

16. Don't believe the hype? Recent 3D printing developments for law and society

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1. INTRODUCTION

This chapter is intended as a follow-up to my monograph, *Socio-Legal Aspects of the 3D Printing Revolution*, published in mid-2016.¹ Much of the research and writing for that work had been completed by late 2015 and so I was unable to take account of certain developments subsequent to that time, which, I submit, strengthen the main argument made in the book: that while 3D printing technically speaking is revolutionary, and in theory also disruptive to both the design and enforcement of law, 3D printing in practice seems not to be fulfilling this potential so far due to the actors involved in 3D printing and the limited take-up of the technology by average consumers.

First, this chapter will begin with a description of what a political economy of law method is and why it is appropriate for the study of technologies such as 3D printing. Then, a brief description of how 3D printing interacts with law in theory will be offered. This will be followed by some recent 3D printing developments in law and society, before a final conclusion.

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¹ Angela Daly, *Socio-Legal Aspects of the 3D Printing Revolution* (Palgrave Macmillan 2016).

2. THE CRITICAL POLITICAL ECONOMY OF LAW

Although legal scholars often take methodology for granted, as something intuitive to us which we learn implicitly as part of a legal education, increasingly academics are turning outside the law to research methods from other disciplines, in combination with our traditional doctrinal approaches. Law and economics and a variety of socio-legal approaches have been used in legal scholarship for some time.² However, more recently, legal researchers have looked to insights from behavioural economics and psychology to inform their own work.³ Furthermore, particularly since the Global Financial Crisis, there has been a growing awareness of economic approaches beyond neoclassicism within law and economics, with heterodox schools or political economy becoming discussed in the context of legal research.⁴

A political economy approach, in seeking to understand the interaction of the State and the Firm in society, is an appropriate one for legal scholars to consider in various areas, including when studying new technological developments and changes. In particular, discerning which state and non-state actors are using a particular new technology, and how, may be informative as to how the law as is ought to apply, or how the law as is ought to be changed to accommodate or prohibit such uses if judged to be socially undesirable. The case of 3D printing in particular ought to attract a political economy approach, given the discipline's interest in production and 3D printing representing a possible paradigm shift in terms of the actors which are able to engage in production and control it.

Furthermore, in emphasising the political economic and socio-economic context in which 3D printing and law exist, we may come to a better understanding of key issues in this nexus. As Fuchs has noted

² Richard A Posner, *The Economic Analysis of Law* (Little Brown 1973); Reza Banakar and Max Travers, 'Introduction to Theory and Method in Socio-Legal Research' in Reza Banakar and Max Travers (eds), *Theory and Method in Socio-Legal Research* (Hart 2005).

³ Richard H Thaler and Cass Sunstein, *Nudge: Improving Decisions About Health, Wealth and Happiness* (Yale University Press 2008); Alberto Alemanno and Anne-Lise Sibony, *Nudge and the Law: A European Perspective* (Hart Publishing 2015).

⁴ Ugo Mattei and John D Haskell, *Research Handbook in Political Economy and the Law* (Edward Elgar Publishing 2016); Martha T McCluskey, Frank A Pasquale, and Jennifer Taub, 'Law and Economics: Contemporary Approaches' (2017) 35(1) *Yale Law & Policy Review* 297; University of Maryland Legal Studies Research Paper No. 2016-05; SUNY Buffalo Legal Studies Research Paper No. 2016-014 <http://ssrn.com/abstract=2728030>.

about the Internet, technology is a site of power struggle in contemporary society.⁵ Understanding this power struggle accompanying new technologies such as 3D printing is insightful for how the law encounters this development, both theoretically and empirically. This is particularly the case given 3D printing has been viewed as a ‘liberation technology’, purportedly empowering end-users by weakening state control,⁶ and contributing towards the elimination of scarcity by weakening intellectual property.⁷ Yet 3D printing has also been of interest to large corporations and the governments of nation-states, including their military apparatus.⁸ In addition, incumbents from the private sector too have been integrating 3D printing into their business models,⁹ possibly lessening the threat that 3D printing poses to the intellectual property and income streams.

