The Effects of In-home 3D Printing on Product Liability Law

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Executive Summary: Additive manufacturing (AM) – also known as 3D printing – has undergone rapid development, fundamentally shifting the applied use of the technology from prototyping to the production of end-user parts and products. Smaller and more portable printers at a low cost may soon be in the homes of the general public. This progression has the potential to cause fundamental changes by integrating the consumer into the traditional supply chain. This shift will transform the consumer-manufacturer relationship, which is the foundation behind product liability law, and the current path to in-home 3D printing does not conform to the administration of product liability law. This incongruence has the potential to introduce market externalities, with implications for both future AM innovation and for consumer safety. In order to overcome some challenges accompanying in-home use of 3D printers, I recommend the institution of a clearinghouse of 3D printing design files to help restore the institution of product liability law, protect the general public, and continue future AM innovation.

1. Introduction

Additive manufacturing (AM) – also known as 3D printing – has undergone rapid development in recent years, shifting the use of the technology from prototyping to producing end-user parts and products. Small portable printers at a low cost may soon be in the homes of the general public. This progression has the potential to fundamentally change the traditional supply chain by incorporating the consumer who acts as the product manufacturer. This shift transforms the consumer-manufacturer relationship and effectively eliminates the third party insurance system, which is the foundation of product liability law in the United States.

The expansion of in-home 3D printing is thus likely to destabilize product liability law by introducing market externalities and uncertainty in determining the responsible party. The technology is still new and flawed. The printing process is not perfectly repeatable and lacks traceability, making it nearly impossible to identify who is responsible for a product defect. Market externalities arise in the absence of an insurance system that can no longer spread the cost to the general public. Courts will be faced with the decision to either uphold designer and online platform licenses, or to deem them invalid. Their decision will disrupt the balance between innovation and consumer safety, and, without an insurance system in place, market externalities will remain. Regardless of forthcoming court decisions regarding 3D printing and product liability, there will be no guarantee for sufficient injury compensation.

New policy is needed to correct the market externality and provide a robust approach to preserving the foundation of product liability law. Limited in its scope to in-home 3D printing for personal product use only, this technology analysis explains the policy implications of the rise of AM and recommends the institution of a clearinghouse to restore product liability law, protect the general public, and continue future AM innovation.

2. Background

AM has advanced tremendously since it was first developed in 1984 when Charles Hull introduced stereolithography, a process that transforms digital data into tangible objects (Grynol n.d.). Over the years, numerous AM methods have been developed to build three-dimensional (3D) objects. The techniques have been organized into seven broad process categories (Scott et al. 2012). These categories include: vat photopolymerization, material jetting, material extrusion, powder bed fusion, binder jetting, sheet lamination, and direct energy deposition (Cotteleer et al. 2014). All techniques involve the same general process. AM begins with a computer-aided design (CAD) file that provides the "exact specifications" for a 3D object (Peacock 2014). The design is sliced into very small horizontal cross-sections, essentially producing two-dimensional (2D) pieces that aggregate to the original object. Raw materials are positioned to match the 2D cross-sectional pattern and then are formed together using a technique from one of the seven categories, such as laser sintering. This process repeats with the next cross-section placed on top. Using an additive procedure, the 2D pieces are stacked layer by layer to form the object specified by the CAD design (Desai and Magliocca 2013).

Initially, prototyping was the main application of this technology. Yet technological advancements have expanded the use of 3D printing to functional testing, tooling for molding and casting, and most recently direct end-user part and product manufacturing (Campbell et al. 2011), which is the fastest growing application (Wohlers & Caffrey 2013). Two recent improvements have led to this development: direct metal AM and desktop-scale printers (Campbell et al. 2011). These innovations have brought benefits, challenges, and changes to the manufacturing industry.

