An Analysis of UK Copyright and Design Laws on 3D Printing and Product Design

Dukki Hong

Thesis for the degree of Doctor of Philosophy at the Centre for Intellectual Property Policy and Management, Bournemouth University, July 2020

Abstract

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The thesis aims to investigate the implications of 3D printing for UK copyright and design rights, with an emphasis on the creation, access and use of computer-aided design (CAD) files by consumers for product design. The thesis has two major objectives. The first is to identify and present the context of 3D printing for legal analysis, and the second is to investigate the implications of 3D printing for UK copyright and design laws, especially relating to consumers.

To this end, the thesis employs the 'law in context' methodology, with the aim of building a contextual framework for the legal analysis of 3D printing. Following the contextual analysis of technological, corporate and societal aspects of 3D printing, it presents the most relevant five scenarios of consumer use of 3D printing, capturing various design activities that are occurring or likely to occur in the 3D printing environment.

The thesis demonstrates that consumers' increased product design prosumption (consumption plus production), as depicted in the scenarios, will pose legal challenges. It is found that there are uncertainties over the protection of and ownership of CAD files, whilst infringement and enforcement issues arise in relation to online platforms facilitating the unauthorised reproduction and dissemination of CAD files.

To address the issues, the thesis asserts that there is a need for the review of UK copyright and design laws to seek further clarity on regulation of consumers' design activities in the 3D printing environment. It is also vital to improve clarity over the regulation of 3D printing online platforms, for which further research is recommended on the enforcement landscape in the 3D printing environment.

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Acknowledgements

I would like to thank my supervisors, Professor Dinusha Mendis and Dr Tania Humphries-Smith, for providing academic guidance and mental support throughout this research project. I am especially grateful for Professor Dinusha Mendis having always stood by me, not only as a supervisor but also as a life mentor and a friend whenever I have been in need of help. I also thank the PGR administrators, Sunny Choi and Jan Lewis, for their support. Finally, I really thank my family for their patience, encouragement and unlimited support.

Introduction

Scope of the Research and Background Information

Emerging as an alternative manufacturing method to traditional manufacturing, 3D printing has been depicted in recent years as one of the most disruptive technologies that can challenge the existing industries, markets, and regulatory frameworks. Against this backdrop, 3D printing has been a topical subject in legal scholarship. A wide array of legal issues has been identified and discussed in academic research, encompassing issues regarding, for example, product safety, 3D-printed arms control, protection of privacy and intellectual property (IP).

As one branch of the subject area, the thesis considers the field of IP law and 3D printing. However, it is noteworthy that IP implications of 3D printing can considerably vary, depending on the types of IP rights and elements of 3D printing that are brought into discussion. For example, technical aspects of 3D printing, such as 3D printing technologies, 3D printers and materials, are best discussed in the context of patent law, whilst copyright and design rights become more relevant where creation and use of 3D printing designs are concerned. Therefore, defining the scope of the research is vital, and this is what the thesis aims to achieve in the Introduction.

The thesis aims to examine implications of 3D printing for UK copyright and design laws, with an emphasis on consumer engagement in product design in the 3D printing environment. As such, the thesis does not cover technical perspectives of 3D printing technologies, 3D printers or materials, but it brings into focus copyright and design rights issues arising in product design processes in the 3D printing environment where 3D printing designs are accessed, created, and used.

The thesis also does not examine industrial 3D printing. Instead, it focuses on increased consumer involvement in product design facilitated in the 3D printing environment. The emergence of 3D printing and the related technological and the social development creates a favourable environment for consumer engagement in product design and manufacturing. 3D printing enables localised and decentralised manufacture of customised products. Increased Internet connectivity, proliferation of online platforms, and the social movements, such as the DIY culture and open design, facilitate the consumer engagement in online access and distribution of designs. The thesis considers that such changes in consumer behaviour in the 3D printing environment could challenge the traditional IP landscape, and therefore legal analysis of this area is extremely beneficial.

The scope of the research and background information will be provided in the following section. In doing so, this section discusses (a) an overview of 3D printing, (b) the relevance of product design and computer-aided design (CAD), (c) the relevance of consumers and prosumers in the 3D printing context, and finally (d) the relevance of copyright and design rights for the research.

Overview of 3D printing

3D printing, often synonymously referred to as additive manufacturing, is one of the broad terminologies that indicate a number of technologies that adopt a process of joining materials, usually layer upon layer, to make objects from 3D model data.[1] The term additive manufacturing (AM) is more prominent in industry,[2] whereas the term 3D printing is more generally used by the public.[3] The thesis will employ '3D printing' to indicate all relevant technologies that exploit additive approaches.

It is suggested that there are two branches of 3D printing. Historically, 3D printing was collectively known as rapid prototyping,[4] due to its main use being prototyping for product development.[5] Owing to significant technological improvements in speed, quality, accuracy and material properties, it is now deemed not a mere prototyping tool but an alternative manufacturing tool for end-use products or components.[6] These two types of 3D printing application currently coexist. The thesis focuses on the latter branch of 3D printing, as a manufacturing tool.

It is noteworthy that 3D printing does not replace traditional manufacturing; these instead coexist for different purposes. Traditional manufacturing means such manufacturing methods as subtractive and formative manufacturing processes.[7] For technical and economic reasons,[8] traditional manufacturing is still more apt for mass production.[9] In contrast, owing to its enhanced design freedom and cost flexibility, 3D printing is useful for small-volume production of individualised products,[10] leading to

[1] ASTM standard f2792, standard terminology for additive manufacturing technologies <https://www.astm.org/Standards/F2792.htm> accessed 25 July 2020
[2] Ian Campbell, David Bourell and Ian Gibson, 'Additive Manufacturing: Rapid Prototyping Comes of Age' (2012) 18 Rapid Prototyping Journal 255
[3] Claire Warnier and others (eds), *Printing Things: Visions and Essentials for 3D Printing* (Gestalten 2014)
[4] Xue Yan and Peihua Gu, 'A Review of Rapid Prototyping Technologies and Systems' (1996) 28 Computer-Aided Design 307
[5] Kaufui Wong and Aldo Hernandez, 'A Review of Additive Manufacturing' (2012) 4 ISRN Mechanical Engineering: Article ID 208760
[6] Ian Gibson, David Rosen and Brent Stucker, *Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing* (2nd edn, Springer 2015)
[7] Vivek Srinvasan and Jarrod Bassan, *3D Printing and the Future of Manufacturing* (CSC, 2012)
[8] For detailed accounts of differences between traditional manufacturing and 3D printing, see Wei Gao and others, 'The Status, Challenges, and Future of Additive Manufacturing in Engineering' (2015) 69 Computer-Aided Design 65. For another reason that 3D printing cannot replace traditional manufacturing, it is also pointed out that products resulting from current 3D printing do not have as much strength as those produced from traditional manufacturing, due to anisotropic mechanical properties. See Gao and others (n 8) 68
[9] Siavash Khajavi, Jouni Partanen and Jan Holmström, 'Additive Manufacturing in the Spare Parts Supply Chain' (2014) 65 Computers in Industry 50; Jan Holmström and others, 'Rapid Manufacturing in the Spare Parts Supply Chain: Alternative Approaches to Capacity Deployment' (2010) 21 Journal of Manufacturing Technology Management 687
[10] Richard Hague, 'Unlocking the Design Potential of Rapid Manufacturing' in Neil Hopkinson, Richard JM Hague and Phill Dickens (eds), *Rapid Manufacturing: An Industrial Revolution For The Digital Age* (Wiley 2006)

product customisation, personalisation and co-creation being one of the most promising areas of 3D printing applications.[11]

Product design and CAD

Against this backdrop, product design becomes relevant and important in the 3D printing context. In broad terms, product design means the practice of designing products,[12] and product designers define and realise the required function and appearance of products in the product design process.[13] In conventional product design processes, computers and specialist software are often utilised to produce designs, and the process of utilising such computational instrument is known as computer-aided design (CAD).

CAD is indispensable for 3D printing purposes, as 3D printing requires digital data for product fabrication.[14] A computer file incorporating such data is known as a CAD file,[15][16] a 3DPDF (3D printing design file),[17] or a CAD design,[18] for example. In this thesis, the computer file will be referred to as a CAD file. A CAD file incorporates a final description of the design in the form of a 3D model, and this is essentially what is going to be manufactured with 3D printing.

As was noted, 3D printing facilitates the production of individualised products, encouraging product designers to produce individualised product designs for the specific needs of consumers. In the 3D printing context, consumers have increased opportunities to decide the design of the product they wish

[11] Brett Conner and others, 'Making Sense of 3-D Printing: Creating a Map of Additive Manufacturing Products and Services' (2014) 1–4 Additive Manufacturing 64
[12] Paul Rodgers and Alex Milton, *Product Design* (1st edn, Laurence King Publishing 2011)
[13] Alex Milton and Paul Rodgers, *Research Methods for Product Design* (Laurence King Publishing 2013)
[14] Chee Kai Chua and Kah Fai Leong, *3D Printing and Additive Manufacturing: Principles and Applications* (4th edn, World Scientific 2014)
[15] This appears to be one of the most widely used terms. See Dinusha Mendis, '"The Clone Wars": Episode 1 – the Rise of 3D Printing and Its Implications for Intellectual Property Law – Learning Lessons from the Past?' (2013) European Intellectual Property Review 155; Dinusha Mendis, '"Clone Wars" Episode II – The Next Generation: The Copyright Implications Relation to 3D Printing and Computer-Aided Design (CAD) Files' (2014) 6 Law, Innovation and Technology 265; Bibi van den Berg and others, *3D Printing: Legal, Philosophical and Economic Dimensions* (Springer 2016); Angela Daly, *Socio-legal Aspects of the 3D Printing Revolution* (Palgrave 2016); Dinusha Mendis, Mark Lemley and Matthew Rimmer (eds), *3D Printing and Beyond: Intellectual Property and Regulation* (Edward Elgar 2019)
[16] The term is also adopted in the most recent UKIPO and EC reports. See Thomas Birtchnell and others, *3D Printing and Intellectual Property Futures* (UKIPO, 2018); Dinusha Mendis and others, *The Intellectual Property Implications of the Development of Industrial 3D Printing* (European Commission, 2020)
[17] Simon Bradshaw and others, 'The Intellectual Property Implications of Low-Cost 3D Printing' (2010) 7 ScriptEd 5
[18] Michael Weinberg, 'It Will Be Awesome if They Don't Screw It Up: 3D Printing, Intellectual Property, and the Fight over the Next Great Disruptive Technology' (Public Knowledge 2011); Michael Weinberg, 'When 3D Printing and the Law Get Together, Will Crazy Things Happen?' in Bibi van den Berg and others (n 15)

to purchase, and in doing so they are even invited to participate in product design processes to co-design with professional product designers.[19]

Consumers and prosumers in the 3D printing context

3D printing and the related technological and societal developments [20] contribute to the democratisation of manufacturing methods and the creation of an environment where consumers have increased access to manufacturing tools.[21] The emergence of CAD programs aimed at cooperative and non-professional use[22] and of intuitive input devices reduces the learning curve,[23] helping consumers utilise CAD programs to create and modify product designs.[24] Meanwhile, enhanced connectivity to the Internet helps consumers to access not only online communities for information and knowledge exchange[25] but also 3D printing online platforms, where various 3D printing manufacturing and design services are offered.[26]

The upshot of these developments is that the 3D printing environment is changing consumers' behaviours,[27] from the passive consumption of goods and services to active consumption and further prosumption.[28] Whilst the traditional form of product consumption mostly entails choosing a selection of products that are already manufactured, 3D printing enables consumers to choose the materials and

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[19] Peter Troxler and Caspar van Woensel, 'How Will Society Adopt 3D Printing?' in Bibi van den Berg and others (n 15) 192

[20] For example, the expiration of core patents for 3D printing technologies in the 2000s led to the emergence of affordable and accessible 3D printers. For more discussion on 3D printing and patents, see Stefan Bechtold, '3D Printing, Intellectual Property and Innovation Policy' [2016] International Review of Intellectual Property and Competition Law 517

[21] Mendis and others (n 16) 17–19; Gibson, Rosen and Stucker (n 6)

