A connected synthesized existence: how the Internet could allow 3D printing to improve the developing world

Mark W. Datysgeld[1]

Abstract

While transformative technologies such as Artificial Intelligence have drawn much attention from academia and the media over the years, the subtler development of additive manufacture has yet to be acknowledged as having substantial weight in the shaping of our future. In this chapter, we attempt to understand how the combination of an ever expanding Internet with the increased availability of 3D printers will bring opportunities of improvement for the developing world. After pondering over the paradox of globalization that leads raw materials to be shipped across the world only to return as finished goods, we proceed to make our analysis based on empirical research and technology that is already beyond proof of concept stage, looking at examples from the construction, health and food sectors. With this data in hand, our investigation moves towards understanding the intersection between the consequences of wider scale 3D printing, a global communications network, and intellectual property rights. We outline a few possible policy routes to turn these developments into benefits for the developing world, while taking into consideration questions such as that of job relocation. Our conclusion is that before the world is caught off guard by additive manufacture and policies are enacted in a reactive manner, it is the responsibility of actors engaged in relevant arenas to advance meaningful discussion on the subject, while there is still time for the shaping of a more sustainable logic for our productive system.

---

[1] BA and Master in International Relations, focused on Internet Governance and the impacts of technology on public and private policymaking. Under the Governance Primer brand, he consults for businesses and individuals in their participation in international institutions and events that relate to technology. Mark is a lecturer and course developer, also supporting programs that increase the participation and inclusion of youth in international arenas. He has previous professional experience of several years, and at times still acts, in multimedia development and the sustainable development field. His career's production is available at: https://markwd.website

Keywords: 3D printing, Internet governance, global governance, intellectual property, policymaking

1. Introduction

When discussing the Internet and its policymaking processes, it is often more practical to put emphasis on procedures that are immediately relevant to the network and its functions, often forgetting the transversal role that it exerts over multiple emerging areas that are still taking form. The development of most technologies now depends on how the network operates, seeing as it has become the default bridge that connects the many different social actors that generate technical progress from within campuses, industries and households around the world.

In this sense, when considering developments in production and the direction economic models will take in the near future, it is key to observe how the Internet is being shaped, as it is the *de facto* international cornerstone of intellectual property rights, commercial relations, news generation and distribution, along with several other factors that inform how technologies are developed and what expectations they are supposed to meet.

In his book “War in the Age of Intelligent Machines”, Manuel DeLanda (1991) ponders over the fact that once, when clockworks were the predominant vectors of technology around the globe, people tended to imagine the world around them as a system of cogs and wheels. A person who was important to an operation but easily replaceable was just “a cog in the machine”, or a “cog in the wheel”. To facilitate a situation was to “grease the wheels”.

The Internet occupies a similar space in our collective comprehension of the contemporary world, at least as far as most people from the connected half are concerned. To “message” somebody means to instantly reach them via the Internet; we have come to think of our friends both as real people and as abstractions on a screen; we “rate” footage being watched in real time from across the globe with a single click and “close” it with the same ease. In this sense, when rethinking paradigms, the Internet cannot be removed from the equation, but rather has to be one of our central concerns.

Out of the many oddities of the contemporary world that does not seem aligned with our digital existence is the state of the industrial process. Creating a part of something, be it machinery or otherwise, depends on a production chain that starts with raw materials being extracted from the soil, then homogenized and sold as commodities, shipped to a factory that is often overseas, chipped at and reduced into the desired part, then freighted to the final consumer, who might be from the very country from which the raw material was extracted.

A quick glance at the trade relationship between Brazil and Japan illustrates a scenario that is consistent across the developing world[2], once we observe that Brazil's top export to Japan is iron ore, while its top import are automotive and tractor parts (ITAMARATY, 2016). Is it efficient to ship raw iron halfway across the world only to have it shaped into parts and then imported back to the country in which the mining initially took place?

2. The paradox of globalization

As the globalization process intensified and communication technologies became more advanced, this system became prevalent in spite of its inherent lack of sustainability. As a process, it works insofar as we consider that at the end of the day it gets goods to customers, in spite of the long and strange journey those goods have to undergo. It should not make sense, though, to send a product through this process and still end up with it costing less than it would were it manufactured in the country from which the raw material was extracted.

