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QUESTIONING POSSIBLE EFFECTS OF 3-D PRINTING TECHNOLOGY ON SOCIAL LIFE[1]

3 BOYUTLU BASKI TEKNOLOJİSİNİN SOSYAL YAŞAMA ETKİLERİNE DAİR BİR İNCELEME

Sevgi Ari

Cukurova University Faculty of Education, Graphic Design Department
sevgiarigrf@gmail.com

ÖZ

Günümüz dünyasında teknolojik gelişmeler daha önce olmadığı kadar çok hayatlarımızın bir parçası haline gelmiştir. Bilim sanat ve inanç sistemleri arasındaki disiplinlerarası etkileşimin artığı bir çağda, yenilikçi teknolojiler insanların dünyaya bakış açısını da etkilemektedir. İçinde bulunduğumuz güncel durumda dünya genelindeki birçok yenilikçi kurum ve kuruluş, 3 boyutlu yazıcıyı kullanarak farklı üretimler yapmaya devam etmektedir. Yine içinde bulunduğumuz bu çağda eğitim her zamankinden daha da büyük bir önem taşımaktadır. Günümüzde eğitimin önemi, yaratıcı potansiyelleri desteklemek ve geleceğin yeni teknolojilerine dair üretimin ve bu teknolojilerin kullanımına dair bilincin yükseltilmesini sağlamak adına gittikçe artmaktadır. 3 boyutlu baskı teknolojisinin sanat, eğitim ve sosyal yaşama getireceği yeni boyutları ve etkilerini araştırma amacı taşıyan bu çalışmada söz konusu güncel teknolojinin yaratıcı alanlarla olan ilişkisi ortaya konulmaktadır. Bu amaç ışığında bu çalışmanın ilk bölümünde 3 boyutlu baskı teknolojisinin teknik anlamda anlaşılabilir boyuttaki alt yapı bilgisine ve 3 boyutlu baskı teknolojisinin hangi farklı alanlarda kullanıldığına dair önem arz eden bilgi ve örneklere yer verilmiştir. Bu farklı ve ilham verici örneklerin ardından 3 boyutlu düşüncenin anlam ve önemi tartışılmıştır. Sonuç bölümünde ise 3 boyutlu baskı teknolojisinin yakın gelecekteki etkileri sorgulanmıştır. Bu alanda yaşanan gelişmeler dikkate alındığında, bilim-kurgu gibi görünen yaşamlara ulaşılmasının çok da uzak olmadığı sonucuna varılmıştır.

Anahtar Kelimeler : 3 boyutlu baskı, Eklemeli üretim sistemleri, Stereolitografi, Biyomateryal bilimi, 3 boyutlu düşünce, 3 boyutlu tasarım

ABSTRACT

In today's world, technological developments have become a part of our lives more than ever before. In an age where interdisciplinary interaction between science, art and beliefs increases, innovative technologies transform people's perception of the world around them. In these days, a lot of innovative institutions / organizations are still working on different types of 3-D printed objects with the help of different experiments all around the World. In this new era, the role of the education is very important and necessary as it has always been throughout the history. One of the most important goals of education must be to support creative potential which will help in making progress in new technologies for the future and increasing awareness by instructing people how to use these technologies in a productive way. The aim of this study is to explore new dimensions and potential impacts of 3-D printing technology in art, education and social life. Another purpose is to convey the

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importance of adapting this technology to our creative fields. For this purpose, a short description about technical infrastructure and different usage areas and examples of 3-D printing technology is provided. After these inspiring actual/major examples, the importance and the meaning of 3 dimensional thinking is discussed. In the closing-final section questions are asked about possible results of 3-D printing technology likely in the future. When the pace of development in this area is considered, living a science-fiction life seems to be very close.

Keywords: 3-D Printing, Additive Manufacturing Systems, Stereo-lithography, Biomaterials Science, 3D Thinking, 3-D Design.