Direct metal AM and desktop-scale printer advancements have sparked the interest of two different societal groups. Through direct metal AM, engineers have been able to create what Campell et al. (2011) describe as "fully functional components from titanium and various steel alloys featuring material properties that are equivalent to their traditionally manufactured counterparts." This capability has the potential to benefit many industries by enabling the production of end use metal parts. Both the automotive and aircraft industries have shown interest in this development. In comparison, the desktop-scale printers have "democratized manufacturing" (Campbell et al. 2011). Numerous "smaller and more portable" 3D printers have been introduced to the market at a lower cost bringing the technology to the general public (Grynol n.d.). Hobbyists and tinkerers now have the opportunity to experiment and create their own products.

Today 3D printers are available for a range of different prices. Many are offered for under $1,000, with the lowest price around $200 (Voo n.d.). Fab@Home is an example of a low cost printing system that has recently been introduced to the public. Kits can be purchased and assembled with only minimal tools required. Users have printed objects ranging from batteries and actuators to edible chocolate structures (Gibson et al. 2010). Rinnovated Design is currently working on the Peachy Printer – a new user-friendly device that will cost a mere $100. The company's goal is to decrease the cost and difficulty of use allowing for dispersion into the homes of the general public ("The Peachy Printer" n.d.). This project is an example of how low-cost 3D printers have fueled the "maker movement" by inspiring further innovation and creation of objects for personal use.

The "maker movement" was originally introduced by Dale Dougherty who is the founder of the magazine Make and the creator of the Maker Faire, where "makers" gather to share their new inventions with others. This movement is led by a community of people who find "their lives enriched by creating something new and learning new skills." (Dougherty 2012). These individuals are often labeled as Do-It-Yourself (DIY). Both the magazine Make and the Maker Faire events have given hobbyists the opportunity to connect with others, share their ideas, and learn new skills. The community stresses the importance of collaborative invention through online communities, as well as physical spaces called 'Makerspaces' (Gobble 2013). TJ McCue (2012), an organizer of a Mini Maker Faire, described the development of the community from DIY to Do-It-With-Others or Do-It-Together. Small, desktop 3D printers have contributed to the growth of the "maker" community. Hobbyists and tinkerers have benefited from having the ability to design, share, and produce their own products.

This opportunity has created a "new market for the dissemination and exploitation of ideas" (Peacock 2014) and has introduced "a broader 'maker movement' that seeks to empower people" (Desai and Magliocca 2013). Collaboration has driven 3D printing innovations. CAD software is widely used today by engineers, designers, and architects, who have learned the software

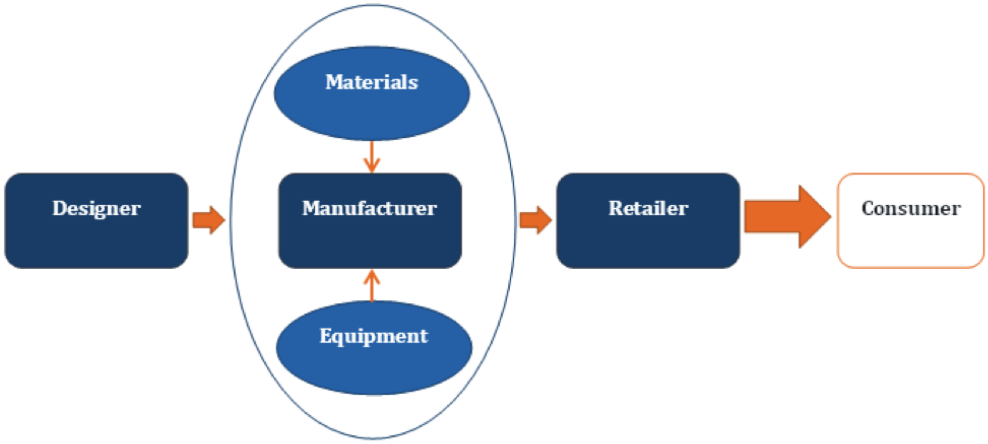

Figure 1: Traditional Supply Chain. The dark blocks represent the three chain components – designer, manufacturer, and retailer. The ovals depict the external resource network for the manufacturer component. The orange arrows illustrate the product development flow through the supply chain. The consumer obtains the good outside of the supply chain.