The answer to that question is well-known by now, but still widely ignored out of convenience: the exploitation of people living below the poverty line is the driving force behind this model. Taking China as a prime example, despite being the world leader in exports (CIA, 2016), the country still has 40% of its people living on less than 6 US Dollars a day, and its enormous rural population continues to be relocated around the country according to governmental strategies aimed at keeping the expansion of its industrial

[2] Whenever we refer to "developing world" in this chapter, there will be a focus on Latin America, as it is the region which more adequately fits the scope of this research. However, given the similar nature of struggles around the periphery, it can broadly be assumed that the questions raised here find equivalents across the developing world.

power steady, even though these workers may end up jobless and marginalized when production plans do not materialize (CHOW, 2018).

Conceptually, the development and distribution of quality goods sold at more accessible prices over a global connected network should tend towards generating better outcomes, increasing global access to technology and helping balance out opportunities in the workforce. The problem lies then in the way that corporations partner with governments to exploit their combined strength in order to generate the most surplus possible without accounting for sustainability, twisting even the best aspects of capitalism into something harmful. Worse than that, at a higher level, these very same corporations and governments fight each other over taxes and the right to either evade or withhold them (SHAXSON, 2011).

All of this has become such a key part of the common perception of how contemporary production and trade works that, apart from very specific and targeted issues such as the home manufacture of working plastic guns, it has come unnoticed to the broader population that the potentially revolutionary process of additive manufacture has become faster, more portable, and much cheaper than it used to be. The idea that in the near future we might be able to eschew more and more of this industrial process has yet to reach the perception of most.

3. Addictive manufacture arises

Better known as 3D printing, the additive manufacture process has a series of advantages and disadvantages over traditional subtractive manufacture. As time goes on, an international community of *makers* is being assembled, sharing working 3D models and collectively improving upon them, while offering support to newcomers in a multitude of languages over the Internet. Leading website *Thingiverse* has amassed a database of over one million objects as of 2018, and has a thriving community that organizes itself around different interests related to additive manufacture (MAKERBOT THINGIVERSE, 2018).

One area in which additive manufacture is quite superior to other methods is in terms of reducing the waste of materials. By mimicking the manner in which the natural world assembles itself, drop by drop, only the raw material which is going to be utilized in the final design is heated and converted from, for example, plastic filament into an actual piece. That piece is assembled layer by layer, with the desired density and characteristics, not leaving behind material to be discarded. Even so, recycling of leftover material is easy and can be done cheaply (HARDING, 2016).

Notable disadvantages lie in the fact that the process is considered even by devotees of the technology to be “messy, gritty, difficult” (RUNDLE, 2014). It cannot be ignored that the process is essentially one of melting or otherwise breaking the raw materials to condense them into a different shape, a process which would normally happen within industrial complexes away from people’s daily lives. Moving that procedure into social spaces means that solutions will have to be found to better accommodate them. The difficulty of the process is also relative often not to the printing itself, but rather in relation to both the design of the model and to the finishing of the piece, which may require some engineering knowledge, as well as chemical and physical effort.

This technology has come a long way in a short time. Born in the 1980s with the purpose of performing rapid prototyping for the industrial sector, it only started to make a dent on the home market in 2005, when mechanical engineer Adrian Bowyer began publishing in open-source over his blog plans for the RepRap, a 3D printer that could print copies of itself, needing only to be assembled with an off-the-shelf motor to function (RUNDLE, 2014). With this opportunity at hand, developers around the world began experimenting with additive manufacture, and this eventually led to the creation of the MakerBot, the most popular printer in the market, having reached 100 thousand machines sold in 2016 and retailing for around 2.500 US Dollars (WATKIN, 2016).

The flexibility of the additive manufacture process is impressive not only when looked at as a way to produce finished objects without the need for intricate artisanal or industrial techniques, but particularly due to the potential held in taking this approach of efficient production on demand in countries that have not fully reaped the benefits of the industrial revolution, and still depend on other actors to finish the products they consume.

When we consider the struggles of the developing world, many of the problems faced by countries such as those of Latin America fall into the realm of the basic, and innovative solutions are necessary to navigate them. For example, the region has largely overcome the late arrival of the Internet by skipping from personal computers straight into access by means of mobile phones, and at this point in time it is the second fastest growing mobile market in the world (GSMA, 2016). This demonstrates how it might be more valuable for the developing world to seek its own solutions rather than follow the path already trodden by developed countries.

In this sense, we will now have a brief look at three fields in which transformative potential is already demonstrable outside of the realm of science fiction, with tangible solutions that could soon start to be deployed in order for the developing world to pursue innovative solutions and achieve the proposed goal of finding answers that deviate from the formulas already in use.