1. Introduction

The development of 3-D printing technology -also called "Stereo-lithography" or "Additive Manufacturing"- started with small-scale trials in the beginning of 1980s. It is known that, the first 3-D printer was developed by Charles W. Hull in 1984 (Charles W. Hull Biography, n.d.). 3-D printing process -also called workflow- is a multistep process starting with a special form of the model and it needs special software compatible with 3-d printer. Once the image is modeled, it is exported in a file format that contains Standard Tessellation Language (STL) for defining the object with triangulated surfaces and vertices (Bell, 2015, p.2). After this divided file created, it is ready to print with some liquid material layer by layer. In this technique, it is possible to design 3-D objects from scratch or it can be a scanned copy of an existing object. It is foreseen that "digitizing real objects into 3-D models will become as easy as taking a picture" in the near future (What is 3d printing?, 2015). Also it is possible to create a digital version of an object and multiply it anywhere in the world.

Over the last few years, there has been an increase in 3-D printing market especially for personal use. It is still an expanding market segment with many different types of 3-D printers - 3-D food printers for personal use included- either as DIY construction kits or pre-assemble products. (Gremmler , 2014, p.208) Nowadays it is possible to buy a 3-D printer starting from US$ 260 depending on the purpose and quality (Voo, 2015). As of 2013, some high-end retail printers that can print a hundred different materials from paper to silver became available (Earls&Baya, 2014). Whereas traditional 3-D printers could use only powder of plastic or photopolymer resin to create hard objects, many companies plan to build industrial models that can print "anything" in the near future.

2. Nonorganic 3-d Printed Objects

As a good example of the multiplying function, Iranian born artist, educator and activist Morehshin Allahyari together with her team is working on sculptures that ISIS has destroyed in 2015. In her project named "Material Speculation: ISIS", Allahyari is modeling and reproducing statues through intense research. She is not only interested in replicating lost statues but also making it possible for anyone by embedding semi-translucent copies in a flash drive (Valentine, 2015). It is a remarkable project against destruction as a form of rewriting history of counter narratives to political and physical violence. (Fig.1 and 2)

Fig. 1. Screenshot of ISIS, 2015,Video courtesy: Morehshin Allahyari. Source: retrieved June 11, 2015 from http://motherboard.vice.com

Fig. 2. King Uthal Statue (left: original, right: 3-D printed version) Images: Morehshin Allahyari, 2015, Source: retrieved June 11, 2015 from http://motherboard.vice.com/

Like this significant current example, 3-D printing technology introduced different ways of thinking for all kinds of designers. Architects, sculptors, animators, fashion designers able to see their models in the real world quickly by using 3-D printing technology. In the graphic design field, a print shop in London called New North Press created a 3-D printed letterpress font by collaborating with A2 Type in 2014 (Harrison, 2014). (Fig. 3) Marilyn Baker displayed her vector illustrations in real world as a part of her graduation project from the University of the Arts London in June 2015 (*New talent: University of the Arts London*, n.d.). These projects ensure digital images become tangible easier therefore they create a more interactive connection with viewers. (Fig.4)

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Fig.3. 3-D Printed Font by A2-Type & New North Press, 2014, Source: retrieved May 20, 2015 from https://vllg.com/news/220

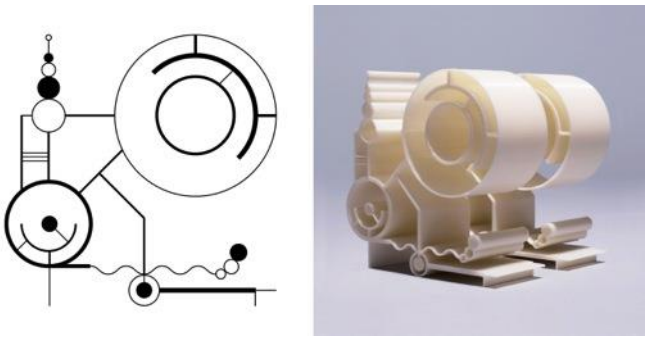

Fig. 4. Marilyn Baker's 3-D printed illustrations, 2015, Source: retrieved July 15, 2015 from

http://marilynbaker.co.uk/illustration/fmp_final_3-jpg

In industrial design, the varieties of 3-D printed objects from decoration to fashion - chairs, shoes, clothes, guns, guitars, candies, lambs etc.- are increasing from all around the world day by day. The 3-D design laboratory CUNICODE released a book named "Beautiful Failures" including photos from accidental 3-D prints. These discarded pieces show layered textures and unusual forms that can occur while trying to print some 3-D objects. The designer behind the book Bernard Cuni notes that; "As a designer I call for honesty on product's aesthetics, I tend to like things that don't hide their nature" (Cuni, 2012). (Fig.5)