(Weinberg 2010). Without training, the program is not easy to use. 3D objects must be designed from a 2D perspective (Campbell 2012). Online communities have emerged to benefit all users through which anyone can take advantage of the available CAD files to simplify the design process, while hobbyists can download, modify, and build on others' designs to advance their 3D printed creations.

Beyond having the ability to create "new innovations without financial, technological or human capital support from large organizations," this technology has created a new space to share ideas and innovate (Grynol n.d.). The digital properties of CAD designs have formed a "new open access network of invention over the Internet" (Peacock 2014). A platform of new online websites has enabled users to share, trade, modify, and print designs. For example, Thingiverse provides a database filled with designs for anyone to download, modify, and print at no cost (Frandsen et al. 2012). The website is described as "a thriving community for discovering, making, and sharing 3D printable things" ("Thingiverse" n.d.). The combination of affordable 3D printers and readily available designs enables the home production of simple products at a reasonably low cost with consumer flexibility (Sissons & Thompson 2012).

In considering future implications, Stanford University associate professor Nora Engstrom brings attention to some potential issues resulting from printing what she describes as the more "complex, sophisticated, and dangerous" products being printed at home (Engstrom 2013). Consumer empowerment is two-fold: with greater capabilities comes greater responsibility. Now acting as manufacturers, consumers must consider the potential consequences of their creations. Producing in-home will transform the future supply chain by combining the consumer and manufacturer roles, raising various legal concerns.

3. Supply Chains

The traditional supply chain (Figure 1) consists of a designer, manufacturer, and retailer (Stewart and Wohlers 2011). Each role in the chain influences the supply of end-user parts and products for consumers. The designer provides the design to the manufacturer, who produces the product for the retailer, who then sells the product to the consumer. All components depend on one another to meet the consumer demand, in addition to external resources needed to fulfill their given role. The manufacturer is responsible for not only producing the provided design, but having the necessary equipment and materials. Additionally, the manufacturer must maintain the equipment and produce goods to meet industry standards. To meet these requirements, manufacturers follow procedures and perform product testing, recognizing that they will most likely be held liable for loss and damage resulting from product defects.

Today product safety problems are magnified in terms of scale and scope due to the development of global supply chains. In recent years, the supply chain has dramatically expanded internationally through the process of globalization. This expansion has significantly increased the complexity of control management and tracking. Issues have been "traced back to design flaws, manufacturing or processing defects, software problems, and packaging errors" due in part to the complexity of the global supply chain (Marucheck et al. 2011). A lack of quality control and safety measures has contributed to these problems.

United States agencies have already taken steps to address some of these issues. The Consumer Product Safety Commission is responsible for overseeing and regulating some consumer products distributed in the United States. They enforce mandatory product standards, research hazardous products, and work with industry to develop voluntary standards to support public safety. Other agencies, such as the Federal Aviation Administration and the Food and Drug Administration, regulate consumer products within their given domain (US CPSC n.d.). In addition to government efforts, companies are incentivized to stress safety and reduce risk through the legal repercussions of tort liability. Quality system assessments for production and testing processes have been introduced to assist in supply chain management. Product life-cycle management has also been implemented in an attempt to collect design, production, support, and dispose data (Marucheck et al. 2011). This is a difficult task, but is critical for traceability. Tracking and tracing is vital for product identification, especially for the detection of counterfeit goods. Furthermore, companies perform hazard analysis to identify potential threats and risks within the system process. These solutions have been adopted into the globalized supply chain in an effort to improve consumer safety and mitigate risk.

In-home printing brings the consumer into the supply chain, in effect merging two supply chain components. There are two kinds of use scenarios to consider for in-home printing and production.

