3D Printing

I. Introducing 3D Printing

3D Printing Technology: 3D printing uses a process called *additive manufacturing* to create three dimensional items from computer models. It's called additive manufacturing because the printer is adding material layer by layer. Additive manufacturing can be contrasted with *subtractive manufacturing*, which involves taking raw material and subtracting away whatever material is unnecessary for the intended outcome (think about how sculpting works). There are many different technologies that can be used for additive manufacturing, but one common version works similarly to a traditional inkjet printer. As Neely explains, "When we print a document, we send a file to the printer which causes the printer head to move back and forth across the paper, depositing ink in the right spaces to create text, pictures, or whatever else the file dictates. A 3D printer works similarly: a file tells the printer where to deposit materials, but the print heads generally contain either a liquid material or a powder which is heated to barely over its melting point; the material solidifies soon after being deposited. By making multiple passes, the printer can deposit layers of material, thus gradually building up a three- dimensional object" (Neely 2015: 2).

Three Main Elements of Additive Manufacturing: (1) Computer aided design (CAD) program, (2) Raw material for the desired object (e.g. metal or plastic), (3) 3D printer that is able to work with the selected raw materials

Two Current Limitations of 3D Printing: (a) Raw materials capable of being printed (current 3D printers are adept at working with plastic, but not with metals), (b) Cost efficiency (high end 3D printers can cost tens to hundreds of thousands of dollars)

Benefits of 3D Printing: Practically endless**.** 3D printing technology has the potential to transform many different industries. Generally speaking, the technology has the capacity to transform physical, real-world industries into information technology industries. Here are some examples:

- **Medicine:** bioprinting (where biomaterials such as cells and growth factors are combined to create tissue-like structures that imitate natural tissues), personalized prosthetics (Banks 2013), copies of tumors for surgeons to investigate without operating on living patients (Thilmany 2012), organ fabrication (Fischer 2013), respirator parts for covid-19 patients (Feldman 2020)

- **Construction**: small houses can be 3D printed in less than 24 hours at a cost of $4,000. The housing charity organization New Story has partnered with the construction tech company ICON to end global homelessness, the first fully 3D printed residential building was constructed in Yaroslavl, Russia in 2017, the first 3D printed pedestrian bridge was constructed in Madrid, Spain in 2016.

- **Education:** low cost, high quality scientific equipment fabrication, duplication of museum items like fossils and historical artifacts, 3-dimensional perspective of topographic maps, 3D models of molecules and chemical compounds

- **Manufacturing:** rapid prototyping (ability to design, manufacture, and test a part efficiently), cost-effective (traditional CNC machining and injection molding require numerous expensive parts), flexibility and customization (can change parts and design without changing physical machinery), higher quality goods, risk reduction, accessibility (can be operated by a wider range of people), environmental impact (additive manufacturing is less wasteful than subtractive manufacturing, allows a reduction in supply chain)

- **Food industry:** practically any food can theoretically be 3D printed. Foods that have already been 3D printed include pizza, chocolate, pasta, sugar, etc. Examples of 3D food printing technology include 3D Systems' ChefJet, Natural Machines' Foodini, and BeeHex's Chef3D. Nasa began researching 3D pained food in 2006 to try to figure out a sustainable way to feed astronauts for long missions.

Downsides of 3D Printing: (1) Safety concerns (general regulatory concerns and concerns about specific object like 3D weapons), (2) Intellectual Property concerns, (3) Unemployment concerns (especially in industries like manufacturing, construction, and the food industry)

II. Safety Concerns

Safety Regulations Currently Depend Upon Centralized Manufacturing: Product safety regulations currently depend on centralized manufacturing. Products are tested as safe and factories are inspected to ensure that the factory-generated products match the safety tested product. The problem is that this model of safety regulation goes out the window with the advent of decentralized 3D printing machines that may be located in a person's home. We want to ensure that the objects that consumers 3D print in their homes are safe (e.g. 3D printed chairs do not collapse under weight, 3D printed scuba hoses do not collapse under a significant amount of pressure).