3D printing was once limited to smaller objects, but this has changed dramatically, and the printing of entire houses and structures has been in testing by companies from around the world since circa 2014. Using some form of powdered concrete or even waste as the ink, these houses are cheap, fast to build, and produce reliable final results. The highest building printed so far stands at 16 meters tall, and one Chinese company has managed to produce 10 houses within a single day, demonstrating the scalability of the technology (KOSLOW, 2017).

In the developing world, this sort of solution could be used with to achieve affordable mass production of housing, as well as providing fast reposition of habitable spaces after natural disasters, which is still a major concern. Between 1990 and 2011, researchers found that the minimum losses in the housing sector for 16 countries in Latin America and the Caribbean amounted to as much as 53 billion US Dollars, and rebuilding efforts often fall short of producing decent results (UNITED NATIONS, 2013).

Another field in which 3D printing is emerging fast is health. As far as prosthetics and implants are concerned, use of this technology allows patients to receive mechanical body parts that are tailored to them from the start, assisting in adaptation and comfort. This has been a struggle throughout the history of prosthesis development, seeing as

humans have the potential to reject foreign bodies both due to physical and psychological concerns, in such a way advances towards making this process smoother are and have always been key (VENTOLA, 2014).

Preliminary tests are underway involving printing with living tissue as ink, with the goal of producing replacement organs in the future, but the printing of small-scale body parts is already becoming a certainty. Researchers at Cornell have used the additive manufacture process to print human ears with gels made of living cells as the ink, and in three months those structures grow into flexible ears with cartilage that can be used as almost identical replacements (CORNELL UNIVERSITY, 2013).

Again, the struggles of the developing world in the health sector are persistent, broad, and systemic, being affected by layers of corruption, mismanagement, and simple inefficiency. Innovative solutions such as the ones outline above are ways to start replacing expensive imports in order to provide cheaper and faster support to the ill and the destitute.

Finally, food production is a subject that still exists at the fringes of additive manufacture, as only recently viable options begun to emerge in this sector. While hunger is slowly being eradicated around the globe thanks to advances in technology and logistics (UNITED NATIONS, 2014), the fact that a person has something to eat does not necessarily mean that their diet is ideal for their development or that this enables them to lead a healthy life.

With the ability to fine tune food, it would be possible to affordably create nutrition that is rich in necessary vitamins and with target amounts of calories, as well as ensuring their longer durability and an ability to better plan for distribution, creating more efficient public policy frameworks that get food to regions that would normally be affected by distribution and management issues. Currently, printed edibles are only offered as novelties in high-end restaurants, but there is no reason for the situation to remain that way (WIGGERS, 2017).

4. The Internet of Printers

The umbrella that unifies all of these solutions and many possible others is the Internet. Different 3D printers are required to perform different tasks, in such a way that it would make more sense for them to be centralized and serve a community instead of being individualized. Those could assembled as a combination of State-run, privatized and crowd-sourced initiatives, but the key outcome is that with the help of connected devices, families would be able to interact with these printing services according to their necessity. Coupled with the collection of aggregate statistics, this would enable further analysis of each region's needs, helping formulate better policies.

There is, however, a set of complex and barely-discussed questions that are in need of examination before these potential benefits can be made real. Revolutionary technologies in the past have generally been met with skepticism during their infancy, until it becomes outright proven that they are viable, by which time preemptive actions cannot be taken anymore. While creations that appear impressive such as robots and artificial intelligence have entire university departments dedicated to studying the philosophy and economics of their implementation, the subtler 3D printing technology remains largely ignored, looming in the background (RUNDLE, 2014).

This chapter will now attempt to analyze in a non-exhaustive manner two key aspects that will make or break the adoption of the additive manufacture as one of the solutions to problems in the developing world: first, in the case that large-scale adoption of 3D printing is made possible by innovation-driven policymaking, how will the current productive environment be affected by such changes, and second, who will the owners of the blueprints be and how will enforcement of intellectual property laws be carried out under this new productive reality?

To the first point, if history serves as any guide, the answer is that such transitions are often complex and tend to cause instability at the outset. This is due to the fact that changes brought by a paradigm shift make it impossible to maintain the *status quo*, and while some activities and business models may catch up, many others simply find it impossible to do so. While some actors work towards reinventing themselves, others

attempt to stifle advances and seek regulatory or other measures to impede fast adoption of the new technology.