The first use scenario (Figure 2A) is when the consumer constructs and prints his or her own design. In this model, the consumer becomes the designer, manufacturer, and consumer, forming a supply chain with a single component. The retailer role has been eliminated. Another subset of this use scenario would be when a user downloads, customizes, and prints a design from an online community. This adds complexity by complicating the designer role. It is unclear whether the level of customization or the final designer will assume the role. The resulting ambiguity identifies a weakness in the supply chain that will most likely cause future disputes between designers who share their personal files and the final designers who modify and print the shared design. For this analysis, the final designer will assume the designer role.

The second use scenario (Figure 2B) is when the consumer downloads a CAD file design and prints the product at home. This model has three central components. The first component in the chain is the designer who provides the CAD file for the digital community. The second component is the website source acting as the retailer. Somewhat similar to the first model, the third component combines the consumer and manufacturer into one role.

In both use scenarios, the resultant supply chain model reduces the dependence on multiple components. Although this simplifies the chain, the open-source design community adds complexity to design traceability. As Frandsen et al. (2012) describe, open source software is "a model for production and product development that is characterized by open access to and free distribution of product designs and implementation details." This lack of traceability would pose a significant risk to quality control management; however no standards or regulations have been established for in-home 3D printing.

The "maker movement" has, in effect, established a digital supply chain and distribution process (Ideas Lab 2013). This new production model has developed around hobbyists who upload and share open-source CAD file designs for others to download and modify. Once a CAD file has been created, it can be widely distributed to the world through the internet (Weinberg 2010). Expanding upon the Etsy online marketplace model where users can sell and purchase customized goods, CAD file designs can be downloaded for free (Desai and Magliocca 2013). However, unlike enterprises that stress safety and perform testing, homemade goods are not inspected. They do not undergo testing, nor do they come with warnings. The consumer choosing to embody the manufacturing role risks the absence of product management.

Within the new supply chain, the common factor in both use scenarios is the merged consumer manufacturer role. Integrating the manufacturer duties, the consumer is forced to accept greater

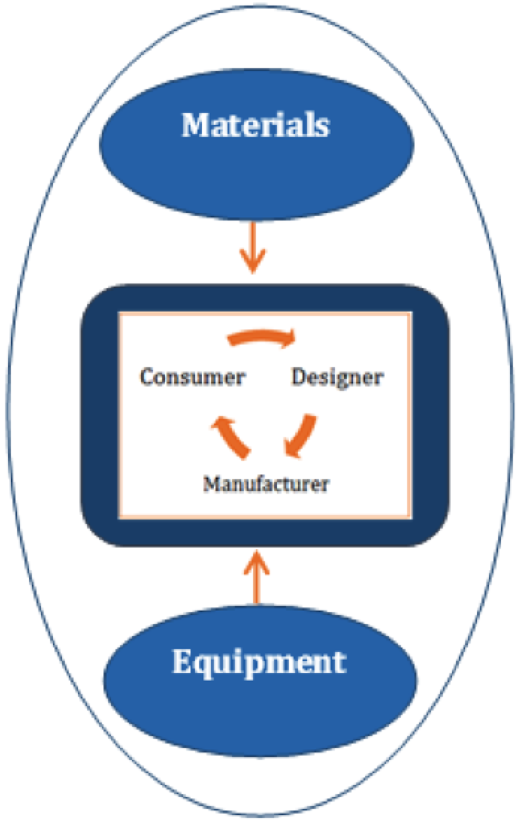

Figure 2A: New Supply Chain – Use Scenario 1. The new supply chain has only one component embodying the roles of the designer, manufacturer, and consumer. The product development flow is within this one component. The external resource network derived from the original manufacturer component continues to support product development.