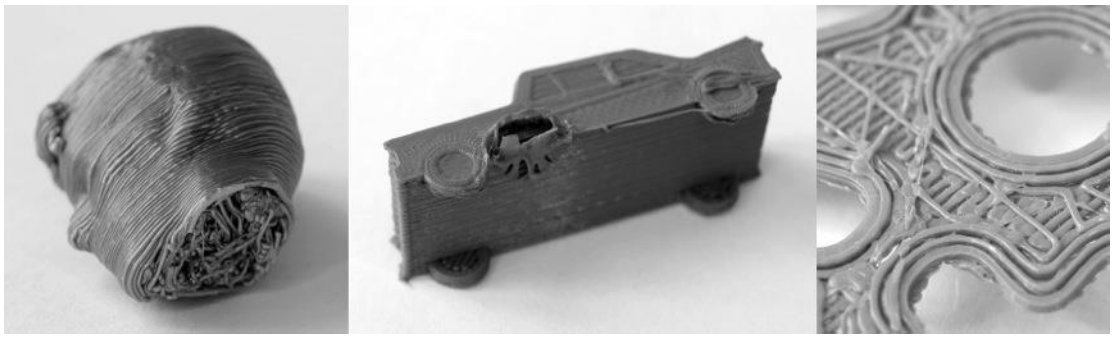

Fig. 5. "Beautiful Failures", accidental 3-D prints by Bernard Cuni, 2012, Source: retrieved July 3, 2015 from http://www.cunicode.com/works/beautiful-failures/

A team under the leadership of Eric Brockmeyer from Disney Research Pittsburgh and Scott E. Hudson from Carnegie Mellon University are still continuing its experiments to create something like a cross between a 3-D printer and a sewing machine. In a press release dated April 2014, Hudson explained the main objective of the project is "to create a machine can turn wool and wool blend yarns into fabric objects that people might actually enjoy

touching" and added; "printing a soft and cuddly object with 3-D printers is one of the most interesting challenges now."

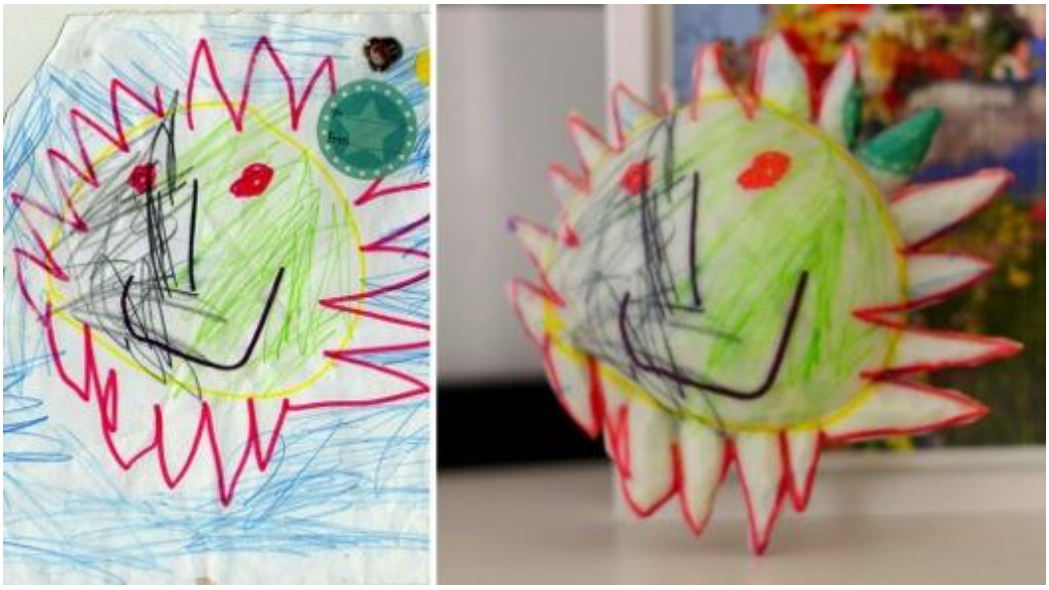

Fig. 7. 4-years old Violet's 3-D printed drawing, Source: retrieved April 12, 2015 from http://www.crayoncreatures.com/gallery/