Whether 3D printing is a technology of freedom or a technology of control – or even both – is important to discern for a legal analysis in order to appreciate how ‘disruptive’ the technology is for existing legal regimes and their enforcement. A political economy approach can facilitate this discussion and accordingly was the approach which was adopted in *Socio-Legal Aspects of 3D Printing*. In doing so, the main findings of that study were that while in theory 3D printing opens up a Pandora’s Box of complexity for areas of law such as intellectual property, precisely how much of a threat consumer 3D printing actually presents, e.g. to incumbent industries’ intellectual property, is unclear, particularly due to factors such as the relatively low take-up of 3D printers at the consumer level and the interest incumbents have already shown in integrating the technology into their own operations. The extent to which the dynamic plays out between 3D printing, consumer and large

⁵ Christian Fuchs, *Foundations of Critical Media and Foundation Studies* (Routledge 2011) 5.

⁶ Gabriel J Michael, ‘Anarchy and Property Rights in the Virtual World: How Disruptive Technologies Undermine the State and Ensure that the Virtual World Remains a “Wild West”’ (2013) SSRN Working Paper http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2233374.

⁷ Mark Lemley, ‘IP in a World Without Scarcity’ (2015) 90(2) *New York University Law Review* 460.

⁸ Clint Arizmendi, Ben Pronk and Jacob Choi, ‘Services No Longer Required? Challenges to the States as the Primary Security Provider in the Age of Digital Fabrication’ (2014) *Small Wars Journal* <http://smallwarsjournal.com/jrnl/art/services-no-longer-required-challenges-to-the-state-as-primary-security-provider-in-the-age>.

⁹ Phil Reeves and Dinusha Mendis, *The Current Status and Impact of 3D Printing Within the Industrial Sector: An Analysis of Six Case Studies* (UK Intellectual Property Office 2015).

bureaucratised entities from the public and private sectors will be key in determining the extent to which 3D printing is truly 'disruptive' of laws and enforcement.

Accordingly, in order to determine the accuracy of these views of 3D printing, the following sections of this chapter will examine some developments which have happened over the last couple of years and will discuss the extent to which they support or refute these findings. First, though, a brief summary will be given of some of the complexity of 3D printing's interaction with legal frameworks, both in terms of the design of laws and also their enforceability.

3. 3D PRINTING AND LEGAL FRAMEWORKS

The emergence of 3D printing has consequences – at least conceptually – for various legal regimes which its operation and application implicate. Prominent among these areas of law is intellectual property due to the new intellectual property rights that can be created as part of the 3D printing process, and the possibility of infringing others' intellectual property rights through that same process. Another prominent area of law which has come into contact with 3D printing so far is regulation of firearms, due to the creation of the Liberator, a gun whose parts can be created on a consumer-level 3D printer (albeit with some difficulty).¹⁰ However, it is not just intellectual property and firearms laws which intersect with 3D printing: product liability, medical regulation and data privacy are other laws which apply to 3D printing's applications and processes. With the increasing use of 3D printing at the consumer and industrial level, it is likely that other legal regimes will also encounter the technology.

These different laws may seem rather disparate, with not much commonality except an application to 3D printing. However, what they do share in this encounter with 3D printing is twofold: the design of these laws; and the enforceability of these laws. Both of these issues are driven by the decentralisation of production brought about by 3D

¹⁰ Isaac Record, ginger coons, Daniel Southwick and Matt Ratto, 'Regulating the Liberator: Prospects for the Regulation of 3D Printing' (2015) 5 *Journal of Peer Production* <http://peerproduction.net/issues/issue-6-disruption-and-the-law/peer-reviewed-articles/regulating-the-liberator-prospects-for-the-regulation-of-3d-printing/>.

printing, and the possibilities for individuals to produce items in their homes and workplaces and bypass traditional gatekeepers and nodes of control.

These laws on the whole have been designed for a Fordist era of mass production, where centralised entities are producing items which are then sold in shops and bought complete by consumers. Many such items have been far too difficult for the average individual to produce themselves, and/or the cost of machinery for such production was far too high for these individuals. An example of legal design based on this assumption about production can be seen in product liability laws which are premised on the basis that the party best able to shoulder the burden of liability is to be held liable. With prosumer production of objects via 3D printing, this assumption no longer necessarily holds true. Other examples of this can be seen in some of the exceptions to intellectual property infringement in various jurisdictions such as the private non-commercial purposes exception to patent infringement in UK law.¹¹ This exception can be viewed as operating under the assumption that such personal and non-commercial uses will not be widespread (since if they were, then rightsholders' interests would be prejudiced).