Regulating the Software as Opposed to the Hardware: A natural suggestion is to regulate the design plans that are used in 3D printing. These design plans are often shared online at well known websites. By preventing unsafe plans from being distributed, consumers would be protected from unwittingly printing unsafe objects. However, an immediate problem arises on this front. Namely, the government has historically had trouble effectively regulating information online. For example, the Digital Millennium Copyright Act was implemented to prevent the pirating of music but music printing happens all of the time. Likewise, as we will seen, the design plan for the 3D gun 'the Liberator' were ordered by the US government to be taken down but could still be accessed elsewhere like The Pirate Bay.

Should There Be No Regulation?: Traditional safety regulations apply to manufactured goods that are *sold to consumers* and not to manufactured goods that are *created by consumers*. For example, if an artisan builds a flimsy chair and gets injured from it, the responsibility is his or her own. If 3D printed goods are created by people according to their own specifications, then maybe the idea of safety regulations does not apply.

- **Problem with No Regulation Solution:** The problem with this solution is that more often than not, people operating a 3D printer will be using someone else's design plan as opposed to a design plan that they personally devised. Now, one could say that by downloading and using the design, the consumers in effect consenting to any possible harm and thus bears responsibility for all of the risk. However, there is a legitimate question as to whether the consent given in cases like this constitutes *informed consent*. If it is not informed consent, then the consent given may be invalid. As Neely elaborates: "For instance, in the United States, the Consumer Product Safety Act (1972) states that [the] complexities of consumer products and the diverse nature and abilities of consumers using them frequently result in an inability of users to anticipate risks and to safeguard themselves adequately In essence, this argues that products and the people who use them are sufficiently varied that we cannot assume that users are able to assess the risks of particular products. If this is the case for ordinary manufactured products, it should also hold for 3D printed ones" (Neely 2015: 6).

- **Rejoinder to Problem:** In response to this problem, one might insist that government regulation is unnecessary because 3D design communities will self-regulate, meaning that consumers will not face the risk on downloading unsafe design plans. For example, the design community might rate different designs such that only designs with very high ratings would be downloaded. Nevertheless, there are issues with this rejoinder. For example, how can you ensure that the people who do the rating have the requisite technical knowledge about consumer safety?

- **Need Not Be Government Regulation:** In light of these issues, Neely ultimately argus that some kind of regulation is necessary when it comes to the distribution of 3D design plans. However, she notes that this regulation need not come from a government body but could come from some professional organization: "I believe that it will be necessary to involve a standards body of some kind, whether governmental or through a professional organization; a plan could be certified by the Institute of Electrical and Electronics Engineers (IEEE) or the American Society of Mechanical Engineers (ASME) or whatever body is appropriate for the particular design" (Neely 2015: 7)

III. The Specific Safety Issue of 3D Weapons

Connection to Internet Censorship and Vulnerable World Hypothesis: The issue of 3D printed guns ties directly into the previously discussed internet censorship topic (see Muller's paper 'Some Information is Too Dangerous to be Online') and the Vulnerable World Hypothesis (see Bostrom paper in surveillance folder).

Brief History of 3D guns: Cody Wilson is the first person to create a 3D printed gun. He was a law student at the university of Texas before creating his own open source hardware company called Defense Distributed. On May 3rd, 2013, the design plans for creating the first 3D gun were published online for free by Defense Distributed. The publication of these blueprints was accompanied by a youtube video of Cody Wilson shooting the gun (which he called the Liberator) for the first time. The liberator is a one bullet gun that consists of 16 parts, 15 of which can be 3D printed.