Fig. 6. Teddy Bear's 3-D printing process, 2014, Source: retrieved July 9, 2015 from http://www.disneyresearch.com/project/printed-teddy-bears/

"Crayon Creatures" is a service that turns children's drawings into unique figurines using 3-D modeling / printing technology. The process starts by sending children's artworks via e-mail to this web site and make an order. Then they send you 3-D printed, full color sandstone copy of the artworks (Cuni, n.d.). Although it may seem like a decorative production, turning two-dimensional images into 3-D, means a lot. It is a different experience that allows imagining new moving stories when inactive characters 'come to life'. It is possible to say, these kinds of transformations are very important for adding new dimensions to children's imagination. (Fig.7)

As well as these small-sized objects, producing large scaled objects like 3-D printed houses and 3-D printed cars have been increased in the last few years, too. Real scaled houses printed firstly by Chinese Company named "Win Sun" in March 2014. This company was able to print 10 houses in 24 hours (Naboni, Paoletti, 2015, p.64). The same company has successfully printed the world's first 3-D printed a five-storey apartment building from a special print material in 2015. All the materials used for printing this apartment were created from recycled construction waste, industrial waste and tailings. This recipe is supposed to save 60% of materials, 70% of time and 80% of labor usually needed to build a house (Starr, 2015). That means, these 3-D printed houses are environmentally-friendly and cost-effective. It is stated, printing a house in 3-D "makes it possible to create unique shapes, adapt the building to personal preferences without additional cost with a low probability to make mistakes." (Wijk, 2015, p.57-66) (Fig. 8)

Fig.8. World's first 3-D printed apartment building by Win Sun, 2015, Source: retrieved July 9, 2015 from http://www.cnet.com/pictures/3d-printed-apartment-building-and-mansion-pictures/

Companies like "Local Motors", "Quirky", "Koenigsegg" and the entrepreneurs like Kevin Czinger are searching for alternative ways to print a car at the same time. (*The First 3D-Printed Supercar*, 2015). As an example, Local Motors have been searching for the best structure for a long time. They opened an online platform for all designers to participate with their design proposals already. It took years to design the world's first drivable 3-D printed car but printing it completed in only 44 hours. In 2014, first prototype "Strati" -which means "layers" in Italian- printed with partnership of "Oak Ridge Labs" and demonstrated at IMTS show. It is reported that the finished Strati can drive at speeds up to 40 mph and can travel 120 miles on a single charge. (Fig.9 and 10)

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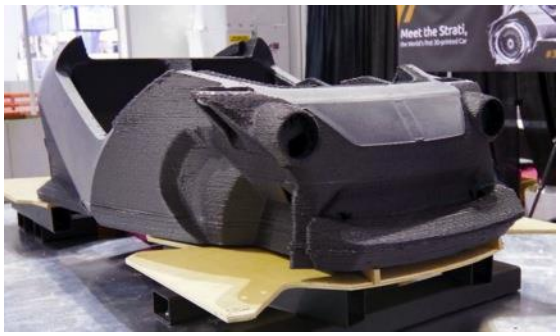

Fig. 9. Strati's 3-D printed body, 2014 Source: retrieved August 19, 2015 from

https://localmotors.com/

Fig. 10. World's first drivable 3-D printed car Strati, 2014 Source: retrieved August 19, 2015 fromhttp://www.epanoticias.com/wpcontent/uploads/2015/05/strati-electric-car.jpg

3. 3-d printed organisms

3-D printing technology has started a new era in medical area called *"Biomaterials Science*" firstly by allowing transplantation of body parts in physical injuries. As an example; surgeons in Swansea Hospital used 3-D printed parts to renew the face of a motorcyclist who had been seriously injured in a road accident in 2013, and than the Swansea project was featured in an exhibition called "3D: Printing the Future" at the Science Museum in London previous year. (*3D printing to rebuild patient's face at Morriston Hospital*. 2013). In addition, a five-year-old girl born without fully formed fingers on her left hand, became the first child in the UK to have a prosthetic hand, made with 3-D printing technology in 2014. (*Inverness girl Hayley Fraser gets 3D-printed hand*, 2014).

