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3D printing and tomorrow

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Abstract
Some say that we are witnessing the fastest progression in terms of technology the world has ever seen. It took around six thousand years for man to make a motorized vehicle since the invention of the wheel and within a century after that, we have already taken it to other planets. Gone are the days when inventions such as steam engines and light bulbs used to transform our lives. This is the time of evolution, when each new invention, innovation and discovery is driving us towards a more efficient future. One such example that has emerged as an evolutionary technology, one which promises to change our lives with its efficiency, speed and applications, is 3D Printing. This paper is an attempt to answer what 3D printing really means for us.

Keywords: 3D printing, fastest progression, technology

1. Introduction
Additive manufacturing or 3D Printing is a process to make three-dimensional objects using a digital model. This is achieved by dividing the digital model into thousands of two-dimensional 'slices' where each slice is a cross-section of the object, and then feeding this information to the 3D-Printer in the required format. The printer further processes this data and prints the object in three-dimension by adding the two-dimensional layers one by one.
To print an object in 3D, one has to start by creating a digital model of it. Now there are two techniques that can be employed to create a digital model. One is by using Computer Aided Design to create the model and the second one is by scanning any existing object using 3D scanners.

2. History
Charles Hull invented 3D printing, which he called "stereolithography," in the early 1980s. Hull, who has a bachelor's degree in engineering physics, was working on making plastic objects from photopolymers at the company Ultra Violet Products in California. Stereolithography uses a stl file format to interpret the data in a CAD file, allowing these instructions to be communicated electronically to the 3D printer. Along with shape, the instructions in the. stl file may also include information such as the color, texture, and thickness of the object to be printed.
Hull later founded the company 3D Systems, which developed the first 3D printer, called a "stereolithography apparatus." In 1988, 3D Systems introduced the first commercially available 3D printer, the SLA-250. Many other companies have since developed 3D printers for commercial applications, such as DTM Corporation, Z Corporation, Solidscape, and Objet Geometries. Hull's work, as well as advances made by other researchers, has revolutionized manufacturing, and is poised to do the same in many other fields [1].

3. Advantages
Benefits of 3D printed are numerous ranging from ease of prototyping to the more efficient way of production. Here are some advantaged as how this technology will help us in the long run.

(i) Time-to-Market: 3D printing allows ideas to develop faster than ever. Being able to 3D print a concept the same day it was designed shrinks a development process from what might have been months to a matter of days, helping companies stay one step ahead of the competition.

(ii) Save Money: Prototyping injection mould tools and production runs are expensive investments. The 3D printing process allows the creation of parts and/or tools through additive manufacturing at rates much lower than traditional machining.

(iii) Mitigate Risk: Being able to verify a design before investing in an expensive moulding tool is worth its weight in 3D printed plastic, and then some. Printing a production-ready prototype builds confidence before making these large investments. It is far cheaper to 3D print a test prototype then to redesign or alter an existing mould.

(iv) Clear Communication: Describing the product you are going to deliver is often misinterpreted since it leaves construction up to the imagination. A conceptual picture of the product is better than the description since it is worth 1,000 words, but getting to hold the tangible product-to-be, in hand, clears all lines of communication. There is no ambiguity when holding the exact, or at least a very close, representation of the product.

(v) Feedback: With a prototype you can test the market by unveiling it at a trade-show, showing it to potential buyers or investors, or raising capital by pre-selling on Indiegogo or Kickstarter. Getting buyer's response to the product before it actually goes into production is a valuable way to verify the product has market potential.

(vi) Get the Feel: One thing you can't get from a picture or virtual prototype on the computer screen is the way

something feels in your hand. If you want to ensure the ergonomics and fit of a product are just right, you must actually hold it, use it and test it.

(vii) Personalize It: With standard mass-production, all parts come off the assembly line or out of the mould the same. With 3D printing, one can personalize, customize and tweak a part to uniquely fit their needs, which allows for custom fits in the medical and dental industries and helps set people apart in the fashion and jewellery world.