Related to this point is that of the enforceability of law. Again, the enforcement of law is premised on the assumption that production happens via centralised entities and products are distributed along recognised supply chains, culminating in a retail store where the consumer makes the final purchase. Thus, the law can be enforced vis-à-vis these identifiable actors at various points along the supply chain. Prosumer production of objects via 3D printing also throws this scenario into some disarray as these supply chains, with their nodes of control, are sidestepped. While the process of 'disintermediation' that 3D printing (theoretically) entails is a change from this status quo, there has also been a process of 'reintermediation', with actors such as 3D printing file-sharing sites including Thingiverse, print-on-demand services such as Shapeways, and the 3D printer manufacturers themselves emerging as potential nodes of control. Yet even if there are still points of control over 3D printing processes, these may look quite different from the predecessor gatekeepers around which certain laws were designed. Another example can be found in intellectual property law, particularly contributory or intermediary liability provisions. The dis/reintermediation of information production and supply brought about by the Internet led to various battles over, and reforms of, copyright law, with, for instance, the

¹¹ Patents Act 1977, s 60(5)(a) and (b).

US Digital Millennium Copyright Act's safe harbours and notice and takedown schemes being responses to this phenomenon. However, other areas of intellectual property, and particularly patents, did not experience these digitisation and decentralisation trends until the advent of consumer-oriented 3D printing, and have not yet adapted, as can be seen from the contributory patent infringement liability provisions in many jurisdictions.¹²

Of course, the extent to which 3D printing is wholly 'disruptive' for the legal frameworks is something that will be measured empirically as well as theoretically. Yet, the theoretical disruptions can be discerned in terms of the design of laws and their enforceability. Even if prosumer 3D printing is not practised by everyone, a significant minority of 3D printing prosumers may entail that these theoretical disruptions to legal frameworks are widespread enough in practice to warrant legal reform and other regulatory measures.

4. RECENT DEVELOPMENTS

Since the finalisation of *Socio-Legal Aspects of the 3D Printing Revolution* in late 2015, various developments have occurred for 3D printing in law and society. These developments, both legal and socio-economic (or 'business'), will be outlined here. They will also be analysed against the backdrop of the book's main argument – 3D printing is technically revolution and theoretically legally disruptive; in practice it is not fulfilling this potential with regard to law and society – to discern the extent to which this argument still holds true.

4.1 Legal

There have been two prominent legal developments since late 2015 – the 3D printing firearms legislation being enacted in the Australian state of New South Wales; and the intervention of 3D printing companies in legal proceedings on the issue of copyright in the USA. Furthermore, the US Food and Drug Administration has released non-binding Draft Guidance on 3D printed medical devices.

¹² Deven Desai and Gerard Magliocca, 'Patents, Meet Napster: 3D Printing and the Digitization of Things' (2013–2014) 102 *Georgetown Law Journal* 1691; Simon Bradshaw, Adrian Bowyer and Patrick Haufe, 'The Intellectual Property Implications of Low-cost 3D Printing' (2010) 7(1) *SCRIPTed* 5.

4.1.1 New South Wales 3D-printed gun laws

The emergence of the 3D printed gun, the Liberator, whose designs were formulated and released by US-based organisation Defense Distributed, has caused dilemmas for governments and law enforcement agencies around the world as to whether their current laws restricting firearms are still adequate when confronted with a 3D-printable gun, and to what extent those laws can still be enforced. Defense Distributed has been involved in lengthy litigation in the US regarding the legality of it posting and otherwise distributing design files for firearms, and the legality of the authorities' attempts to restrict the files, which are still ongoing at the time of writing.¹³ However, other jurisdictions have also tried to restrict the spread of 3D-printed guns via legal means, notably the Australian state of New South Wales (NSW), which passed new legislation on the topic in November 2015.