Together with these transplantations, scientists are testing to print organisms like human tissues, organs and stem cells. Bioengineer Jennifer Lewis at Harvard University explains; "scientists are looking ahead to radical emerging technologies that use live cells as 'ink', assembling them layer-by-layer into rudimentary tissues." (Ledford, 2015) But, until this time scientists have not been able to survive 3-D printed bio-organisms. A research team from Sydney and Harvard Universities announced that they achieved to prevent cells from dying with a method called "vascularization". This method will let surgeons transplant 3-D printed organs that can grow and survive by themselves, probably in near future. In article published on May 2014, researchers noted; "vascularization remains a critical challenge in tissue engineering. The development of vascular networks within densely populated and metabolically functional tissues facilitate transport of nutrients and removal of waste

products, thus preserving cellular viability over a long period of time." (Bertassoni, Cecconi& Manoharan, 2014)

While all these innovative experiments were developing in healthcare industry, there were a lot of green friendly projects in progress, too. One of them was a green 3-D printer designed and developed by the students at the University of Maribor / Slovenia in 2013. The device that was named "PrintGREEN" has ability to grow grass with a combination of soil, seeds, and water, rather than plastic or metal. The mud holds its' form and, over time grass is able to grow from the organic, printed materials (Barnes, 2015). (Fig. 11)

Fig.11. PrintGREEN from students of University of Maribor in Slovenia, 2013 Source: retrieved June 11, 2015 from http://www.mymodernmet.com/profiles/blogs/printgreen-3d-printed-grass

In 2014, A Royal College of Art graduate Julian Melchiorri created World's first man-made, biologically functional silk leaf made from chloroplasts. Like the real leaves of a plant, these 3-D printed leaves require only exposure to sunlight and a small amount of water to produce oxygen. It is foreseen that, this breakthrough technology could clean our air here on Earth, and even fight against global warming. Melchiorri states; "Plants don't grow in zero gravity" and adds; "NASA is researching different ways to produce oxygen for long-distance space journeys to let us live in space. This material could allow us to explore space much further than we can now." (Nelson, 2014). (Fig.12) Similar with Melchiorri, The Technical Centre of Finland (VTT) came up with a 3-D Printed 'tree' at the beginning of 2015. These 3-D printed leaves able to produce solar energy with its organic/solar cells, and also it captures the vibrations to produce kinetic energy. It is said that the electricity generated by the leaves can be used to power mobile phones, LED lighting or thermometers (Luimstra, 2015). (Fig. 13)s

Meanwhile some innovative companies in the food industry are providing 3-D printed foods like ice cream, confectionery, pizza and burgers for users' taste. It is known that, the first 3-D chocolate printer of the World, made by the students of the University Of Exeter in Britain with the financial help of a chocolate company in 2011. This printer -which the

research team calls ChocALM for Chocolate Additive Layer Manufacturing- uses similar software with nonorganic Printing Tech. (Fig.14.) The team also tried to make an interactive connection with public, so they created a web site that all the people can upload their own chocolate designs. Dr. Liang Hao, from University of Exeter said; This solution will provide a great potential to use the collective intelligence of users and producers (manufacturers and service providers) to co-design and co-produce user-centric chocolates and bring them into the mainstream market. (Lanks, 2011).

