The Impact of 3-D Printing on Society

Leonel M Cabrera

IT 104-004

02/24/16

George Mason University

Introduction

Imagine you could design and make prosthetic arms, specialized cars and even live-in castles with a single device. Do not think it is possible? The reality of today is that with the ever approaching wave of technological advancement, these outcomes and much more are breaking into the world to provide potentially final solutions to the ever present, biggest problems, such as world hunger, poverty, disease and lack of industrial and agricultural resources. Enter the 3-D printer, a device, whose closest relative is the ink printer, but instead of feeding it ink to print out text paper documents, it is fed plastic, metal wire materials to produce any physical object in one's imagination. This paper will discuss the technology of 3-D printing at depth, with an overview of its past, present and future, as well as the positive and negative implications it could have on society. Just as with all technology, if it is used wisely, it has the potential to make a better world than before.

Background

The first 3-D printer was started by Hideo Kodama back in 1981; he used the technique called "additive manufacturing," a sequential layer by layer process starting out in the digital stage/modeling where an identical virtual image to the physical product is made to the printing stage that have fusions of layers setting the foundation for the final object to, finally the finished product stage (Pirjan, Petrosanu 2013). In other words, the "additive" part in the making of a product means that the desired product is created out of many complex component parts that tie together to form the end final stage. Whereas, the opposite, "subtractive" manufacturing entails forming a final product out of a predetermined material, akin to carving a sculpture out of raw clay. It is interesting to note that these two processes are almost identical to the biological process found in nature consisting of anabolism and catabolism. In anabolism, several tiny

proteins form together to form giant amino acid chains, while in catabolism, the amino acid chains reduce to single components. It looks like we took this natural principle and applied it to technology.

Potential Benefits

The benefits that this new technology is going to give us are very diverse and far-reaching. With the printers becoming more affordable and mass produced every year, poor sectors in developing countries could soon be able to get one. With a 3-D printer, they would be able to print out farming equipment parts, makeshift house parts and even solar panels (Bass, 2011). That alone would help immensely the people who rely on agriculture as their primary means of income and free up more of their time to invest in setting up businesses and sending their children to school. However, the printer not could have its impact on the far away farmlands, but also closer to home, with doctors and medical engineers already devising printable 3-D organs, a practice known as bio-printing. The bio-print process consists of 6 steps starting with the initial imaging of either an X-ray, CT or MRI of the part of choice and progressing to the design, material/cell selection, bio-printing and application stages (Murphy and Atala, 2014). This practice of 3-D organ printing would especially benefit patients who are waiting for a kidney or a pancreatic transplant. The printer could also altogether change the painful skin grafting process in which skin is outright removed from burn victims to graft new skin; in this case, the printer could just make new layers of skin on top of the burned skin to alleviate the patient of much discomfort (Mukherjee, 2013). The impact this technology is making cannot be slighted, mainstream industries such as the agricultural and medical industries examined above as well as single individuals are already creating solid concept-stage plans to make use of the printer. For instance, researcher Roy Ombatti from Stanford University is pondering a plan to create 3-D

printed medical shoes that protect against the poor of jiggers, a parasitic flea that eats the flesh of the toe and lays eggs inside (2014). If that were not enough, company Local Motors 3-D printed an ABS plastic and carbon fibered external frame of a car, while the Winsun Decoration Design Chinese company literally printed 10 houses in a single day at a cost of $5,000 each out of high-grade cement and glass material (Diamandis, 2015).

Legal and Ethical Issues

Just as with the piracy issue in regards to downloading illegal content such as videos, music, and books, there is also the concern for that to extend over to the 3-D printing industry. Illegal product prints could put at risk the intellectual property of its owner, and enable the user to profit unfairly from a product that is copyright protected. Another issue has to do with liability; predicting from past human behavior, there is little doubt that as the technology becomes ever more affordable, certain people will try to produce novel drugs, guns etc that could prove to be potentially hazardous in how reactive and volatile they are. If the user get injured, who would be liable for the injury, himself or the company that manufactured the 3-D printer? (Coraggio, 2015). A most pressing issue would be that some 3-D printed replicas could contain personal information that third parties would then use to change their treatment to a customer, for instance the printing of 3-D organs (Coraggio, 2015).

Security Concerns

Each technology that is newly made has its major positives and drawbacks, and with 3-D printing it is no different. Security issues concerning anyone who is considering purchasing a printer include unhealthy air emissions, which are similar in number to the particles emitted when smoking a cigarette, the printer's reliance on plastic, especially ABS plastic that is not biodegradable and ends up unused in landfills, gun control safety, where current laws have not

yet been established in preventing users from obtaining a permit authorizing 3-D printed firearms, 3-D printed drugs that could encourage the drug cartel industry to increase its output, questionable safety of printed silverware and several other issues.