The NSW police had been concerned about 3D-printed guns for some time, notably buying their own 3D printer in 2013 to print a Liberator and holding a press conference on the topic.¹⁴ In the wake of the Sydney Siege terrorist attack in December 2014, which involved an illegal weapon (albeit not a 3D-printed one), a bill was introduced into the NSW legislature to combat the use of 3D-printed weapons, the Firearms and Weapons Prohibition Legislation Amendment Bill. The bill passed into law in November 2015 and is an amendment to NSW's Firearms Act 1996.

The amendments have some general provisions strengthening the existing laws in relation to illegal firearms, including increasing the maximum penalties for various existing firearms offences. However, the amendments also contain specific new offences relating to 3D printing: possession of blueprints for the manufacture of firearms on a 3D printer or 'milling machine', with a maximum penalty of 14 years.¹⁵

It is unclear how necessary these amendments are in relation to 3D printing, given it is unclear how widespread 3D printed weapons are in Australia. There have been two reported instances of 3D-printed gun parts being found in Australian police raids in the states of Queensland

¹³ Emily Dreyfuss, '3-D Printed Gun Blueprints Are Back and Only New Laws Can Stop Them', *Wired* (29 August 2018) <https://www.wired.com/story/3-d-printed-gun-blueprints-return-laws-injunction/>.

¹⁴ Ilya Grindeff, '3D-printed gun "will kill", police warn', *Sydney Morning Herald* (24 May 2013) www.smh.com.au/digital-life/digital-life-news/3dprinted-gun-will-kill-police-warn-20130524-2k59g.html.

¹⁵ Section 51F, Firearms Act 1996.

and Victoria in 2015 and 2016 respectively.¹⁶ Yet these instances appear to be a drop in the ocean of illegal and illicit firearms produced by more conventional means which are currently thought to be circulating in Australia.¹⁷ Furthermore, the need for new firearms laws specifically to address any concerns arising from 3D printing in Australia was dismissed by a majority of Senators on a Committee inquiring into gun-related violence during 2014 and 2015, and a separate report from the Committee Chair also acknowledged that existing firearms laws would apply equally to firearms and their parts emanating from a 3D printer.¹⁸ Yet following the enactment of this law in NSW, in early 2017 one person in Sydney was charged with its violation by allegedly producing imitation guns with a 3D printer.¹⁹

The extent to which the NSW legislation has been driven by an evidence-based approach or a more general (and unsubstantiated) moral panic around 3D printers and terrorism remains an open question. They may be seen as a 'preventive' measure to already be in place if and when illicit 3D-printed guns become more widespread. For the moment, it seems that illicit 3D-printed guns are not in widespread use in Australia and elsewhere in the world. However, an initial study Mann and I have conducted based on media reports found that Australia has a relatively high incidence of illicit 3D printed guns being detected by police.²⁰ The extent to which 3D-printed firearms fundamentally 'disrupt' the effective enforcement of firearms laws in Australia and elsewhere remains to be seen.

¹⁶ Harry Tucker, 'Melbourne police have seized a 3D printer used to print guns in a bikie raid', *Business Insider Australia* (26 May 2016) www.businessinsider.com.au/melbourne-police-have-seized-a-3d-printer-used-to-print-guns-in-a-bikie-raid-2016-5.

¹⁷ 'Fact check: Where do Australians get illegal guns?' *ABC News* (3 March 2016) <http://www.abc.net.au/news/2015-05-26/source-of-illicit-guns-in-australia/6483762>.

¹⁸ Australian Senate Legal and Constitutional Affairs References Committee, *Ability of Australian Law Enforcement Authorities to Eliminate Gun-related Violence in the Community* (2015).

¹⁹ Jean Kennedy, '3D printed guns found in Sydney, man charged for manufacture', *ABC News* (1 March 2017) www.abc.net.au/news/2017-02-28/3d-printed-guns-found-in-sydney,-man-charged-for-manufacture/8312382.

²⁰ Angela Daly & Monique Mann, *3D Printing, Policing and Crime*. Crime Justice and Social Democracy Research Centre Briefing Paper Series (2018) (1). Crime Justice and Social Democracy Research Centre, Brisbane, QLD, Australia <https://eprints.qut.edu.au/119689/>.