[22] Most beginner CAD programs are available online. See, for example, Google Sketchup <http://www.sketchup.com>, Tinkercad <http://www.tinkercad.com>, FreeCAD <http://www.freecadweb.org>. Furthermore, the introduction of cloud-based and VR-integrated CAD systems is also noteworthy. See Dazhong Wu and others, 'Cloud-Based Design and Manufacturing: A New Paradigm in Digital Manufacturing and Design Innovation' (2015) 59 Computer-Aided Design 1; Angel Bachvarov, Stoyan Maleshkov and Polina Stojanova, 'Design-by-the-Customer through Virtual Reality' in Paulo Jorge da Silva Bártolo and others (eds), *Innovative Developments in Design and Manufacturing: Advanced Research in Virtual and Rapid Prototyping* (CRC Press 2010)

[23] Hod Lipson and Melba Kurman, *Fabricated: The New World of 3D Printing* (John Wiley & Sons 2013)

[24] Barry Berman, '3-D Printing: The New Industrial Revolution' (2012) 55 Business Horizons 155

[25] For example, see the Rep-Rap Project (Replicating Rapid prototype) <http://reprap.org>

[26] Thierry Rayna and Ludmila Striukova, 'A Taxonomy of Online 3D Printing Platforms' in Bibi van den Berg and others (n 15)

[27] Jan Kietzmann, Leyland Pitt and Pierre Berthon, 'Disruptions, Decisions, and Destinations: Enter the Age of 3-D Printing and Additive Manufacturing' (2015) 58 Business Horizons 209

[28] Jarkko Moilanen and Tere Vadén, '3D Printing Community and Emerging Practices of Peer Production' (2013) First Monday <http://firstmonday.org/ojs/index.php/fm/article/view/4271/3738#2> accessed 29 July 2020; Thierry Rayna and Ludmila Striukova, 'Involving Consumers: The Role of Digital Technologies in Promoting 'Prosumption' and User Innovation' (2016) Journal of the Knowledge Economy <http://link.springer.com/article/10.1007/s13132-016-0390-8> accessed 19 April 2017; Pingyu Jiang, Kai Ding and Jiewu Leng, 'Towards a Cyber-Physical-Social-Connected and Service-Oriented Manufacturing Paradigm: Social Manufacturing' (2016) 7 Manufacturing Letters 15; Babak Mohajeri and others, 'Shift to Social Manufacturing: Applications of Additive Manufacturing for Consumer Products' (IEEE International Conference on Service Operations and Logistics, and Informatics, Beijing, 25 August 2016)

designs of what is to be manufactured.[29] Industries expand their 3D printing applications into offering customisable consumer goods,[30] along with high-end industrial applications for aerospace[31] and automotive parts.[32]

The thesis takes the view that such a changing nature of consumers' behaviours in the 3D printing environment is one of the most significant factors that can affect the current IP landscape. In the thesis, the term 'consumers' is employed, taking its ordinary meaning, to denote people who buy goods or services for their own use.[33]

In the 3D printing environment, however, the roles of consumers are likely to diversify. In addition to the passive consumption of products, consumers can actively engage in design activities to decide the design of the products they wish to buy, and even further produce individualised designs and products.[34] For example, some will buy CAD files that are already provided in online marketplaces for the passive consumption of products; some will use design services to individualise their products for more active consumption;[35] and some will take advantage of 3D printing and the related technologies for design production and physical fabrication.[36] In effect, consumers using 3D printing are likely to be simultaneously involved in both production and consumption[37] and become prosumers – a merged concept of producers and consumers.[38]

Prosumer engagement in product design can potentially reshape the relationship between professional product designers and prosumers. Some argue that the increased possibility to partake in such design

[29] Ruth Jiang, Robin Kleer and Frank Piller, 'Predicting the Future of Additive Manufacturing: A Delphi Study on Economic and Societal Implications of 3D Printing for 2030' (2017) 117 Technological Forecasting & Social Change 84
[30] Aurelie Merle and others, 'Perceived Value of the Mass-Customized Product and Mass Customization Experience for Individual Consumers' (2010) 19 Production and Operations Management 503
[31] Jyothish Kumar and Krishnadas Nair, 'Current Trends of Additive Manufacturing in the Aerospace Industry' in David Ian Wimpenny, Pulak M. Pandey and L. Jyothish Kumar (eds), *Advances in 3D Printing & Additive Manufacturing Technologies* (Springer 2016)
[32] Jürgen Gausemeier, Thinking Ahead the Future of Additive Manufacturing – Analysis of Promising Industries (DMRC, 2011)
[33] Cambridge Dictionary <https://dictionary.cambridge.org/dictionary/english/consumer>
[34] Sam Halassi, Janjaap Semeijn and Nadine Kiratli, 'From Consumer to Prosumer: A Supply Chain Revolution in 3D Printing' (2019) 49 International Journal of Physical Distribution & Logistics Management 200
[35] Kietzmann, Pitt and Berthon (n 27)
[36] Christoph Ihl and Frank Piller, '3D Printing as Driver of Localized Manufacturing: Expected Benefits from Producer and Consumer Perspectives' in Jan-Peter Ferdinand, Ulrich Petschow and Sascha Dickel (eds), *The Decentralized and Networked Future of Value Creation: 3D Printing and Its Implications for Society, Industry, and Sustainable Development* (Springer 2016); Avner Ben-Ner and Enno Slemsen, 'Decentralization and Localization of Production' (2017) 59 California Management Review 5
[37] George Ritzer, 'Focusing on the Prosumer: On Correcting an Error in the History of Social Theory' in Birgit Blättel-Mink and Kai-Uwe Hellmann (eds), *Prosumer Revisited* (Springer 2010); Rayna and Striukova (n 28)
[38] It is suggested that the concept was initially formulated by Alvin Toffler, and defined as 'a person that creates goods, services or experiences for his own use or satisfaction, rather than for sale or exchange'. See Sabina Seran and Monica Izvercian, 'Prosumer Engagement in Innovation Strategies: The Prosumer Creativity and Focus Model' (2014) 52 Management Decision 1968. See also Alvin Toffler and Heidi Toffler, *Revolutionary Wealth* (Alfred A. Knopf 2006)

activities is blurring the borderlines between the roles of product designers and consumers.[39] However, it is suggested that the fact that anybody is endowed with the ability to design does not necessarily make them competent designers; professional designers have a high level of technical proficiency and specialised knowledge in product design.[40] Despite the controversy, it is found that, with the increased awareness of 3D printing, consumers' demand for individualised products and willingness to participate in product individualisation have been growing.[41]

Prosumer engagement in product design will have an impact upon product design processes and IP rights management within them. Prosumers have the potential to bring extra value to product designs by participating in various design activities, such as product customisation, personalisation and co-creation.[42] This can lead to the generation of new IPs and associated IP rights, and potentially result in conflicts regarding the management of the generated IP rights between the participants in the design activities. The next section will further elaborate the relevance of IP rights in this context.

Relevance of IP rights: copyright and design rights

As illustrated above, the emergence of 3D printing opens possibilities for consumers' prosumption of products. Such changes are relatively new in the context of IP law. The current legal framework was built in consideration of the existing industries' product development and manufacturing practice (i.e. mass production, centralised manufacturing and firm-centric product development).[43] This poses a question over whether the emergent prosumer engagement can be fully regulated within the ambit of the current legal framework.[44]

IP law is an umbrella term that denotes various IP rights, such as copyright, design rights, patents and trade marks. The scope of protection afforded by IP rights differs; for example, patents protect novel and inventive ideas underlying product designs,[45] whereas their aesthetic value can be protected by

[39] Jürgen Bertling and Steve Rommel, 'A Critical View of 3D Printing Regarding Industrial Mass Customization Versus Individual Desktop Fabrication' in Jan-Peter Ferdinand, Ulrich Petschow and Sascha Dickel (eds), *The Decentralized and Networked Future of Value Creation: 3D Printing and Its Implications for Society, Industry, and Sustainable Development* (Springer 2016); Cindy Kohtala, Sampsa Hyysalo and Jack Whalen, 'A Taxonomy of Users' Active Design Engagement in the 21st Century' (2020) 67 Design Studies 27
[40] Ezio Manzini, *Design, When Everybody Designs: An Introduction to Design for Social Innovation* (MIT Press 2015) 37
[41] Laura Bravi and others, 'Attitudes and Behaviours of Italian 3D Prosumer in the Era of Additive Manufacturing' [2017] Manufacturing Engineering Society International Conference 2017 (28–30 June 2017, Spain)
[42] Seran and Izvercian (n 38) 1968
[43] Alexander Carter-Silk and Michelle Lewiston, *The Development of Design Law Past and Future: From History to Policy* (Intellectual Property Office, 2012) 35 (following the second industrial revolution in America, what we call 'modern design' was born. And industrial design was regarded as 'the process that converts technology into desirable, appropriate, and needed material goods for mass consumption')
[44] Jos Dumortier and others, *Legal review on Industrial Design Protection in Europe: Under the Contract with the Directorate General Internal Market, Industry, Entrepreneurship and SMEs* (European Commission, 2016)
[45] Patents Act 1977 (hereinafter PA77), s 1(1)

design rights or copyright.[46] Trade mark law comes into play in relation to the potential use of protected signs.[47] As such, the legal implications of 3D printing can be different for each IP right.

The thesis considers UK copyright and design rights for the legal analysis of 3D printing, as these are relevant in the context of prosumer engagement in product design in the 3D printing environment. Theoretically, consumers' contribution to product designs can attract the protection of any type of IP right, as long as it meets the legal requirement; however, in practice, most consumers will be rarely capable of creating functional values that are patentable, owing to the lack of expertise in product design and engineering.[48] In contrast, without such professional knowledge, consumers can still make aesthetic contributions and potentially create aesthetic values that can be protected with copyright and design rights. Furthermore, copyright and design rights, in particular UK unregistered design rights, are non-registered rights that can arise automatically over the course of design activities. This implies that these rights will be those that consumers will most likely generate in prosumer engagement in product design.

Rationalisation for the Research

The purpose of this section is to provide justifications for the thesis. To this end, this section reviews the existing literature, identify research gaps and formulate a research question.

Literature review

For a legal analysis of 3D printing, the thesis considers three subject areas: IP law, 3D printing and product design. The existing literature discusses various aspects of these topics, and this section aims to examine legal literature on 3D printing and product design.

Legal studies on 3D printing are relatively young: one of the earliest scholarly articles dealing with UK IP law was published in 2010. Since then, a fair amount of academic literature on 3D printing has been published, some of which has concerned all types of IP, whereas other works have focused on specific types of IP. This section briefly reviews the literature covering UK copyright and design rights.

Given the novelty of the topic, earlier literature explored the legal implications of 3D printing in a broad manner, discussing all types of IP rights. Bradshaw et al.[49] and Mendis[50] discussed how the UK

[46] Registered Designs Act 1949 (hereinafter RDA 1949), s 1B; Copyright, Designs and Patents Act 1988 (hereinafter CDPA 1988), ss 3–8; CDPA 1988, s 213
[47] Trade Marks Act 1994 (hereinafter TMA 1994), ss 3–8
[48] Weinberg, It Will Be Awesome (n 18). However, it is notable that patent protection can be provided for simple products. See Marc Mimler, '3D Printing and Patent Law – a UK Perspective: Apt and Ready?' in Mendis, Lemley and Rimmer (n 15)
[49] Bradshaw and others (n 17)

IP framework can be challenged in the 3D printing environment. In particular, they identified that 3D printing would facilitate consumers to partake in design creation, modification and reproduction and submitted that regulation of such activities would be crucial.

Based upon these groundworks, further research was conducted on various aspects of IP law and 3D printing. The legal status of CAD files was largely discussed in legal scholarship. Most notably, Mendis scrutinised the copyright status of CAD files in significant detail, with reference to the established case law in the UK and EU.[51] Malaquias analysed the protectability of CAD files from the perspective of UK design rights and copyright.[52] Meanwhile, the protection of CAD files in EU copyright and design rights was also discussed.[53] The majority of the literature concluded that there was uncertainty about protection of CAD files in the current IP framework.

