denote an assembly method wherein the final shape of an object results from the layer by layer addition of various layers in producing the structure of an object. The procedure is better termed additive manufacturing is a relatively novel term and has been an active part of modern developments in Dentistry. Much publicity surrounds the history of 3D printing, billed as an innovation that will forever alter CAM manufacturing, especially in the dental industry. Actually, authorities in the medical field have been attracted by the use of 3D printing which requires precision down to millimetric distances, and they started developing this process since the 1990s. Yet, the concept of 3D printing goes even further back to the 1980s. In 1983, Charles Hull made the first three-dimensional print.

II. LITERATURE REVIEW

- *Use in Education*

Along with increased participation in both the chair side and the laboratory setting, Oberoi et al. found that a much greater number of research studies and projects carried out 3D dentistry. With this increased number of studies, 3D printing is seen as more favourable, and hence consumer confidence has also improved. Furthermore, 3D printing and the research setting have led to the addition of this technology into education too. in both postgraduate with academies such as the International Digital Dental Academy, and in an increasing number of undergraduate Universities to assist in preparing and advancing the abilities of trainees and students. By an integrated approach of research, training in dentistry and clinical treatment, it may be feasible that 3D printing and fast prototyping might offer numerous alternative scenarios for education where alternative scenarios would be looked upon with variations like porosity, design and surface texture shifted quickly and easily.

- *Use in Orthodontics*

The use of digital dentistry has transformed what once was the most complex, time-consuming procedure into something simple, effective, and relatively easy to plan through both the laboratory and, as well as chairside. 3D printing has also enabled orthodontic procedures to be speeded up in terms of adapting to sudden changes required in treatment with new intraoral scans being added to amend/refocus alignment at any stage. With the digital dentistry aspect of it, the orthodontist can severely hasten up the time for treatment at the same time that keeps storage space and material waste minimized. The future of 3D printing and orthodontics fundamentally falls into place for the direct 3D printing of orthodontic clear aligners. That development will be more efficient and less wasteful but will depend on the development of elastomeric resins that retain shape after deforming. Found the potential with a 3-D printer doing the legwork for dental labs to eradicate the manual workflow by utilizing 3D printing to enhance further their business. Conventional impression material, by far most universally used in dentistry, has been alginate for orthodontics. These replicas are used in fabricating structural orthodontic oral structures consisting of mouth guards, retainers, expanders, and space maintenance devices. However, the digital manufacturing technologies have permitted the application of 3D printing to the fabrication of dental and orthodontic appliances from 3D model designs.

III. IMPROVED PRODUCTION EFFICIENCY

However, the 3D printing technologies prove a paradigm shift that removes complex processes in traditional manufacturing by reducing energy consumption and cost of production, respectively.AM is characterized by increased capacity to manufacture a wide range of functional products on market demand more easily due to increased design flexibility. In addition, the manufacturing processes are cost-effective with reduced waste and blending unique materials to enhance the functionality of the end-product and prolong its lifespan. The technologies utilized in AM have various industrial applications among them are in healthcare, aero-space, automotive, and consumer electronic devices. In the healthcare sector, the potential of 3D printing technology in fabricating customized patient-specific implants in the needed precision and accuracy has increasingly being applied in different healthcare specialties, orthopedic, cardiology, and dentistry. Some of the examples of 3D printing technologies in healthcare are implantable bones and rib cages and heart valves. Number of assorted materials like metals, ceramics, and polymers have been processed to make several implants using 3D printing. Applications of 3D printing technologies in dentistry include maxillofacial implants, dentures, etc

A. Early Beginnings: 1980s

The roots of 3D printing go back to 1980s. In 1981, then, Dr. Hideo Kodama of Nagoya Municipal Industrial Research Institute developed the first rapid prototyping system. His method was a photopolymer resin that could be cured layer by layer by ultraviolet light. The first commercial application of SLA was by Chuck Hull-the founder of 3D Systems in the year 1984. He came up with the first commercially viable stereolithographic apparatus (SLA) at 3D Systems. Hull's invention gave a heads-up on the direct realization of solid objects from digital files, which preceded several further developments.

The most significant landmark in the history of 3D printing was the SLA process patented by Hull in 1986. The process uses UV light to solidify liquid resin, creating very detailed prototypes. It was soon bound to attract the attention of product development time reducers in all sectors, but most particularly those of the automotive and aerospace industries.

B. Growth and Commercialization: 1990s

Interest and investment in 3D printing technologies exploded within the 1990s. A technique known as Fused Deposition Modelling was introduced by Stratasys, extruding melted thermoplastic material onto the building of the object in layers. That made 3D printing more accessible and cheaper and thus applicable for far greater purposes than simply prototyping.

