ALLOCATING RISK AND LIABILITY FOR DEFECTIVE 3D PRINTED PRODUCTS: PRODUCT SAFETY, NEGLIGENCE, OR SOMETHING NEW?

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ABSTRACT

The traditional relationships and roles of the manufacturer, wholesaler, retailer, and consumer are being challenged. The rise of the sharing economy, demonstrated through applications such as Uber, online auctions sites such as eBay, and service advisory facilities such as TripAdvisor, has created a very different, and a somewhat less vertical, capitalist economy than what it was 10 years ago. Perhaps the most significant factor in the shared economy evolution has been the rise of the affordable 3D printer, now available for home use. The consumer can now also be a manufacturer and a retailer. A person can purchase the 3D printer, and through their own skills, or through the purchase or gift of a computer-assisted design file, can now create their own products for personal use or for resale. Law, as it traditionally does, now has to play catch-up to science. Society must ask the question whether the current regulatory regime is suitable, or in need of modification? This paper, in the context of the 3D printer, suggests that the increasing use of this technology requires careful consideration of whether the current law, be it product safety law or negligence, provides adequate protection to consumers.

I INTRODUCTION

One of the defining features of the modern economy lies in the breakdown of the traditional division between producer and consumer. Manufacturers, wholesalers, retailers and consumers are now increasingly collaborating in a sharing economy, whereby labour resources are co-dependent on one another to produce a product or service provided to an ultimate user. This notion of a sharing economy has the potential to redefine the Western economy and whom we see as a manufacturer or a consumer. With the rise of web-based advisory services built around the experiences of consumers (such as TripAdvisor), commuting designed on a shared and mutual commitment (such as Uber), and online auction sites (such as eBay, Alibaba), the benefits and opportunities of being a provider of goods and services are expanded significantly.

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A similar phenomenon is observable in the context of goods production. One of the most significant recent developments within the sharing economic model lies with affordable three-dimensional ('3D') printing.[1] This technology provides the ability for people on an individual level to be intricately involved in the production chain of various goods, something which, for the most part, was not practically possible before the advent of 3D printing. While this will, in time, have a very significant influence on redefining the shape of manufacturing in this country, it also raises the spectre that existing obligations now imposed on the stereotypical manufacturer might attach to those we have traditionally classified as consumers. 3D printing will 'democratize product creation',[2] but the benefits this provides may come with costs attached. One of the most notable costs this new manufacturing paradigm presents is legal uncertainty. The degree to which 3D printing can be expected to shift the legal balance in the product liability landscape has been explored in the US context,[3] but its legal ramifications have been considered to a very limited extent with reference to Australian law.[4] This paper seeks to redress this imbalance. It is inevitable that the law will lag behind scientific advances and be reactive and responsive to developments and disputations as they occur — our private law has been built not on the framework of academic hypotheticals, but on the reality of damage, injury and conflict. In this context, the increasing availability of 3D printing technologies will see more products produced using these technologies, even though the existing legal framework is opaque at best. From a product safety perspective, we can expect to see some benefits: smaller and more localised production runs will enable better control over product quality.[5] Goods can easily be trialled, tweaked and refined before production. The ability to customise will also mean that consumers are provided with goods that better suit their needs, resulting in ergonomic benefits, and the production of goods more effectively designed to fit purpose.[6] In short, reduced supply chains are likely to maximise control over product quality.

1 The term '3D printing' 'is a term used to describe a range of digital manufacturing technologies': Phil Reeves and Dinusha Mendis, 'The Current Status and Impact of 3D Printing within the Industrial Sector: An Analysis of Six Case Studies' (Study No 2, Intellectual Property Office UK, March 2015) 1 <https://www.gov.uk/government/publications/3d-printing-research-reports>. It is a lay term commonly used to describe the process of additive manufacture, also known as 'additive layer manufacturing'.

2 Nora Freeman Engstrom, '3-D Printing and Product Liability: Identifying the Obstacles' (2013) 162 *University of Pennsylvania Law Review Online* 35, 41 <https://www.pennlawreview.com/online/162-U-Pa-L-Rev-Online-35.pdf>.

3 See ibid; Lucas S Osborn, 'Regulating Three-Dimensional Printing: The Converging Worlds of Bits and Atoms' (2014) 51 *San Diego Law Review* 553; Heidi Nielson, 'Manufacturing Consumer Protection for 3-D Printed Products' (2015) 57 *Arizona Law Review* 609; Nicole D Berkowitz, 'Strict Liability for Individuals? The Impact of 3-D Printing on Products Liability Law' (2015) 92 *Washington University Law Review* 1019; Patrick J Comerford and Erik P Belt, '3DP, AM, 3DS and Product Liability' (2015) 55 *Santa Clara Law Review* 821.

4 For example, few reports exist that even reference (let alone consider reform to) Australian consumer law as a result of the uptake of 3D printing: see, eg, Gail Greatorex, '3D Printing and Consumer Product Safety' (White Paper, Product Safety Solutions, January 2015) <http://www.a3dma.org.au/wp-content/uploads/2015/03/3D-printing-and-Consumer-Product-Safety-White-Paper-v1.0.pdf>.

5 Ibid 13–14.

6 Ibid 13.

There is, however, likely to be a product safety downside. The process of producing one product from a 3D printer is still cumbersome, so its use beyond prototyping is relatively new. In addition, 3D products require a significant amount of refining after printing, as the finishes are far from perfect. Nevertheless, this will not prevent users printing products they would previously have had no option but to buy, increasing the capacity of 'consumers' to construct and self-supply. While 3D printing technology heralds a wealth of possibilities in terms of what home users can produce using a 3D printer, the breadth of these possibilities also raises product safety concerns. They can use 3D printed objects in their home or car, consume food from them, or even produce consumable food.[7] Printing businesses have no real control over who uses the products they produce, or how they are used. Products produced as prototypes might be put to uses beyond those envisaged. Product safety standards and regulations may not be consulted, acknowledged or followed.[8] Warnings required if particular goods are supplied might not be provided.[9] The broad range of possibilities in relation to product design and the experimental nature of the design process are bound to present issues in relation to product quality.[10]

This article, in recognising that the genie of innovation and customisation is now loose within society, explores the potential of 3D printing for Australia, and in the process highlights qualitative data taken from interviews by one of the authors with service providers in the 3D printing industry in Australia. Specifically, 3D printing studios print items for consumers in return for a fee for service. These interviews were conducted with a view to eliciting where issues are likely to present within the Australian legal framework. Printing studios are currently the main conduit through which 3D printed products reach Australian consumers, and are likely to remain so for some time. It has, however, been optimistically predicted that 3D printers will become ubiquitous in households as the technology becomes more affordable and accessible.[11] Consequently, the issues that service providers identify can be expected to become more generally applicable. The question is whether existing laws can adapt, or whether the technology will necessitate that these laws be revisited.

In addressing this, we of course recognise that traditional manufacturing currently involves a number of parties such as suppliers of raw materials, designers, and producers; in this sense there are significant parallels with objects produced through 3D printing. What is critically different is that complexity increases as additional parties become part of the design and manufacturing framework, and

7 See Hod Lipson and Melba Kurman, *Fabricated: The New World of 3D Printing* (Wiley & Sons, 2013) 129–30.

8 Ibid 14–15.

9 Ibid 14.

10 Note that there may also be issues associated with 3D printers themselves in that they have the capacity to emit potentially toxic particles when used without adequate ventilation: see, eg, Parham Azimi et al, 'Emissions of Ultrafine Particles and Volatile Organic Compounds from Commercially Available Desktop Three-Dimensional Printers with Multiple Filaments' (2016) 50 *Environmental Science and Technology* 1260. This issue is not considered in this paper.

11 See, eg, 3ders.org, *MTU Study: 3D Printers May Soon Be in Every Home* (30 July 2013) <http://www.3ders.org/articles/20130730-mtu-study-3d-printers-may-soon-be-in-every-home.html>.

users become producers — it is this latter point that distinguishes 3D printing from traditional or conventional subtractive manufacturing. The degree of intricacy made possible by 3D printing and the wideranging prospective uses of 3D printed products also marks 3D printing out as being a revolutionary technology.

Specifically, because users of 3D printing technologies may be considered to be manufacturers of the goods that emanate, we consider their liability under two broad umbrellas: that of the legislative product safety provisions, and that of the law of negligence. In addressing this, we also understand that the archetype the law ultimately provides delivers an important societal message in respect of allocation of risk and apportionment of liability. It is only when these elements align with community expectation that extant legal regimes can be assessed for suitability. Following a brief primer on 3D printing in the Australian context, we will examine the role of product safety law and negligence law as they currently stand, before concluding as to whether, and how, we see the legal landscape altering in shape and form to accommodate the bespoke product creation made possible by 3D printing.

II THE SPECIFICS OF 3D PRINTING

A *A Primer on 3D Printing*

3D printing is a process by which materials are joined 'to make objects from 3D model data, usually layer upon layer, as opposed to subtractive manufacturing methodologies'.[12] The more technical term for the process is 'additive manufacturing', which highlights the feature that distinguishes it from traditional manufacturing techniques.[13] These technologies have been in existence for some time: the first patent for a 3D printer was granted in 1977,[14] while the first commercial printer was produced in 1988.[15] The addition of scanners has made possible reasonably accurate, digital copies of existing objects. At the same time, 3D printing hardware has become increasingly affordable.[16] Recently, rapid developments have taken place in the materials sphere: although most domestic

12 Hod Lipson and Melba Kurman, 'Factory @ Home: The Emerging Economy of Personal Fabrication' (Report, US Office of Science and Technology Policy, December 2010) 12 <http://risti.kaist.ac.kr/wp-content/uploads/2013/08/Factory-at-Home-The-Emerging-Economy-of-Personal-Fabrication.pdf>, quoting ASTM International Committee, 'Standard Terminology for Additive Manufacturing Technologies' (Standard, ASTM F2792-10, ASTM International) 2 (superseded).