At the same time, various other themes and contexts relating to consumer 3D printing have been also identified and discussed in further works. In particular, Bradshaw et al.[54] and Malaquias[55] discussed the implications of consumer 3D printing for UK IP law. The impact of use of 3D printing by consumers was also examined in the context of EU design law.[56] Most recently, an EC report consolidated the existing literature and, as part of the research, discussed the implications of IP rights exceptions for consumers, and it was submitted in the report that the scope of copyright and design rights exceptions was not clearly established at the EU level and there would be a need for more judicial clarity.[57]

The IP implications of consumer engagement in 3D printing were also explored in various literature. Reeves and Mendis highlighted in a UKIPO-commissioned research that product customisation would be one of the most prospective 3D printing areas where various IP issues could arise from consumer engagement.[58] Daly noted that consumer- or prosumer-oriented 3D printing could challenge the

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[50] Mendis, '"The Clone Wars": Episode 1' (n 15)
[51] Mendis, '"Clone Wars" Episode II' (n 15); Dinusha Mendis, 'In Pursuit of Clarity: The Conundrum of CAD and Copyright – Seeking Direction through Case Law' (2018) 40 European Intellectual Property Review 694
[52] Pedro Malaquias, 'Consumer 3D Printing: Is the UK Copyright and Design Law framework fit for purpose?' (2016) 6 Queen Mary Journal of Intellectual Property 321
[53] Viola Elam, 'CAD Files and European Design Law' (2016) 7 Journal of Intellectual Property, Information Technology and E-Commerce Law 146; Ana Nordberg and Jens Schovsbo, 'EU Design Law and 3D Printing: Finding the Right Balance in a New e-Ecosystem' in Rosa Maria Ballardini, Marcus Norrgård and Jouni Partanen (eds), *3D Printing, Intellectual Property and Innovation – Insights from Law and Technology* (Wolters Kluwer 2017); Mikko Antikainen and Daniël Jongsma, 'The Art of CAD: Copyrightability of Digital Design Files' in Rosa Maria Ballardini, Marcus Norrgård and Jouni Partanen (eds), *3D Printing, Intellectual Property and Innovation – Insights from Law and Technology* (Wolters Kluwer 2017); Mendis and others (n 16)
[54] Bradshaw and others (n 17)
[55] Malaquias (n 52)
[56] Nordberg and Schovsbo (n 53); Jos Dumortier and others, *Overview of 3D Printing & Intellectual Property Law: Under the Contract with the Directorate General Internal Market, Industry, Entrepreneurship and SMEs (MARKT2014/083/D)* (European Commission, 2016)
[57] Mendis and others (n 16), Chapter 3: 3D Printing and Exceptions and Limitations
[58] Phil Reeves and Dinusha Mendis, *The Current Status and Impact of 3D Printing Within the Industrial Sector: An Analysis of Six Case Studies* (Intellectual Property Office, 2015)

traditional notion of IP rights ownership and management.[59] Li et al. suggested in their case study on customised chocolate that consumer engagement in the customisation could lead to generation of new copyrights.[60] Most notably, in their empirical studies, Ballardini et al. found that firms' lack of awareness of the legal nature of co-creation and the resulting absence of proper co-creation business models and IP rights management strategies were hindering consumer engagement, and posited that legal clarity on the legal status of CAD files and introduction of structured licensing models would be required for effective IP management strategies.[61]

3D printing online platforms, as a vital infrastructure that facilitates consumer engagement, were studied in literature in the context of IP law. Moilanen et al. analysed the terms and conditions provided on Thingiverse, one of the most popular 3D printing online platforms, and the licence choices of its users.[62] He analysed the terms and conditions of copyright licensing in 3D printing online platforms from the perspective of EU copyright law.[63] Mendis and Secchi, commissioned by the UKIPO, studied user behaviour on 3D printing online platforms and found that, despite the use of various public licensing schemes, unlawful reproduction that could lead to IP rights infringement was increasingly spotted.[64] It was highlighted that public licensing schemes adopted in 3D printing online platforms, such as Creative Commons, were not feasible in the 3D printing environment.[65]

Literature on IP law and product design broadly covers two aspects: the use of IP rights in product design processes and product design firms' IP rights management. In relation to product design processes, it is found that the literature is limited in its scope, and most of it focused on discussing the importance of considering IP rights in product development. For example, it was suggested that existing IPs can be used for product innovation, such as for the generation of design solutions[66] and

[59] Daly (n 15) (the author argues that the impact of consumer- or prosumer-oriented 3D printing upon the socio-legal landscape might not be, at present, as significant as it is argued to be in other literature, but more widespread use of 3D printing by consumers as a result of technological development can have the potential to challenge the current IP law). See also Angela Daly, 'Don't Believe the Hype? Recent 3D Printing Developments for Law and Society' in Mendis, Lemley and Rimmer (n 15); Birtchnell and others (n 16) 13

[60] Phoebe Li and others, 'Intellectual Property and 3D Printing: A Case Study on 3D Chocolate Printing' (2014) 9 Journal of Intellectual Property Law & Practice 322

[61] Rosa Ballardini and others, 'Co-creation, Commercialization and Intellectual Property – Challenges with 3D Printing' (2016) 7 European Journal of Law and Technology 1

[62] Jarkko Moilanen and others, 'Cultures of Sharing in 3D Printing: What Can We Learn from the Licence Choices of Thingiverse Users?' (2015) Journal of Peer Production Issue 6 Disruption and the Law <http://peerproduction.net/issues/issue-6-disruption-and-the-law/peer-reviewed-articles/cultures-of-sharing-in-thingiverse-what-can-we-learn-from-the-licence-choices-of-thingiverse-users> accessed 14 July 2020

[63] Kan He, 'Regulating Terms and Conditions of Copyright Licences on the User-Generated Content 3D Printing Platform' in Rosa Ballardini and others (eds), *3D Printing, Intellectual Property and Innovation: Insights from Law and Technology* (Wolters Kluwer 2017) (the author argues that the terms and conditions used in 3D printing online platforms are unfair to their users)

[64] Dinusha Mendis and Davide Secchi, *A Legal and Empirical Study of 3D Printing Online Platforms and an Analysis of User Behaviour* (Intellectual Property Office, 2015)

[65] Ballardini and others (n 61) and Mendis and others (n 16), Chapter 5: Licensing and New Business Models in the 3D Printing Sector

[66] Thomas Howard and others, 'Reuse of Ideas and Concepts for Creative Stimuli in Engineering Design' (2011) 22 Journal of Engineering Design 565

for assessment of novelty.[67] To avoid IP infringement in product design processes, the importance of adopting systematic methods to check IP rights infringement in product design processes was also highlighted.[68]

Meanwhile, more literature examined IP and product design from the perspective of firms' IP rights management. In particular, the related literature largely discussed IP rights management and strategy in collaborative product development.[69] It was suggested that firms had been encouraged to cultivate new IP rights management strategies harmonising control and openness of the IP in various forms of collaborative innovation,[70] including product customisation,[71] co-design[72] and crowdsourcing.[73] In this regard, IP-related issues were identified, such as risks from the involuntary disclosure and transfer of firms' intellectual assets,[74] and potential conflicts between firms and consumers, in relation to the ownership and further control of consumer-generated IP rights.[75] A study suggested that such legal issues are context-specific, and thus should be grappled with, taking into consideration the types and degree of consumer participation.[76] As such, the need for an ontological understanding of consumer inputs and their relationship with IP in product design processes was emphasised.[77]

The IP literature on both 3D printing and product design was not identified during the literature review. However, from the review of the existing IP literature on 3D printing and on product design, it can be observed that consumer engagement could challenge conventional methods of protecting and managing IP rights in the context of both 3D printing and product design, and it was found that there is still limited research on certain aspects of it, such as the legal status and protection of CAD files and the IP rights ownership in those created by consumer engagement in product design.

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[67] Prabir Sarkar and Amaresh Chakrabarti, 'Assessing Design Creativity' (2011) 32 Design Studies 348
[68] Edwin Koh, 'Engineering Design and Intellectual Property: Where Do They Meet?' (2013) 24 Research in Engineering Design 325
[69] Donal O'Connell, *Harvesting External Innovation: Managing External Relationships and Intellectual Property* (Gower 2011) 65–74
[70] Anja Tekic and Kelvin Willoughby, 'Configuring Intellectual Property Management Strategies in Co-creation: A Contextual Perspective' (2020) 22 Innovation 128; Matthew Ohern and Aric Rindfleisch, 'Customer Co-creation: A Typology and Research Agenda' (2010) 6 Review of Marketing Research 84
[71] Ohern and Rindfleisch (n 70)
[72] Nikolaus Franke and Frank Piller, 'Value Creation by Toolkits for User Innovation and Design: The Case of the Watch Market' (2004) 21 Journal of Product Innovation Management 401
[73] Jeremy de Beer and others, 'Click Here to Agree: Managing Intellectual Property when Crowdsourcing Solutions' (2017) 60 Business Horizons 207; Kevin Boudreau and Karim Lakhani, 'Using the Crowd as an Innovation Partner' (2013) 91 Harvard Business Review 60
[74] Kaveh Abhari and others, 'A risk Worth Taking? The Effects of Risk and Prior Experience on Co-innovation Participation' (2018) 28 Internet Research 804
[75] Pierre Berthon and others, 'CGIP: Managing Consumer-Generated Intellectual Property' (2015) 57 California Management Review 43; Yun Mi Antorini and Albert Muñiz, 'The Benefits and Challenges of Collaborating with User Communities' (2013) 56 Research-Technology Management 21
[76] Ravi Sikhwal and Peter Childs, 'Product Design for Mass Individualisation for Industrial Application' [2017] Proceedings of the 2017 IEEE IEEM 674
[77] Charles Greer and David Lei, 'Collaborative Innovation with Customers: A Review of the Literature and Suggestions for Future Research' (2012) 14 International Journal of Management Reviews 63; Raffaella Manzini and Valentina Lazzarotti, 'Intellectual Property Protection Mechanisms in Collaborative New Product Development' (2016) 46 R&D Management 579

Research questions and contribution

Against this backdrop, the thesis aims to examine the implications of consumer engagement in product design in the 3D printing environment for IP law, particularly relating to UK copyright and design rights. To this end, the thesis addresses the following sub-questions:

- How are consumers engaged in product design in the 3D printing environment?
- What intellectual contributions do consumers and/or product designers make in that process?
- What is the legal status of CAD files, which are the outcome of the intellectual contributions?
- What rights do consumers have to CAD files they have either created or accessed?
- What are the implications of consumers' unlawful dissemination of and physical fabrication of CAD files via online platforms, in relation to IP rights infringement and enforcement? and
- What types of IP rights exemptions can apply to consumer use of 3D printing?

The thesis fills the gap in the IP literature on 3D printing and product design, by covering a controversial topic of IP and consumer engagement in the existing legal studies. In particular, it provides a fresh insight into understanding the legal status of CAD files and IP rights ownership, by bringing product design processes into focus for legal analysis. This original approach contributes to overcoming the pitfalls of existing IP studies, which focus almost exclusively on 3D modelling processes for legal analysis, and to attaining a holistic understanding of collaborative design creation processes where issues of IP generation and ownership arise.

The thesis also contributes to adding clarity on the scope of IP rights infringement and exceptions and on the enforcement landscape in the 3D printing environment. Most of the existing literature highlighted the importance of seeking further legal clarity on these areas. The thesis consolidates the existing literature to identify prominent issues and analyses them from the perspective of product design and consumer 3D printing.