Government backlash to blueprints being published online: There was immediate backlash to Wilson publishing the blueprints to this weapon online. Five days later, on May 8th 2013, the US department of States, Bureau of Political-military affairs, and office of defense trade control compliance, sent a letter to Wilson demanding that he take down the blueprints because he was violating the Export Control Act (designed to restrict the export of military related technologies to protect U.S. national security). Wilson complied, though the blueprints were apparently downloaded more than 10,000 times within that five day span.

A First and Second Amendment Issue: Wilson and his team countersued against the State Department claiming that they were infringing upon his first amendment rights to free speech. This was an interesting move. The topic of 3D weapons is obviously a second amendment issue, but Wilson forced people to recognize that it is also a first amendment issue as well.

- **Quote on the First and Second Amendment Issue:** "There is a large amount of Constitutional debate on any regulations that may pertain to 3D printed weapons. The most obvious is the Second Amendment, which protects an individual right to keep and bear arms. The amendment also recognizes the right to acquire and make arms. Therefore, any ban on 3D printers creating weapons would be in violation of the right to make arms. There is an additional argument that banning 3D printing weapons would also affect the right to acquire arms as well. For example, a physically handicapped person's only way of acquiring a weapon might be through the creation of a customized weapon on a 3D printer. Another Constitutional Amendment surrounding 3D printed weapons is the first amendment – the right to free speech. Was it legal for the State Department to request Defense Distributed to take down the CAD files of the first 3D printable gun, the Liberator? Or was this in violation of free speech? There also exists the difficulty of preventing people from sharing CAD files of 3D weapons – is that even feasible to monitor? A bulletin from the Department of Homeland Security stated that "even if the practice is prohibited by new legislation, online distribution of these digital files will be as difficult to control as any other illegally traded music, movie, or software files." (https://3dprinters181.wordpress.com/weapons/ by Jack Bordoni)

Two Specific Security Risks Associated with 3D Guns: 3D guns pose security risks that normal guns do not pose. Namely, 3D guns are *untraceable* and they are *largely invisible to metal detectors*, which opens the door to the possibility of terrorists sneaking 3D weapons onto a plane, for example. In response, to the latter threat a metal detector law has been implemented related to 3D printed guns. Moreover, it is worth noting that current 3D guns require metal bullets, as the technology does not yet have the capacity to manufacture effective plastic bullets.

- **Quote on Metal Detector Law:** "In December 2013, a federal law requiring that all guns be detectable by metal screening machines was extended for another 10 years. The law prohibits guns that don't contain enough metal to trigger screening machines commonly found in airports, courthouses and other secure areas accessible to the public. Plastic gun designs got around this restriction by adding a removable metal block, which isn't required for the firearm to function. In June, Sen. Bill Nelson, D-Florida, introduced a bill in the Senate that would amend the Undetectable Firearms Act to prohibit firearms that do not have a major component that can be detected at airport security screening" (https://www.cnn.com/2018/07/31/us/3d-printed-plastic-guns/index.html; August 2nd, 2018).

Three Current Limitations of 3D guns: (1) Printing a 3D gun is currently extremely expensive. For example, the M1911 metal gun printed by Solid Concepts required over 100 hours of printing and costs $10,000 for the gun itself, not including the cost of the $100,000 printer it was printed on. So, its much easier right now for a criminal to get a normal gun as opposed to a 3D printing gun; (2) The performance of the guns currently depends on the kind of plastic used in the creation. For example, the use of plastic from the company Visijet resulted in the explosion of the gun during firing; (3) Even when someone can get access to the gun and the gun works, it will still not be that effective in a terrorist situation, at least if we are talking about one bullet guns like the liberator. For the terrorist will have to immediately reload. Of course, as the technology develops, these limitations could fade away. I know that blueprints have already been published online for semi-3D automatic guns, and we could see the cost and efficiency of the guns drop as time moves on as well.