13 Lipson and Kurman, *Fabricated*, above n 7, 11.

14 Wyn Kelly Swainson, 'Method, Medium and Apparatus for Producing Three-Dimensional Figure Product' (US Patent 4041476, United States Patent, 9 August 1977).

15 3D Printing Industry, *The Free Beginner's Guide: History of 3D Printing* <http://3dprintingindustry.com/3d-printing-basics-free-beginners-guide/history/>.

16 For example, as of September 2016, a simple printer such as the MakerBot Replicator Mini+ could be purchased for AUD2288: MakerBot, *The All-New MakerBot Replicator Mini+* <http://www.makerbot3d.com.au/3d/blog/products/replicator-mini/>. Cheaper printers are available for as little as AUD619 (excluding GST): 3D Printer Superstore, *da Vinci 1.0 Jr* <http://3dprintersuperstore.com.au/collections/3d-printers/products/da-vinci-jr>.

printers print in plastics, more sophisticated machines are capable of using metals, ceramics, glass, and even human cells.[17] A range of 3D printing techniques offer various options for product development, including stereo-lithography ('SLA'), fused deposition modeling ('FDM'), inkjet, laser sintering ('LS'), laminated object manufacturing ('LOM'), and laser powder forming ('LPF').[18]

One of the primary advantages that 3D printing offers is decentralisation: it gives consumers with access to printing hardware an opportunity to create or buy a digital file, and print any object within the machine's capabilities. As to the types of products that may be produced, a chief advantage of 3D printing is that intricate shapes can be created far more effectively and cheaply than is possible using traditional manufacturing techniques, making customised manufacture more feasible. The technology has reached the point where 3D printers are capable of producing parts for jet engines,[19] houses,[20] artificial body parts,[21] and pharmaceuticals.[22]

Three-dimensional printed products appear to emerge magically from materials fed into relatively simple looking pieces of machinery. Yet the process for producing a product using additive manufacturing is complex, and involves a number of inputs. In addition to a computer and raw materials, 3D printers require printing instructions. Critical to the process is an object design embodied in a file, generally a computer-assisted design ('CAD') file. CAD files have been described as being the equivalent of an architectural blueprint for a building.[23] CAD files evolve through a process of design, involving on-screen surface modelling which produces a geographically complex image of the envisaged object.[24] This image is then converted by design software into a binary (computer-readable)

17 Gordon G Wallace et al, '3D Bioprinting: Printing Parts for Bodies' (ARC Centre of Excellence for Electromaterials Science, 2014).

18 For an explanation of these types of technologies, see Lipson and Kurman, *Fabricated*, above n 7, ch 5.

19 Jake Sturmer, '3D Printing: Australian Researchers Create Jet Engine, Breakthrough Captures Attention of Airbus and Boeing', *ABC News* (online), 26 February 2015 <http://www.abc.net.au/news/2015-02-26/australian-researchers-create-first-3d-jet-engine/6262462>.

20 See, eg, Ruby Lott-Lavigna, 'Watch This Giant 3D Printer Build a House', *Wired* (online), 21 September 2015 <http://www.wired.co.uk/news/archive/2015-09/21/giant-3d-printer-builds-houses>.

21 See Wallace et al, above n 17; Lijie Grace Zhang, John P Fisher and Kam W Leong, *3D Bioprinting and Nanotechnology in Tissue Engineering and Regenerative Medicine* (Elsevier, 2015).

22 Mary-Ann Russon, 'FDA Approves World's First 3D-Printed Drug that Could Transform the Pharmaceutical Industry' *International Business Times* (online), 4 August 2015 <http://www.ibtimes.co.uk/fda-approves-worlds-first-3d-printed-drug-that-could-transform-pharmaceutical-industry-1514076 >.

23 Santoso, Horne and Wicker have described CAD files as being the equivalent of the 'architectural blueprints for a building or the sewing pattern for a dress': Stephanie M Santoso, Benjamin D Horne and Stephen B Wicker, 'Destroying by Creating: Exploring the Creative Destruction of 3D Printing Through Intellectual Property' (Research Report, Team for Research in Ubiquitous Secure Technology, 2013) 5 <https://www.truststc.org/education/reu/13/Papers/HorneB_Paper.pdf>.

24 Phil Reeves, Chris Tuck and Richard Hague, 'Additive Manufacturing for Mass Customization' in Flavio S Fogliatto and Giovani J C da Silveira (eds), *Mass Customization: Engineering and Managing Global Operations* (Springer, 2011) 275, 277–9.

file.[25] The manufacturing chain is, for this reason, far from straightforward, and encompasses the following parties:

- Hardware manufacturers: while the primary producers of 3D printers are 3D Systems[26] and Stratasys,[27] a number of alternative producers of hardware have emerged. Examples include Hewlett Packard,[28] Solido Ltd,[29] MakerBot Industries,[30] and open source initiatives RepRap[31] and Fab@Home[32] (which allow users to build their own 3D printers at home using online instructions);
- Producers of raw materials: frequently, machine manufacturers such as 3D Systems and Stratasys produce materials suitable for use with their printers. Many machines are suitable for use with certain materials only. Nevertheless, materials development has seen rapid growth, and it is in this area that significant innovative activity is currently occurring and further predicted;[33]
- Digital designers: while some users of machines have the capacity to produce CAD files, specialist knowledge provides a distinct advantage in producing 3D printed objects that are functional and fit for purpose. Scanners assist in producing copies of existing products, although tweaks to resulting CAD files will assist in altering finished products. There is a significant amount of CAD material available for purchase online and through open-source websites such as Thingiverse,[34] Quirky,[35] and Shapeways;[36] and
- Producers of 3D printed products: any user with access to a printing machine, appropriate materials, and a CAD file can produce a product. While many products might be produced for personal use, reductions in cost will see 3D printers used to an increasing degree in manufacture. Thus, 3D printed products are likely to be used to an increasing degree in producing products for consumption by various business manufacturers, and members of the public.

25 Lipson and Kurman, *Fabricated*, above n 7, 94–5. Standard tessellated language ('STL') is the industry standard file type in the 3D printing industry, the software having been developed by 3D Systems in association with its STL technology. Its limitations have prompted other system manufacturers to explore possible alternatives that in the future may replace or compete with the STL format.

26 See 3D Systems, *3D Systems* <http://www.3dsystems.com>.

27 See Stratasys, *Stratasys* <http://www.stratasys.com/>.

28 See HP Development Company, LP, *HP 3D Printers and Printing Solution* <http://www8.hp.com/us/en/printers/3d-printers.html>.

29 See Solido Ltd, *Solido Model* <http://www.solido3d.com/>.

30 See MakerBot Industries, *Connected 3D Printing Solutions* <http://www.makerbot.com>.

31 See RepRap, *RepRap 3D Printer Shop* <http://reprap.me/>.

32 Evan Malone and Hod Lipson, 'Fab@Home: The Personal Desktop Fabricator Kit' (2007) 13 *Rapid Prototyping Journal* 245.

33 See generally Alan Earls and Vinod Baya, 'The Road Ahead for 3-D Printers' [2014] (2) *PwC Technology Forecast* 1 <http://www.pwc.com/us/en/technology-forecast/2014/3d-printing/features/future-3d-printing.html>.

34 See MakerBot Industries, *Thingiverse* <https://www.thingiverse.com/>.

35 See Quirky, *What Is Quirky?* <https://www.quirky.com/>.

36 See Shapeways, *Digitally Hand Crafted* <www.shapeways.com>.

Because 3D printing offers such broad potential for customisation and specialised production, it is being increasingly utilised in the manufacturing context. The future importance of the technology to the manufacturing industry has been noted at international[37] and national levels.[38] In the Australian context, the most significant contribution to the development of 3D printing technology is in the materials sphere. Several Australian public sector institutions are contributing to world-class materials research and development efforts.[39] A sub-industry comprising printing studios of varying sizes has also developed. These studios have a range of clients varying from public sector, to businesses engaged in manufacturing, to domestic consumers wishing to have one-off items printed. Officeworks recently announced an intention to enter this industry sector.[40] Simultaneously, many hobbyists (and thus households) now possess basic 3D printers as the price of printers (and materials) drops dramatically.[41] These printers can now be purchased from manufacturers, and in major retail outlets such as Officeworks and Harvey Norman in addition to being available for purchase online.[42]

B *Empirical Evidence of Product Safety Concerns*

A recent study by the one of the authors of this paper which aimed at discerning gaps in the legal landscape pertaining to 3D printing examined issues relevant to product safety. [43] This qualitative study involved semi-structured interviews with participants in the 3D printing industry, notably 3D printing studios. This cohort was selected as the study respondents for several reasons. First, they were an easily identifiable sample. Secondly, another recent study in which one of the

37 'A Third Industrial Revolution', *The Economist* (online), 21 April 2012 <http://www.economist.com/node/21552901>.

38 Wohlers Associates, 'Additive Manufacturing: Technology Roadmap for Australia' (Technology Roadmap, CSIRO, March 2011) 10 <http://3dprintingexpo.org/wp-content/uploads/Additive-Manufacturing-Technology-Roadmap-CSIRO-2011.pdf>; Gordon Wallace and Stephen Beirne, 'How 3D Printing Can Revolutionise Australian Manufacturing', *Comment*, *Sydney Morning Herald* (online), 25 January 2015 <http://www.smh.com.au/comment/how-3d-printing-can-revolutionise-australian-manufacturing-20150125-12xl7t.html>.