Methodology

To address the research questions, the thesis employs a 'law in context' methodology. A 'law in context' methodology, also known as a socio-legal approach, is an approach to the study of law encompassing the theoretical and/or empirical analysis of law as a social phenomenon.[78] It is built on the theoretical premise that law cannot exist in isolation from its social, political and economic

[78] Fiona Cownie, *Legal Academics: Culture and Identities* (Bloomsbury Publishing 2004); Caroline Hunter (ed), *Integrating Socio-legal Studies into the Law Curriculum* (Palgrave 2012); Fiona Cownie and Anthony Bradney, 'Socio-legal studies: A Challenge to the Doctrinal Approach' in Dawn Watkins and Mandy Burton (eds), *Research Methods in Law* (2nd edn, Routledge 2018) 42

context and, therefore, that legal research should consider the relationship between law and social situations to ensure the reduction of the gap between law in books and law in reality.[79] In this approach, law is often viewed as an instrument or means to realise policy objectives.[80] Thus, a legal analysis taking this approach often attempts to observe the roles that the law plays in the creation, maintenance and/or change of the social situation.[81]

In comparison with the traditional legal doctrinal approach, where the focus of research is upon analysing internal issues in law, such as coherence, determinacy and non-contradiction in the rules, the 'law in context' approach takes an external view of the rules, analysing its practical effects and efficiency in attaining policy objectives.[82] In this sense, the 'law in context' approach is often described as research *about* law, in contrast with traditional legal doctrinal research, often referred to as 'black letter law', being research *in* law.[83]

As for the relationship between black letter law and a 'law in context' approach, Wheeler and Thomas viewed the latter as an alternative and a challenge to the traditional doctrinal research.[84] However, it should be noted that, despite the fundamental disparity, the two legal methodologies are not entirely exclusive. The 'law in context' approach should be based upon an accurate understanding of the law to understand its implications for society, and thus the formulation of legal doctrines through analysis of the law, which is believed to be the role of black letter law, also forms an essential part of the methodology.[85] In fact, the 'law in context' approach and black letter law are correlated to an extent, in that the former enables the rules to be interpreted in the relevant social context and, by doing so, it contributes to the resolving of indeterminacy[86] of the rules.[87]

In the 'law in context' approach, diverse research methods and perspectives are available to be adopted.[88] The Economic and Social Research Council's review highlighted that researchers from various backgrounds conduct many different types of research under the name of the 'law in context'

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[79] Alan Thomson, 'Critical Legal Education in Britain' (1987) 14 Journal of Law and Society 183, 185
[80] ibid
[81] David Schiff, 'Socio-legal Theory: Social Structure and Law' (1976) 39 The Modern Law Review 287, 287. However, research on the impacts that the social situation has upon legal norms is also within the broader scope of socio-legal studies. See, for example, Maayan Ravid and Alice Schneider, 'Legal Concepts in Flux: The Social Construction of Legal Meaning' in Naomi Creutzfeldt, Marc Mason and Kirsten McConnachie (eds), *Routledge Handbook of Socio-legal Theory and Methods* (Routledge 2020) 244
[82] Thomson (n 79) 185–86
[83] Paul Chynoweth, 'Chapter Three: Legal Research' in Andrew Knight and Les Ruddock (eds), *Advanced Research Methods in the Built Environment* (Wiley-Blackwell 2008) 29
[84] Sally Wheeler and Philip Thomas, 'Socio-legal Studies' in David Hayton (ed), *Law's Future(s)* (Hart Publishing 2002) 271, cited in Reza Banakar and Max Travers (eds), *Theory and Method in Socio-legal Research* (Bloomsbury Publishing 2005) 12
[85] Cownie (n 78) 54–57
[86] Kenneth Kress, 'Legal Indeterminacy' (1989) 77 California Law Review 283, cited in Paul Chynoweth, 'Chapter Three: Legal Research' in Andrew Knight and Les Ruddock (eds), *Advanced Research Methods in the Built Environment* (Wiley-Blackwell 2008) 34 ('the rules … can sometimes be used to justify a number of possible, and opposing, legal outcomes … where this occurs, the law is said to be indeterminate')
[87] Chynoweth (n 83)
[88] Cownie and Bradney (n 78) 43

research (or socio-legal research, as termed in the report) and this has led to considerable eclecticism in methodology, including, for example, macro-theoretical scholarship through empirical analyses designed to test and generate theoretical propositions or small-scale case studies.[89] In the same vein, Creutzfeldt viewed the 'law in context' approach as a fluid and continually developing area of scholarship that allows the flexible combination of methods and theories, which are not necessarily required to be empirically driven, politically oriented or geared towards social change.[90]

The 'law in context' approach can be useful to analyse the interaction of law with technology. Emerging technologies could have various impacts upon human lives and legal domains to a greater or lesser extent.[91] In legal scholarship, the technological and social aspects of such technologies have been studied from different perspectives. For example, where such technologies are considered to cause potential risks to society, legal scholarship often poses and addresses the question of how to regulate the potentially harmful technologies; in the meantime, where the technologies change people's behaviour, creating new social phenomena, it questions whether the current legal framework is adequate to govern the emerging phenomena and what measures should be taken for it to keep pace with the rapidly changing technologies.[92]

The thesis takes the 'law in context' approach to analyse UK copyright and design laws in the context of 3D printing and product design and to assess the applicability and adequacy of the laws in that context. In particular, an emphasis is put on analysing how the laws are interpreted and enforced by some of the key actors, such as IP rightsholders, users (or consumers) and third-party intermediaries, in relation to product design activities in the 3D printing environment, and discussing a potential need for the revision of law to contribute to policy debates.

The first part of the thesis examines how UK copyright and design laws interact with social phenomena accompanying the emergence, adoption and use of 3D printing, in connection with product design studies, and presents a series of possible situations as scenarios for legal analysis. For this purpose, the thesis reviews the literature to investigate the current state of 3D printing and the interaction between the laws and social phenomena emerging in that context. It discusses various aspects of 3D printing, such as its technological capacity and limitation, the corporate exploitation of 3D printing technologies, and end users' behaviour with and perceptions of 3D printing. In doing so, it attends to a discernible feature of the 3D printing environment in which consumers are afforded

[89] Economic and Social Research Council (ESRC), *Review of Socio-legal Studies: Final Report* (ESRC, 1994)
[90] Naomi Creutzfeldt, 'Traditions of Studying the Social and the Legal: A Short Introduction to the Institutional and Intellectual Development of Socio-legal Studies' in Naomi Creutzfeldt, Marc Mason and Kirsten McConnachie (eds), *Routledge Handbook of Socio-legal Theory and Methods* (Routledge 2020) 9
[91] Alicia Solow-Niederman, 'Emerging Digital Technology and the "Law of the Horse"' (*UCLA Law Review*, 19 February 2019) <https://www.uclalawreview.org/emerging-digital-technology-and-the-law-of-the-horse> accessed 28 November 2020
[92] Roger Brownsword, 'Field, Frame and Focus: Methodological Issues in the New Legal World' in Rob van Gestel, Hans-W. Micklitz and Edward Rubin (eds), *Rethinking Legal Scholarship: A Transatlantic Dialogue* (CUP 2018) 124

increased opportunities to access, create and use product designs in the form of CAD files, whilst 3D printing online platforms play facilitative roles for such design activities. Then, it captures the design activities involving consumers and 3D printing online platforms and presents them as scenarios.

Incorporating product design studies, the thesis further analyses consumers' design activities and the role that 3D printing online platforms play in these activities. Product design studies provide a detailed account of the product design process, enabling the understanding of technicalities of the product design creation process in a sequential manner; of the interaction and interconnection between product designers, consumers and 3D printing online platforms in that process; and of types of creative inputs afforded in that process. This analysis provides a context in which the legal rules are interpreted, applied and assessed in the next part of the thesis.

The second part of the thesis interprets the laws and applies them to the scenarios to examine whether the regulatory framework is clear and fit for purpose to regulate issues arising in the context of 3D printing and product design. To this end, the thesis follows these two steps. First, it explains what the current law is, namely how the statutory provisions are interpreted in relation to the scenarios. As highlighted in major law reports on 3D printing,[93] there are no reported cases at present that directly concern legal issues with 3D printing. Thus, the thesis aims to interpret the law through reasoning by analogy of the precedents dealing with similar facts, as well as consulting secondary sources.

Second, the thesis identifies potential issues by application of law to the scenarios and discusses their implications. On the one hand, taking internal views of the law, it brings into focus an analysis of determinacy and coherence of the rules in UK copyright and design laws and assesses the adequacy of the laws in regulating issues arising in the 3D printing environment. The issues may encompass various aspects of law, such as the protection of CAD files, (co-)ownership of the rights and licences, and infringement and exceptions. On the other hand, it also discusses the practical implications of the laws in society by analysing the 3D printing enforcement landscape. A particular concern in copyright and design rights enforcement in the 3D printing environment would relate to the increased complexity resulting from 3D printing online platforms serving as third parties to facilitate copyright and design rights infringement. Furthermore, an issue such as lack of clarity over the laws would also complicate the matter. Thus, the thesis identifies and discusses the enforcement issues in the 3D printing environment from the perspective of intermediary liability and accountability, in connection with the legal pitfalls found in the internal analyses of the laws.

[93] Reeves and Mendis (n 58); Mendis and Secchi (n 64); Mendis and others (n 16)

Structure of the Thesis

The thesis comprises six chapters. Each chapter addresses in turn the research questions presented below:

- How are consumers engaged in product design in the 3D printing environment?
- What intellectual contributions do consumers and/or product designers make in that process?
- What is the legal status of CAD files, which are the outcome of the intellectual contributions?
- What rights do consumers have to CAD files they have either created or accessed?
- What are the implications of consumers' unlawful dissemination of and physical fabrication of CAD files via online platforms, in relation to IP rights infringement and enforcement? and
- What types of IP rights exemptions can apply to consumer use of 3D printing?

Chapter 1 investigates the emerging social phenomena in the 3D printing environment. It establishes that, in that environment, consumers have increased opportunities to partake in product design activities, in which they have increased access to product designs in the form of CAD files, can create product designs, and can use the obtained product designs via access and creation for digital use and physical fabrication. Based upon this observation, scenarios relating to such product design activities, namely access, creation and use scenarios, are formulated for legal analysis.

Chapter 2 scrutinises the product design activities presented in the scenarios from the perspective of product design studies and demystifies the interconnections between the access, creation and use scenarios and the interactions between the key actors in the product design framework, including consumers, product designers and 3D printing online platforms. In doing so, first, it examines the product design process, focusing upon the use of the CAD systems therein, and establishes that various creative inputs, such as geometric and engineering knowledge, expertise in CAD and drawing and computing skills, should be afforded throughout the product design process. It then demonstrates that product design access, creation and use, depicted as disparate scenarios, are in practice closely related, with 3D printing online platforms facilitating and integrating these activities to occur in the digital space at a time dictated by the users.

Chapter 3 establishes the legal status of CAD files and 3D printing online platforms within the ambit of UK copyright and design law. As a preliminary chapter prior to the legal analysis of the respective scenarios in the forthcoming chapters, it aims to clarify the law on protection of CAD files and the regulatory framework of online intermediaries such as 3D printing online platforms, on which the CAD files are accessed, created and used.

Chapters 4, 5 and 6 discuss the implications of consumer engagement in product design activities in the 3D printing environment, with an emphasis on doctrinal issues, such as the coherence and determinacy of the rules, arising in relation to the scenarios. Based upon a doctrinal analysis of UK copyright and design laws, Chapter 4 discusses the access and creation scenarios from the perspective

of copyright and design rights protection and ownership. Chapter 5 examines issues of copyright and design rights infringement and the enforcement landscape. In particular, it discusses enforcement challenges arising from the identified doctrinal issues in the preceding chapters and infringement facilitated by 3D printing online platforms. Highlighting the difficulties in the pursuit of individual infringers, it introduces the recent development of law on intermediary liability and discusses its applicability in the 3D printing environment. Finally, Chapter 6 delves into the copyright and design rights exceptions applicable in the 3D printing environment.

Chapter 1

Contextual Framework

Introduction

The purpose of Chapter 1 is to build a contextual framework for the legal analysis of 3D printing. In this chapter, technological, corporate and societal aspects of 3D printing are explored to survey how 3D printing and the related technologies have developed and been adopted and used in society.

In doing so, the various literature on 3D printing, including both expert and non-expert sources, is examined and discussed. As for academic literature, online searches were mainly used through e-databases, such as Westlaw or Google Scholar, with diverse sets of keywords, some of which were extremely broad – such as '3D printing' or 'additive manufacturing' – and others more specific – including 'home 3D printing', 'domestic 3D printing' and 'consumer 3D printing'. The search results were then again narrowed down by using more relevant search words for each of the segments, i.e. technology, business and society. The search words are set out in Table 1 below. For web-blogs, *3D Printing Industry*, *TCT Magazine* and *3ders* were visited to follow up the recent trend of 3D printing. Meanwhile, online platforms, including Thingiverse or Shapeways, were visited.

Base search	3D printing, additive manufacturing, home 3D printing, home additive manufacturing, domestic 3D printing, domestic additive manufacturing, consumer 3D printing, consumer additive manufacturing
Technology	Adoption, design, technological implication, customisation, home fabrication, consumer CAD program, consumer-level 3D printers
Business	Adoption, co-creation, customisation, business, business models, online platforms
Society	Adoption, use of 3D printing, societal, social, openness, open design, co-creation, collaboration

Table 1 Search words used for contextual framework

The thesis focuses on examining empirical resources that were published later than 2008. It is often said that the expiration of patents for major 3D printing technologies, which occurred in around 2008, accelerated the emergence of domestic 3D printing and the related social phenomena. Hence, the timeframe is considered appropriate to observe the adoption and use of domestic 3D printing in society and emerging social phenomena led by consumers.

1.1. Technological Developments and Capabilities of Domestic 3D Printing

The technological development of 3D printing and the related technological and societal changes led to the introduction of domestic 3D printing.[94] 3D printing has been adopted and used for industrial applications for a few decades, but the domestic adoption and use of 3D printing has been relatively recent.[95] This section examines the technological developments around domestic 3D printing, such as

[94] Gibson, Rosen and Stucker (n 6)
[95] Gao and others (n 8)

the development of domestic 3D printers and design software for consumers, and the potential technological limitations remaining for the domestic adoption and use of 3D printing.