Picture 14: ChocALM, University Of Exeter in Britain, 2011 Source: retrieved July 9, 2015 from http://www.fastcodesign.com/1664454/theworlds-first-3-d-chocolate-printer

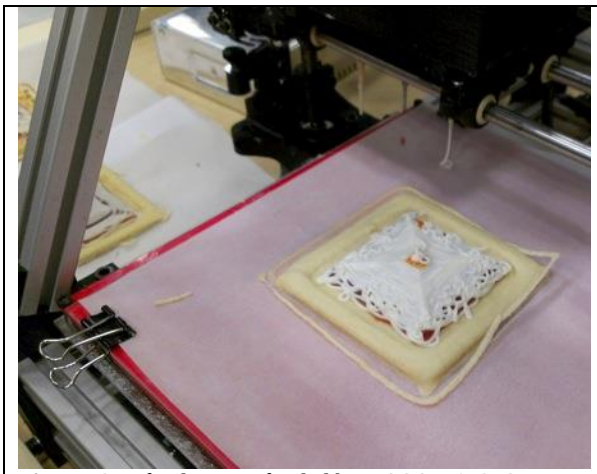

Fig. 15. 3-D food printer funded by NASA, 2013 Source: retrieved May 12, 2015 from http://i.ytimg.com/vi/uphIwHFz0no/maxresdefault.jpg

Fig.16. 3-D handguns manufactured with a commercial printer, 2014 Source: retrieved June 10, 2015 from http://www.japantimes.co.jp/ news/2014/05/08/

Meantime, NASA and US Army are investigating alternative ways to building / produce foods for he future that will be able to grow in space and deliver important nutrients (Hall, 2013). It is reported, in 2013; NASA granted 'Systems & Materials Research Corporation' to spend six months building a prototype of a 3-D food printer that prints pizza. NASA's Advanced Food Technology Project scientist Grace Douglas explains; "Pizza is one of the comfort foods unavailable to astronauts on current missions; The contractor's 3-D food

printer could change that. And since the 3-D printer does most of the work, astronauts wouldn't have to deal with extensive food prep." (Schwartz, 2013). (Fig.15)

As well as these examples, it is reported that some individuals started to use 3-D printers for to make fake copies of original brands like Ray-Ban because it is easy to create a pair of Ray-Ban Wayfarers by using a high-fidelity 3-D printer, and it is hard to distinguish the copy from the real one; "Individuals doing this for their own use could impact a brand's bottom line, but the real nightmare is counterfeiters who have access to those printers." (Williams-Alvarez, 2014). In May 2014, another report from Japan it was announced that a 27-year-old man was arrested in his house after finding he had manufactured five handguns using a commercial 3-D printer. Under the Japanese strict gun laws, the arrested man said that; "I produced the guns, but I didn't think it was illegal (…) I can't complain about the arrest if the police regard them as real guns." (Thomson, 2014). (Fig.16)

Conclusion

After Gutenberg generated "movable type" print system in 1450, it spread all over Europe and changed social, cultural life dramatically. The next major turning point in history was the Industrial Revolution of the 18th century. The Industrial Revolution set the shift away from hand-made products to machine-made ones. It was a transition period of modern production methods that use human labor as a part of the mechanism as now. This method provided the modern conditions of living but also loaded people's lives with mass products. It is possible to criticize, increasing of automation, significantly reduced individuals' creativity from the production process.

Like all the big inventions in history, this new technology leads a new phase in intellectual profundity. Today, the process of 3-D printing is called "The Third Industrial Revolution". Thus, mass produced goods require a long time, with high transport costs and need for large warehouse networks. By contrast, a 3-D printed items can be printed locally and distributed to close proximity and allow for customized production." (Nafukho, 2015, p.15). Unlike the 18thcentury's Industrial Revolution; 3-D printing technology refers a sense that brings individuals' creativity to the forefront. This technology enables people to personalize their tools / objects to their personal space.

It is possible to consider this new level as a kind of democratization in the consumption/production chain. It is noted that in the future "it will not be based on a small