Social Problems

With all the benefits of 3-D printing, it is easy to look away from the number of unanswered social issues it can cause. According to Gages, the machine is slow in producing a lot of a single part, where manufacturing using injection molding would be much more cost-smart (2015). Not only that, but it is also expensive to make. Generally, with the advent of each new technology, certain biases tend to surface; these include favoring the sector that is rich in finances to be able to afford it, favoring the sector that is educated enough to be able to competently and safely operate the machine (in this case, the 3-D printer) and the fact of bringing down labor-intensive jobs, such as blue collar occupations (Roubini, 2015). These changes, if not properly assessed cold have the result of only affecting the wealthy population of the world, unfairly distributing the 3-D printing resources without prioritizing the benefit of the poor first. To use this technology, the poor sector needs to be educated in the use and practice of this technology for it to benefit all.

Further Required Research

By this point, the technology of 3-D printing has made a strong case for its integration in masse to most companies' inventories, however as with any technology, one should look at the "difficult" questions first, as in does my company even need this technology at this time? What impact and what specific goals do I hope to accomplish purchasing this piece of equipment? Is there an even cheaper and faster way to get more product that does not require the 3-D printer? These questions are philosophical in nature, but form the basis of any company's mission, and it

is necessary to understand that the 3-D printing technology is still in its neonate stage and it is limited in the range of products it can create (Vasquez, 2015). Furthermore, before jumping on to the new technological wave, it would be advisable to look at the advantages and disadvantages of 3-D printing versus current manufacturing technologies, say CNC machining in subtractive manufacturing. Currently, it makes much more sense to devise new products using CNC because of its affordable cost, the high accuracy it offers and the wide range of materials from which it can operate, with not being limited to only plastic fiber as in the 3-D printer (Lennings, 2013).

Conclusion

This new surge of technological advancement has taken the world by storm (namely, the developed world), and we are already seeing all the different possibilities we can devise with utilizing the 3-D printer. If its full capabilities are realized, this machine would dramatically help in improving the quality of life of many of a population, including but not limited to agricultural crops, low-cost houses, affordable body transplants, mass food resources to eliminate world hunger and much more. Though most of this potential still lies a ways away in the future, with the current forbearer being the CNC machine, the 3-D printer is on another level.

References (Annotated Bibliography)

1) Pîrjan, A.; Petrosanu, D.M. (2013): The Impact of 3-D printing on the society and the economy. *Journal of Information Systems & Operations Management* 2013, 1-11. Retrieved from Proquest on February 12, 2016 http://search.proquest.com.mutex.gmu.edu/pqrl/docview/1477205392/8A393B4ED31A4F9DPQ/1?accountid=14541

This database journal article's theme is about the how 3-D printing technology evolved throughout the decades since it was first discovered, and its collateral, economic, political, social and moral impact on society. The article weighs the pros and cons of this advancement, and attempts to predict the effects of this technology in the near and far off future.

(2) Vasquez, M. (Aug. 2015). Embracing 3-D printing. *Mechanical Engineering* 137.8, 42-45. Retrieved from Proquest on February 12, 2016

http://search.proquest.com.mutex.gmu.edu/pqrl/docview/1700137900/591BC6F8F46D4912PQ/9?accountid=14541

This article goes over a brief historical account of 3-D printing, which was invented by scientist Chuck Hull and offers a broad view of the technology by taking the reader from its infancy stage to the more advanced stage that 3-D printing is today. It also talks about

the current prohibitive costs of acquiring such technology and the limited as well as the future potential vast impact that it could have on society.

(3) Murphy, S.V; Atala, A. (Aug 2014). 3D bioprinting of tissues and organs.*Nature Biotechnology* 32.8 ,773-85. Retrieved from Proquest on February 12, 2016 http://search.proquest.com.mutex.gmu.edu/pqrl/docview/1551941052/591BC6F8F46D4912PQ/19?accountid=14541

This scholarly article delves on the impact of 3-D printing in the medical industry, more specifically the bioprinting of new organs and tissues from synthetic materials that could have the potential to greatly reduce the shortage of the donor organ industry, and as a side effect reduce the number of people considering on selling organs for profit. It also pieces over the theme of how biology and 3-D printing are interconnected to make this posible.

4) Giges. N.S. (September 2015). 3-D printing: compete or coexist? Retrieved on February 12, 2016 from https://www.asme.org/engineering-topics/articles/manufacturing-design/3d-printing-compete-or-coexist

This article explores the possibility of 3-D printing becoming of mainstream use to companies in mass, and stop being an isolated novel technology as it is currently being touted to be at the present time. It goes over the likelihood of the technology in ever making it to the public market, and explains why it is not being used widely right now by famous companies.