1.1.1. Development of domestic 3D printers

In literature, domestically used 3D printers are termed in various ways, including home 3D printers, desktop 3D printers, and consumer or entry-level 3D printers. These terms have slight differences in meaning; for example, 'home 3D printers' means 3D printers designed for use at home by consumers, such as hobbyists, as distinguished from 'professional 3D printers'. 'Desktop 3D printers' are named according to their size as they are small enough to be placed on a desk. 'Consumer or entry-level 3D printers' are cheap 3D printers affordable to consumers, costing less than $5,000.[96]

The history of domestic 3D printers is relatively short. In contrast with industrial 3D printers, which appeared on the market in 1986, domestic 3D printers made their first appearance in 2000, whilst being actually sold from 2008 onwards.[97] Domestic 3D printers started developing exponentially under the influence of social movements, including the maker or do-it-yourself movement.[98] Most notably, the RepRap open hardware community played a significant role in enabling the production of low-cost 3D printers.[99]

1.1.2. Design software (CAD programs) development for domestic use

Along with domestic 3D printers, CAD programs have been also developed for consumer use. Web-based and cloud-based design tools (e.g. Autodesk Fusion 360, Onshape, or Tinkercad) have been opening up possibilities for consumers to partake in co-design with professionals.[100] For improved user-friendliness of CAD programs, natural user interfaces (NUIs), including sketch-based,[101] gesture-

[96] Terry T. Wohlers and others, *Wohlers Report 2014: 3D Printing and Additive Manufacturing State of the Industry Annual Worldwide Progress Report* (Wohlers Associates, 2014)
[97] Gao and others (n 8)
[98] Gibson, Rosen and Stucker (n 6); Peter Troxler, 'Fabrication Laboratories (Fab Labs)' in Jan-Peter Ferdinand, Ulrich Petschow and Sascha Dickel (eds), *The Decentralized and Networked Future of Value Creation: 3D Printing and Its Implications for Society, Industry, and Sustainable Development* (Springer 2016)
[99] Camille Bosqué, 'What Are You Printing? Ambivalent Emancipation by 3D Printing' (2015) 21 Rapid Prototyping Journal 572; Joei West and George Kuk, 'The Complementarity of Openness: How MakerBot Leveraged Thingiverse in 3D Printing' (2016) 102 Technological Forecasting & Social Change 169; Timothy Horn and Ola Harrysson, 'Overview of Current Additive Manufacturing Technologies and Selected Applications' (2012) 95 Science Progress 255; Lian Chen and others, 'The Research Status and Development Trend of Additive Manufacturing Technology' (2017) 89 International Journal of Advanced Manufacturing Technology 3651; Jürgen Bertling and Steve Rommel, 'A Critical View of 3D Printing Regarding Industrial Mass Customization Versus Individual Desktop Fabrication' in Jan-Peter Ferdinand, Ulrich Petschow and Sascha Dickel (eds), *The Decentralized and Networked Future of Value Creation: 3D Printing and Its Implications for Society, Industry, and Sustainable Development* (Springer 2016)
[100] Wu and others (n 22); Jingeng Mai and others, 'Customized Production Based on Distributed 3D Printing Services in Cloud Manufacturing' (2016) 84 International Journal of Advanced Manufacturing Technology 71
[101] Chao Ding and Ligang Liu, 'A Survey of Sketch Based Modeling Systems' (2016) 10 Front Comput Sci 985; Christopher Lentzsch and Alexander Nolte, 'From Sketching to Modeling – Supporting End-Users to Elicit

based [102] and motion-based modelling, [103] have been introduced by major CAD developers. [104] Meanwhile, CAD has been implemented on not only computers, but also mobile devices, increasing consumers' access to CAD programs.[105]

1.1.3. Limitations in the domestic adoptability of 3D printing

Notwithstanding the significant improvement in domestic 3D printers and CAD programs, it is identified in the literature that the low production quality of entry-level 3D printers can be a stumbling block for consumers' adoption of 3D printing. Dimensional accuracies of entry-level 3D printers are considerably lower than industrial 3D printers. [106] For example, a performance test conducted by Roberson et al. showed that a high-level 3D printer (uPrint by Stratasys/FDM, $20,900) was able to produce an object that was different in dimensions by an average of 4mm from the original CAD drawing, whereas an entry-level 3D printer (Replicator by MakerBot/FDM, $2,072) had an average discrepancy of 18mm.[107] Likewise, online surveys conducted by the 3D printing communities showed that a large proportion of respondents were dissatisfied with the quality of the object they had created.[108]

Processes' (MKWI 2016, Ilmenau, 9–11 March 2016). See also Tess, 'Microsoft Updates Paint App with 3D Drawing Tools' (*3ders*, 11 October 2016) <http://www.3ders.org/articles/20161011-microsoft-updates-paint-app-with-3d-drawing-tools.html> accessed 28 July 2017

[102] Mario Covarrubias and Monica Bordegoni, 'Immersive VR for Natural Interaction with a Haptic Interface for Shape Rendering' (Research and Technologies for Society and Industry Leveraging a Better Tomorrow, Turin, 16–18 September 2015); Miglena Dontschewa, Sabrina Rosmann and Marin Marinov, 'Using Motion Capturing Sensor Systems for Natural User Interface' (International Scientific Conference Electronics, Sozopol, 12–14 September 2016); Benedict, 'Incredible 3D Printed Ogre Designed Using Oculus Medium VR Sculpting Tool' (*3ders*, 20 January 2017) <http://www.3ders.org/articles/20170120-incredible-3d-printed-ogre-designed-using-oculus-medium-vr-sculpting-tool.html> accessed 28 July 2020

[103] Gao and others (n 8); Mary Thompson and others, 'Design for Additive Manufacturing: Trends, Opportunities, Considerations and Constraints' (2016) 65 CIRP Annals – Manufacturing Technology 737

[104] Laura Griffiths, 'The Changing Face of CAD' (*TCT Magazine*, 13 March 2017) <https://www.tctmagazine.com/tctblogs/laura-griffiths-blog/the-changing-face-of-cad> accessed 28 July 2020

[105] TCT Magazine, 'Leopoly Launches New Virtual Reality App and Business Solutions' (*TCT Magazine*, 13 December 2016) <https://www.tctmagazine.com/3d-software-news/leopoly-launches-virtual-reality-app-business-solutions> accessed 28 July 2020; Chun-An Lai and Pei-Ying Chiang, 'Modeling Go: A Mobile Sketch-Based Modeling System for Extracting Objects' [2017] NPAR 17 Proceedings of the Symposium on Non-Photorealistic Animation and Rendering

[106] Conner and others (n 11); Garrett Melenka and others, 'Evaluation of Dimensional Accuracy and Material Properties of the MakerBot 3D Desktop Printer' (2015) 21 Rapid Prototyping Journal 618; Brian Turner and Scott Gold, 'A Review of Melt Extrusion Additive Manufacturing Processes: II. Materials, Dimensional Accuracy, and Surface Roughness' (2015) 21 Rapid Prototyping Journal 250; Martin Lotz, HCvZ Pienaar and Deon de Beer, 'Entry-Level Additive Manufacturing: Comparing Geometric Complexity to High-Level Machines' (AFRICON, Mauritius, 9–12 September 2013)

[107] David Roberson, David Espalin and Ryan Wicker, '3D Printer Selection: A Decision-Making Evaluation and Ranking Model' (2013) 8 Virtual and Physical Prototyping 201

[108] Moilanen and Vadén (n 28); Bosqué (n 99); Harm-Jan Steenhuis and Leon Pretorius, 'Consumer Additive Manufacturing or 3D Printing Adoption: An Exploratory Study' (2016) 27 Journal of Manufacturing Technology Management 990 (finding that people still seem to find that an object created via injection moulding has better quality). See also Yudhi Ariadi and others, 'Combining Additive Manufacturing with Computer Aided Consumer Design' [2012] Proceedings of the Solid Freeform Fabrication Symposium 238;

A higher level of user-friendliness of domestic 3D printers is still required in relation to both hardware and software use. Steenhuis and Pretorius experimented with desktop 3D printers to assess the friendliness of desktop 3D printing.[109] They found that the adoption of consumer 3D printing may be hindered by to the low quality of home-printed objects and the low reliability of 3D printing processes, and that a significant amount of technical knowledge is certainly required for successful use of consumer 3D printers.[110]

The environmental impacts of using desktop 3D printers at home are also notable.[111] For example, a number of studies highlighted that ultrafine particle emission rates from some of the tested desktop 3D printers, which use plastics, were high enough to cause harmful effects on humans. As a corollary, the researchers emphasised that well-designed ventilation systems and occasional removal of indoor particle containments are vital for the use of domestic 3D printers.[112]

1.2. Use of 3D Printing in Businesses and Its Impact upon Consumers

Technological development of 3D printing has diversified the industrial application of 3D printing and, taking advantage of 3D printing, new business models that involve consumers in product design and manufacturing have been emerging.[113] Against this backdrop, this section investigates business aspects of 3D printing and its implications for consumers.

1.2.1. Overview of 3D printing business trends

Traditionally, 3D printing was used in the manufacturing industries as a prototyping tool for product development.[114] In fact, the Sculpteo survey 2016 found that firms still used 3D printing primarily for accelerating product development,[115] owing to the still-low manufacturing quality of 3D printing.[116]

However, firms saw that, with technological improvement, there would be more 3D printing applications in the future.[117] A large number of respondents in the Sculpteo survey 2016 anticipated

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Yuwei Zhai, Diana Lados and Jane Lagoy, 'Additive Manufacturing: Making Imagination the Major Limitation' (2014) 66 The Journal of the Minerals, Metals & Materials Society 808

[109] Steenhuis and Pretorius (n 108)

[110] ibid

[111] Danfang Chen and others, 'Direct Digital Manufacturing: Definition, Evolution, and Sustainability Implications' (2015) 107 Journal of Cleaner Production 615

[112] Brent Stephens and others, 'Ultrafine Particle Emissions from Desktop 3D Printers' (2013) 79 Atmospheric Environment 334; Yu Zhou and others, 'Investigation of Ultrafine Particle Emissions of Desktop 3D Printers in the Clean Room' (2015) 121 Procedia Engineering 506

[113] Thierry Rayna and Ludmila Striukova, 'From Rapid Prototyping to Home Fabrication: How 3D Printing Is Changing Business Model Innovation' (2016) 102 Technological Forecasting & Social Change 214

[114] Yan and Gu (n 4); Hopkinson, Hague and Dickens (n 10); David Bak, 'Rapid Prototyping or Rapid Production? 3D Printing Processes Move Industry towards the Latter' (2003) 23 Assembly Automation 340

[115] Arthur Cassaignau and others, *The State of 3D printing* (Sculpteo, 2016)

[116] Reeves and Mendis (n 58)

that 3D printing would be useful in the following five years in increasing production flexibility and enabling co-creation.[118] Indeed, it was found in the Sculpteo survey 2020 that, although industrial use of 3D printing for proofs of concept and prototyping was still the top application areas for firms, a significant increase in the use of 3D printing for production had been observed between 2016 and 2020.[119]

At the same time, it is observed that new 3D printing business models based on online platforms have been emerging in recent years. Rayna et al. conducted research on the role of online 3D printing platforms in relation to co-creation and user innovation by investigating 22 online 3D printing platforms that were open to, and provided services for, consumers.[120] The researchers identified various services that 3D printing online platforms offered, including design supply, design hosting, design customisation, co-design service, design crowdsourcing, printing, printer sales, and printing crowdsourcing.

As for the revenue models of 3D printing online platforms, it was found that both design and printing marketplaces, in general, charged a percentage per item sold.[121] For design marketplaces, the range of charging rate was very broad, between 0% and 70%.[122] For printing marketplaces, most corporations made use of a quote system that was based upon the complexity of the designs that were intended to be printed, whereas some corporations used a set price based upon the volume of the object to be printed.[123] For co-creation services, corporations charged varying fees for turning sketches into 3D models: some charged based upon the complexity of the work, and some provided the service for free.[124]

1.2.2. Business forecast: co-creation and open innovation

The adoption and use of 3D printing are not completely new, since 3D printing has already been employed in industry for rapid prototyping and rapid tooling. Rapid prototyping and rapid tooling are early forms of 3D printing, facilitating product development and helping to flexibly set up production tools that are used for mass production under traditional manufacturing systems.[125] By contrast, the

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[117] Gausemeier (n 32); Srinvasan and Bassan (n 7); Frank Cooper, 'Sintering and Additive Manufacturing: "Additive Manufacturing and the New Paradigm for the Jewellery Manufacturer"' (2016) 1 Progress in Additive Manufacturing 29
[118] Cassaignau and others (n 115)
[119] Sculpteo, *The State of 3D Printing* (Sculpteo, 2020)
[120] Thierry Rayna, Ludmila Striukova and John Darlington, 'Co-creation and User Innovation: The Role of Online 3D Printing Platforms' (2015) 37 Journal of Engineering and Technology Management 90
[121] Rayna and Striukova (n 26)
[122] ibid., 163
[123] ibid
[124] ibid
[125] Gibson, Rosen and Stucker (n 6)

emergence of 3D printing as a production means for a final product is, indeed, a new phenomenon for businesses and it has brought about diverse discussions on the future business landscape.