The widespread adoption of the telegraphic system in the late 19th century forced drastic changes in commerce, journalism, human relations, crime and war. The same can be said of the Internet, which to a large degree magnified the effects of the telegraphic revolution. The consequences to commerce in particular were significant, leaving a deep mark on businesses worldwide, and while before prices had to be formulated with a combination of historic data, attention to trends and a fair amount of guesswork, it suddenly became possible to communicate shortages and surpluses within a matter of minutes. This made it so that markets had to react much faster and become more malleable, making use of other technologies such as those of meteorological pattern tracking, reacting to ever changing outcomes. Needless to say, the Internet has taken this to a whole different level, with investors fighting for fractions of seconds to get information that will provide them with an edge (STANDAGE, 2014).

Evaluating the current state of the market, the previously described process of raw materials travelling around the world before returning as finished products could be significantly reduced. While high-end circuitry would still need to be imported from developed countries, blueprints for simpler objects could be circulated and produced locally, including replacement parts for local industial machinery, eventually progressing towards the adoption of more complex techniques to produce more specialized parts.

On-demand production based on recyclable materials would also mean less waste and a firmer hold on sustainability – which would in turn help combat accumulation of garbage and consequently reduce the risk of inundations and the spread of diseases. This would generate gains to sustainability without requiring extra effort, but in an optimistic scenario in which there is proactive government involvement, the maintenance of products could become more constant, and a culture of repairing and reuse could be furthered, which makes sense when per-capita earning is not high (FORD and DESPEISSE, 2016).

Several products that are currently branded or dependent on specific manufacturers could shift towards being produced by independent third-parties locally, including

wheelchairs, car parts, shells for electronic devices, and even more complex multi-part devices. For populations with limited expenditures, this could enable the maintenance of a higher standard of living by paying less for the same products; many of which currently arrive at abusive prices in the developing world due to import taxes and assorted backroom deals.

However, whenever governments lose hold over a major aspect of production or the economy, a series of dilemmas arise. As observed with the phenomenon of the Bitcoin boom, as soon as a technology takes off that escapes current taxation schemes, governments immediately move towards regulating and finding ways to build taxes into the technology. Following this example, in more extreme cases the solution found has been to simply shut down and prohibit operations with cryptocurrencies in certain countries (SHARMA, 2018).

One important point of contention concerns jobs. This innovative production model would end up taking employment away from certain sectors and increasing demand in others, in such a way that job relocation would become necessary. Only with proper planning and active collaboration between all involved stakeholders could this transition be smooth. Given the lackluster track record of developing world governments in the implementation of robust social policies, slack would likely need to be picked up by NGOs and private initiatives.

It should be made clear, however, that effective retention and migration of the work force between different production arrangements is not a utopic goal, and is currently being achieved by a handful of countries. In Sweden, by means of substantial federal investment on individual support during job transitions and the involvement of industry-unions in keeping watch of problematic sectors, a success rate of 90 percent has been achieved in job relocation in case of the worker being displaced by a machine (GROSE, 2018).

As far as China is concerned, the productive giant seems to be a step ahead in the game, and many of the additive manufacture strategies outlined in this chapter are either being spearheaded or supported by Chinese companies. The country may start losing profits from the exportation of certain goods, but the highest revenue from their exports

has been coming from machinery in recent years, in spite of the high volume of imports of integrated circuits (WTO, 2016). As the country begins a slow march out of impoverishment, other Asian markets also start to seem more attractive to corporations for their low wages, so China's jump into the next step of the industrial revolution is only logical.

To the second point of who will the owners of the blueprints be and how will enforcement of intellectual property laws be carried out, we again need to draw from history to evaluate how such developments may play out. As such, we will engage in a theoretical exercise and attempt to compare 3D printing with digital multimedia file sharing. While the differences between both technologies are many, the multimedia sharing example remains our best point of reference in regards to the interaction between intellectual property and the Internet, and the driving logic behind both cases is the same: a finished product can be boiled down to a digital file and sent over the Internet to be recreated elsewhere without authorization of the rights holder.

As bandwidth availability increased in the early 2000s, so did the viability of Peer-to-Peer file sharing, something that was first attempted at a large scale by means of the Napster software. While digital music files were already being traded since the early days of the Internet, the possibilities brought about by high speed connections and larger computer hard drives hit the sweet spot for the technology to take off. Popularity surged, and instead of partnering up with Napster to transition illegal trading into a more sustainable model, the industry choose to sue it out of existence. While many users were interested mostly in getting music for free, others liked the flexibility of having access to music anywhere, being able to burn tracks freely to CDs, and easily transfer tracks between devices. This was eventually proved true with the successful release of the iTunes service (KNOPPER, 2009).

