3d printing essay sample

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I. Historical development and context

a. The birth of 3-D printing

b. Building Parts: Layer by Layer

c. New advances to medicine thru the use of engineered organs d. Open-source collaboration with 3-D printing

e. Mass customization in manufacturing thru the use of selective laser sintering (SLS) machines f. First self-replicating printer

g. Do-it-yourself co-creation service launches

h. Major breakthrough for prosthetics

i. Do-it-yourself kits for 3-D printers enter the marketplace j. From cells to blood vessels

k. World first’s in 3-D printing

When the 3-D printing was first introduced it remained relatively unknown to the greater public. It wasn’t until the second decade of the 21st century that the 3-D technology became well known. The popularity of 3-D printing was mainly due to the mixture of U. S. government funding and a handful of commercial businesses who first made it popular. This combination created a new wave of extraordinary popularity around the idea of 3-D printing ever since. Nowadays, 3-D printing is extremely widespread and it’s used in various fields such as aviation, automotive, medical, and manufacturing. The 3-D technology can be defined as the printing of physical 3-D objects from a digital data. The first 3-D commercial printer was invented by Charles Hull in 1984. However, it wasn’t until 1986 that the first 3-D machine, called stereolithography apparatus and a technique called a stereolithography was

patented and used. This technique relied on a laser to harden an ultraviolet-sensitive polymer material wherever the ultraviolet laser touched it (The Tower Price Connections). As with all new items on
the market, the first 3-D machine was imperfect at first, however it also proved that vastly complex parts can be manufactured overnight. In the next twenty years, the use of 3-D printing boomed. Throughout the years, 3-D printing slowly gained popularity in many fields. However, the biggest advancements in 3-D printing were seen in the medical field. Human bladders were the first 3-D printed, human organs designed and created in a lab and implanted into people. In 1999 a young patient underwent a urinary bladder augmentation using a 3-D synthetic framework coated with their own cells (The Tower Price Connections). This brand new technology, developed by a group of scientists at the Wake Forest Institute for Regenerative Medicine, allowed for the creation and development of other approaches for engineering 3-D printed human organs. Due to the fact that the 3-D printed organs are made with a patient’s own cells, there was much less chance of the host body rejecting the new organ (The Tower Price Connections). These new advancements, using the 3-D printing in the medical field, opened new doors for researchers in medical professions everywhere. With time, more and more various other human organs were created using 3-D printing. This new technology helped not only improve the research and scientific part of the medical field, but it also helped save human lives by allowing replacement organs to be created almost on demand . There are few steps involved in producing a 3-D printed bladder. First of all, the doctors have to eradicate a tiny piece of a patient’s organ and isolate the muscle cells and urothelial cells, which are located in the urinary

tract. The next step involves putting the cells into lab dishes and making them multiply by bathing each in a special type of fluid. They are left in the lab dishes for six weeks, after which there are usually enough living cells to create an entire bladder. Next, the researchers create an outside of a framework made of collagen, the protein that’s located in the connective tissue, and polyglycolic acid and pour the muscle cells onto it. After two days has passed, the scientists coat the inside of the framework with urothelial cells (Vogel, 2010). The new 3-D bladder is transported into an incubator and left there to develop. The incubator imitates human body conditions, allowing the cells to grow and join together. After the bladder matures, it is then implanted into a patient, where the framework gradually melts away (Vogel, 2010). This 3-D printing technology of a bladder has been perfected so that now scientist are able to create bladders of many different sizes depending on the patient’s needs. There continued to be advances in the medicine field using 3-D printing. Just three years after creating the first bladder using the 3-D technology, in 2002, scientists engineered a small kidney. It proved to be a functional animal kidney. The first 3-D printed kidney was able to filter blood and produce diluted urine. This extraordinary development motivated the research team at the Wake Forest Institute for Regenerative Medicine to aim at “ printing” human organs and tissues using 3D printing technology (The Tower Price Connections). This discovery proved to be very significant because it allowed the scientists to strive for creating a functional human kidney. Advances in 3-D continued to make headlines and attract attention and this time it was in the manufacturing field. In 2005 Dr. Adrian Bowyer at University of Bath initiated a new endeavor. He aimed at discovering and building a 3-D printer that can print most of its own parts.