(viii) Build your Imagination: In the modern boom of digital art and design, the possibilities are not only accelerating but limitless. One can now 3D print almost anything they imagine after drawing it up virtually. In a relatively short time, an idea, concept, dream or invention can go from a simple thought to a produced part that you can hold.

(ix) Flexibility in Design geometry: The limitations of standard machining have constrained product design for years. With the improvements in additive manufacturing, now the possibilities are endless. Geometry that has been historically difficult or impossible to build; like holes that change direction, unrealistic overhangs, or square interior cavities, is now possible and actually simple to construct.

(x) Fail Fast, Fail Cheap: Being able to test ideas quickly and discover what doesn't work accelerates discovery leading to an ideal solution. 3D printing allows a product developer to make breakthroughs at early stages that are relatively inexpensive leading to better products and less expensive dead-ends [2].

4. Groundbreaking disruptions

The technology of Additive Manufacturing is getting adopted in the industry pretty quickly. Below are the examples of some giants from different industrial backgrounds, who have adopted and implemented 3D-Printing in the manufacturing of their products.

4.1. General Electric

General Electric made big investments in 3D printing in their quest to produce more than 85,000 fuel nozzles for the new Leap jet engines. The printers can make the nozzles in one metal piece and the finished product is stronger and lighter than the ones made in the traditional assembly line. However, the 3D printers currently on the market can't produce the nozzles fast enough. GE's business development leader, Greg Morris, joined the company last year when it acquired his 3D company, Morris Technologies, so the company wants to expand its 3D printing staff as well as the production of the nozzles and other equipment using 3D printers. They already have more than 300 3D printers and GE Aviation wants to produce 100,000 additive parts by 2020.

4.2. Boeing

The airline company was one of the early adopters of 3D printing technology and has made more than 20,000 3D printed parts for 10 different military and commercial planes. The 787 Dreamliner has 30 3D printed parts, including air ducts and hinges, which is a record for the industry. Using Stratasys 3D printers, the company also printed an entire cabin. The company also supports additive manufacturing programs at the University of Sheffield and University of Nottingham in the UK, where there is research for aerospace and other manufacturing sectors using 3D printing technology.

4.3. Ford

Ford made engine covers for the 2015 Ford Mustang with 3D printers. The auto company has been using 3D printing technology since the 1980s and recently printed its 500,000th part with a 3D printer, which was an engine cover for the new Ford Mustang. According to Ford's website, traditional methods would take four months and $500,000, but with 3D printing, the same process takes four days and $3,000.

Ford also teamed with 3D Systems Sugar Lab around Valentine's Day this year to 3D print an edible 2015 Mustang model, made from chocolate and sugar. The company plans to work with 3D printers in the near future, using sand printing and direct metal printing.

4.4. Nike

Nike reported 13% growth for its latest quarter. CEO Mark Parker has previously stated that 3D printing technology has been a big boost for the company recently. Nike made 3D printed cleats for the 2014 Super Bowl. The Nike Vapor Laser Talon has a 3D printed plate and cleats made from selective laser sintering technology, and the Vapor Carbon Elite also has parts produced with a 3D printer. The Nike Vapor Laser Talon, which weighs 5.6 ounces, was designed for football players running the 40-yard dash on football turf. The company indicated that it has plans to extend its use of 3D printing in future products, but hasn't revealed details.

4.5. American Pearl

Can't decide on an engagement ring? With American Pearl Jewelry Company, customers can create a unique piece of jewellery by choosing specific metals, gems, or diamonds, ordering them online, and then 3D printing them. There are eight metal options to choose from, such as platinum or rose gold, as well as an array of diamonds and other gems like sapphires and emeralds. Then, American Pearl's CAD software makes a digital file of the custom jewellery, which is turned into a 3D printed thermoplastic wax mould via a Solidscape T-76 3D Printer. The metal is poured into the mould, the gems are added, and the piece ships within a few days. However, the service is quite expensive — the company is making jewellery that costs hundreds of thousands of dollars.