Shortly thereafter, in 1992, the first commercial available 3D printer, namely the SLA-250, appeared from 3D Systems, integrating with enhanced printing speed and quality. Improvements in materials and software constitute later developments that add capability to the 3D printing technology.

The first 3D printing materials were much more based on plastics. At the end of the 1990s, new materials like metals and ceramics were discovered, and the scope for usage was broadened. This decade also paved the way for the creation of standards that had to be followed in terms of 3D printing for manufacturing: it paved the way for future innovations.

C. The Rise of Open Source and DIY Movement: 2000s

It was in the early 2000s that birthed open source 3D printing, which changed the face of 3D printing. This project, initiated by Adrian Bowyer in the year 2005, was a basically a project that sought to make self-replicating 3D printers. The company used to be a democratized source of access to acquire 3D printing technology as hobbyists and entrepreneurs could build their machines and share designs online.

Another factor was the availability of the first low-cost 3D printers: available since 2009, with the MakerBot, people could start experimenting with 3D printing for themselves and small businesses. That was the scale of innovation and creativity it triggered. By this reason, the DIY community grew, as well as the available designs and applications, such as custom jewelry or even functional prototype production.

Another significant aspect of this period was the development of 3D printing service companies like Shapeways and Sculpteo that offered services where anyone could upload a design and have it printed. Service-oriented market expansion and enablement of designers to make money out of their designs are also developments during this time.

D. Mainstream Adoption: 2010s

The decade of the 2010s would be remembered fully as 3D printing penetrated into businesses by all sectors. Large corporations realized that 3D printing could become the alternative revolution for manufacturing, prototyping, and developing a product. Now, in 2013, the media was raving about it, not to mention a TED talk by one of the most respected inventors and futurists, Neil Gershenfeld.

In healthcare, 3D printing revolutionized the production of medical devices, prosthetics, and dental applications. Custom implants and surgical models became more accessible, improving patient outcomes. The ability to create tailored solutions for individuals marked a significant advancement in medical technology.

The aerospace and automotive industries, too, began embracing 3D printing in the fabrication of complex and lightweight parts. For instance, Boeing and General Electric invested so much in additive manufacturing that produce stronger yet efficiency parts.

In 2015, the first 3D-printed drug was approved by the U.S. Food and Drug Administration and marked a landmark in the pharmaceutical industry. The potential of this technology opens up avenues for the possibility of changing the way drugs are produced because 3D printing will allow diverse dosages and formulations.

E. Innovation and Expansion: Late 2010s to Present

The decade was 3D printing's expansion of capabilities. New materials started to be integrated- metals, ceramics, and bio-inks in bioprinting, further broadening the potential of the technology. Big industries began researching 3D printing to create massive volumes on a different scale.

Through the latter part of the 2010s, funding for early-stage 3D printing startups as well as incumbent companies increased multifariously. Heavy players like HP and Siemens jumped into the realm of 3D printing. This brought more legitimacy to the technology, calling it a hot area in modern manufacturing.

In addition, software solutions and AI introduction evolve continuously to make design and production processes simpler and easier. This will allow doing iterations faster and of higher quality. "Industry 4.0" refers to the digital enhancement of modern manufacturing and includes 3D printing as one of its core components.

The pharmacy sector increasingly is being explored for 3D printing technology, offering innovative solutions in drug formulation, personalized medicine, and production processes. Some of the key applications include these among others;

- *Personalized Medicine:*

This is possible through 3D printing: A customized dosage of drugs can be formulated according to individual patients' needs. This could be quite useful, especially to patients with special needs, for example, those who have chronic illnesses or allergies.

- *Complex Formulations in Drug File:*

By using the technology, complicated geometries and structures could now be produced that standard manufacturing methods cannot. This encompasses multi-layered tablets or capsules with dispersed release profiles to enhance their therapeutic effectiveness.

- *Rapid Prototyping:*

With three-dimensional printing, it is possible to rapidly prototype drug formulations and delivery systems. Researchers can quickly create and test new forms, which accelerates the development of drugs.

- *Lower Cost Production:*

For small-scale production or niche drugs, 3D printing will cut the costs associated with traditional production, thus making it economically feasible to manufacture drugs that would not economically be worthwhile for commercial manufacture.

- *Educational Material:*

Use 3D printed drugs and human anatomy in the teaching environment within pharmacy school and on-the-job training for further clarification of pharmacology and interactions between drugs.