4.1.2 Copyright clarification

Another interesting development in another area of law has been the intervention of various 3D printing companies in US legal proceedings on a point of copyright. The applicability of copyright to various parts of the 3D printing process is not a settled issue: similar jurisdictions would seem to take different positions on precisely where copyright can subsist and the application of exceptions to copyright infringement; and even within the one jurisdiction there is often disagreement on these points in the absence of specific legislation or case-law on the issue. This entails a rather confusing and uncertain situation for both copyright holders and copyright users.

In order to seek some clarity on the subsistence of copyright in US law, a group of 3D printing companies (Formlabs, Shapeways, and Matter and Form) sent an amicus brief to the US Supreme Court in 2016.²¹ The Supreme Court agreed to hear an appeal from a 2015 Sixth Circuit Court of Appeals ruling in the case of *Star Athletica v Varsity Brands*, which involved the copyright status of cheerleader uniforms. This case did not involve 3D printing per se, but the case's outcome may have profound implications for 3D printing. The Sixth Circuit Court asserted that the shape of the uniforms and the position of stripes and lines on the uniform can be copyrighted, seemingly comprising a new approach to the 'severability' concept in US copyright law, and comprising the first time that clothing has been recognised as copyrightable in US law.

Prior to this case, the severability doctrine in US law has operated to ensure a delineation of subject-matter that is protected by copyright ('creative') and subject-matter that is protected by patents ('functional'). When there is a design for an object which has both creative and functional aspects, the severability doctrine has operated such that these designs are only protected by copyright to the extent that they go beyond the utilitarian requirements of designing a useful article, i.e. any decorative elements of the object that exist beyond the scope of the useful object can be protected by copyright.²² The 'useful' aspects of the object may be protected by patent if the criteria for patenting are fulfilled.

The 3D printing companies in their brief implored the Supreme Court to rule definitively and authoritatively on the issue of severability in US

²¹ Brief of *Amici Curiae* Formlabs Inc, Matter and Form Inc, and Shapeways Inc in support of Petitioner in *Star Athletica v Varsity Brands* (2016).

²² Michael Weinberg, *It Will Be Awesome If They Don't Screw It Up: 3D Printing, Intellectual Property, and the Fight over the Next Great Disruptive Technology* (Public Knowledge 2010).

copyright law, in order to dispel the lingering legal uncertainty for the 3D printing industry as well as for the clothing industry, which they argue results in the over-claiming of copyright and the chilling effects that entails for innovation in their industry.

The Supreme Court handed down its judgment on the case in early 2017, with a majority of the court holding that a feature incorporated into the design of a useful article is eligible for copyright protection if it

(1) can be perceived as a two- or three-dimensional work of art separate from the useful article and (2) would qualify as a protectable pictorial, graphic, or sculptural work – either on its own or fixed in some other tangible medium of expression – if it were imagined separately from the useful article into which it is incorporated.²³

Accordingly, elements of a garment's design, if they fulfil these criteria, can be protected by copyright law.

Certainly, this test conceptually simplifies and clarifies US copyright law on this issue. Yet problems remain as to how this will be implemented in practice, particularly in 'grey areas' of ambiguous real-life scenarios. In particular, it is unclear what effect this decision may have on 3D printing practices but it seems to entail that the fashion industry is able to assert intellectual property protection over more objects than was previously the case, something the 3D printing companies seemed wary of in their amicus brief, with the potential to stifle innovation.

Furthermore, after this decision global harmonisation issues still remain a problem given the transnational nature of 3D printing. However, the US is probably the most important jurisdiction for 3D printing given the preponderance of 3D printing companies emanating from there, and the fact US law governs many online transactions and interactions such as on 3D-printing file-sharing sites, through their Terms and Conditions of Use.²⁴ Thus this US copyright decision in *Varsity Brands* may have global effects throughout the 3D printing industry and ecosystem.

4.1.3 Guidance for 3D-printed medical devices

The US Food and Drug Administration (FDA), which regulates *inter alia* medical devices and medicines in that jurisdiction, weighed in on 3D printing in May 2016, issuing Draft Guidance on medical devices

²³ *Star Athletica v Varsity Brands* 580 U.S. ____ (2017), 17.