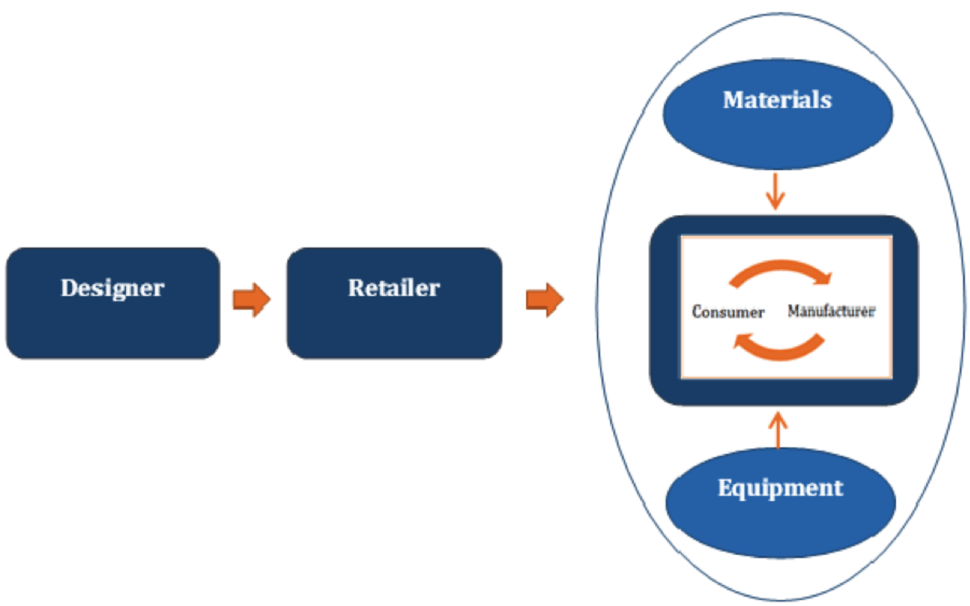

Figure 2B: New Supply Chain – Use Scenario 2. The new supply chain has the original three components. The consumer has entered the supply chain by combining the manufacturer and consumer roles. The manufacturing external resource network supports the consumer-manufacturer component for production development. The retailer and manufacturing components have been interchanged.

responsibility. Keeton (1965) describes, "Recent cases make it clear that a manufacturer is not to be judged simply on the basis of what he knows and what manufacturers generally know. Rather he is often expected to know at least what an investigation of the scientific literature will disclose, i.e., he must keep reasonably abreast of scientific information." The manufacturer is held accountable for researching product dangers and taking necessary precautions prior to making a product (Keeton 1965). Applying this expectation to the new model, the consumer must be aware of any potential dangers resulting from the use of in-home 3D printers and the complementary materials.

Another element requiring attention is open source provisions within the online community. As Frandsen et al. (2012) explain, open source licenses often assert that "the licensor waive guaranties and liability to the largest extent allowed by the law to assure the risk of using the product is shifted from the licensor to the user." These licenses apply to both the websites distributing the designs, as well as the designers providing the CAD files. For example, Thingiverse maintains an open platform and encourages all designs to be licensed under a Creative Common (CC) license ("Thingiverse" n.d.). CC licenses were created to build a digital commons of content that could be "copied, distributed, edited, remixed, and built upon" within the boundaries of copyright law (Creative Commons n.d.). These promote technological developments by offering inventors and hobbyists credit, while also allowing for distributing, copying, and derivative work. There are six available licenses with three requirements: (1) licensees must credit the licensor, (2) copyright notices must stay intact on all copies of work, and (3) licenses must link to the copies of work (Creative Commons n.d.). Beyond understanding the open-source provisions, consumers must be aware of the websites terms of use. Thingiverse uses their terms to protect the company from damage and loss liability and remove any legal responsibility. The terms of use also include indemnification to exclude the company from any website related disputes. These provisions force the consumer to accept great responsibility.