The literature suggests that 3D printing will likely facilitate consumer involvement in product design and manufacturing.[126] The involvement could vary, depending on consumers' needs. To take an example of product customisation, consumers can join up with professional designers to customise a design.[127] Alternatively, consumers may be involved in product manufacturing where they utilise 3D printers available at home or bureau services to produce a product for themselves.[128]

Against this backdrop, Kietzmann et al. highlighted that future business models will change from a centralised distribution model to a decentralised distribution model, in which a product is supplied in a digital form, giving rise to a shift of the role of corporations from manufacturers to service providers.[129] Further, Jiang et al. confirmed that the theoretical predictions are likely to happen in the following decade, particularly regarding the decentralised and localised production of spare parts[130] and the increased importance of the relationships between customers and designers.[131]

1.3. The Prospect of Domestic 3D Printing from Societal Perspectives

This section examines the domestic adoption and use of 3D printing and the related societal changes. The first part discusses how 3D printing has been adopted and used by consumers and highlights that, despite the increased availability of 3D printing due to technological developments and newly

[126] This type of customer is often called 'prosumers'. See Berman (n 24); Kietzmann, Pitt and Berthon (n 27); Rayna and Striukova (n 26); Rayna, Striukova and Darlington (n 120); Christian Weller, Robin Kleer and Frank Piller, 'Economic Implications of 3D Printing: Market Structure Models in Light of Additive Manufacturing Revisited' (2015) 164 International Journal of Production Economics 43

[127] This so-called complete customisation is distinguishable from contemporary mass-customisation, which gives customers only a few options to choose from. See Troxler and Woensel (n 19); see also Coimbatore Prahalad and Venkat Ramaswamy, 'Co-creating Unique Value with Customers' (2004) 32 Strategy & Leadership 4; Leon Cruickshank, *Open Design and Innovation: Facilitating Creativity in Everyone* (Gower 2014)

[128] This is often referred to as localisation or decentralisation of manufacturing. See Ihl and Piller (n 36); Ben-Ner and Slemsen (n 36)

[129] Kietzmann, Pitt and Berthon (n 27)

[130] Jiang, Kleer and Piller (n 29) (Jiang et al. conducted a study utilising a Delphi method to gather experts' opinions, including both industry experts and academics, upon the future of 3D printing in 2030 in societal and economic perspectives. The proposition upon which the experts agreed: 'In 2030, manufacturing of spare parts will be divided into two systems: less critical parts will be produced locally via additive manufacturing, whereas critical parts will be made at specialist hubs with specific qualification/quality control skills, primarily using conventional manufacturing techniques')

[131] ibid (the proposition upon which the experts agreed: 'By 2030, additive manufacturing will have shifted the sources of competitive advantage from manufacturing and supply chain capabilities towards *access to customer and designer networks*' (emphasis added))

emerging business models,[132] it seems that the adoption and use of 3D printing at home is still considerably immature.[133]

1.3.1. The status quo: domestic adoption and use of 3D printing

The rate of domestic adoption of 3D printing purports to have been increasing in recent years, given the growing number of sales of consumer 3D printers.[134] Yet, this may not be entirely true in that it is not precisely known how many consumer 3D printers were actually sold to and used by consumers, rather than small/medium businesses or makerspaces. According to the online survey conducted by Bosqué in November 2014, it was still makerspaces where the majority of consumer 3D printers were located and used.[135] Moreover, it was observed in the Wohlers Report 2019 that, despite the exponential increase in revenue from additive manufacturing products and services, manufacturers of consumer 3D printers saw a significant decline in annual growth, with several shutting down their businesses.[136] This implies that the increase in the sale of consumer 3D printers may not be sufficiently convincing to suggest that 3D printing has now become widespread in the domestic sector.

There appears to be scant research data to show in what ways 3D printing is used by consumers.[137] In contrast, actual, but mostly experimental, use of 3D printing by enthusiastic makers has been observed in makerspaces. Makers create a wide range of various objects:[138] decorative and utilitarian objects are mostly fabricated by consumers, who claim themselves to be beginner or intermediate users, whereas consumers whose proficiency in 3D printing is beyond that level – advanced or expert users – tend to produce parts for other 3D printers or parts for industrial objects.[139]

However, there is noteworthy research on the potential use of home 3D printing. Acknowledging a paucity of current home use of 3D printing, a group of researchers conducted an exploratory research study on the potential use of home 3D printing in 10 randomly picked households (28 participants)

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[132] This point was established in Sections 1.1. and 1.2.
[133] For that reason, various studies take a future-oriented research on potential use of 3D printing in the domestic sector. See, for example, Reeves and Mendis (n 58) 67; Mendis and Secchi (n 64) 43; Birtchnell and others (n 16) 62
[134] In 2013, consumers bought more 3D printers than industrial buyers had in the first 25 years. See Wohlers and others (n 96)
[135] Bosqué (n 99)
[136] TJ McCue, 'Significant 3D Printing Forecast Surges to $35.6 Billion' (*Forbes*, 27 March 2019) <www.forbes.com/sites/tjmccue/2019/03/27/wohlers-report-2019-forecasts-35-6-billion-in-3d-printing-industry-growth-by-2024/#33eda39e7d8a> accessed 7 July 2020. See also *Wohlers Report 2019: 3D Printing and Additive Manufacturing State of the Industry* (Wohlers Associates, 2019)
[137] Rita Shewbridge, Amy Hurst and Shaun Kane, 'Everyday Making: Identifying Future Uses for 3D Printing in the Home' (2014) Digital Fabrication Landscapes 815
[138] For example, many makers gather every year in the Maker Faire, presenting creative items they make with a 3D printer, such as diverse household items and even food like pancakes or chocolates. See Michael Petch, 'New York City Maker Faire 2017 – the 3D Printing Perspective' (*3DPI*, 2nd October 2017) <https://3dprintingindustry.com/news/new-york-city-maker-faire-2017-3d-printing-perspective-122074> accessed 28 July 2020
[139] Bosqué (n 99)

who had little to no prior knowledge of 3D printing.[140] The participants were given a dummy 3D printer and were told that the 3D printer could create any 3D object. In this research, the technological limitations of current home 3D printing, such as the limited capability of processing multiple materials and the limitations derived from difficulties in handling CAD software, were intentionally dismissed. Rather, the research aimed at identifying the potential demands of the domestic 3D printing users. Most of the participants in the research desired to produce replicas of whole or parts of existing utilitarian objects, with a view to replacement and repair of those.[141] In the meantime, they wanted to produce a part to improve the functionality of the existing utilitarian objects by adding upgrades or accessories.[142] On the other hand, and quite surprisingly, the use of 3D printing for the purpose of creating entirely new objects was seen to be unpopular.[143]

It appears that consumers, albeit mostly enthusiasts or hobbyists, access 3D printing online platforms to obtain CAD files.[144] According to Mendis and Secchi, the number of uploads of CAD files on major 3D printing online platforms have been on an exponentially increasing trend since 2008.[145] This implies that the pool of CAD files is growing larger so consumers are becoming more capable of finding the CAD files they want on 3D printing online platforms. This was somewhat proved by the above research by Shewbridge et al., where the potential use of home 3D printing was explored. It was found in the research that many participants were able to obtain the CAD files they wanted on 3D printing online platforms, despite some participants still being dissatisfied.[146]

The contents of CAD files that are obtainable on 3D printing online platforms encompass various items, including toys, mobile phone cases, spare parts and machine parts, but the most widely accessible ones were found to be leisure- and hobby-related items, according to the UKIPO research in 2015.[147] In respect of the types of CAD files, there are two distinct models: a concrete model and a meta model. A meta model or meta design is an abstract 3D model that enables the generation of a family of printable 3D concrete models.[148] Within the range of predefined parameters, consumers can easily change the design of the model, including its shape and size. Through an investigation of the

[140] Shewbridge, Hurst and Kane (n 137)
[141] ibid (one of the participants wanted to replicate cups and plates to complete the set of dishware by replacing chipped cups and plates)
[142] ibid (a participant wanted to add a handle to the coffee tumbler he used when commuting to work; another wanted to change the colour of the face of his watch and add a bezel to it)
[143] ibid (amongst all the objects the participants desired to make, only 4% were completely new objects)
[144] Mendis and Secchi (n 64)
[145] ibid
[146] Shewbridge, Hurst and Kane (n 137) (the discontent participants were looking for customised models whose sizes were bigger or smaller, whose colour was different and whose shape is slightly different from the original ones accessible on the online 3D printing platforms)
[147] The most frequently used keywords on major online 3D printing platforms, which are set by the uploaders for describing uploaded files, were *miniature*, *art*, *jewellery*, *design* and *household*. See Mendis and Secchi (n 64)
[148] This will be further discussed in detail at Chapter 2, section 2.3.3.1. Meta design. See also Harris Kyriakou, Jeffrey Nickerson and Gaurav Sabnis, 'Knowledge Reuse for Customization: Metalmodels in an Open Design Community for 3D Printing' (2017) 41 MIS Quarterly 315

use of meta models on Thingiverse,[149] Kyriakou et al.,[150] found that meta models were, indeed, more popular than concrete models amongst users of Thingiverse.

With regard to the creation process of CAD files, one of the most notable phenomena is that CAD files are created by copying, modifying and mixing the existing CAD files shared online.[151] On Thingiverse, the CAD files that are created upon the basis of the other CAD files are called remixes. According to Flath et al., the number of remixes found on the platform between 2008 and 2014 was more than that of isolated designs, taking up the majority of all the CAD files.[152] The forms of remixes vary, based on the degree of complexity of remixing.[153] Thus, some models at a lower level of remix complexity take very similar forms to the parent models, whereas those at a higher level of remix complexity are almost completely distinct from their parent models. At the same time, it is also remarkable that a diverse range of people create CAD files, but design experts play a significant role in providing good-quality CAD files on online 3D printing platforms.[154]

1.3.2. Future anticipation: co-creation and knowledge sharing by peers

The societal impact of 3D printing is often discussed with reference to a bigger societal context, including the maker movement (i.e. Fab Labs) and various branches of the open movement (open hardware, open software or open design).[155] This is due to a large part of the development of domestic 3D printing having been achieved within these contexts. For example, Fab Labs, as an early adopter of 3D printing, played a salient role in forming the public and media perception of 3D printing as a general production means usable by consumers.[156] The open hardware movement RepRap is deemed to enable the diffusion of low-cost 3D printing in society.[157] Within the context of the open design movement, numerous online 3D printing platforms have emerged to allow consumers not only to create and share designs but also to learn and share the related knowledge for designing.[158] The

[149] Thingiverse is one of the largest online 3D printing platforms, run by MakerBot Industries, and provides space for making, sharing and discovering various types of CAD files. <www.thingiverse.com>
[150] Kyriakou, Nickerson and Sabnis (n 148)
[151] Christoph Flath and others, 'Copy, Transform, Combine: Exploring the Remix as a Form of Innovation' [2017] Journal of Information Technology 1
[152] ibid
[153] ibid
[154] ibid (seasoned designers contributed to much more sophisticated remixes than novice designers); Kyriakou, Nickerson and Sabnis (n 148) (most of the meta models on Thingiverse were created by expert designers and non-expert users created concrete models based on the meta models)
[155] Lipson and Kurman (n 23); Sascha Dickel, Jan-Peter Ferdinand and Ulrich Petschow, 'The Multiple Applications of 3D Printing: Between Maker Movements and the Future of Manufacturing' in Jan-Peter Ferdinand, Ulrich Petschow and Sascha Dickel (eds), *The Decentralized and Networked Future of Value Creation: 3D Printing and Its Implications for Society, Industry, and Sustainable Development* (Springer 2016)
[156] Troxler (n 98)
[157] Vasilis Kostakis and Marios Papachristou, 'Commons-Based Peer Production and Digital Fabrication: The Case of a RepRap-Based, Lego-Built 3D Printing-Milling Machine' (2014) 31 Telematics and Informatics 434
[158] West and Kuk (n 99)

overarching postulations underlying the maker movement and the open movement are collaboration and freeness.[159]