39 See, eg, Australian Research Council, 'ARC Research Hub to Transform Manufacturing through 3D Metal Printing' (Media Release, 19 November 2014) <http://www.arc.gov.au/news-media/media-releases/arc-research-hub-transform-manufacturing-through-3d-metal-printing>; ARC Centre of Excellence for Electromaterials Science, *Home* (2014) <http://www.electromaterials.edu.au/>; CSIRO, *Lab 22 Offers 3D Printing* (15 December 2015) <http://www.csiro.au/en/Research/MF/Areas/Metals/Lab22>.

40 Guy Provan and Brittany Howard, *Officeworks to Commence In-House 3D Printing Service* (13 May 2015) Watermark <http://www.watermark.com.au/watermarks-news/2015-may-13-1>.

41 See above n 16.

42 See Patrick Avenell, 'Officeworks Starts Retailing Cube 3D Printer, Modifies Australian Retail First', *Appliance Retailer* (online), 31 January 2014 <http://www.applianceretailer.com.au/2014/01/officeworks-starts-retailing-cube-3d-printer-claims-australian-first/#.VgT6gGSqqko>.

43 Jane Nielsen, 'Delivering on the Commercial Promise of 3D Printing: Identifying Legal Barriers' (Research Project Ref N21974, University of Tasmania, 29 June 2015).

authors was involved confirms the importance of printing studios.[44] When asked about accessing 3D printing technologies, 56 per cent of respondents stated they would use a printing service to print objects for them. Eighty-six per cent stated they would not buy their own printer. Presently, at least, most people accessing the technology appear to be doing so via printing studios.

Thirdly, given their client base, personnel involved in providing printing services are in a position to offer evidence and views on a wide range of issues that might affect 3D printing. Finally, they are part of a growing range of businesses that disrupt traditional manufacturer-to-consumer models, and as such could be expected to provide useful insights into issues that may create safety concerns for consumers. A list of potential interview respondents was created through existing knowledge, online search engines, and industry literature. From nine 3D printing studios identified, seven agreed to be interviewed. These interviews were conducted by phone, and lasted 30 to 50 minutes. Many smaller businesses (generally operating from home) offer similar services, but they were not included in the sample.

Interviews explored themes relating to a number of issues including intellectual property and product safety. With the exception of one respondent, respondents agreed to have their interviews recorded and transcribed — transcribed notes were sent to all respondents for checking.

In outlining the types of products produced, it is clear that consumers form a component of the business of most of our respondents. Requests from consumers for one-off or low-volume production are consistently received. These range from spare parts to art, fashion, and novelty items. Product safety formed an important subset of questions in all interviews. All respondents appeared to be well aware of this issue. They were at pains to stress that 3D printed objects have limitations, and that clients need to be informed of these limitations.

Some respondents are engaged in the design aspect of 3D printing, and are very careful to enquire of clients as to the use(s) to which finished products would be put, in order to try to ensure that goods are fit for purpose. Several respondents considered it their responsibility to provide advice if a client wished to print a product that was clearly unfit for purpose. The exception to this is generally when another party designs an object or part, and a printing studio merely prints a product from file. Even so, two respondents indicated that they still validate whether the material used was safe for the intended purpose. One respondent stated they always make it clear they do not use food-grade plastics.

Most respondents (six) indicated that they attempt to indemnify themselves against liability in respect of product safety. This indemnification is considered

44 Gordana Bruce and Christine Critchley, 'The Swinburne National Technology and Society Monitor' (Monitor Survey, Swinburne University of Technology, 2015). The survey is conducted annually by researchers at the CATI facility at the Department of Statistics, Data Science and Epidemiology, Swinburne University of Technology. It surveys 1000 respondents by telephone, asking a series of general comfort questions and then questions relating to specific areas of technology. In 2015 we designed questions on 3D printing in conjunction with colleagues at Swinburne University.

contractual and contained in the terms of quotation (four respondents), on a website, or in a non-disclosure agreement. Verbal advice is also generally provided. A client might not take on board this advice, but this is obviously a difficult thing to police.

There is no doubt that many of the issues that will arise reflect those we are familiar with in the context of other technologies. Product safety issues might arise with any product produced at home which causes damage to another when provided to them for their consumption (foodstuffs are a case in point). Issues peculiar to 3D printing technology arise because of two features unique to 3D printing:

- The necessity for a CAD file, which might be the link between an object and a new physical manifestation of that object; and
- The increasing simplicity and affordability of 3D printing, including the modification and distribution of CAD files.[45]

Essentially, digital design files are the intangible link between a concept and the tangible world in 3D print manufacturing. Because CAD files embody the object design, there is also a real question as to whether a digital designer could be liable for a product that causes injury. As we have pointed out, while some of our respondents reported that they provide scanning and/or design services, a number outsource this task. Many consumers requesting printing services provide their own CAD file, which might be a downloaded file, or product of their own design. Manufacturers will always be at the forefront of legal liability for products that compromise safety, but in the 3D printing world traditional categories of manufacture are blurred. A party that prints a product may have no input into the product's design. Similarly, the evolving nature of materials' properties may be to blame for a product that is seemingly safe in design but lacks core stability once manufactured. In the following sections, the question of who might incur liability for defective products is examined, first in the context of Australian consumer law, and second in the context of Australian tort law.

III REVIEW OF CURRENT AUSTRALIAN LAWS AFFECTING THE LIABILITY OF MANUFACTURERS

Centuries of common law evolution and accompanying statutory incursions have delivered four possible models for the imposition of liability where a manufacturer puts a defective product into the market place. These are:

1. That liability should only be imposed when the manufacturer has been negligent;

45 See also Osborn, above n 3, 562.

2. That any person who puts a product into the market place that is subsequently revealed to be faulty is liable irrespective of any negligence (ie strict liability);

3. That option two is used, but the manufacturer does have the capacity to argue that the product was constructed in line with the existing knowledge at the time (ie strict liability with a state-of-the-art defence); and

4. No-fault schemes.[46]

Australia has opted for the third model, though this does not operate to the exclusion of common law negligence. Schedule 2 pt 3-5 div 1 of the *Competition and Consumer Act 2010* (Cth) (the '*Australian Consumer Law*' or '*ACL*')[47] provides that proof of the following elements will impose liability on a manufacturer where:

1. That person is a manufacturer supplying goods;

2. The goods were supplied in trade or commerce;

3. The goods have a safety defect;

4. An individual dies or suffers injuries because of the safety defect; and

5. No defences are available to the manufacturer.

In the context of the discussion of products made using 3D printing, the first two of these elements, along with relevant defences warrant discussion.[48] It is these elements that will prove critical in framing whether a person will be responsible as a 'manufacturer' for defects within a product produced using a 3D printer.

A *Manufacturer*

Section 7 of the *ACL* defines a manufacturer in a way that encompasses not only the builder of the product whom all would regard as the manufacturer, but also a person who represents themselves as a manufacturer, allows their brand name to be applied to the good, permits others to promote the goods as being manufactured by it, or imports the product. Allied to this statutory definition is a common law interpretation that has expanded the class of people that might otherwise be seen as manufacturers. For example, in *Ryan v Great Lakes Council*[49] a corporation that distributed oysters to local retailers was deemed the manufacturer, even though the process was organically driven.[50] Further, a person is not required to choose between the actual manufacturer and the deemed manufacturer, both can

46 S G Corones, *The Australian Consumer Law* (Lawbook, 2nd ed, 2013) 494–5 [12.05].

47 The *Australian Consumer Law* can be found in the *Competition and Consumer Act 2010* (Cth) sch 2.

48 There is nothing specific to the 3D printing context to the issue of whether the item has a safety defect, or the person has suffered injuries because of that defect. For a discussion of these elements, see Corones, above n 46, ch 12.

49 (1999) 102 LGERA 123.

50 Ibid 222–3.

be pursued.[51] Finally, a statement indicating the person is not the manufacturer will not prevent liability attaching,[52] and liability is joint and several where several parties are at fault.[53]

In the current scenario, a number of possibilities present, and they are not mutually exclusive. The possessor of the 3D printer (ie the maker of the good) would likely be seen as a manufacturer (they have a direct role in the production of the goods). Adding to this complexity is the position of the owner or designer of a CAD file, and whether this person is a manufacturer. This is by no means a homogenous group, consisting as it does of designers who construct these blueprints as part of their work, but also people who scan 3D objects for subsequent printing, or downloaders who possess designs taken from publicly available, freely accessible, and possibly internationally-located, websites. A CAD file designer may well suggest that they did not produce the good in question, only the blueprint enabling production. Although CAD files undergo significant transformation prior to reaching a consumer (3D embodiment via printing), the design embodied in a CAD file is integral to the makeup of a printed product. It is conceivable that a defect in the design of the good itself could be attributed to the designer. But whether or not designers undertaking the design of an object using CAD software produce a 'good' as required by the *ACL* is debatable. Software itself is a 'good',[54] and CAD files share some characteristics of software in that they provide instructions to a printer to print an object. But CAD files are not software, they are data files that are more in the nature of architectural blueprints. As they are binary files that cannot be read by humans they are a further step removed from physicality.

Given that their role in the supply chain is critical, and that many finalised goods are an admixture of various components,[55] it might be thought that a designer of a CAD file should be seen as a manufacturer in that the CAD 'design' might be viewed as a component part of a finished product. This is supported by the strict liability premise of manufacturers' liability, and the desire to impose liability on participants within the production chain irrespective of any finding of negligence. This reflects the position with regard to traditional manufacturing techniques. While strict liability principles might render this approach appropriate, the fact that the CAD design may not even be definable as a 'good' presents a formidable challenge to product liability laws. It is just one complex, legal problem that arises in this new era.

By contrast, the user of a commercial 3D printing operation and having not designed the CAD file themselves, would not be considered a manufacturer

51 *Leeks v FXC Corporation* (2002) 118 FCR 299. In this case a parachute failed and the injured party could pursue both the importer into Australia (the deemed manufacturer) as well as the US corporation that built the parachute.