5) Mukherjee, S.Y. (May 23, 2013). The Five Most Promising Uses of 3D Printing In Medicine. Retrieved on February 12, 2016 from http://thinkprogress.org/health/2013/05/23/2054281/promising-uses-3d-printing-medicine/

This article goes right into the practical effects of 3-D printing as opposed to the more theoretical impact of the previous 3-D bioprinting article. The effects explored are decreasing the donor shortage list, so less people feel compelled to donate, regulating diabetes, grafting skin onto burn victims, making prosthetic limbs look similar to the real ones, and addressing the dental health needs of poor Americans.

6) Ombatti, R. (December 30, 2014). Of feet, fleas and 3-D printing. Retrieved on February 12, 2016 from http://fablearn.stanford.edu/fellows/blog/feet-fleas-and-3d-printing

This article by a Phd student is a hypothetical proposal delving into his goal of aiming for a cure of jiggers, a parasite that goes inside the toe of victims without adequate food protection and lays eggs while destroying the toe, causing deformities and even death. His plan is to use 3-D printing to create low cost, customized medical shoes that are resistant to the bites of this organism.

7) Diamandis ,P. (May 26, 2015). Why 3-D printing a jet or a car is just the beginning. *SingularityHub*. Retrieved on February 12, 2016 from

http://singularityhub.com/2015/05/26/why-3d-printing-a-jet-engine-or-car-is-just-the-beginning/

This article by the Singularity Hub online magazine aims to inform the reader about the raw impact that 3-d printing could have on society and shows the most breathtaking cases in the printing of rocket engines, jet engines, cars and even houses. It goes over the impact of printing in each of these categories. For example, for houses, a company in China is already taking advantage of the technology to build low-cost houses in record times.

8) Roubini, N. (March 07, 2015). Where will all the workers go? *The Huffington Post*. Retrieved on February 12, 2016 from http://www.huffingtonpost.com/nouriel-roubini/digital-economy-jobs_b_6414046.html

This article from the Huffington Post explains the tricky situation of more jobs becoming automated than ever before, and how this effect is only going to grow exponentially when the potential of 3-D printing is more realized. The author informs how workers may need to adapt to the change in technology and be ever more willing to learn how to use it, if they want to remain in the upper bracket of the workforce.

9) Bass. C. (August 24, 2011). The past, present and future of 3-D printing. *The Washington Post*. Retrieved on February 12, 2016 from https://www.washingtonpost.com/national/on-innovations/the-past-present-and-future-of-3-d-printing/2011/08/21/gIQAg4fJZJ_story.html

This is an interview with the CEO of Autodesk Inc, a company that specializes in 3-d printing design and engineering software. He gives a straightforward explanation to the interviewer about the historical past, present and future of 3-D printing. Also, the CEO goes over in a nutshell what 3-D printing is all about so the lay person can understand and how it needs to be scaled to the needs of the consumer.

10) Lennings, L. (June 7, 2013). Digital manufacturing: 3-D printing and cnc machining. *TCT Magazine*. Retrieved on February 12, 2016 from http://www.tctmagazine.com/3D-printing-news/digital-manufacturing-3d-printing-and-cnc-machining/

This article is a comparison between the new lauded, but unproven 3-D printing technology and the already proven, workhorse, but limited technology of CNC machining. It goes on to explain how these two are different as well as how they are similar and the positive and negative aspects of each. For now, CNC machining is here to stay, and it is doubtful that it will ever completely cease to exist, even when 3-d printing is in full bloom.

11) Coraggio, G. (September 7, 2015). Top 3 legal issues of 3-d printing. [Web log post]. Retrieved on February 23, 2016 from .https://www.technologyslegaledge.com/2015/09/top-3-legal-issues-of-3d-printing/

This is a legal themed article with an emphasis on the legal repercussions that 3-d printing will carry. The issues explored include the argument that 3-d printing will encourage lay consumers to pirate the products of other companies, the liability of the

technology if an accident happens to the buyer, and the issue on whether exact replicas of an original model is a breach of privacy.

12) Gilpin, L. (March 5, 2014). The dark side of 3-d printing: 10 things to watch. *TechRepublic.* Retrieved on February 23, 2016 from http://www.techrepublic.com/article/the-dark-side-of-3d-printing-10-things-to-watch/

This article by the newsletter TechRepublic makes it a point to bring to light the dark, negative of 3-d printing, an often unexplored topic of any novel technology, but a crucial one nonetheless. These include the question of 3-D printing being energy hogs, giving out unhealthy air emissions, its over reliance on using plastic material, the loopholes on printed gun regulation and the problem on manufacturer liability.