Retaining the spirits of collaboration and freeness rooted in the combination of all these societal contexts, 3D printing has been characterised as a part of or an instigator of commons-based peer production or social manufacturing.[160] Commons-based peer production is 'a socio-economic system of production that is emerging in the digitally networked environment'.[161] The crux of this production system is physical and/or cognitive collaboration amongst large groups of people.[162] Social manufacturing, instead, is defined as a new form of manufacturing in which various users – manufacturers and customers alike – participate in the manufacturing process, facilitated by multi-way communication.[163] With the development of information and communication technologies, collaboration does not necessarily require the collaborators to be in close proximity since cognitive collaboration can be carried out globally over the Internet.[164]

By extension of the trend above, theoretical prospects have been provided in literature, namely that more and more people will take part in the current trend of social movement, by which they will start creating something with digital fabrication methods in collaboration with others based in open communities.[165] It seems somewhat true in that, despite a weak indication at present, there are online 3D printing platforms that facilitate cooperative design creation and fabrication. Furthermore, more and more designs are being increasingly uploaded on the online platforms, which are mostly freely accessible and remodifiable.[166]

Reinforcing such predictions, in the research by Jiang et al.[167] a large number of experts from both academia and industry anticipated that:

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[159] Chris Anderson, *Makers: The New Industrial Revolution* (Random House Business 2013); With regard to the conceptualisation of open design, some discrepancies exist in the literature. See, for example, Pieter Jan Stappers, Froukje Sleeswijk and Visser Kistemaker, 'Creation & Co: User Participation in Design' in Bas van Abel and others (eds), *Open Design Now* (BIS 2011) <http://opendesignnow.org/index.html%3Fp=421.html>; Michel Bauwens, 'The Emergence of Open Design and Open Manufacturing' We_magazine <http://www.we-magazine.net/we-volume-02/the-emergence-of-open-design-and-open-manufacturing/#.WQrbKGw2yUk> accessed 4 May 2017; Cruickshank (n 127); Jos de Mul, 'Possible Printings: On 3D Printing, Database Ontology, and Open (Meta) Design' in Bibi van den Berg and others (n 20)

[160] Moilanen and Vadén (n 28); Jiang, Ding and Leng (n 28); Mohajeri and others (n 28); Kostakis and Papachristou (n 157). See also Birtchnell and others (n 16)

[161] Yochai Benkler and Helen Nissenbaum, 'Commons-Based Peer Production and Virtue' (2006) 14 The Journal of Political Philosophy 394

[162] ibid

[163] Byounghyun Yoo, Heedong Ko and Sungkuk Chun, 'Prosumption Perspectives on Additive Manufacturing: Reconfiguration of Consumer Products with 3D Printing' (2016) 22 Rapid Prototyping Journal 691

[164] Kostakis and Papachristou (n 157). For more theoretical discussion, see also Vasilis Kostakis and Michel Bauwens, *Network Society and Future Scenarios for a Collaborative Economy* (Palgrave 2014)

[165] Joshua Tanenbaum and Karen Tanenbaum, 'Fabricating Futures: Envisioning Scenarios for Home Fabrication Technology' in Nelson Zagalo and Pedro Branco (eds), *Creativity in the Digital Age* (Springer 2015); Troxler and Woensel (n 19)

[166] See discussion presented above in sections 1.1 and 1.2

[167] Jiang, Kleer and Piller (n 29)

> in 2030, a significant number of consumers will utilize online databases (repositories) to purchase product designs or to access open-source designs freely for additive manufacturing printing purposes.

Meanwhile, and as a result of the increased reliance of consumers upon online platforms, the experts consensually forecast that the exploitation of conventional intellectual property will be difficult in relation to digital products, giving rise to a significantly larger use of novel forms of intellectual property exploitation, and that regulating 3D printing online platforms will be one of the most important tasks by 2030.[168] Notwithstanding the experts' strong belief in the increased participation of consumers in the design process through 3D printing online platforms, most of the experts, particularly from industry, viewed the domestic adoption of 3D printing (i.e. consumers' own 3D printers at home) to be less likely by 2030. This is because, *inter alia*, they believed that technological barriers and alternative channels for better fabrication (e.g. using 3D printing bureaus) will diminish the needs of consumers for having 3D printers at home.[169]

1.4. Discussion

Chapter 1 has reviewed various literature to examine technological, corporate and societal aspects of 3D printing. This section discusses the findings and present scenarios capturing consumer activities in product design and manufacturing expected in the 3D printing environment.

1.4.1. Implications: from product consumption to design production and consumption

The application of 3D printing has gradually diversified by virtue of rapid technological development over a few decades, even enabling 3D printers to be domestically adoptable and usable by consumers to a certain extent.[170] The findings indicate that a large number of consumer 3D printers have been sold and the domestic adoption of 3D printing purports to be increasing. However, there is no clear evidence of how many consumer 3D printers have been, in fact, sold to homes rather than SMEs or makerspaces.

Whether 3D printing will be adopted in the domestic sector is extremely controversial.[171] In the literature, a number of technical, environmental and financial barriers that could hinder the widespread adoption of 3D printing in the domestic sector have been identified, implying that the domestic adoption of 3D printing may be somewhat elusive in the near future. Nonetheless, some experts maintain a positive view, anticipating that the domestic adoptability of 3D printing will

[168] ibid
[169] ibid
[170] This point was discussed in section 1.1. Technological Developments and Capabilities of Domestic 3D Printing
[171] See mainly Jiang, Kleer and Piller (n 29)

accelerate as 3D printing technologies improve in a way to become more user-friendly, environmentally sustainable and affordable, and that the widespread adoption of 3D printing will eventually be possible. On the other hand, others, in particular industry experts, believe that 3D printers are highly unlikely to be supplied at home on a wide scale, at least in the coming decade. The rationale behind this is, aside from various technical barriers etc., that alternative ways (e.g. 3D printing businesses or 3D printing service bureaus) would provide consumers with better-quality 3D-printed products and economic benefits, diminishing the need to own a 3D printer at home.

Notwithstanding the controversy of the domestic adoptability of 3D printing, experts in almost all of the literature consistently view that new forms of behaviours on the part of consumers will emerge, with regard to designs consumption. Owing to the technical capabilities of 3D printing, consumers no longer have to consume manufactured products whose designs have already been decided by product manufacturers. Instead, they can directly consume designs. One of the most notable changes in this direction is the emergence of 3D printing online platforms. As discussed earlier, the increased use of these platforms has been, in fact, remarkable over a few years.[172] Many experts appear to believe that the current trend will continue over the next decade. In particular, they predict that more and more people will use online 3D printing platforms to either purchase or freely download CAD files. Furthermore, the current legal framework of intellectual property will be significantly challenged as a result of the increased use of 3D printing online platforms.[173]

To summarise, the future landscape of 3D printing in which consumers utilise 3D printers at home for fabrication purposes might not happen in the following decade. However, they will still have access to 3D printing via 3D printing businesses or service bureaus. 3D printing will change the ways in which they consume designs. In the next decade, it is envisaged that they will readily access designs on the Internet, and some may start creating them by themselves.

1.4.2. How will consumers be involved in design consumption and production?

A salient question that follows the preceding section is, then, in what ways consumers will be engaged in design consumption and production.

The simplest but most highly anticipated way of design consumption is that consumers will access designs on the Internet. For example, they can purchase or freely download designs in the form of CAD files that are created in advance and distributed on online platforms. This is similar to consumers buying manufactured products off the shelves at shops, but in this case what they acquire is a *digital computer file* containing the design of a product.

[172] See section 1.2.1. Overview of business trends around 3D printing and section 1.3.1. The status quo: domestic adoption and use of 3D printing
[173] See mainly Jiang, Kleer and Piller (n 29)

A notable point is such designs can be adjusted, repurposed and altered by consumers' choice for production of individualised designs.[174] For example, consumers can access customisable designs, called meta designs, on online platforms to resize the design, whilst some may go beyond that, making significant alterations to the design.[175] This opens up possibilities for consumers to be actively engaged in product design, where they provide intellectual inputs in determining the final form of the design, and in this sense become prosumers who produce and consume the design at the same time.

However, it is likely that many consumers will lack sufficient expertise in product design and CAD, and thus professional design services offered by firms will become one of the viable options for consumers.[176] In fact, there is growing evidence that online platforms, such as Shapeways or i.materialise, are providing design services in relation to some types of consumer goods, but such design services are still not widespread owing to the relatively low adoption rate of 3D printing by firms, as well as the lack of appropriate business models.[177] As a result, the extent to which consumers will be allowed to participate in the design process, such as whether they merely provide ideas through verbal description or whether they actually collaborate with corporate designers with the aid of web-based and cloud-based CAD systems, is not straightforward.[178]

Another scenario relating to design production is where consumers create designs based upon the existing designs (commons) available on the Internet in collaboration with other peers in makerspaces or over the Internet.[179] This model might be currently limited to a talented few who are capable of producing designs with a considerable knowledge and skills in CAD, and yet, as noted in the literature, there is evidence that a large number of CAD files have been increasingly uploaded and shared on online platforms.[180]

Finally, consumers can use the designs obtained in the above design access and creation scenarios. Taking advantage of the ease of digital reproduction, consumers can easily share or sell CAD files over the Internet. Meanwhile, they can use the obtained designs for physical fabrication using bureau

[174] Kohtala, Hyysalo and Whalen (n 39)
[175] ibid
[176] Marcel Bogers, Ronen Hadar and Arne Bilberg, 'Additive Manufacturing for Consumer-Centric Business Models: Implications for Supply Chains in Consumer Goods Manufacturing' (2016) 102 Technological Forecasting & Social Change 225
[177] Hyunwoong Ko, Seung Ki Moon and Jihong Hwang, 'Design for Additive Manufacturing in Customized Products' (2015) 16 International Journal of Precision Engineering and Manufacturing 2369; Namchul Do, 'An Extended Product Data Management System Supporting Personal Manufacturing Based on Connected Consumer 3D Printing Services' (2016) 21 Korean Journal of Computational Design and Engineering 215
[178] Chapter 2 aims to complement the uncertainty within the context of product design. See section 2.2.1. Product customisation, personalisation and co-creation
[179] This model is devised from societal prospects of 3D printing. It is notable that commons-based production is also predicted by one of the major recent socio-legal studies to be a possible scenario in the UK. See Birtchnell and others (n 16)
[180] Mendis and Secchi (n 64)

services or at home. In fact, 3D printing online platforms have been facilitating consumers' use of CAD files with various services.[181]

To summarise, in the 3D printing environment, consumers are expected to have increased involvement in product design for production of individualised designs. Rather than merely buying prefabricated goods, they will access, create and use CAD files for design individualisation. They will do what the manufacturing and design industries have dominantly done, leading to a shift of their social and legal status, from passive consumers to prosumers and from users to IP rightsholders, whilst reshaping their relationship with product manufacturers and designers.[182] Such changes in consumer behaviour will also likely challenge the IP framework, and thus the thesis aims to examine the legal implications, with a particular focus on consumers' access, creation and use of CAD files.

1.4.3. Scenarios

Recapitulating the above discussion, the thesis presents the following five scenarios in Table 2 below. The scenarios are the encapsulation of consumers' design activities that are either currently occurring or likely to occur in the foreseeable future in the 3D printing environment.