52 *Glendale Chemical Products Pty Ltd v Australian Competition and Consumer Commission* (1998) 90 FCR 40.

53 *ACL* s 144.

54 Ibid s 2.

55 'Goods' are defined as including 'any component part of, or accessory to, goods': ibid.

provided they are developing the item for their own use — the person would not be in trade or commerce (discussed below).[56] If they were on-selling the product and attaching their name or brand or representing themselves as the manufacturer, then the answer would be different, assuming that they were acting in trade or commerce.[57]

Finally, consideration must be given to the supplier of the raw materials that are used to produce the 3D printed item. Again, they may be holding themselves out as a manufacturer, allowing their brand name to attach to the final item, or allowing, explicitly or implicitly, others to represent them as a manufacturer. In any of these scenarios, this supplier of materials may be considered to be a manufacturer, though this would parallel traditional subtractive manufacturing techniques.

In summary, given that an injured party can currently take action against all relevant parties in the manufacturing chain, liability could well be joint and several, though identification of relevant parties and roles may not be easy. Practically, the current state of the law will only encourage the joinder of multiple parties to litigation, with an attendant increase in legal costs and complexity.

B *Trade or Commerce*

Any liability imposed on a manufacturer can only occur where that manufacturer is in trade or commerce.[58] For this element to be satisfied, the conduct itself must bear a trading or commercial character.[59] Purely personal transactions will fall outside its remit.[60] Liability, however, can be imposed on employees who are seen to be acting in trade or commerce: 'a representation can be made in trade or commerce even though it is not the trade or commerce of the person making the representation'.[61]

A commercial printing studio undertaking a service of printing an item for a customer, whether from the customer's supplied CAD file, from one supplied in-house, or from a scanned 3D product, would be acting in trade or commerce. The transaction advances their commercial interests.[62] Through the linkage between trade and commerce and the deeming provisions of being a manufacturer, the printing studios interviewed as part of this study would all satisfy this aspect — they are, without question, manufacturers in trade or commerce. We also submit that the supplier of raw materials would, in nearly every instance, be acting in

56 The person creating the product for their own use would not be acting as part of a business, trade, or profession: *Plimer v Roberts* (1997) 80 FCR 303, 327–8.

57 For example, in *Glendale Chemical Products Pty Ltd v Australian Competition and Consumer Commission* (1998) 90 FCR 40, 41 it was held that Glendale Chemicals, by lending its name and logo to a product, was deemed to be the manufacturer, even though Glendale only packaged the product.

58 See generally, *ACL* sch 2 pt 3-5.

59 *Concrete Constructions (NSW) Pty Ltd v Nelson* (1990) 169 CLR 594, 603–4.

60 *Argy v Blunts & Lane Cove Real Estate Pty Ltd* (1990) 26 FCR 112, 127–9.

61 Corones, above n 46, 68 [3.70], citing *Houghton v Arms* (2006) 225 CLR 553.

62 *E v Australian Red Cross Society* (1991) 27 FCR 310, 340–2, 355.

trade or commerce. Generally speaking, those items will have been provided on a commercial basis.

The position with respect to the designer of a CAD file is not so clear-cut. Where this person is in the business of creating CAD files for profit,[63] then undoubtedly their activities would be in trade or commerce. In contrast, if a non-professional designer placed what is ultimately a blueprint that causally connects to an unsafe or defective product on the commons of open source, then arguably they would not be acting in trade or commerce (though we address below whether such actions would be negligent). We suggest that the focus here should be on the nature of the particular transaction, and whether that is in trade or commerce. As the owner of the ultimate product, a consumer (if this person is legally distinct from the others) would arguably not be in trade or commerce. What is lacking is a business or professional connection.[64] This conclusion would differ however, if the owner became a maker and/or designer, for example, by purchasing their own 3D printer and utilising available software to design and manufacture their own items for retail sale.[65]

C *Defences*

Paraphrased, s 142 of the *ACL* provides for the following defences:

(a) That there was no defect at the time of supply;

(b) That there was compliance with a mandatory standard;

63 The profit motive is not critical; a non-profit entity can be in trade or commerce. See *ACL* s 2 (definition of 'trade and commerce').

64 This paper is not considering the consumer guarantees contained in ch 3 pt 3-2 div 1 of the *ACL*. The two most notable that could apply to the instant matter are that a good must be of acceptable quality (*ACL* s 54) and fit for purpose (*ACL* s 55). Goods supplied, in trade or commerce, and which otherwise meet the requisite elements, must meet these consumer guarantees. As with the safety defect provisions, the trade or commerce requirement will be a restricting factor in imposing liability under these provisions where the consumer is producing the good, but in a context without any commercial connotation. The consumer guarantee of acceptable quality will not apply where problems were drawn to the consumer's attention, where there was the opportunity for inspection, or where the goods were subjected to abnormal use (*ACL* s 54(6)–(7)). In determining acceptable quality, matters considered include the nature of the goods, the price, any statements made, any representation and any other relevant circumstance (*ACL* s 54(3)). Furthermore, acceptable quality requires that the items be fit for all purposes for which they are commonly supplied, acceptable in finish and appearance, free from defects, safe, and durable (*ACL* s 54(2)). Fitness for purpose requires that the item supplied must be fit for any disclosed purpose (*ACL* s 55(1)). This provision, however, will not apply where it was unreasonable for the consumer to rely on the skill or judgement of the supplier (*ACL* s 55(3)). While there is a possibility of these provisions applying to 3D printed products, the authors' view is that the strict liability nature of the product safety provisions (*ACL* pt 3-5) will make these latter provisions more likely to be applicable.

65 We would also suggest that if the item is gifted to a person, but the creator of the product is not in trade or commerce (ie they are not acting towards a business, trade or profession), then it is unlikely that the provisions establishing liability would apply. In *Argy v Blunts & Lane Cove Real Estate Pty Ltd* (1990) 26 FCR 112, the private sale of the house was held not to be in trade or commerce; *a fortiori,* where the good is gifted.

(c) That the product was only defective in light of subsequent technical and scientific knowledge, with such knowledge not available at the time of supply (the 'state of the art defence');

(d) That if the goods with the safety defect were comprised in other goods and the safety defect in the final product is only attributable to the design of the other goods, the markings on those other goods, or the instructions or warnings given by the other goods (the 'component defence').

The three defences that appear particularly applicable are the state of the art defence, the component defence, and the defence of compliance with mandatory standards. With regard to the state of the art defence, the owner of a 3D machine, the supplier of raw materials, and the designer of a CAD file will need to ensure that they are keeping abreast of the latest technological advances — a considerable task given the evolving and rapidly-changing nature of this area. For the small scale manufacturer, the statute of repose of 10 years provides an additional, onerous requirement in terms of record keeping.[66]

Furthermore, the component defence provides that a component manufacturer will not be liable if the defect results from the design of the ultimate product, or any instructions, warnings or markings that may have been given on the final item. This opens an avenue for disputation and litigation between the parties that have contributed to the production of the final item, and the question of who is the manufacturer, and to whom responsibility should attach.

As for the compliance with standards defence, this will only be available if the standard was the sole cause of the defect. It becomes unavailable if the standard was only partially responsible for the defects that lay. These defences will not necessarily absolve a manufacturer or other relevant party from liability in negligence.[67]

In addition to these defences, the individual harmed can also have their monetary compensation reduced if the loss or damage was caused by the individual as well as a safety defect within the goods. The damages will be reduced to such extent as the court thinks fit having regard to the individual's share in the responsibility for loss or damage.[68]

On these bases, product safety litigation seems an unlikely beast to adequately address the concerns around safety defects within 3D printed products, particularly when the requirement to act in trade or commerce will be a barrier to effective enforcement. When a good is produced in trade or commerce however, manufacturer liability is possible, albeit confusing and complex. Each

66 *ACL* s 143(2) provides that actions must be commenced within 10 years of supply. This would require all manufacturers, including small scale manufacturers (whether using traditional or additive manufacturing techniques) to keep records for 10 years. Such a burden on a small business would not seem inconsiderable.

67 Corones, above n 46, 509–10 [12.125].

68 *ACL* s 137A. The scope of the predecessor to this provision was considered in *Australian Competition and Consumer Commission v Glendale Chemical Products Pty Ltd* (1998) 40 IPR 619.

party within the chain, should they be individually pursued, will seek to rely on joint and several liability and enjoin other perceived manufacturers to putative litigation. What aggregate manufacturing does is sever 'the long-established identity between manufacturers and sellers, on the one hand, and enterprises, on the other. And this decoupling, in turn, destroys … and unsettles product liability law's traditional theoretical foundation'.[69] It voids any notion that products-based liability should be imposed on manufacturers because of the disparity in bargaining power, the control exercised by the manufacturer and the incapacity of the consumer to check a product. With consumers now being intricately involved in the production process, this lack of bargaining power is non-existent, and control over component parts is vested in others. For some, these concerns have led to a view that assuming the 'enormous potential for innovation and societal benefit [that comes from 3D printing] is worth encouraging, products liability law must be modified to at least partially mitigate this deterrent effect'.[70] While beyond the scope of this paper to consider what those changes could be,[71] there is no doubt that product liability law will need to evolve if it wishes to meet the challenges of additive manufacturing.

Given these problems in product liability litigation, and the practical unlikelihood of substantive change to this established regime, we now consider whether the fluidity and nuances of case-based, inductive reasoning inherent in negligence law will provide a forum more suitable to the resolution of these issues, and respond in a way that does not inhibit the creative opportunities presented by this new technology. At its heart, negligence allows a consumer to make individual choices about how they balance risk with safety,[72] hence it may provide a better vehicle for recalibrating innovation and safety in a way that encourages consumer self-responsibility.[73] The evidentiary requirements imposed on the consumer would undoubtedly be greater than under a strict liability regime, but the consumer would not be without recourse.