4.6. DIY Rockets

Last year, DIY Rockets, a global space company that was created to lower the cost of space exploration using crowdsourcing, launched a competition for people to develop 3D printed rocket motors using Sunglass cloud-based design platform. The only rules were that the designs had to be open source and the participants had to present a business case. The winner for the best rocket engine, announced in July, was Team Stratodyne, which won a $5,000 prize. The design will be created with the help of Shapeways, the world's biggest 3D printing marketplace.

4.7. Hasbro
Hasbro recently announced a partnership with 3D Systems, the company that first commercialized 3D printing, to develop and commercialize 3D printers later this year for children's toys and games. Hasbro has a range of children's franchises that may be featured for 3D printing, including My Little Pony, Playskool, and Sesame Street.
"We believe 3D printing offers endless potential to bring incredible new play experiences for kids, and we're excited to work with 3D Systems, a recognized industry leader in this space," Hasbro President and CEO Brian Goldner said in the press release about the announcement in February.

4.8. Hershey's
Hershey's has partnered with 3D Systems to make a special 3D printer for making chocolate. 3D Systems has also partnered with Hershey's to make a 3D printer for chocolate and other edible products. The 3D printing company said this partnership is a good way to show how the technology can be mainstream, though there is no word when the chocolate-making machine may be available. The ability to 3D print food is nothing new, as 3D systems have shown with its Sugar Lab, where the company prints icing and other sugary confections.

4.9. Makie Lab
Design your own Makie doll with MakieLab, which 3D prints 10-inch flexible fashion dolls from thermoplastic. Customers can choose all of the features of the doll: face, eyes, jaw, smile, hair, and more. They are made in the London headquarters and shipped around the world. The company markets the product as environmentally friendly not only because of its custom printing that produces less waste but also because the packaging is made from recyclable materials. MakieLab prints other games and toys, though the doll is still its most popular product.

4.10. Matter.io
A team of MIT and Cornell engineers created Matter.io, a company that is attempting to capitalize on the vast world of 3D printing designs on the web by making it easier to make, download, and share designs. The idea came from the founders' realization that CAD files, which are used with every 3D printer, are made for engineers to understand, rather than the average person. The Matter founders wanted to change that by making it easy to embed the files into websites so users can download and customize the designs before sending them off to Shapeways to print or print them at home. The bottom line? Matter wants to make 3D printers easier to use so they will be more quickly accepted by the average consumer. [3]

5. 3D Printing: A Boon for Medicine
Kaiba Gionfriddo was born prematurely in 2011. After 8 months, his lung development caused concerns, although he was sent home with his parents as his breathing was normal. Six weeks later, Kaiba stopped breathing and turned blue. He was diagnosed with tracheobronchomalacia, a long Latin word that means that his windpipe was so weak that it collapsed. He had a tracheostomy and was put on a ventilator – the conventional treatment. Still, Kaiba would stop breathing almost daily. His heart would stop, too. Then, his caregivers 3D printed a bioresorbable device that instantly helped Kaiba breathe. This case is considered a prime example of how customized 3D printing is transforming healthcare as we know it.
Since Kaiba's story, 3D printing in medicine has been skyrocketing. And the list of objects that have already been successfully printed in this field demonstrates the potential that this technology holds for healthcare in the near future. [4]
Medical practitioners have now begun using 3-D printers to produce medical devices. Examples of medical 3-D printing successes include the creation of plastic tracheal splints and limb prosthetics as well as titanium replacements for jaws and hips.
3-D printing represents a shift in the medical manufacturing industry because the relatively low cost and small size of printers promises to make the technology widely accessible, allowing doctors and researchers to create personalized devices for patients. A physician whose patient experiences pain or has developed an infection from a non-customized prosthetic can now use imaging technology and a 3-D printer to customize a new prosthetic that conforms to the specific shape and movements of the patient's body.
A related area of 3-D printing called bio printing, involves printing human tissue and organs by layering living cells instead of plastic or titanium. While bio printing remains in the experimental phase, the ability to print human tissue could have a huge impact on such things as pharmaceutical research, transplants, surgical operations and reconstructive surgery. [5]