This new technology which came to be known as the “ self-replicating rapid prototyper” or RepRap could massively decrease the cost of 3-D printers, therefore making them available to general public (Biever, 2005). By allowing individuals everywhere to purchase the future 3-D printers cheaply, Dr. Bowyer would enable them to create everyday items on their own in the comfort of their own homes. They would be able to customize how various everyday products look like, choosing their shape, texture and color. Only a year later, 3-D printing made headlines once more in the manufacturing field. In 2005, the first selective laser sintering (SLS) machine became possible. This type of machine used a laser to fuse materials into 3-D products. This new technology allowed for the development of mass customization of manufacturing parts such as industrial parts, and later, prostheses (The Tower Price Connections). In addition to the SLS machine, that same year a 3-D printing systems and material provider known as Objet, created a machine that was able to print in multiple materials, including elastomers and polymers. This new technology allowed an individual part to be made with an assortment of densities and material properties (The Tower Price Connections). After the first initiation of a self-replicating 3-D printer by Dr. Bowyer back in 2005, finally for the first time such machine was created in 2008. The RepRap company finally released the first self-replicating 3-D printer which was capable of printing the majority of its own parts, allowing users who already own a 3-D printer to create more printers for their friends and family. The new machine was named Darwin after the well-known biologist Charles Darwin. The 3-D printer Darwin was extremely efficient and capable of printing about half of its components itself (Can Print 3D, 2013). This was a great accomplishment for Dr. Bowyer and

wonderful news for those interested in acquiring a 3-D printer. With the constant increase of development in the field of 3-D printing more and more individuals had access to this brand new and amazing technology. Also in 2008, another 3-D printing company called Shapeways, focused on making our everyday lives even easier by permitting artists, architects and designers to make their 3-D designs as physical objects at a bargain price. Shapeways is currently working with many different building materials such as plastics, stainless steel, silver, ceramics, and glass, with different finishes for each to service the community. The company is a big proponent of customization because they believe that each individual has different needs and people do not like mass produced products (Ludwig, 2001). 2008 was a big year for advancements in the 3-D printing technology because that same year even more major developments were made in the medical field with the help of 3-D printing. For the first time, a person was able to walk on a 3-D-printed prosthetic leg, which included all the parts such as the knee, foot, and socket. This new 3-D printed prosthetic leg was constructed as a one complex structure without any additional assembly. One the 3-D printed prosthetic leg was completed and tested to be functional, a manufacturer called Bespoke Innovations, began working on customized coverings that surround prosthetic legs (The Tower Price Connections). Once again, the customers had the option and the ability to customize their 3-D printed products to their liking. In 2009 3-D printing reached even more customers when an open-source hardware company called MakerBot Industries, started selling do it yourself kits that enabled customers to make their own 3-D printers and various other 3-D related products (The Tower Price Connections). This was yet another important milestone in the 3-D printing

technology because it once again allowed for more customers to have easier access to 3-D printing at a minimal expense. Moreover, once again that same year, 3-D printing made tremendous headlines in the medicine industry.

Bio-printing visionary Organovo, pursued the assistance of Dr. Gabor Forgacs in order to use a 3-D bio-printer to print the first blood vessel (The Tower Price Connections). It seems as if the medical field is one of the major fields that could really benefit from the 3-D printing. However many other fields also experienced certain advances when it came to 3-D printing as time went by. As recently as 2011, scientists and engineers at the University of Southampton in United Kingdom designed, created and flew the world's first 3-D printed airplane. This was a first unmanned aircraft fully created with the 3-D printing technology. It took the team of engineers seven days and a combined budget of 5, 000 pounds to complete the aircraft (The Tower Price Connections). This was yet another successful endeavor using 3-D printing and it allowed for the aircraft to be built inexpensively. In addition, that same year, Kor Ecologic revealed Urbee, a sleek prototype car that was also extremely environmentally friendly. The body of that car for completely designed by 3-D printing. As with the first 3-D aircraft, this car was not only inexpensive, but also extremely fuel efficient. It was capable of getting 200 miles per gallon on the highway and 100 miles per gallon in the city. Td he car was designed to be sold to general public at an estimate retail price between $10, 000 to $50, 000, however, thus far it has not bec0me commercially viable (The Tower Price Connections). This doesn't however rule of the fact that somewhere in the near future we can be driving 3-D printed cars. The last major milestone in the use of 3-D printing came as

recently as 2012 and this time it was once again in the medical field. Doctors and scientists in the Netherlands used a specifically designed 3-D printer created by LayerWise to print a personalized 3-D prosthetic lower jaw. This newly designed 3-D printed jaw was successfully implanted into an 83-year old woman who suffered from a chronic bone infection. This is the newest medical advancement using the 3-D printing technology and is presently being explored to promote the growth of new bone tissue (The Tower Price Connections). In the last 29 years since its discovery, 3-D printing contributed tremendously to various aspects of our lives. We can see the benefits of using 3-Dpriting in many different fields and there continue to be advances and improvements as to how we can better use and customize 3-D printing to fit our needs. Implications for the environment