IV LIABILITY IN NEGLIGENCE

The law of negligence offers an additional route to claim for damages suffered through defects in products.[74] A claim in negligence may be usefully pursued

69 Freeman Engstrom, above n 2, 41.

70 Berkowitz, above n 3, 1043.

71 Ibid. Berkowitz considers some proposals in the American context, most notably the creation of an affirmative defence for the seller. Others are more cautious and suggest that stakeholders must take an active role in mapping 'an Additive Manufacturing landscape that will be navigable and recognizable by today's traditional manufacturing community. The passive role carries much more risk': Comerford and Belt, above n 3, 836.

72 Note, 'Assumption of Risk and Strict Products Liability' (1982) 95 *Harvard Law Review* 872, 877.

73 Large businesses involved in 3D printing will undoubtedly still insure against liability in any event.

74 Product liability law is somewhat of a 'morass' of intersecting causes of action — another possibility is breach of statutory duty, which provides a further layer on the 'product liability matrix': see Jocelyn Kellam, S Stuart Clark and Mikhail Glavac, 'Theories of Product Liability and the Australian Consumer Law' (2013) 21 *Competition and Consumer Law Journal* 1, 2, 9.

where an entity that supplied goods does not fit the definition of a 'manufacturer' in 'trade or commerce'. The product safety provisions under the *ACL* do not preclude a parallel action in negligence. Negligence requires a defendant to do no more than exercise reasonable precautions to avoid harm to a plaintiff. In other words, liability is not strict and is contingent on the defendant's wrongful conduct rather than simply proof that a product is defective. In this respect, Australian law presents an interesting counterpoint to strict liability jurisdictions such as the US.[75]

In addition to a demonstration of fault, establishing a causal link between an allegedly negligent act and a resultant injury presents what can be a formidable hurdle for a plaintiff. The next section examines the requirements for establishing liability in negligence through the lens of 3D printing, placing particular emphasis on the issues generated by the multi-layered industry structure and the empirical evidence described earlier.

Because negligence is a fault-based tort, in order to establish liability for defective products, culpability on the part of a defendant must be proved. In the 3D printing context, the implications are clear: the manufacturer of a printer will not incur liability unless there is some defect inherent in the machine itself. Suppliers of raw materials will potentially be liable,[76] so too will users of machines who print defective products that are ultimately used by others. This includes printing studios in the event that they fail to take reasonable care. Interesting questions arise in relation to designers of CAD files for products that are ultimately dangerous — their potential liability is far murkier and more difficult to discern.

Founded on common law principles, recent statutory modifications have partially codified the law of negligence.[77] In order to establish liability on the part of any party, a plaintiff must establish that party owed them a duty of care, breached (by failing to discharge) that duty of care, and that there was a causal link between the negligent act and their injury.

A *Duty of Care in the World of 3D Printing*

Under the tort of negligence, a party owes a duty to take reasonable care to avoid a risk of harm to those who might foreseeably be at risk of harm. Decades of jurisprudence have firmly cemented the principle that manufacturers owe a duty of care to consumers of their products.[78] These principles remain unchanged by

75 Under US law, a product is defective if it has a manufacturing defect, a design defect or is accompanied by inadequate instruction or warning: American Law Institute, *Restatement (Third) of Torts: Product Liability* (1998) §2.

76 There seems to be little doubt that, in the right circumstances, manufacturers or suppliers of component parts may be liable to consumers: see *Evans v Triplex Safety Glass Co Ltd* [1936] 1 All ER 283, 284. See further the discussion below, in relation to damage and its consequences.

77 See the civil liability reforms of the early 2000s: *Civil Law (Wrongs) Act 2002* (ACT); *Civil Liability Act 2002* (NSW); *Civil Liability Act 2003* (Qld); *Civil Liability Act 1936* (SA); *Civil Liability Act 2002* (Tas); *Wrongs Act 1958* (Vic) (as amended in 2002); *Civil Liability Act 2002* (WA).

78 *Donoghue v Stevenson* [1932] AC 562*; Grant v Australian Knitting Mills Ltd* [1936] AC 85.

legislative intervention. In identifying defendants, manufacturers generally bear primary responsibility for defective products, unless downstream suppliers in the chain of supply either knew or ought to have known of dangers inherent in a product.[79] This proviso is critical within the 3D printing framework: a supplier will be at risk of liability if they themselves create a risk,[80] or fail to warn of a known defect.[81] They may also be liable if a risk is obvious and they failed to observe it and issue a warning.[82] These points are applicable to any individual who owes a duty of care — negligence principles are not restricted to manufacturers and suppliers.

Where, however, the relationship between parties is more tenuous, courts will consider whether it is just and reasonable in the circumstances to impose a duty of care,[83] and it is this flexibility that makes it particularly suitable for the novel arrangements that are part of the landscape of 3D printing. Thus, precedent and policy will play a large part in determining in a novel case whether a duty of care exists. Incremental expansion of the common law duty category of 'manufacturer' also means that producers have been found to be manufacturers in respect of a wide range of products, 'natural or processed, that are not reasonably safe to the life, health or property of others'.[84] A duty of care has been found to be owed by manufacturers of mass-produced items, as well as in respect of one-off items.[85]

In considering novel cases, courts will weigh 'salient features' indicative of the presence or absence of a duty of care relationship. These factors will vary depending on the facts of the case at hand. Particularly relevant factors where goods are being provided for consumption are factors such as control,[86] vulnerability (on the part of the consumer),[87] existing statutory standards and coherence between tort law and other areas (such as the *ACL*).[88] Importantly, a duty of care may exist in respect of gifted or donated goods,[89] and there is no requirement that goods be provided during the course of business.[90] It may be

79 W V H Rogers, *Winfield and Jolowicz on Tort* (Sweet & Maxwell, 14th ed, 1994) 259.

80 *Romeo v Conservation Commission (NT)* (1998) 192 CLR 431.

81 See *Wallace v Kam* (2013) 250 CLR 375.

82 *Graham Barclay Oysters Pty Ltd v Ryan* (2002) 211 CLR 540, 576 (McHugh J).

83 *Sullivan v Moody* (2001) 207 CLR 562.

84 Martin Davies, 'Product Liability' in Carolyn Sappideen and Prue Vines (eds), *Fleming's the Law of Torts* (Thomson Reuters, 10th ed, 2011) 555, 557.

85 See, eg, *Brown v Cotterill* (1934) 51 TLR 21; *McGee v RJK Building Services Ltd* 2013 SLT 428.

86 See, eg, David G Owen, 'Products Liability: Principles of Justice for the 21st Century' (1990) 11 *Pace Law Review* 63; David G Owen, 'The Moral Foundations of Products Liability Law: Towards First Principles' (1993) 68 *Notre Dame Law Review* 427.

87 See generally Kellam, Clark and Glavac, above n 74.

88 The need for coherence within the private law of obligations was noted by Gageler J in *Australian Financial Services and Leasing Pty Ltd v Hills Industries Ltd* (2014) 253 CLR 560, 625 [156]: 'It is sufficient for present purposes to recognise that the coherence of the law is enhanced if commonality of concept results, so far as possible, in commonality of principle.'

89 *Hawkins v Coulsdon and Purley Urban District Council* [1954] 1 QB 319, 333 (Denning LJ).

90 See, eg, *Swanson v Hanneson* (1972) 26 DLR (3d) 201. This overcomes the limitation in the safety defect provisions, which only apply when the good is supplied in trade or commerce.

owed to an immediate consumer or to any other party foreseeably at risk due to a defect in a product.[91]

Major hardware manufacturers are unlikely to produce defective printers given the scale of their operations. CAD files, however, are now available to print 3D printers at home:[92] conceivably if these machines are printed with some defect that renders them dangerous to use, or that leads to the production of defective items, a duty of care may arise. More likely, though, manufacturers of innovative new materials should ensure that their materials are fit for purpose, and that this purpose is clear when the goods are supplied in order to avoid liability. There is no doubt a duty of care would be owed to those provided with materials to use.

Manufacturers using 3D printing techniques owe a duty of care to those provided with their manufactured goods in line with that owed by manufacturers using traditional, subtractive techniques. Printing studios providing printing services would thus be at the frontline of liability and would certainly owe a duty of care. Other parties such as Amazon or Shapeways that print products to order may also owe a duty of care, regardless of the fact that they self-identify as 'service providers' rather than manufacturers, taking no responsibility for product design.[93] The role of designers, assemblers,[94] makers of component parts,[95] and to some extent suppliers[96] also requires consideration. Whether or not their role in the design and production process is sufficient to attribute legal fault is another matter, as discussed below. Digital designers in particular need to understand the requirements of their client in designing a product that is safe and fit for purpose, given that it is firmly established that designers owe a duty of care in undertaking product design.[97] To this extent, an action in negligence circumvents the difficulty of establishing that intangible CAD files are 'goods' as discussed above in relation to the *ACL*.[98] Home users, too, in manufacturing products that others are likely to use, would also need to be aware that a duty of care may well be owed to anyone using those products in respect of foreseeable uses. This would be the case despite the fact that they are not engaged in a commercial enterprise.[99]

91 See, eg, *Adelaide Chemical and Fertilizer Co Ltd v Carlyle* (1940) 64 CLR 514. Notably, the successful plaintiff in *Donoghue v Stevenson* [1932] AC 562 was a friend of the purchaser of the offending ginger beer. It is important to note that Donoghue ultimately settled out of court, and that her litigated success was only in establishing a duty of care — breach was never proven.

92 See the discussion of how to build you own 3D printer: 3D Printing from Scratch, *How to Build a 3D Printer from Scratch* <http://3dprintingfromscratch.com/common/how-to-build-a-3d-printer-from-scratch/>.