The major concern of in-home 3D printing is determining the supply chain component as liable for product damages and losses. Without the manufacturer-consumer relationship, perplexing legal disputes will most likely arise. Currently there is no legal precedent concerning these issues (Ideas Lab 2013). CAD files and 3D printers have yet to be examined by the court system (Peacock 2014). A consumer could attempt to sue the contributing chain components – the distributor and the designer – along with the resources within their own network – the equipment or material suppliers. Applying the current product liability law framework will demonstrate the difficulty associated with distinguishing and assigning accountability. The weakness of the in-home 3D printing process exposes the additional burden assumed by the newly defined consumer-manufacturer.

4. Product Liability

Acting as the consumer and manufacturer, the user must accept the responsibilities of both parties. First the consumer is expected to use the product for its intended purpose. Injuries and damages resulting from negligence will be the consumer's fault. Second, the manufacturer is expected to know any information an investigation would conclude regarding the production of a product. In addition, the manufacturer will be responsible for verifying the legitimacy and safety of a design taken from an open source platform. These responsibilities have liability implications for the consumer-manufacturer.

Liability results from tortious conduct by a defendant that causes harm to a plaintiff of the general class. As Harper (1993) describes, "This conduct is characterized as either (1) conduct intended to invade the plaintiff's interests, (2) conduct that is negligent toward the plaintiff's interests, (3) conduct which is extra-hazardous toward the plaintiff's interests." Product liability law has two main purposes: to provide injured consumers with compensation through a third-party accident insurance system imposed on manufacturers to spread the risk and to improve product safety by reducing the production of dangerous products (Owen 1992). Product liability exists throughout the United States and is settled at the state level.

A common defense against product liability lawsuits is contributory negligence, which disentitles the plaintiff from recovering damages due to his own fault (Harper 1993). Today contributory negligence has been adapted to comparative negligence by almost all United States. Comparative negligence "places liability for the economic loss suffered by the plaintiff on each of the parties in proportion to their fault." Two types have been used in the United States: pure and partial comparative negligence. Most states use partial comparative negligence, which requires the defendant to be more at fault than the plaintiff, where as pure comparative negligence does not (Enghagen 1992). This theory provides a strong defense against the in-home 3D printer scenario.

Applying contributory negligence to the first use scenario, the plaintiff embodies the single component in the supply chain. The resources within the manufacturing network are the only other potential sources of liability. The plaintiff could attempt to hold the 3D printer company and the material supplier responsible for a product defect. However, the contributory negligence defense exploits the interdependence of the 3D production process.

Current AM technology lacks repeatability. Parts must be evaluated on a "case-by-case basis" (Ideas Lab 2013). Some flaws can be attributed to file conversion errors when the design data are extracted from the CAD file and transformed into an STL file for 3D printing purposes. Problems can arise from unit changes, geometry formation, inaccurate geometric alignment, and poorly generated models (Gibson et al. 2010). A design created for production on one printer with designated materials could produce an object with characteristics unlike the original CAD file. "This fluid interplay between the design, the materials, and the printing process makes liability difficult to establish in the event of a loss" ("Printing in the Third Dimension." 2014). For example, imagine your kitchen table has an old screw needing replacement. Rather than searching for a matching screw online or in stores, you decide to print a new screw at home. If the table collapses due to the new screw and results in damages or injuries, it will be difficult to determine the cause of the product defect. The interdependent process obscures the ability to identify a culpable party. Courts will likely struggle to distinguish the responsible parties and assign appropriate levels of liability to the various defendants, especially with lacking substantial evidence. The plaintiff will be unlikely to overcome this absence of traceability in the production processes.

