The State of 3D Printing

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***Abstract*—3D printing is a very interesting technology that has caught the public attention a few years ago, with the introduction of affordable models to the consumer market. The idea of having a machine that could produce your own objects was a new opportunity that consumers had never been given. Since then models have become cheaper and more capable but their presence in homes doesn't seem to grow. Could it be that 3D printing has no real use for consumers? Would that explain why it is "limited" to the "Do it yourself" (DIY) world?**

Keywords—3D printing, printer

I. INTRODUCTION

For the industry, it is a different subject; the possible applications could have a meaningful impact on our society as they would cause big advances and breakthrough in many study fields, even maybe creating new ones. However, the benefits could come at a cost: restructuring the supply chain could cause massive unemployment. Still, the technology is not ready to replace actual manufacturing methods. What needs to be improved in it to be fully viable to implement?

It is very difficult to predict with exactitude what will happen in the years to come. It has an immense potential but will it be enough for it to cause a change? What would be the positive and negative aspects of such a revolution?

II. POSITIVE ASPECTS

A. *Home Use*

Home manufacturing is a special case; we can't know how 3D printing will work for home users. 3D printing best use for consumers will be to print unique artifacts, special commodities or have a small income secondary source.

Price isn't as much of a factor for the mainstream market, low prices kits have been released recently making it possible to own a 3D printer for as much as 100$. This is a nice price drop considering that some years ago, you couldn't get one (that worked) for less than a thousand dollars. Also, filament can be bought for 20$ per kilo, which gives you approximately 330 meters (for a 1.75mm filament) to print with.

However it is clear that 3D printers are best suited for inventive people who are always trying to make new things or repair them on their own.

B. *Industry*

We are barely discovering 3D printing possibilities. The technology could potentially reduce the production line, create new research fields, allow the development of objects with new properties, and heavily simplify complex tasks.

The actual supply [1] chain includes many steps that delay the arrival of an item to the end user:

IDEA – PROTOTYPE – MANUFACTURE – ASSEMBLY – DISTRIBUTION- WAREHOUSE – RETAIL- END USER

With 3D printing, many of the phases can be skipped, the chain can be simplified to 4 steps:

IDEA - PROTOTYPE- PRINTING - END USER

Such change could change production rates and act as a counter balance to their relatively slow print speed to actual manufacturing methods.

New applications like organ printing could potentially solve problems like finding compatible organ donators, unpractical and costly prosthesis, or damaged tissue. It could be practical for teaching since it can be used to produce extremely accurate 3D models.

Other new uses areas of interest include gastronomy, architecture, aerospace and automotive industry. Gastronomy is especially interesting since it allows creating unique looking dishes that would be impossible to replicate with human hands; in aerospace and automotive it would allow experimenting with new materials and aerodynamic designs with new properties, possibly even lowering costs.

Further advantages for the industry include more efficient use of material (less wasted material); complexity no longer an obstacle; no assembly required and easier customization. The flexibility the technology presents makes it so that we are its only limit in the long run.

III. NEGATIVE ASPECTS

A. *Home Use*

Even though 3D printing is promising it still needs to be improved in many ways. Every new technology must go through a process on implementation and adoption that can take many years and even decades in some cases, due to various reasons. For instance, the US nuclear defense system is still working with floppy disks in 2016 because they aren't hackable. In other cases, the technology may not even be ready and come ahead of its time; a good example of this is Nintendo's virtual boy. The virtual reality (vr) headset felt like a very early prototype to be honest: the design was faulty, not a lot of games were optimized, and only two colors could be displayed (red and black) and motion sickness was just too big of an issue. We would have to wait until 2012 with the foundation of the Oculus company to see vr reproach the game industry and even nowadays with the multitude of headsets that are coming out vr still feels like a pricy demo, a luxury that still needs polishing and maturing. For consumer 3D printing is in that position.

The two main problems for consumers are that 3D printing is not user friendly and it lacks apparent usefulness. Problems with quality, hardware and software failure are common and tricky to solve. If computers randomly corrupted files or stopped working out of nowhere more frequently than what they do nowadays. They wouldn't probably be as mainstream as they are because they are not reliable and thus not practical. 3D printing is partially suffering from this, the percentage of failed prints can be high, especially for people who do not fully understand how the machine works and even for professional these issues can be daunting. Solutions to problems like over/under extrusion, lack of adhesion, shifting layers, gaps between layers may be related to a specific machine design and thus hard to detect if you're not a specialist. The same can be said about hardware and software failures. As far as hardware goes one single defective pin on the board can ruin your day and for software one wrongly parameter configured can transform your square into a rhombus.

The problem with usefulness or the lack of it thereof, is that most people do not think that 3D printed objects may have an impact in their daily life. The fact that you can print your own personalized iPhone case or Star Wars figure doesn't seem to be worth the investment. 3D printing needs to have a compelling application for consumers that are exclusive to home manufacturing otherwise people will prefer to buy it at the store. Right now, the maker communities are the ones who feel its usefulness. For them a 3D printer is a very powerful instrument that can assist them in their prototyping process so the investment of a machine is more useful to them than it is for a normal consumer.

Finally, a danger with home use of 3D printing is the inability to efficiently regulate what is printed and how it is used. It is possible to print functional guns. The first 3D printed gun was downloaded over 100 000 times before the United States Department of State demanded to retract the plans; however, the plans can still be obtained online in file haring sites illegally. This gives us an insight of what could be a future fight for gun control enforcement.

B. Industry

For the industry, the problems are slightly different since its requirements differ from the ones of consumers. Even though 3D printing could possibly bring new interesting possibilities that are inviable with traditional techniques there are aspects holding it back.

Time is an important factor in todays manufacturing, objects must be printed fast and in big quantities to respond to the market demand. Companies must meet certain production numbers so they can earn a benefit and continue to exist. Actual 3D printing machines can't meet the production standard of traditional techniques without sacrificing the quality of the object that also needs new methods of post processing.

Next there is also the cost of industrial grade 3D printers: anywhere from $300,000 to $1.5 million [2]. This combined to the fact that those models can't print more than one object at a time blocks the possibility of using economics of scale to fix the price of the product, however this is partially balanced by the fact that the production cost is already low.

Subsequently there is the problem of implementing it in the industry which would mean a radical change in the production chain. Although it would probably reduce it to make it more effective this would mean that many of the jobs in the sector would be no longer necessary. The unemployment rate would drastically increase, disrupting the economy. In the US, there are 12.3 million workers in the manufacturing industry, 9% of the total workforce in the country [3]. As of 2015 the unemployment rate in the country is 5.3% [4] that means that because of 3D printing there could be up to three times more unemployed. Even if the arrival of new technologies creates new jobs the situation would still take time to deal with.

Finally, the copyright sector would face new struggles as it would need to adapt and develop new regulations to protect intellectual properties from being exploited. Fair use regulations would need to be revised and probably re-established.

IV. CONCLUSION

Even though 3D printing isn't all that new we have just recently started realizing the possibilities it offers. Its arrival to the consumer market and implementation in new fields of study are a hint of how it has evolved in the past few years and of what we can expect to see from it in the future. It may not have a place in every home but it could become an instrument to favorize innovative thinking and assist in education at many levels; the industry is where it would have a meaningful impact without any doubt. Right now, its disadvantages show us what challenges we must surmount: new legislations, efficiency improvements, restructuring an entire economical sector and heavy investment. Nonetheless we see that it might be a new revolution: creation of new study fields, merge of actual ones, new scientific and technical breakthroughs, etc.

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