93 See also Nielson, above n 3, 616.

94 *Stennett v Hancock and Peters* [1939] 2 All ER 578; *Malfroot v Noxal Ltd* (1935) 51 TLR 551.

95 *Evans v Triplex Safety Glass Co Ltd* [1936] 1 All ER 283. In relation to the attribution of liability in respect of component parts, see further below, pt IV D.

96 Where a defect or a requirement to warn is apparent to them: see, eg, *McPherson's Ltd v Eaton* (2005) 65 NSWLR 187.

97 *Independent Broadcasting Authority v EMI Electronics and BICC Construction Ltd* (1980) 14 BLR 1; *Suosaari v Steinhardt* [1989] 2 Qd R 477.

98 See above pt III A.

99 Under the US doctrine of strict liability in tort, this factor would eliminate the possibility of bringing an action against such parties: for discussion see Freeman Engstrom, above n 2, 37–8.

B *Breach of Duty of Care*

In addition to demonstrating a duty of care is owed, a party seeking recompense must prove that a defendant failed to take precautions to guard against a risk that is foreseeable, not insignificant, and in the circumstances would have been guarded against by a reasonable person in the defendant's position.[100] A foreseeable risk is one that is not far-fetched or fanciful.[101] Whether or not any precautions taken by a defendant were 'reasonable' will be adjudged against a relevant standard of care: the standard of care permits a finding to be made about what precautions would have been reasonable in the circumstances, and involves weighing together factors relevant to the facts of the case at hand. These factors include (but are not limited to) the probability of harm, the likely seriousness of harm, the burden of taking precautions to avoid the risk of harm, and the social utility of the defendant's act.[102] In addition to these factors required by the civil liability legislation to be weighed in determining whether there has been negligence,[103] other factors have been developed by the courts and may be considered where applicable.

In product liability cases, products may present dangers in respect of their design, manufacture, or marketing.[104] Of these categories, design defects are the most challenging. The challenge is brought about by the difficulty in measuring the standard of reasonableness against which to measure the design.[105] In traditional manufacturing, a finding of negligence would influence the entire manufacturing line with corresponding high costs.[106] In the 3D printing context, mass production is rare. Design defects will probably be the most common product liability issue in the 3D printing environment and it is the bespoke nature of these defects that may make product liability law unsuitable (it being designed and implemented for the sale of consumer products to the market generally).

Manufacturing defects, due to quality control issues, are not so problematic,[107] but products must be safe for all *foreseeable* uses of a product, not just intended uses. Where a product is ornamental and has no real intended use (an issue with many products printed by printing studios using 3D printers), care must nonetheless be taken in protecting against harm that might arise from foreseeable uses.

100 *Civil Law (Wrongs) Act 2002* (ACT) s 43(1); *Civil Liability Act 2002* (NSW) s 5B(1); *Civil Liability Act 2003* (Qld) s 9(1); *Civil Liability Act 1936* (SA) s 32(1); *Civil Liability Act 2002* (Tas) s 11(1); *Wrongs Act 1958* (Vic) s 48(1); *Civil Liability Act 2002* (WA) s 5B(1).

101 *Wyong Shire Council v Shirt* (1980) 146 CLR 40. This principle remains good law subsequent to the enactment of the civil liability legislation: *New South Wales v Fahy* (2007) 232 CLR 486; *Council of the City of Greater Taree v Wells* [2010] NSWCA 147 (1 July 2010).

102 *Civil Law (Wrongs) Act 2002* (ACT) s 43(2); *Civil Liability Act 2002* (NSW) s 5B(2); *Civil Liability Act 1936* (SA) s 32(2); *Civil Liability Act 2002* (Tas) s 11(2); *Wrongs Act 1958* (Vic) s 48(2); *Civil Liability Act 2002* (WA) s 5B(2).

103 See Corones, above n 46, 68 and the text accompanying above n 61.

104 Davies, above n 84, 557.

105 Ibid 558.

106 Ibid 559.

107 Ibid 557.

A failure to take reasonable care in marketing a product may also be established when a defendant knows or ought to know of a defect in their product: the relevant duty of care can be discharged in this case by provision of an adequate warning. This requirement to warn of a known risk will be negated, however, where the risk is obvious to a reasonable person in the position of that person (generally the consumer).[108] There is no duty to warn under such circumstances.[109] A risk will be obvious despite not being prominent, conspicuous, or physically observable.[110]

Perhaps the most pertinent 'mandatory' factor in the 3D printing context is the burden of taking precautions to avoid the risk of harm. Where there is an alternative method of manufacturing available with an established safety record, this will be compelling evidence that the risk of harm might have been allayed or avoided. The social utility of the activity carrying the risk may also be an influential factor if there is a demonstrable benefit in producing customised items (prosthetics, for example), at a reduced price.[111]

The fact that the application of the technology to some uses and in respect of some materials is experimental will also be a very relevant discretionary factor: the probability and seriousness of the risk resulting from the allegedly negligent act is assessed at the time it occurred, not in relation to the subsequent state of knowledge.[112] Conceivably, this innovative aspect may command a lower standard of care than that required by larger manufacturers whom consumers have come to trust without question. Developments in 3D printing processes and materials are fast-paced which might suggest greater anticipation of possible risks[113] and subsequent precautions.[114] In settings where customisation is desirable, for example where medical devices are customised for particular patients in a clinical context, clinicians involved in designing and 3D printing will need to be sure that adequate warning is given in order to protect them should an adverse event ensue.[115] Concurrently, any particular skills possessed by a defendant will be used in the assessment of reasonable precautions to establish whether a breach occurred, and evidence that they acted in accordance with competent professional practice in accordance with accepted peer opinion may well operate to prove they

108 *Civil Liability Act 2002* (NSW) s 5F; *Civil Liability Act 2003* (Qld) s 13; *Civil Liability Act 1936* (SA) s 36; *Civil Liability Act 2002* (Tas) s 15; *Wrongs Act 1958* (Vic) s 53; *Civil Liability Act 2002* (WA) s 5F.

109 *Civil Liability Act 2002* (NSW) s 5H(1); *Civil Liability Act 2003* (Qld) s 15(1); *Civil Liability Act 1936* (SA) s 38(1); *Civil Liability Act 2002* (Tas) s 17(1*); Wrongs Act 1958* (Vic) s 54(1); *Civil Liability Act 2002* (WA) s 5O(1).

110 *Civil Liability Act 2002* (NSW) s 5F(4); *Civil Liability Act 2003* (Qld) s 13(4); *Civil Liability Act 2002* (Tas) s 15(4); *Wrongs Act 1958* (Vic) s 53(4); *Civil Liability Act 2002* (WA) s 5F(4).

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

112 *Roe v Minister of Health* [1954] 2 QB 66; *H v Royal Alexandra Hospital for Childr*en (1990) ATR 81-000.

113 See, eg, *McLean v Tedman* (1984) 155 CLR 306, 311–12; *Nagle v Rottnest Island Authority* (1993) 177 CLR 423, 431.

114 *Independent Broadcasting Authority v EMI Electronics and BICC Construction Ltd* (1980) 14 BLR 1.

115 See Kevin Timms, 'Exploring Product Liability: Putting Medical Devices into a Clinical Context' (2014) 3 *Journal of Aesthetic Nursing* 450.

did not act negligently.[116] This factor may be relevant, inter alia, to designers and to operators of 3D printing studios,[117] if they profess to possess particular skills in making products fit for a purpose specified by a subsequently injured consumer.[118]

Other factors often considered relevant in the product liability context are the existence of statutory and customary standards.[119] Although industry custom or practice will be a relevant factor in determining the standard to be reached, it will not be determinative of the appropriate standard.[120] The fact that design in the 3D printing world can be personalised for (or by) a particular individual may point to an absence of either standards regulating production of that item, or standards of practice inherent in a particular industry. Globally, the International Standards Organisation[121] has begun the process of developing technical standards regulating additive manufacturing.[122] Product safety standards are another matter, and the fact that much 3D printing takes place outside the scope of regulatory control has implications for the applicability of any standards enacted. General standards governing manufactured products will also be applicable to 3D printed products.[123]

Clearly, the requirement to prove fault is the mainstay of an action in negligence, and is an integral difference between tort law and an action under the *ACL*. Despite this, however, Australian courts have demonstrated remarkable adaptability in applying first the common law, and then statutory rules, in finding in favour of a wide variety of injured parties. There is no reason to think courts will not apply the same adaptability once they are required to begin considering the application of product liability rules to products manufactured using 3D printing.

116 *Civil Liability Act 2002* (NSW) s 5O; *Civil Liability Act 2003* (Qld) s 22(1)–(4); *Civil Liability Act 1936* (SA) s 41(1)–(4); *Civil Liability Act 2002* (Tas) s 22(1)–(4); *Wrongs Act 1958* (Vic) s 59.

117 Note that different considerations in respect of medical practitioners apply in some jurisdictions, in that the relevant statutory provisions do not extend to the giving of warnings or advice: see *Civil Liability Act 2002* (NSW) s 5P; *Civil Liability Act 2003* (Qld) s 22(5); *Civil Liability Act 1936* (SA) s 41(5); *Civil Liability Act 2002* (Tas) s 22(5); *Wrongs Act 1958* (Vic) s 60.

118 'Professional activity' has been defined broadly in some cases, for example, as 'intellectual activity, or manual activity controlled by the intellectual skill of the operator, whereby services are offered to the public, usually though not inevitably for reward and requiring professional standards of competence, training and ethics …': *Prestia v Aknar* (1996) 40 NSWLR 165, 186 (Santow J).

119 *Mercer v Commissioner for Road Transport and Tramways (NSW)* (1936) 56 CLR 580; *Woods v Multi-Sport Holdings Pty Ltd* (2002) 208 CLR 460.