number of centralized manufacturing sites with high investment costs but rather on a large number of small investments in distributed manufacturing locations" (Wijk, 2015, p.27). It means that people will be able to produce their own unique objects instead of uniform products without the necessity of mass production systems. "Like other revolutions, 3D printing is going to revolutionize how you live, and sooner than you think. No more going to the store; just go online, buy a file, download it to your printer, and out comes the object you want." (Biehler & Fane, 2014, p.2). One of the leading biotech thinkers Andrew Hessel believes that coming innovations in 3-D technologies will mirror those of personal computing in the 1980s and biotech -which is the basis of all creatures-, will be bigger than the internet. (Piscione, 2013, p.89) Lipson & Kurman explain possible effects of 3-D printing technology to education by looking back at how computers affected education; "Computers were initially used only to enhance classes that were deemed 'computer related' (…) but that changed, and today computers are used in each and every class, from history to arts. Most importantly, they have opened the door to entirely new ways of teaching and learning these subjects. (…) 3D printers are likely to follow the same path. Initially, 3d printers have been adopted in classes where they are deemed relevant, like tech shop class. Soon they will be adopted in other classes, from math to biology, eventually making their own way into art, history, and literature. Like computers, they will open the door to entirely new ways of teaching and learning that we cannot imagine yet today." (Lipson&Kurman, 2013, p.174).

Futurist Frank Spencer points out, it is inescapable to develop anticipatory and alternative perspectives in organizational, global settings up to current events in 3-D technology. Like the companies, individuals are going to have come up with innovative ways to stimulate the innovation itself. As Spencer notes; "Without acquiring the skills and culture that foster long-term thinking- anticipation, multiple perspectives, alternative outcomes, adaptive and resilient thinking and aspirational outcomes- innovation processes still lack the creative capacity needed to keep pace with accelerating change and complexity in today's world of business and global development. If we are going to solve big world problems of the twenty-first century, we will need to reframe innovation in the context of future thinking and foresight, igniting a whole new way of seeing 'that which does not yet exist' and fanning flames of exploration beyond the tried and true. " (Piscione, 2013, p.89).

If schools invest in 3-D printers, classrooms can turn into an experimentation place to put ideas into practice easily. 3-D printers can routinize prototyping as a part of the design

process. Also it would help students to fail early and safely, which means finding a solution quickly. It is reported; "students find it helpful since they can catch design errors early on rather than investing time and materials in a one-shot gamble." (Lipson&Kurman, 2013, p.158). In addition, transferring some abstract subjects like math, chemistry or physics into practice, experiencing them in three-dimensional displays would make these concepts more unforgettable for students.

As we have seen from different examples given in this report, there is an on-going process in 3-d printing technology. Varieties of the possibilities bring along very complex questions that have to be addressed both scientifically and philosophically. Questions might be asked; can we perceive the leaves produced by Julian Melchiorri as real? What are the consequences of printing a copy of a heart? Will humans live longer with transplanted 3-d organs such as heart or liver? Will it be possible to print a body entirely? This technology will give a chance to the people for being replicated and resume on life? To multiply something easily will change the meaning of 'uniqueness'?

Living in 3-D printed houses will mean eco-friendly life? Will architectural structures able to "breathe" and produce energy by its supplies? Is it possible to undo the damage of industrialization through this new technology? How the democratization of production systems -from cars to outfits- will change the variations of living? Will it be possible to wear iron or all the other elements as a dress in the future? Will people need to go shopping centers to buy something instead of printing it at home? Will this technology lead us to high living standards?

It is clear that 3-D printing technologies are leading people to embrace multidimensional thinking right now. In our age of rapid change, creative and innovative thinking has become as critical skills together with multidimensionality. Surely, many professions from cookery to restoration will change their function and draw near to design. Designers will be able to design a hand or a leaf from scratch. This availability probably will remove borders between human-made and naturally created. It means that maybe a "wood looking table" won't be included real wood itself.

We must conclude that, we are experiencing an important transition period in human history and we have a significant role in this process. As in science and design, new thinking models in education will help us re-frame and redefine innovation. This type of thinking

which is beyond the traditional/classical world perspective advises people to look “the other side of the coin”. The times ahead of us is a turning point just as the times Galileo said; “The Earth is not flat”. It is our responsibility to gain an awareness to use this technology in all the positive directions. It is important to comprehend new technologies to create sustainable and eco-friendly systems for both our-selves and future generations. We have a chance to take back detrimental effects of industrialization and have better quality of life in the future due to 3-D printing technology. With this possible way, we can expect that 3-D printing technology provides environment-friendly life standards, together with diversity and uniqueness for all of us.

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