- *Supply Chain Flexibility:*

Decentralized production through 3D printing will allow pharmacies to print many medicines at those locations. However, noticing drug shortages and enabling nearly zero-waste production will need to be manufactured when needed.

- *Innovative Drug Delivery Systems*

Researchers are planning to use 3D printed devices for target drug delivery, thereby maximizing how medications are administered and absorbed.

This means that pharmacy, with the medicine development and delivery face to result in a more personalized and effective health solution.

IV. BENEFITS OF 3D PRINTING

There are plenty of benefits from 3D printing

A. Degrees of Customization:

The ability to make customized products for particular needs is a game changer in most industries.

B. Rapid Prototyping:

Designers can rapidly create prototypes, which facilitate iterative testing and speed to market for new products.

C. Reduced Waste:

Unlike traditional methods of subtractive manufacturing, which cut away material, 3D printing adds material only where necessary.

D. Cost-Effectiveness:

With low-volume production runs, 3D printing is more cost-effective as compared to the more traditional modes of manufacturing since it eliminates all expensive molds and tooling.

V. CHALLENGES IN 3D PRINTING

With many advantages, 3D printing still has certain disadvantages:

A. Material Limitations:

The speed at which printable materials are increasing; in many applications, materials are needed that are not printable easily or yet available in forms amenable to printing.

B. Regulatory Barriers

Sectors like healthcare and aerospace are forced to undergo considerable testing and certification, which, under necessary and strict regulations, is difficult to establish by 3D printing for critical parts.

Additionally, ease of designs replication brings along issues of counterfeit and infringement of intellectual property rights.

C. Technical Expertise:

Availability of specific knowledge in using the 3D printing technology may become a hindrance to smaller companies or companies that have no access to training.

VI. FUTURE TRENDS

A. The future of 3D Printing seems Bright, with Quite a Few Trends Shaping its Evolution:

- *Bio-printing*

As research advances, the potential for printing living tissues and organs could revolutionize transplants and regenerative medicine.

- *Sustainability:*

As concerns about the environment grow, incorporating recycled materials and sustainable practises in 3D printing will become increasingly more prevalent.

- *Industry 4.0:*

The alignment of 3D printing with the Internet of Things (IoT) and artificial intelligence (AI) will provide a smart evolution of manufacturing that will look at optimizing production efficiency and quality.

- *Mass Customization:*

The trend for personalization continues, using 3D printing as a means for businesses to embrace consumer demand for unique and cust End.

B. Future Perspectives

Future development of 3D printing has so many promising trends that are shaping it. For instance bioprinting can revolutionize healthcare by actually designing functional tissues and eventually organs.

In construction, 3D printing techniques are being explored for building homes and structures, presenting solutions to housing shortages and reducing waste generated in the construction process.

Sustainability is another important factor, as there is continued research in biodegradable materials and the advent of more energy-efficient printing processes. As environmental awareness continues to advance, 3D printing's ability to minimize waste and use recycled materials will prove important in the industry's future.

VII. CONCLUSION

From the 1980s to the present day and the current status of being a transformative technology, 3D printing has undergone great changes. A continuous cycle of innovation, collaboration, and adaptation across various sections characterises its journey. As we look ahead, the on - going advancements in 3D printing promise to reshape industries, redefine manufacturing processes, and enhance our ability to create customized solutions. The overall potential of the technology is immense, and it is a crucial element in the future of design, production, and sustainability.

REFERENCES

[1]. Dawood, A., Marti Marti, B., Sauret-Jackson, V., & Darwood, A. (2015). 3D printing in dentistry. Br Dent. J, 219(11), 521-529. doi: 10.1038/sj.bdj.2015.914.
[2]. Zaharia, C., Gabor, A. G., Gavrilovici, A., Stan, A. T., Idorasi, L., Sinescu, C., & Negru?iu, M. L. (2017). Digital dentistry-3Dprinting applications. Journal of Interdisciplinary Medicine, 2(1), 50-53.
[3]. Oberoi, G., Nitsch, S., Edelmayer, M., Janji?, K., Müller, A. S., & Agis, H. (2018). 3D Printing Encompassing the Facets of Dentistry. Frontiers in bioengineering and biotechnology, 6, 172. doi:10.3389/fbioe.2018.00172.
[4]. Brown, G. B., Currier, G. F., Kadioglu, O., & Kierl, J. P. (2018). Accuracy of 3-dimensional printed dental models reconstructed from digital intraoral impressions. Am J Orthod Dentofacial Orthop, 154(5), 733-739. doi: 10.1016/j.ajodo.2018.06.009.
[5]. Prasad, S., Kader, N. A., Sujatha, G., Raj, T., & Patil, S. (2018). 3D printing in dentistry. Journal Of 3D Printing In Medicine, 2(3).doi: 10.2217/3dp-2018-0012.
[6]. Choi, J. W., & Kim, N. (2015). Clinical application of three-dimensional printing technology in craniofacial plastic surgery. Archives of plastic surgery, 42(3), 267.
[7]. Apparatus for production of three-dimensional objects by stereolithography, August 1984. Show in Context Google Scholar
[8]. Layer-by-layer: the evolution of 3D Printing", IEEE member Charles Hull invented the original process in 1983 IEEE Spectrum, vol. 14, Nov. 2014. Show in Context Google Scholar