120 *Woods v Multi-Sport Holdings Pty Ltd* (2002) 208 CLR 460, 481–2.

121 International Standards Organisation, *Standards Catalogue: ISO/TC 261 — Additive Manufacturing* <http://www.iso.org/iso/home/store/catalogue_tc/catalogue_tc_browse.htm?commid=629086&published=on&includesc=true>.

122 *ISO/TC 261 Additive Manufacturing* has been adopted in 21 countries at the time of writing: ibid. See also Greatorex, above n 4, 21–2.

123 As there is a move to an international regime surrounding product safety. See generally Standards Australia, *Home* <http://www.standards.org.au/Pages/default.aspx>.

C *Damage and Its Consequences*

Damage is the 'gist' of an action in negligence,[124] and in the case of defective goods must manifest in physical form. Although psychiatric injury flowing from the use of a defective product may be compensable,[125] financial loss alone will not be.[126] This includes damage to the product itself resulting from its intrinsically defective nature.[127] In order to claim under allowable heads of damage, a causal connection must be established between the defendant's breach and the damage. The test for causation under the civil liability legislation is a two-limbed test: once negligence is established, a plaintiff must prove that the breach was a necessary element of the plaintiff's damage, and that it is appropriate for the scope of the defendant's liability to extend to compensation for the damage.[128] As to whether a negligent act (or omission) was a necessary element of a plaintiff's damage, the statutory test is essentially an application of the common law 'but-for' test,[129] requiring a factual inquiry devoid of policy considerations[130] as to whether a historical connection exists between the negligence and the damage.[131]

It may be necessary on the evidence available to draw an inference as to the likely cause of a mishap, particularly in a product liability case where there is generally no privity between a manufacturer and a consumer. In this context, the maxim of *res ipsa loquitur* is frequently invoked in cases involving defective products, permitting a court to draw an inference of negligence on the part of a defendant, and a causal link because the mishap occurred.[132] Invocation of the maxim places an evidentiary burden on the defendant to produce evidence negating an inference of negligence. Its role in cases involving apparent defects during the manufacturing process has been particularly prominent, essentially because of the degree of control a manufacturer (or its employees on its behalf) has during the manufacturing process.[133] A plaintiff is not required to identify that their injury came about due to the negligence of a particular employee or to

124 *Williams v Milotin* (1957) 97 CLR 465, 474.

125 *APQ v Commonwealth Serum Laboratories Ltd* [1999] 3 VR 633.

126 *Minchillo v Ford Motor Company of Australia Ltd* [1995] 2 VR 594.

127 See, eg, *Bellefield Computer Services Ltd v E Turner & Sons Ltd* [2003] TCLR 10. Recovery may be allowed in some instances: see the detailed discussion in Michael A Jones and Anthony M Dugdale (eds), *Clerk & Lindsell on Torts* (Thomson Reuters, 21st ed, 2014) [11-21]–[11-24].

128 *Civil Law (Wrongs) Act 2002* (ACT) s 45(1); *Civil Liability Act 2002* (NSW) s 5D(1); *Civil Liability Act 2003* (Qld) s 11(1); *Civil Liability Act 1936* (SA) s 34(1); *Civil Liability Act 2002* (Tas) s 13(1); *Wrongs Act 1958* (Vic) s 51(1); *Civil Liability Act 2002* (WA) 5C(1).

129 *Barnett v Chelsea and Kensington Hospital Management Committee* [1969] 1 QB 428.

130 *Strong v Woolworths Ltd* (2012) 246 CLR 182. For the contrasting common law position see *March v E & M H Stramare Pty Ltd* (1991) 171 CLR 506, 516–17.

131 *Strong v Woolworths Ltd* (2012) 246 CLR 182; *Adeels Palace Pty Ltd v Moubarak* (2009) 239 CLR 420, 425–6.

132 *Schellenberg v Tunnel Holdings Pty Ltd* (2000) 200 CLR 121, 134 [25] (Gleeson CJ and McHugh J).

133 See, eg, *Grant v Australian Knitting Mills Ltd* (1935) 54 CLR 49 (underwear causing dermatitis); *Fletcher v Toppers Drinks Pty Ltd* [1981] 2 NSWLR 911 (exploding soft drink bottle — *contra Kilgannon v Sharpe Bros Pty Ltd* (1986) 4 NSWLR 600); *Suthern v Unilever Australia Ltd* [2007] ACTSC 81 (28 September 2007) (mercury present in unopened ice-cream).

a flawed system of production.[134] This renders the maxim a very effective tool in many cases because the defendant must point to evidence supporting the efficacy of its manufacturing methods and disproving its employees' negligence.[135]

Further complications arise where products are made of component parts. Commonwealth courts have been reluctant to impose an excessive degree of responsibility on manufacturers for parts manufactured by others during the production process,[136] although this trend has been apparent in the US.[137] They may be, however, liable for defects that are relatively easy to discern.[138] Where there is an opportunity for intermediate third party examination of a product that would have reliably alerted them to a defect that ultimately caused a consumer's harm, this may influence a court's findings as to what caused the harm. It is important to bear in mind that the mere possibility of inspection will not suffice to excuse the defendant,[139] there must be evidence that the inspection would have generated sufficient awareness of the defect to reduce the danger to the consumer.[140]

These cases demonstrate that even where a historical connection between negligence and damage is established, more complex policy grounds for attributing liability are required to be considered under the scope of liability test.[141] In evaluating which causes are legally significant, the role of all parties in the supply chain should be considered, and liability will be allocated accordingly. This has considerable relevance in the 3D printing scenario, where an ultimate manufacturer (such as a printing studio) may have very little input into product design, or the way in which a finished product works. Principles of causation provide scope to attribute liability to those who are negligent in materials and product design, in addition to those who provide manufacturing services.[142] This may be of little comfort to consumers who download design files from file-sharing websites and print their own products: jurisdictional issues and difficulty in identifying (potentially, very small) responsible parties may mean that many injuries go uncompensated.[143]

134 *Grant v Australian Knitting Mills* (1935) 54 CLR 49, 61–2 (Lord Wright). A plaintiff must be able to establish that (1) there is an absence of explanation of the occurrence that caused the injury; (2) the occurrence was of such a kind that it does not ordinarily occur without negligence; and (3) the instrument or agency that caused the injury was under the control of the defendant: *Schellenberg v Tunnel Holdings Pty Ltd* (2000) 200 CLR 121.

135 Davies, above n 84, 561.

136 Ibid 568.

137 See, eg, *Boeing Airplane Co v Brown*, 291 F 2d 310 (9th Cir, 1961); American Law Institute, *Restatement (Second) of Torts* (1965) § 400.

138 It is evident from the case law that manufacturers or 'assemblers' will not necessarily be absolved from liability by selecting competent suppliers: see discussions in *Taylor v Rover Co Ltd* [1966] 2 All ER 181, 186; *Optus Networks Pty Ltd v Leighton Contractors Pty Ltd* [2002] NSWSC 327 (24 April 2002) [712]–[718].

139 *Rimmer v Liverpool City Council* [1985] QB 1, 13.

140 *Suosaari v Steinhardt* [1989] 2 Qd R 477.

141 *Adeels Palace Pty Ltd v Moubarak* (2009) 239 CLR 420.

142 Jane Stapleton, *Product Liability* (Butterworths, 1994) 342–3.

143 See also Daly, above n 111, 69.

D *Defences*

Two defences are particularly relevant in the product liability scenario. The first, contributory negligence, will be applicable where a plaintiff's negligence has contributed to his or her own injury.[144] If successfully argued, it results in an apportionment of liability rather than complete exoneration of the defendant. Negligence is judged, once again, on an objective standard.[145] The second, voluntary assumption of risk, can be pleaded where a plaintiff had full knowledge of a risk[146] and allegedly consented to it.[147] In consenting, a plaintiff must have acknowledged the risk and expressly or impliedly agreed to waive his or her right to a remedy in the event that injury occurs.[148] Again, if the risk is an obvious one, this will assist defendants in establishing the assumption of risk by the injured party.[149] The defence is a complete defence to an action in negligence.[150]

Similar considerations will be relevant to the application of both defences. The fact that many 3D printed products are developed and manufactured on a bespoke basis is highly relevant — it may raise the likelihood that consumers have some awareness of the deficiencies inherent in particular products, particularly where they have been alerted to those potential defects by parties designing and printing products for them. For example, a plaintiff might fail to properly inspect a customised product for defects, or put it to a use for which it was not intended,[151] raising the possibility that contributory negligence will be successfully argued. In the case of voluntary assumption of risk, the characteristics of a plaintiff will be taken into account in determining whether a risk was voluntarily assumed: if a plaintiff has considerable experience in relation to the product in question this may support a finding of acceptance of risk.[152] On the other hand, where consumers have an expectation that a 3D printed product is of a similar quality standard to a product produced using traditional manufacturing techniques, a defendant may not be assisted by either of these defences.

The upshot of this discussion is that 3D printing raises issues that, although not unfamiliar, will test the ability of negligence law to apportion fault. There is no obligation on courts to attempt to identify every party to a dispute in negligence: indeed the exercise of selecting defendants is subject to some arbitrariness. Parties implicated in injury to consumers may not be pursued by virtue of their small

144 *Commissioner of Railways v Ruprecht* (1979) 142 CLR 563, 570–1.

145 *Civil Liability Act 2002* (NSW) s 5R; *Civil Liability Act 2003* (Qld) s 23; *Civil Liability 1936* (SA) s 44; *Civil Liability Act 2002* (Tas) s 23; *Wrongs Act 1958* (Vic) s 62; *Civil Liability Act 2002* (WA) s 5K.

146 See, eg, *Canterbury Municipal Council v Taylor* [2002] NSWCA 24 (5 March 2002) [141].

147 *Imbree v McNeilly* (2008) 236 CLR 510, 535–6.