The intellectual property industry has been known to handle digital matters with an aggressive approach. Streaming services for video and music have been instrumental to the decline in online multimedia piracy, particularly decreasing Peer-to-Peer trading, though for the longest time, such solutions were considered unworkable from an industry standpoint until it was proven that the ease of access was what many customers desired, not necessarily the zero price tag (NEVOLA, 2017).

According to an article published by the World Intellectual Property Organization (MALATY e ROSTAMA, 2017), existing laws are sufficient to accommodate for 3D printed objects, suggesting that international agreements for copyright and industrial design rights protect almost all aspects that the innovation brought about by additive manufacture could require. What stands out, in their point of view, is the matter of intermediary liability, questioning how accountable would platform owners of digital file lockers or printing machines be to illegal activities. They go one step further by suggesting the digital fingerprinting of models, to be identified at a base level via cooperation with 3D printer manufactures, further locked in by forming partnerships with distribution platforms.

In other words, if matters unfold as they intend, the technology will be neutered from the start, populated by patent trolls, counterproductively overregulated, and prices will be dictated according global north standards. It is not a matter of some vague need for a lawless haven for 3D printing to thrive, but it is necessary to take into account that this technology will, for the first time, create a truly global market, in which a product can be instantly transferred from one location to the other with minimal environmental impact, and produced on-demand to fit the needs of specific populations. This will carry complex, multilayered intellectual property implications that cannot simply be made to fit current laws without regard for the particularities of the technology.

Imposing tight regulations on the market will invariably lead 3D printing down the same path other recent technologies have been submitted to: abrasion with law enforcement, grey markets and mass piracy. It is a prerequisite that solutions are negotiated to accommodate the needs of developing countries, which are not the same as those of developed countries. The intellectual property industry will have, even if this is achieved through force, to come to terms with the fact that the global south is not just looking to have goods for free, but rather that income disparity is so high that setting prices in such markets is much more complicated than just figuring out the highest price a parcel of the population is willing to pay for a certain product.

This will help avoid the need for extreme action from countries in disadvantaged position and create an overall better environment for 3D printing. If this does not happen, the situation might end up turning the same way it did when Brazil, pressured

by increased prices forced on by international pharmaceutical conglomerates, opted to break the patents of AIDS drugs and produce them nationally, leaving patent holders out of the loop. This, in turn, led other global south countries to seek similar alternatives, creating a vast market of generic drugs that were still subject to patent law according to international agreements (THE ECONOMIST, 2001).

Conclusion

As we can observe, implications for the adoption of additive manufacture processes are not few. It is important to be watchful as its development unfolds, as time and again the world seems to have underestimated the effects of existing technologies, only to notice them in awe after they are rushed onto the global stage, and the battle then becomes one of reaction rather than one of finding proactive strategies to better accommodate innovations.

The developing world stands to benefit from the coming productive revolution, as long as it sets a clear perception on how to benefit from it in a sustainable and scalable manner. This is necessary on an individual level, and it is not an unattainable goal by any means, as there are already non-State actors positioned strategically within forums and arenas where such matters are starting to be discussed.

While coming governments may or may not be aligned with these goals, the international community involved in technical and policymaking processes shares a collective responsibility to act as vectors of information, working together with local media, schools, academia, trade associations, and all available venues to educate proactively and help create a connected synthesized existence that is worthwhile to all of us.

Bibliography (ABNT 6023:2002)

CHOW, E. K. China's War on Poverty Could Hurt the Poor Most. **Foreign Policy**, 2018. Disponivel em: <http://foreignpolicy.com/2018/01/08/chinas-war-on-poverty-could-hurt-the-poor-most/>. Acesso em: jan. 2018.

CIA. Country Comparison: Exports. **The World Factbook**, 2016. Disponivel em: <https://www.cia.gov/library/publications/the-world-factbook/rankorder/2078rank.html>. Acesso em: jan. 2018.

CORNELL UNIVERSITY. Bioengineers, physicians 3-D print ears that look, act real. **Cornell Chronicle**, 2013. Disponivel em: <http://news.cornell.edu/stories/2013/02/bioengineers-physicians-3-d-print-ears-look-act-real>. Acesso em: fev. 2018.

DELANDA, M. **War in the Age of Intelligent Machines**. New York City: Zone Books, 1991.

FORD, S.; DESPEISSE, M. Additive manufacturing and sustainability: an exploratory study of the advantages and challenges. **Journal of Cleaner Production**, Cambridge, v. 137, p. 1573-1587, may 2016.