6. Limitations
Limitation in this technology comes in the form of Materials. Those developing materials to be utilized for 3D printing must take into account variety, composition, strength, and finishing procedures in order to increase the versatility of the technology. Currently, the variety of materials is limited to the ability of the materials to be powder-based or have low enough viscosities to be extruded from the printing head. Many manufacturers require proprietary materials to be used in their 3D printers or risk forfeiting the warranty. This scenario has limited the material pool, and thus, for 3D printing to continue to grow, the quantity and diversity of materials must increase. Research for the development of 3D printing materials has a plethora of opportunities. Including synthesis and discovery of new or mixed material compositions that are amenable to printing techniques, new methods of printing to increase speed while simultaneously reaching higher resolutions, and materials on par with the strengths of materials machined by conventional methods. Another area of growth centres on the need for post-print processing. More efficient ways to remove support material will prove beneficial, specifically in microfluidics, by allowing smaller details and features, such as channels, to be printed and subsequently cleared of support material. The development of a chemical polish for clear materials would be advantageous for developing optically transparent devices, especially for designs with areas that are difficult to access by conventional polishing methods. [6]

7. Current Scenario
This technology can be compared to the personal computers in its nascent stages. Additive manufacturing is perhaps at the

point of the earliest development of personal computers or at the beginnings of the Internet and World Wide Web. In those previous cases, there was little if any sense of the game-changing impact and ubiquity of these emerging technologies fifteen to twenty years in the future. But the Internet and PC examples enable us to foresee a significant potential for this new technology, even if only rough outlines of that disruptive future can be sketched at this point. AM could prove to have as profound an impact on the manufacturing world as the PC and the Internet in the information world. It could also provide a step forward in environmental protection and resource productivity [7].

8. Final Words

As discussed earlier, 3D-Printing or Additive Manufacturing technology is in a nascent stage of its evolution. There are certain limitations in its use of materials. Still, many companies have successfully adopted it in manufacturing their products or parts of their products. The scope of application of this method of manufacturing is immense and we are currently witnessing just the tip of the iceberg. Times are not far when whole buildings will be printed in a matter of days and we will be able to customise almost every product that we buy, according to our use and personal needs. Practitioners in healthcare have already started innovating in this field and using the findings to provide better treatment and cases as that of Kaiba Gionfriddo only confirm the success in this area. With all this enthusiasm and positive developments, all can be said is that we have begun on a road to a better future, a 3D Printed future.

9. References

1. Gross B, Erkal J, Lockwood Y. Evaluation of 3D printing and its potential impact on biotechnology and the chemical sciences. Anal Chem. 2014; 86(7):3240-3253.
2. Yakos D. http://salient-tech.com/3d-printing-technology-for-the-future/top-10-benefits-of-3d-printing/
3. Gilpin L. 2014. http://www.techrepublic.com/article/3d-printing-10-companies-using-it-in-ground-breaking-ways/
4. Meskó M. 2015. https://3dprintingindustry.com/news/12-things-we-can-3d-print-in-medicine-right-now-42867/
5. Margaret Rouse, Laura Aberle. 2015. http://searchmanufacturingerp.techtarget.com/definition/medical-3-D-printing
6. Bethany C, Gross Jayda L, Erkal Sarah Y, Lockwood Chengpeng C, Dana M. Evaluation of 3D Printing and Its Potential Impact on Biotechnology and the Chemical Sciences' ACS Publications. 2014.
7. Campbell T, Williams C, Ivanova O, Garret B. Could 3D Printing Change the World?
8. Technologies, Potential, and Implications of Additive Manufacturing, 2011.