The second use scenario includes three supply chain components; the designer, the retailer, and the consumer-manufacturer. The consumer-manufacturer component is represented as in the first use scenario and introduces the same liability concerns previously discussed. The designer and retailer roles are two new chain components connecting to the consumer-manufacturer. These components offer two potentially liable parties. However, the market path to digital designs presents multiple issues. Websites acting as the retailer do not sell CAD files to consumers. Rather the website provides an open-source digital commons for free design sharing. The open-source licenses, the CC design licenses, and the terms of use place all risk on the consumer. A downloaded open-source design could have multiple authors and overlook the traditional "contractual arrangements between supply chain" components ("The Future in 3D" 2013). The unregulated designs can be rapidly distributed and transmitted on a global scale without common work standards ("Printing in the Third Dimension." 2014; Sissons & Thompson 2012). These combined factors will threaten author traceability.

The merged consumer-manufacturer role not only adds great responsibility, but forces the consumer to accept numerous risks when printing homemade goods. The consumer will need to verify the design "is from a reputable, traceable source" to ensure "recourse if a product produced is defective" or causes harm ("How to Explore the Potential" 2013). This extra burden could potentially "undermine consumer confidence in 3D printed goods" (Sissons & Thompson 2012). Consider the previous screw example. If you choose to download a design from an open source, you are responsible for ensuring the design is not only legitimate, but also safe and reliable. Drawing a comparison to software security, Bruce Schneier argues that improvements in the software security space will not occur until liability is introduced to ensure quality products. Schneier explains, "Much of Internet security is a common…keeping it working benefits everyone, but any individual can benefit from exploiting it. In our society, we protect our commons…by legislating those goods and by making companies liable for taking undue advantage of those commons" (Schneier 2009). By holding companies liable, we avoid a 'buyers beware' society (Schneier 2009). The open-source environment lacks a comparable party with an advantageous position for accepting liability. The evolution of open-source CAD file sharing has led to a "buyers beware" online community. This issue poses a serious threat to the general consumer by destabilizing the foundation of product liability law.

Apart from complicating legal responsibilities for safe product designs, the resultant supply chain lacks a component with the power to mitigate risk and provide necessary compensation to those harmed. The retailer only serves as a digital commons promoting innovation. The designer is most likely a mere hobbyist, lured by the power of being a "maker", but deterred by legal responsibility. The consumer-manufacturer is not an enterprise, but rather a typical citizen desiring consumer product safety and trusted brands.

The purpose of product liability law is to effectively reduce the number of unsafe products in the marketplace, regulate the risk of using market products, and provide optimal compensation to those harmed by such products, all at a minimum cost to society (Litan and Winston 1988). Laws impose two important economic effects: (1) provide incentives to reduce non-preventable accidents, and (2) provide victims compensation through insurance tied to market prices. Historically, product liability expansion has reduced the number of consumer products in the marketplace, driving up product prices (Litan & Winston 1988). The in-home 3D printer supply chain challenges the current method. Engstrom (2013) asserts that "3D printing democratizes product creation, severing the long-established identity between manufacturers and sellers on one hand and enterprises on the other; unsettling product liability laws traditional theoretical foundation." Courts impose strict liability on sellers and manufacturers who tend to be enterprises with the ability to reduce social costs to society. Those profiting from imposing risks take responsibility, bearing the costs and distributing the losses (Engstrom 2013). The new supply chain disrupts the model because the consumer-manufacturer component cannot identify with a large enterprise. The original theory provided excessive compensation to consumers, distorting market prices by instituting "involuntary insurance" (Litan & Winston 1988). This created a balance between manufacturers and consumers; spreading the cost across the masses. The new supply chain eliminates this equilibrium.