GROSE, T. The Worker Retraining Challenge. **U.S. News**, 2018. Disponivel em: <https://www.usnews.com/news/best-countries/articles/2018-02-06/what-sweden-can-teach-the-world-about-worker-retraining>. Acesso em: fev. 2018.

GSMA. Mobile Internet Users in Latin America to Grow by 50 Per Cent by 2020, Finds New GSMA Study. **GSMA**, 2016. Disponivel em: <https://www.gsma.com/newsroom/press-release/mobile-internet-users-in-latin-america-to-grow-by-50-per-cent-by-2020-finds-new-gsma-study/>. Acesso em: jan. 2018.

HARDING, X. Feed Your 3D Printer Recycled Plastic. **Popular Science**, 2016. Disponivel em: <https://www.popsci.com/feed-your-3-d-printer-recycled-plastic>. Acesso em: jan. 2018.

ITAMARATY. O comércio Brasil-Japão em 2015. **Invest & Export Brasil**, 2016. Disponivel em: <http://www.investexportbrasil.gov.br/o-comercio-brasil-japao-em-2015>. Acesso em: fev. 2018.

KNOPPER, S. **Appetite for Self-Destruction:** The Spectacular Crash of the Record Industry in the Digital Age. Berkeley: Soft Skull Press, 2009.

KOSLOW, T. 3D Printed House – World's 35 Greatest 3D Printed Structures. **All3DP**, 2017. Disponivel em: <https://all3dp.com/1/3d-printed-house-homes-buildings-3d-printing-construction/>. Acesso em: jan. 2018.

MAKERBOT THINGIVERSE. About. **Thingiverse**, 2018. Disponivel em: <https://www.thingiverse.com/about/>. Acesso em: fev. 2018.

MALATY, E.; ROSTAMA, G. 3D printing and IP law. **WIPO**, 2017. Disponivel em: <http://www.wipo.int/wipo_magazine/en/2017/01/article_0006.html>. Acesso em: jan. 2018.

NEVOLA, J. Internet Piracy: The Effects of Streaming Services and the Digital Marketplace. **Science and Technology Law Review**, 2017. Disponivel em: <http://stlr.org/2017/11/14/internet-piracy-the-effects-of-streaming-services-and-the-digital-marketplace/>. Acesso em: jan. 2018.

RUNDLE, G. **A Revolution in the Making**. Melbourne: Affirm Press, 2014.

SHARMA, R. Bitcoin Has a Regulation Problem. **Investopedia**, 2018. Disponivel em: <https://www.investopedia.com/news/bitcoin-has-regulation-problem/>. Acesso em: jan. 2018.

SHAXSON, N. **Treasure Islands:** Tax Havens and the Men Who Stole the World. London: The Bodley Head, 2011.

STANDAGE, T. **The Victorian Internet:** The Remarkable Story of the Telegraph and the Nineteenth Century's On-Line Pioneers. New York City: Bloomsbury USA, 2014.

THE ECONOMIST. Brazil and AIDS drugs: A cure for high prices. **The Economist**, 2001. Disponivel em: <http://www.economist.com/node/623985>. Acesso em: jan. 2018.

UNITED NATIONS. **Impacto de los desastres en América Latina y el Caribe 1990-2011: tendencias y estadísticas para 16 países**. UNISDR. [S.l.], p. 72. 2013.

UNITED NATIONS. World hunger falls, but 805 million still chronically undernourished. **Food and Agriculture Organization of the United Nations**, 2014. Disponivel em: <http://www.fao.org/news/story/en/item/243839/icode/>. Acesso em: fev. 2018.

VENTOLA, L. Medical Applications for 3D Printing: Current and Projected Uses. **Pharmacy and Therapeutics**, Yardley, v. 39, n. 10, p. 704-711, oct. 2014.

WATKIN, H. MakerBot Milestone: 100,000 3D Printers Sold Worldwide. **All3DP**, 2016. Disponivel em: <https://all3dp.com/makerbot-milestone/>. Acesso em: jan. 2018.

WIGGERS, K. From pixels to plate, food has become 3D printing's delicious new frontier. **Digital Trends**, 2017. Disponivel em: <https://www.digitaltrends.com/cool-tech/3d-food-printers-how-they-could-change-what-you-eat/>. Acesso em: jan. 2018.

WTO. Trade Profiles – China. **World Trade Organization**, 2016. Disponivel em: <http://stat.wto.org/CountryProfile/WSDBCountryPFView.aspx?&Country=CN>. Acesso em: jan. 2018.