148 Ibid.

149 See *Williams v Milotin* (1957) 97 CLR 465; *APQ v Commonwealth Serum Laboratories Ltd* [1999] 3 VR 633; *Minchillo v Ford Motor Company of Australia Ltd* [1995] 2 VR 594.

150 *Imbree v McNeilly* (2008) 236 CLR 510, 536.

151 See *Poole v Crittal Metal Windows (NZ) Ltd* [1964] NZLR 522; *Gledhill v Liverpool Abattoir Utility Co Ltd* [1957] 3 All ER 117.

152 See, eg, *Leyden v Caboolture Shire Council* [2007] QCA 134 (20 April 2007).

size, their seemingly limited role in the injury in question, or because pursuing them is just not viable.[153] Having said this, there is certainly adequate scope for the law of negligence in Australia to deal with product safety concerns in a 3D printing context, the real questions relate to whether this potential is realised.

V CONCLUSION

From the earliest foundations of modern negligence law,[154] to its modern incarnation in civil liability legislation[155] and the late 20th century addition of strict liability product safety laws,[156] the policy question as to who is responsible for damage clearly informs who should bear the costs of injury from negligently designed, defective, or unsafe products. Risk allocation, after all, is ultimately a social construct.[157] Modern day risk matrices will consider both the probability of the event occurring, and the degree of harm should the risk eventuate before attaching or denying responsibility to a particular party. An event which has a low probability of occurring, but which has catastrophic consequences should it happen, will need different risk minimisation and legal enforcement strategies than one where the probability is close to certain but the outcome is likely to be minor.[158] When this idea is married with the notion that the imposition of legal liability is inevitably a policy choice as to where responsibility and costs should lie,[159] our juridical response to 3D printed products, if we are to impose product safety or negligence liability on some or all parties, informs us as to how we allocate risk between stakeholder groups and the extent to which innovation will be correspondingly curtailed or restricted.

A number of justifications predicated the allocation of liability squarely on manufacturers for safety defects at the end of the 20th century, including manufacturer control, imbalance of bargaining power, the imposition of standard form contracts, incapacity to inspect prior to purchase, consumer vulnerability, and capacity to spread loss through insurance.[160] These grounds might also compel the imposition of liability on various producers within the 3D printing supply chain. Similarly, the motivations that prompted Lord Atkin in *Donoghue*

153 See Stapleton, above n 142, 295–9.

154 Commencing with *Donoghue v Stevenson* [1932] AC 562.

155 *Civil Law (Wrongs) Act 2002* (ACT); *Civil Liability Act 2002* (NSW); *Civil Liability Act 2003* (Qld); *Civil Liability Act 1936* (SA); *Civil Liability Act 2002* (Tas); *Wrongs Act 1958* (Vic); *Civil Liability Act 2002* (WA).

156 See generally, *ACL* pt 3-5.

157 Gail Pearson, 'Risk and the Consumer in Australian Financial Services Reform' (2006) 28 *Sydney Law Review* 99, 100.

158 See generally the discussion by Pearson: ibid 99–105.

159 See generally Serge Galitsky, 'Manufacturers' Liability: An Examination of the Policy and Social Cost of a New Regime' (1979) 3 *University of New South Wales Law Journal* 145.

160 See, eg, the groundbreaking work of Guido Calabresi and Jon T Hirschoff, 'Toward a Test for Strict Liability in Torts' (1972) 81 *Yale Law Journal* 1055, and more recently, Dominick Vetri, 'Order out of Chaos: Products Liability Design-Defect Law' (2009) 43 *University of Richmond Law Review* 1373, 1375–85.

v Stevenson[161] to endorse a principle of looking after one's neighbour[162] might also prompt a call for change in a modern context of individual responsibility and distributed capacity.

Ultimately, however, the answer as to what type of legal infrastructure should be put in place to respond to the problem of damage consequent on a defective 3D product relies on identification of the appropriate party responsible, and as we have outlined, the 3D printing industry is characterised by a multitude of stakeholders and corresponding opacity in identification of 'manufacturers'. This layering and complexity results in a danger that the imposition of liability will lead to a stifling of innovation, an overburdening of costs, and a consequential rise in the cost of the final product as all potential parties attempt to limit or reduce their own potential for liability. These legal difficulties will not prevent an expansion of the technology and its uses. Three-dimensional manufacturing and the consequent shift from a vertical industry structure to one that tends toward the horizontal, necessitates significant thought and discussion as to the inevitable challenges and tensions that 3D printing will bring.

The two areas of law examined in this paper (product safety legislation and negligence) have undergone major amendment over the last 15 years. Having been recognised as deficient, legislative changes represented an attempt to overcome identified deficiencies. Yet the advent of 3D printing will test both regimes. The technology will change the face of manufacturing permanently, and there is a real question as to whether these areas of law are equipped to deal with this new way of producing goods. Both legal schemes are fundamentally representative of decisions made by society about the allocation of risk, and in some ways this issue remains unchanged with 3D printing. Nevertheless, to some degree changes are apparent because many people who are now manufacturing are doing so on a very small scale with the result that risk may not be efficiently allocated.

For this reason, product liability law as it presently stands seems problematic. Product safety legislation was designed and developed in an era of mass manufacturing, separation of consumers from producers through the intervention of a retailer, and an acceptance that consumers would play a limited role in inspecting or understanding the complexities inherent in modern consumables. Now, there are real questions as to whether Australia's product safety legislation is fit for purpose in respect of its applicability to the unique, bespoke, and joint production that emanates from 3D printing. Importantly, the identification of the appropriate manufacturer might be difficult, and may encase those whom the community would not normally envisage bearing responsibility for this role. In addition, the requirement of trade or commerce seems intuitively

161 [1932] AC 562.

162 Lord Atkin relied on the parable of the Good Samaritan in *Luke* 10:25–37 (New Revised Standard Version Bible) to support the neighbour principle in *Donoghue v Stevenson* [1932] AC 562. He was also part of the committee that drafted the constitution of the Church in Wales. For an overview of the influences on Lord Atkin, see: Richard Castle, *Lord Atkin and Christianity* <https://docs.google.com/viewer?a=v&pid=sites&srcid=ZGVmYXVsdGRvbWFpbnxyaWNoYXJkY2FzdGxlbGF3eWVyfGd4OjQ0MDY0MTRhOWYwMzNkMA>.

unsuitable for a home producer or hobby manufacturer of custom-made products on their small-scale 3D printer. Loss-spreading, control, and protection of the vulnerable consumer as the policy-based rationales for strict liability product safety are arguably not designed for an era where the economy grows through sharing or collaboration. This is not surprising given the difficulty of predicting technological change from generation to generation. Questions therefore arise as to whether further changes to this regime will need to be considered. While the United States academe has suggested amendments to the product liability regime in that jurisdiction,[163] the requirement for multi-government approval for legislative change to the *Australian Consumer Law*,[164] and the resonance of the current product safety regime make further substantive change unlikely.

Because of these problems it may well be negligence law that comes to the fore in terms of establishing when and how stakeholders invested in the sharing economy of 3D printing will incur liability. The broad nature of negligence principles and its capacity to evolve and meet current needs[165] are evidence of its chameleon-like nature and adaptability to changing circumstances. Its fluidity, flexibility, and focus on the conduct of the defendant will allow the private law of obligations to develop and alter, as it has done in other areas,[166] to the varied circumstances and diverse parties involved in the 3D printing process. Of course, application of this area of law is not without significant problems. By reason of its flexibility, the law surrounding duty of care, breach, damage, and contributory negligence raises a level of uncertainty that will translate to difficulties in the provision of advice. Fundamentally though, questions will be asked as to whether this legal scheme meets community expectations in terms of facilitating compensatory principles. Intuitively, it would seem unlikely. Current consumer protection principles built on foundations of empowerment and intervention only when there is empirical evidence of need,[167] have, since the 1960s, been based on a premise of consumer vulnerability and inability to inspect and discern product defects. For this reason, such a move out of product safety in favour of greater emphasis on negligence will be long debated. We hope that this article begins that debate. We do not

163 Berkowitz suggests an affirmative defence should be available for the micro-seller. This defence would take into account the seller's experience in manufacturing, the scale of the business, the capacity to take out insurance, the good faith of the seller, and the benefits to society of the product in determining whether a seller was liable for a breach of the product safety provisions: Berkowitz, above n 3, 1049.

164 The Intergovernmental Agreement on the *Australian Consumer Law* requires that, for major amendments, the agreement of the Commonwealth and four other parties (including at least three states) is needed: Council of Australian Governments, 'Intergovernmental Agreement on the Australian Consumer Law' (Agreement, COAG, 2 July 2009) cl 19 <http://consumerlaw.gov.au/files/2015/06/acl_iga.pdf>.

165 For example, for the first time, credit rating agencies were held liable to councils that had purchased complex and incomprehensible financial instruments which had been given solid credit ratings by those agencies: *Wingecarribee Shire Council v Lehman Brothers Australia Ltd (in liq)* (2012) 301 ALR 1; *ABN AMRO Bank NV v Bathurst Regional Council* (2014) 224 FCR 1.

166 Such as in dangerous recreational activities. Today, the state and territory civil liability Acts and the *Competition and Consumer Act 2010* (Cth) provide opportunities for providers of these services to exempt or limit their liability: see, eg, *Competition and Consumer Act 2010* (Cth) s 139A.

167 See, eg, Organisation of Economic Cooperation and Development, *Consumer Policy Toolkit* (9 July 2010) OECD <http://www.oecd.org/sti/consumer/consumer-policy-toolkit-9789264079663-en.htm>.

advocate immediate change, but rather, careful consideration of the challenges wrought by new technologies such as 3D printing, and whether Australian law in its current form is equipped to deal with these challenges.