[9]. Apparatus and method for forming an integral object from laminations, 1988. Show in Context Google Scholar
[10]. Method and apparatus for producing parts by selective sintering, 1989. Show in Context Google Scholar 11. Three-dimensional printing techniques, December 1989. Show in Context Google Scholar
[11]. Apparatus and method for creating three-dimensional objects (A system and a method for building three dimensional objects in a layer-by-layer manner via Fused Deposition Modeling), June 1992. Show in Context Google Scholar
[12]. A Bowyer, The Self-replicating 3D printer - Manufacturing for the Masses in Eight National Conference on Rapid Design Prototyping and Manufacture, 2007. Show in Context Google Scholar
[13]. E. Malone and H Lipson, "Fab@Home: the Personal Desktop Fabricator Kit", Proc. of the 17th Solid Freeform Fabrication Symposium, Aug. 2006. Show in Context Google Scholar
[14]. E.A. Von Hippel, Democratizing innovation, Cambridge, MA:MIT Press, April 2005. Show in Context Google Scholar
[15]. N.A. Geshenfeld, Fab: the coming revolution on your desktop -from personal computers to personal fabrication, New York:Basic Books, 2005. Show in Context Google Scholar
[16]. E. Rogers, The diffusion of Innovation, New York:The Free Press, 2003. Show in Context Google Scholar
[17]. Print me a Stradivarius", How a new manufacturing technology will change the world The Economist, February 2011. Show in Context Google Scholar
[18]. B. Obama, Address on the State of the Union, January 2013. Show in Context Google Scholar
[19]. Surgeon creates pelvis using 3D printer. Telegraph.http://www.telegraph.co.uk/health/1062755 6/Surgeon creates-pelvis-using-3D-printer.html (cited June 2014). Google Scholar
[20]. Patient has 3D-printed hip replacement in Southampton. BBC News. http://www.bbc.co.uk/news/uk england-hampshire-27436039 (cited June 2014). Google Scholar
[21]. Woman gets artificial jawbone transplant. NHS Choices. pring-jawbone-implant-created.aspx (cited June 2014).Go to Citation. Google Scholar
[22]. Take a look at the first successfully transplanted, 3D-printed skull. io9. http://io9.com/take-a-look-at-the first -successfully-transplanted-3d-1553869043 (cited June 2014).Go to Citation. Google Scholar
[23]. Bioengineer: the heart is one of the easiest organs to bioprint, we'll do it in a decade. Cardiovascular Innovation Institute. http://cv2i.org/bioengineer-heart-one-easiest-organs-bioprint-well-decade/ (cited June 2014).
[24]. 3D Printing: What You Need to Know". PCMag.com. Archived from the original on 18 October 2013. Retrieved 30 October 2013
[25]. Lam, Hugo K.S.; Ding, Li; Cheng, T.C.E.; Zhou, Honggeng (1 January 2019). "The impact of 3D printing implementation on stock returns: A contingent dynamic capabilities perspective". International Journal of Operations & Production Management. 39 (6/7/8): 935-961. doi:10.1108/IJOPM-01-2019-0075. ISSN 0144-3577. S2CID 211386031.
[26]. 3D Printing: All You Need To Know". explainedideas.com. Archived from the original on 20 August 2022. Retrieved 11 August 2022.
[27]. Most used 3D printing technologies 2017-2018 | Statistic". Statista. Archived from the original on 2 March 2019. Retrieved 2 December 2018.
[28]. Google Ngram Viewer". books.google.com. Archived from the original on 6 July 2024. Retrieved 23 August 2019.
[29]. About - RepRap". reprap.org. Archived from the original on 27 December 2023. Retrieved 27 November 2023.
[30]. Moussion, Alexandre (2014). "Interview d'Alain Le Méhauté, l'un des pères de l'impression (Interview of Alain Le Mehaute, one of the 3D printinf technologies fathers) 3D". Primante 3D.