1. 3-D benefits over traditional manufacturing techniques
2. Environmental implications of 3-D printing

3-D printing has various implications on our environment. More and more resources are becoming scares as time goes by. Resource scarcity, as it continues to become a problem, will have an increasing influence on how businesses function, especially how manufacturers choose what type of products to produce, how and where they produce those items, as well as how they efficiently allocate them. 3-D printing will be able to help us maintain those resources because now we will be able to create exactly what is needed more efficiently and inexpensively. According to Chris Park, a principal at Deloitte who specializes in helping his customers with their environmental, social, and sustainability performance, we can use 3-D printing to essentially generate a physical product that is equivalent in

quality and price to those created using raw resources (Ludwig, 2013). However, these new products created using 3-D printing will have a less of a damaging impact on our environment. In his research Chris Park states that there is a “ direct link between sustainability and 3-D printing as a developing manufacturing technology” (Ludwig, 2013). The companies producing 3-D printed products will be able to reduce the general price of the product since all of the energy, water, waste and emission cost that are usually involved in creating manufactured products no longer play a role in the manufacturing system (Ludwig, 2013). As of now, 3-D printing is still being employed on a very small scale, but as it continues to grow and it becomes more advanced it could really be beneficial to our environment. The implications of 3-D printing can first be seen on a smaller scale, but with time, as the technology advances, it could be used to create entire buildings. As additional 3-D printing technology enterprises understand how to put more varied materials through the 3-D printing process the shift will come from creating simple stuff made of plastic to more complex designs. In addition to having a significant impact in the various fields such as medicine or manufacturing, 3-D printing has also impacted our environment. As with many other technologies, there are both positive and negative implications of 3-D printing. 3-D printing has various positive implications on our environment. First of all, the individual parts, as
well as the finished products that are produced using the 3-D printing technology are designed for optimal performance. They are not mass created, but are designed to exact specifications and fit the exact needs of the customer. This type of production can reduce the weight of the product, extend the product’s life as well as reduce the price of the finished product.

3-D printing technology is also capable of fabricating small batches of custom parts. This means that items are only created when needed for purchase or consumption. This helps in maintaining inventory, reduces leftovers or overstock and helps in reducing the pollution created by transportation (Kurman, 2013). Another great benefit of 3-D printing and a positive implication on our environment is the reduction of waste. Creating plastic and metal products generally products a large amount of waste during the manufacturing process. There are often great amounts of surplus materials and spare parts left over. For example, when manufacturing some aircrafts, up to 90 percent of the material is usually wasted (Caliper Media, 2013). With the use of 3-D printing, items are only produced as needed and there is no waste created in the process. According to research, some of the finished products created using the 3-D printing technology can be up to 60 percent lighter than the products manufactured using the traditional manufacturing process, but are still sturdy and dependable (Caliper Media, 2013). Since the 3-D printing produces items without creating as much waste it not only brings in huge savings in costs, but it also means a lesser effect on the environment. On the other hand, there are many negative implications of 3-D printing. Since the 3-D printing technology is so new, it is not yet designed to be environmentally friendly. 3-D printing relies heavily on the use of plastic which has negative effect on our environment. Plastic, in all shapes and forms, and regardless of how it is manufactured has never been good news when it comes to the environment. Industrial-grade-plastic 3-D printers that use powdered or melted polymers leave behind a significant amount of unused raw material in the print bed. These plastic byproducts can often be reused once more, but usually, its material

properties are tarnished and therefore no longer fit for reuse (Kurman, 2013). When it comes to reusable plastic, there is some hope for our environment in a new technology that is currently being worked on and improved upon. It is a corn-based printing plastic also known as polylactic acid (PLA). This new technology plays a big role in 3-D printing as it is a viable and a biodegradable replacement to traditional plastic manufacturing. The many benefits of this new corn-based printing technology include the reduction in the emission of greenhouse gases because it comes from renewable, carbon-absorbing plants. In addition, the new technology will not release toxic vapors into the environment when incinerated (McInnes, 2008). Less pollution and less toxic fumes equal cleaner air and less damage to our atmosphere and environment. Another negative implication of 3-D printing is the energy consumption during the manufacturing process. According to the research performed at Loughborough University in the United Kingdom “ 3D printers that use heat or a laser to melt plastic consumed an estimated 50 to 100 times more electrical energy than injection molding to make an object of the same weight” (Kurman, 2013). This is a rather frightening amount of energy used in the 3-D printing and pollutes our air and damages the atmosphere. There needs to be more research completed as to how we can reduce the amount of energy being used in the 3-D printing process.

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