²⁴ See Burke Ward, Janice Sipior and Linda Volonino, 'Internet Jurisdiction for E-commerce' (2016) 15(1) *Journal of Internet Commerce* 1.

manufactured using 3D printing.²⁵ While the Draft Guidance, even when finalised, will not be legally binding, it does represent the FDA's current thinking on the topic of 3D-printed medical devices. The Draft Guidance pertains to two broad areas (design and manufacturing considerations; and device testing considerations) and explicitly states that it does not apply to bioprinting activities. The draft contains mostly technical directions to those creating such devices using 3D-printing technology, and encompasses issues such as device design, mitigating for inaccurate imaging of a patient's anatomical features, problems resulting from incompatible software, process validation, cleaning and sterilising the device, and potential problems posed by the raw materials used. Essentially the Draft Guidance makes suggestions to potential manufacturers about how to comply with FDA medical device regulation, pointing out these risks and other issues to consider, and advising certain practices and information documentation at these stages.

However, the FDA in issuing these Draft Guidelines has not engaged with the 3D printing prosumer community printing what would be classified as medical devices through projects such as the e-NABLE network.²⁶ For prosumers such as these, they may not be aware in the first place that they are creating a 'medical device' which in most jurisdictions is subject to specific regulatory regimes to ensure a certain minimum quality as well as other health and safety standards. So the FDA's Guidelines cannot be helpful for those who are not even aware in the first place that they are manufacturing medical devices using their 3D printers. Nor do they begin to approach the issue of regulating decentralised, non-traditional medical device providers when the existing law and regulation in this area is based on the idea of a centralised manufacturer and a clearly identified chain of distribution which includes medical professionals.

The FDA should be recognised for its positive engagement in the 3D printing space through issuing these Guidelines. As medical 3D printing grows as an area of activity, which includes a small but significant prosumer component, the FDA and its equivalents in other jurisdictions will need to keep abreast of how existing regulation can be implemented but they may also need to consider in greater detail how prosumer activity can best be encouraged for its attempts to make these products

²⁵ US Department of Health and Human Services Food and Drug Administration, *Technical Considerations for Additive Manufactured Devices Draft Guidance for Industry and Food and Drug Administration Staff* (10 May 2016).

²⁶ Enabling the Future <http://enablingthefuture.org/>.

more accessible, while under conditions which continue to prioritise patient health and safety.

4.2 Business Developments

In the last couple of years or so there have also been various interesting developments in the 3D printing business ecosystem: on the one hand, companies from certain incumbent industries have been moving into the 3D printing space; while on the other hand, 3D printing firms which have been particularly active in consumer- or prosumer-oriented markets have been scaling back their operations.

4.2.1 Incumbents' 3D printing interest

One noticeable trend has been the growing interest of certain players from incumbent industries in consumer-oriented 3D printing. This has led to a couple of notable partnerships and initiatives from well-known brands in the 3D printing space.

In 2015 the US confectionery manufacturer Hershey's announced a partnership with 3D Systems to launch a chocolate 3D printer.²⁷ The 3D printing of food has attracted great interest from the wider public and industry but has also thrown up legal and regulatory issues, especially around ensuring consumer safety, as recognised by Tran.²⁸ However, Hershey's has evidently seen the business opportunity presented by 3D printing and may be hoping to benefit as one of the first movers in the food industry to embrace the technology, as well as preserve its brand's standing.

Toy manufacturer Mattel has also recently announced the development of its own sub-US\$300 3D printer, the Thingmaker, which will let children customise and print their own 3D-printed figurines via a smartphone app.²⁹ This can also be viewed as a strategic move by Mattel to preserve its brand, particularly when faced with 'fan art' being created by 3D printing enthusiasts. Unauthorised fan art involving existing brands' characters has already been the subject of intellectual property

²⁷ Sarah Buhr, 'Hershey's Chocolate 3D Printed Whips Up Any Sweet Design You Want', *Tech Crunch* (16 September 2015) <http://techcrunch.com/2015/09/16/likeachocolateselfie/>.