Current legal predicament of 3D Weapons: In June of 2018, the Trump administration reached a settlement allowing Defense Distributed to post the blueprints online but this settlement has been blocked by a federal judge. James Vincent writing for TheVerge on November 13th, 2019, writes "A federal judge has struck down a decision by the Trump administration to allow blueprints for 3D-printed guns to be shared online. In a ruling published Tuesday, Judge Robert Lasnik said the deal made in July last year was "arbitrary and capricious" and thus a violation of the federal Administrative Procedure Act and the Constitution**" (**https://www.theverge.com/2019/11/13/20962658/3d-printed-gun-download-ban-reversed-trump-administration-defense-distributed)

IV. Intellectual Property Concerns

Two Different Ways to Engage in Intellectual Property Theft Using a 3D Printer: It is currently hard for individuals to reproduce products that are made in factories, as this typically requires a similar extensive manufacturing set up. Thus, the threat that most companies currently face when it comes to intellectual property theft comes not from individuals, but rather from other companies. However, 3D prating allows individuals to engage in intellectual property theft in two different ways: (1) Using a copy of the relevant CAD program to 3D print the desired object, (2) Using a 3D scanner to scan an object and devise an original CAD program for how to print it. In the case of (1), all of a company needs to do is protect their CAD program. If a person obtains an illegal copy of this program, then that is a kind of theft. As Neely notes, however, the case of (2) is a bit more complicated as it does not involve theft in any straightforward sense. Moreover, (2) is a kind

of intellectual property theft, it will be extremely hard to find and prosecute individuals who print single copies of objects.

- **Patents and 3D printing:** "The patenting of an invention is a process that has to be undertaken by the inventor or his/her agent; it must be applied for, and the invention must exhibit some degree of originality and not be obvious. Many manufactured or produced objects are not patented, although particular parts of them may be. As such, you will not necessarily be violating a patent by scanning a common object, unless that item or a part of it has been patented" (Neely 2015: 9).

- **Trademark and 3D printing:** "Trademark refers to a manufacturer's mark, and exists mainly to designate something as authorized; it exists to protect the consumer from illicit copies. Assuming that a person is creating something for home use, trademark protection does not apply since presumably she will be aware that she 3D printed it—there is no way to deceive herself, so she does not require the consumer protection of trademark. If the object is being distributed, and thus there is some concern about deception, that can easily be addressed by simply omitting the trademarked image or symbol; the rest of the object can be printed without infringement" (Neely 2015: 9).

- **Copyright and 3D printing:** "Copyright is probably the kind of intellectual property which is most familiar to a general audience, since it exists automatically and pertains to photographs, texts, and other common forms of creative expression. With respect to an object, copyright applies to the artistic or decorative elements of an object; an object itself is only subject to copyright if it is intended to be a sculpture or purely decorative. As such, assuming the item is not a sculpture, the decorative element of an item could be copyrighted, but the rest of the item is not; if you altered your plan to omit the copyrighted element, then the object could be legally reproduced" (Neely 2015: 9).

The Question of Intellectual Property and Creativity: The upshot of Neely's argument is that currently existing intellectual property laws cannot stop people from scanning objects and recreating those objects using a unique CAD program (with the exception of patented objects). Do you still nevertheless feel as if 3D scanning involves a kind of intellectual property theft? Should we change exiting intellectual property laws in response to the advent of 3D scanning? Neely answers in the negative. She first emphasizes that one of the main motivations behind IP law is to reward creativity and innovation. Then, she argues that what counts as creative and innovative changes over time and that the advent of 3D printing renders things that were previously creative and innovative no longer creative and innovative. She concludes on this basis that we do not need to radically modify existing intellectual property laws in response to 3D scanning: "we have reached a point where designing a physical object is not sufficient to count as particularly creative. If the object is particularly artistic, we might recognize that. If creating it involves new manufacturing techniques that cannot be easily copied, then that will almost certainly be eligible to be protected. Yet it may simply be that, as a society, we do not think that manufacturing a common object is deserving of protection; a person or company must do more to count a putative invention as being innovative" (Neely 2015: 11). Do you agree with Neely's argument here?

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