5. The Status Quo of Product Liability Policies

Current policies will not be able to restore balance to the in-home 3D printer supply chain. State courts will be faced with the decision to promote innovation and "maker" developments, or to provide consumer product safety by reducing the availability of unsafe products, but simultaneously imposing restrictions on innovation and the freedom to develop. Cases will likely involve a consumer plaintiff seeking compensation after suffering injuries or damages resulting from the use of a 3D printed product. The defendant could include a 3D printer manufacturer, a material supplier, a designer, or an online website design repository. It will be unlikely for the court to rule against a 3D printer manufacturer or material supplier due to the lack of traceability in the production process. The court will be left with the decision to rule in favor of the plaintiff or the designer and online website design repository. Ruling against the plaintiff by upholding open-source licensing, CC design licenses, and retailer terms of use will progress the "maker movement" and foster future innovation. Designers will continue to copy, share, and modify CAD files available to all online in website design repositories. Yet, this decision will reduce public confidence in consumer 3D products and enable the production of dangerous goods at home. Ruling in favor of the plaintiff will ultimately reduce the accessibility of dangerous designs to download. Designers and online website repositories will become wary of sharing CAD files for anyone to use. This will deter potential designers from participating in the "maker movement", weaken the collaborative environment built around democratized 3D printing, and hinder future innovations. However, in making this decision, there is no guarantee the court will provide the plaintiff with sufficient compensation for injury without a third-party insurance system in place. This absence introduces a market externality that ultimately bears a great cost on the consumer. Improved production and design traceability may enable a more educated court decision, yet this externality will persist.

Policy must be instituted to correct this market externality and solve the product liability quandary around 3D printing. The policy should strive to achieve the following four goals: (1) discourage unsafe product design dissemination, (2) minimize overall social cost, which includes private costs as well as external and indirect costs, (3) allocate risk to the party with a comparative advantage in cost mitigation, and (4) minimize the hindrance on technological development and innovation. A solution composed of these four elements will establish a robust approach to preserving the foundation of product liability law.

6. Recommendations

One solution to address the given problem would be to institute a clearinghouse for the distribution and sale of authorized 3D printer CAD files. Adding this component to the supply chain would offer consumers a trustworthy source to reduce responsibility and risk. This source would encourage consumer confidence in 3D printed products. Regulating the available designs will increase product safety and decrease the production of dangerous and unsafe products. Introducing a new enterprise role establishes a party in a position to spread the cost of product risk to the masses through use of insurance. This minimizes the cost to society by ensuring compensation for wrongful harm imposed on a consumer. Continuing to allow the "maker movement" open-source community to develop will benefit the hobbyists and promote innovation in the field. Consumers would need to use caution when downloading free, open-source, and unauthorized designs comprised in a "buyer beware" digital commons. The recommended solution reduces market externality, protects consumers from product harm, and provides a user-friendly and easily accessible environment for general public use.

Instituting a 3D printer CAD file clearinghouse would achieve the four policy goals, while also addressing the market externality threatening to destabilize product liability law. This solution reduces the risk assumed by the consumer when printing 3D objects at home. As a source for consumers to purchase safe and authorized designs, the clearinghouse must ensure quality to maintain a trusted brand name. By guaranteeing safe CAD files, the clearinghouse would need to accept responsibility for verifying each design and be held accountable if a design causes harm. Their position in the market provides a comparative advantage to mitigate the cost of accountability. Through a third-party insurance system, the clearinghouse could provide consumers with necessary compensation for losses, while spreading this additional cost to the general public through CAD file prices. This would lead to less unsafe designs available to the general public.

Consumers will have the choice to either pay for an authorized design or download a free, but potentially dangerous file. The consumer would be responsible for recognizing the risk associated with both decisions. Losses resulting from a free design would be assumed by the consumer – "buyers beware". This would allow for hobbyists to continue innovating and collaborating through open source networks. Courts would not be forced to decide between innovation and safety. This solution allows for all to take advantage of in-home 3D printing opportunities without accepting major risks. Yet, it bears mentioning that other concerns surrounding in-home 3D printing will continue to exist. The lack of production traceability still presents a challenge in identifying the party responsible for a product defect, and, even with a clearinghouse in place, assigning liability will continue to be a difficult task for courts. This problem will not be solved until the technology improves. In the meantime, instituting a clearinghouse will restore a degree of balance between innovation and consumer safety and protect the foundation of product liability law for the future.

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