²⁸ Jasper Tran, '3D-Printed Food' (2016) 17 *Minnesota Journal of Law, Science and Technology* 855.

²⁹ James Vincent, 'Mattel's \$300 3D printer lets you design and create your own toys', *The Verge* (15 February 2016) www.theverge.com/2016/2/15/10995090/mattel-childrens-3d-printer-thingmaker.

disputes involving Digital Millennium Copyright Act takedown notices, even when it was not necessarily clear that the fan art was infringing the brand's copyright or other intellectual property rights.³⁰ However, by integrating these kinds of activities in a Mattel-branded environment, the company appears to be co-opting this user engagement in a way which supports its business activities rather than threatening its profit margins.

4.2.2 Diminishing returns for consumer 3D printing?

The hype around consumer- or prosumer-oriented 3D printing has also taken a hit with announcements from some major firms that they are downsizing operations and moving out of that market segment.

For instance, MakerBot, which was prominently bought by Stratasys in 2013 for US\$400 million, fired 20 per cent of its workforce in 2015³¹ and recently announced the closure of its manufacturing operations in Brooklyn.³² It also announced that it was shifting its focus to educational and professional markets rather than consumer 3D printing markets.

A similar trend can be seen with Stratasys' main rival, 3D Systems. The company also announced it would no longer be producing its entry-level Cubify printer, and would instead be focusing on educational and 'engineer's desktop' markets.³³

5. CONCLUSION

These recent law and society developments in 3D printing certainly do not seem to refute *Socio-Legal Aspects of the 3D Printing Revolution's* main argument, that 3D printing in practice is not prevalent enough yet to be truly disruptive for law and society, despite its theoretical potential to be so.

³⁰ Daniel Harris Brean, 'Asserting Patents to Combat Infringement via 3D Printing: It's No "Use"' (2013) 23 *Fordham Intellectual Property, Media & Entertainment Law Journal* 771.

³¹ Jordan Pearson, 'MakerBot Just Laid Off 20 Percent of Its Staff', *Motherboard* (17 April 2015) <http://motherboard.vice.com/read/makerbot-just-laid-off-20-percent-of-its-staff>.

³² Emma Whitford, 'MakerBot Is Outsourcing Its Brooklyn Manufacturing Jobs To China', *Gothamist* (26 April 2016) http://gothamist.com/2016/04/26/china_is_the_new_brooklyn.php.

³³ Kira Charron, '3D Systems closing Cubify 3D printing marketplace, discontinues \$999 Cube 3D printer', *3Ders* (28 December 2015) www.3ders.org/articles/20151228-3d-systems-exits-consumer-marketplace-discontinues-cube-3d-printer.html.

With the NSW legislation on 3D-printed guns and the FDA's issuing of Draft Guidance on 3D-printed medical devices, entities of the nation-state can be seen to be engaging with 3D printing, and in the case of 3D-printed guns, attempting to nullify any disruptive effect that 3D printing may have on their activities. The other developments mentioned – the US copyright proceedings and the business developments – show the engagement of private corporate actors with 3D printing, including actors from incumbent industries which might otherwise see 3D printing as being disruptive to their business practices. This engagement may be seen as deflecting any disruption to profits that 3D printing might otherwise cause. Yet it also further reinforces this interest from existing corporate actors in 3D printing, which may continue to 'dull' how socially (and legally) revolutionary 3D printing actually is. Furthermore, the exiting of 3D printer manufactures from consumer-oriented desktop 3D printing markets suggests a lower than expected take-up of these devices by individuals, and again would seem to dull the revolutionarily decentralised production in the home that 3D printing offers.

As with other new technological developments, technologies' trajectories in society will determine precisely how disruptive to existing regulatory frameworks they actually are, and will allow an assessment of this, past any initial technologically determinist hype. Part of this trajectory includes what actors are using the technology and for what purposes, and the extent to which these actors possess power. Accordingly, a political economy approach to law and technology, as followed here, can be illuminating as to issues of disruption and revolutionary change (or lack thereof). 3D printing remains a fascinating technological development and is certainly technically revolutionary. However, the extent to which it is transformative for law and society is something which remains to be seen – and should be studied as technological take-up progresses.