Type of design activity	Scenario
Access	(1) Consumers download/purchase a design on online platforms
Creation	(2) Consumers create a design with a firm
	(3) Consumers create a design based on commons
Use	(4) Consumers share/sell a design on online platforms
	(5) Consumers fabricate a physical object at bureau services or at home

Table 2 Five scenarios for legal analysis of 3D printing

The key actor of the scenarios is the consumers who partake in design activities. Consumers are likely to have increased opportunities in the 3D printing environment to access, create and use designs and become prosumers. An important implication is that such activities by consumers can lead to the dynamic IP landscape where IP rights are generated, exploited and infringed not only by traditional commercial players but also by the wider public for either commercial or non-commercial purposes, and, as will be elaborated in other chapters,[183] this can potentially complicate the regulation of IP rights.[184]

[181] ibid
[182] de Mul (n 159). For more discussion on the changing relationships between product designers and end users, see also Manzini (n 40) and Steinar Killi, 'Chapter 1: Scope of the Book' in Steinar Killi (ed), *Additive Manufacturing: Design, Methods, and Processes* (Pan Stanford Publishing 2017)
[183] Various IP issues are discussed throughout Chapters 3–6, including legal status of CAD files and online platforms (Chapter 3), lack of clarity in copyright ownership and licensing (Chapter 4), challenges of copyright

It is also worth noting the importance and relevance of 3D printing online platforms in the scenarios. Consumers make complex interactions with 3D printing online platforms and other related actors in the scenarios. For instance, in relation to the access and use scenarios, 3D printing online platforms serve as intermediaries between their users, who download/purchase and who share/sell designs on the platforms.[185] In the creation scenarios, consumers may interact with individual product designers or those who are employed in a design firm, and the 3D printing online platforms liaising with them.[186] Positioned at the centre of diverse actors, 3D printing online platforms play a mediating role facilitating consumers' design activities. In the IP realm, such an act of facilitation can be deemed infringing where the facilitated act constitutes IP infringement.[187] In effect, 3D printing online platforms appear to be one of the important potential regulatees, along with consumers in the IP landscape.

The five scenarios presented above are broadly constructed for the purpose of legal analysis. More complex situations may occur in reality, some of which may not squarely fit in one of the scenarios. As was already noted, 3D printing online platforms provide multiple services, such as design hosting, and design and manufacturing services.[188] For example, the users on Thingiverse can access and download CAD files and at the same time they can customise the CAD files with the built-in customisation tool on the website and further order to print.[189] The integrated multiple services provided by 3D printing online platforms makes it possible for users to access, create and use the designs in one flow. In this sense, the proposed scenarios, in practice, can take place very closely in place and time, and even overlap to an extent.

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and design rights infringement and enforcement (Chapter 5), and uncertainty of the scope of copyright and design rights exceptions (Chapter 6)

[184] Mendis and others (n 16); Carter-Silk and Lewiston (n 43) 35

[185] See, for example, online design repositories (e.g. Thingiverse, CGTrader or Pinshape), design search engines (e.g. Yeggi), online design marketplaces (e.g. Shapeways, i.materialise or Sculpteo)

[186] See, for example, Shapeways's co-design services, discussed at 4.3.4. Contractual terms and copyright and design rights ownership

[187] Online platforms have been attractive targets in the copyright enforcement in the UK and EU over the past decades, owing to their technical capability of controlling use of IP-protected content shared on their website. For discussion of the development of regulation of online platforms, see section 3.5. Legal Status of 3D Printing Online Platforms

[188] Rayna and Striukova (n 26); Rayna, Striukova and Darlington (n 120)

[189] Thingiverse Customizer <https://www.thingiverse.com/customizer>

Chapter 2

Product Design

Introduction

Chapter 1 established the relevance and importance of increased consumer engagement in product design and presented scenarios capturing consumers' design activities in the 3D printing environment. In this chapter, the thesis expands on the notion of consumer engagement in light of product design.

Chapter 2 aims to demystify the design creation process in the 3D printing context and identify the types of intellectual contribution involved therein. To this end, the chapter, first, analyses the whole product design process. Establishing that CAD is an essential part of the product design process for 3D printing, it looks further into how CAD is utilised for production of the final description of design, which is referred to in the thesis as CAD files. Based on the analysis, the final part of the chapter discusses product design processes from the perspective of IP law: establishing intellectual inputs afforded therein can lead to the generation of IP and the associated IP rights.

2.1. What Is Product Design?

Product design is the practice of designing products. The fundamental purpose of designing is to meet unfulfilled needs, such as commercial success and the enrichment of quality of life, by enhancing the function and appearance of products.[190]

To achieve this purpose, product designers perform various tasks. Their role might encompass improving particular features of a product's function for easier usage of it; employing new technologies and materials for more efficient and cheaper manufacture of products; and exploring and pushing new aesthetic boundaries to improve a product's emotional appeal.[191]

One of the largest categories of products that product designers deal with is consumer durables, such as domestic appliances, automobiles, personal computers and furniture.[192] Such end-use products often comprise numerous components, and thus are designed by a group of professionals, including product designers, mechanical and electronic engineers, ergonomists and manufacturing specialists.[193] As such, product design processes can be defined in broad terms as processes in which a group of professionals define and realise the required function and appearance of products.

[190] Rodgers and Milton (n 12)
[191] ibid. It should be noted that the concept of product design in the thesis is based on the design practice in the UK. Product design may be defined in different ways in other countries. See, for example, KwangMyung Kim and Kun-pyo Lee, 'Collaborative Product Design Processes of Industrial Design and Engineering Design in Consumer Product Companies' (2016) 46 Design Studies 226
[192] Rodgers and Milton (n 12)
[193] ibid

2.1.1. Overview of the product design process

The product design process comprises a number of stages, and a division is often made between the two different perspectives – the descriptive and prescriptive approaches.

The descriptive model focuses on the sequences of activities occurring in the product design process. For example, Rodgers and Milton suggest a six-stage model, comprising (a) research, (b) brief, (c) concept design, (d) design development, (e) detail design and (f) production.[194] In contrast, the prescriptive model, such as proposed by Pahl and Beitz, presents stages of the product design process as systematic procedures that product designers should follow for improved workflow.[195]

For the purpose of the thesis, the generic descriptive model of product design processes, such as Rodgers and Milton's model, would be suitable. The thesis will simplify their six-stage model into four stages by condensing some of the stages and removing irrelevant parts. The four-stage product design process proposed in the thesis is as follows:

(1) Problem identification (research and brief) stage
(2) Concept design stage
(3) Design development stage
(4) Detail design stage

Any reference to the product design process or the product design process model henceforth in the thesis will mean the above four-stage model. It is also notable that the four-stage model is for both traditional manufacturing and 3D printing. More specific issues with 3D printing will be dealt with in section 2.2. in the context of product customisation, personalisation and co-creation.

2.1.2. Problem identification (research and brief) stage

The problem identification stage is where product designers explore ill-defined problem spaces to identify design problems. Product designers' roles in this stage include design research, construction and analysis of a design brief, and the establishment of a product design specification (PDS).[196]

The purpose of product design research is to obtain information by asking, observing, thinking and learning about products, spaces and systems from people, such as end users or clients. To that end, product designers might conduct interviews and surveys to acquire the participants' ideas and experiences of products and their needs whilst reviewing the existing literature including online materials to learn about recent trends in the market such as competitors' product search.[197]

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[194] ibid
[195] Nigel Cross, *Engineering Design Methods: Strategies for Product Design* (4th edn, Wiley 2014) 29–42
[196] Rodgers and Milton (n 12) 56–76
[197] ibid

A brief is a statement of intent setting out design problems, as well as corporate restrictions such as budgets and deadlines that must be met by product designers in designing a product. It serves as the essential guide for them to initiate designing. Some factors that are considered in creating a brief include the aims and expected production volumes of the product, the functionality of the product and conformity with the relevant regulations.[198] They are all important and relevant to product designers in producing design solution at later stages.

The final part of the problem identification stage is to create the PDS. A PDS is a document laying out all the relevant design problems in detail, including any numeric properties, which are identified through the design research and the analysis of the brief.[199] For example, the performance of the product, any environmental conditions by which the product is likely to be affected, the service life of the product and maintenance issues, the quantity, size, weight, aesthetics and ergonomics of the product, safety and other legal issues may be included in the PDS.[200] Product designers are expected to consult the PDS throughout the whole design process, and thus it is crucial that the PDS is created very clearly at the outset.

2.1.3. Concept design stage

In this stage, product designers generate viable conceptual solutions to the design problems identified in the problem identification stage. A concept design is 'an approximate description of the technological, functional, and aesthetic form of the product in development'.[201] The concept design stage generally comprises three steps. The first step is that product designers generate ideas to address the design problems. Following that, they externalise the generated ideas with visualisation methods. Finally, a number of alternative visualised concepts are evaluated for a selection of the concept design that best resolves the design problems.[202]

The generation of ideas is a process in which product designers produce ideas that could potentially address the design problems, drawing upon the information and knowledge obtained at the problem identification stage. The process requires product designers to perform deliberate thinking to generate new ideas and fresh insights. To this end, they might utilise techniques such as brainstorming or mind mapping.[203] These techniques are deemed useful and creative, in that they encourage them to adopt non-linear and organic thinking to address design problems.[204]

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[198] ibid
[199] ibid
[200] ibid
[201] ibid., 78
[202] Milton and Rodgers (n 13)
[203] Rodgers and Milton (n 12)
[204] Milton and Rodgers (n 13) 56

Product designers, then, visualise the generated ideas, utilising various methods including drawing, sketching and modelling. The purpose of the visualisation is to give form and meaning to an idea, so that the idea can be further developed, evaluated and effectively communicated with others including clients or fellow designers.[205]

One of the most common methods adopted by product designers in an earlier visualisation process is sketching.[206] Sketching is an explorative tool useful for giving form to an idea, and it has the added benefit of tracing the evidence of an ongoing process.[207] Owing to its immediacy and temporary nature, sketching with a pen and paper is often used to capture the ideas into a form in a quick and fluid manner. Sketches drawn at this stage are generally of low fidelity, delivering rough images of the physical form of a product, whereas at a later stage it becomes a more realistic higher-fidelity sketch for evaluation and communication with others.[208]

Alternatively, product designers use computer software to generate a sketch digitally. Designing with the aid of a computer is generally referred to as CAD. CAD is beneficial for product designers, as it can help them visualise concept designs more quickly and accurately, whilst enabling effective communication with others.[209]

Other methods such as modelling or prototyping are also used in the concept design stage. However, they are generally used later at the design development stage, where product designers wish to further develop the concept designs. This will be demonstrated more in detail in the design development stage, discussed below.

At the end of the concept design stage comes the evaluation and selection of concept design, in which product designers, along with other individuals, choose concept designs that best meet the requirements set out in the PDS. However, it is notable that the process does not necessarily enable product designers to choose a dominant concept; if they cannot, they need to modify and improve the existing concept design until they find a suitable one. In some cases, they might have to create a new concept design from the outset. In effect, the process of concept design evaluation and selection is heavily iterative.

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[205] Rodgers and Milton (n 12)
[206] Kevin Henry, *Drawing for Product Designers* (Laurence King Publishing 2012)
[207] ibid., 43
[208] The term 'fidelity' adopted in the thesis means the degree of realism in product design. For example, a high-fidelity sketch presents an object in high level of realism with tighter lines and shade. See, for more detail, ibid., 12
[209] Douglas Bryden, *CAD and Rapid Prototyping for Product Design* (Laurence King Publishing 2014) 11–13. CAD will be discussed further in detail in section 2.3. Use of CAD: Consumer Engagement in Product Design

2.1.4. Design development stage

The design development stage is where product designers refine the selected concept design. In doing so, they often use modelling or prototyping. These techniques are particularly useful for testing and proof of concept, as well as for communication to clients and end users.

Design models are used to evaluate the concept design's functionality, aesthetic, ergonomics and usability. At the same time, models or prototypes created with high fidelity could be shown to individuals like clients or end users to deliver the impression of the concept design. There are different types of design models used for different purposes. These include sketch models, mock-ups, appearance models and test rigs.[210]

Sketch models are full-size or scale models, hand-carved or sculpted, with easily accessible materials at an earlier stage of design development. Similarly, mock-ups could also be created with easily accessible materials such as rigid card or wood, but their size is normally life-size so that it is particularly useful to explore and evaluate the concept designs' relation to space.[211] Test rigs are models that replicate a mechanical action of the concept design, primarily used for testing functionality such as strength, stiffness or durability. In contrast, appearance models, which closely reproduce the appearance of a product as a scale model, are utilised almost only for aesthetic evaluation and communication with clients or end users.[212]

Some types of low-fidelity prototypes could also be utilised for design development, such as paper prototypes, in a similar manner to design models. Paper prototypes are rough and simple representations of the concept, and are useful for product designers to quickly test the basic functionality and usability of the concept design. On the other hand, prototypes comprising a higher level of detail tend to be used before production stage.[213]

2.1.5. Detail design stage

Detail design is the final stage of the design process, where product designers transform the selected and developed concept design through the concept design and design development stage into a fully detailed design represented by a set of manufacturing drawings and documentation. The process can be divided into three distinct steps: part design detailing, product prototype testing and preparation of the manufacturing information set.[214]

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[210] Rodgers and Milton (n 12) 98
[211] Milton and Rodgers (n 13) 95–109
[212] ibid
[213] ibid
[214] ibid

For detailing designs of parts, product designers first divide the chosen design concept into multiple components that need to be designed separately.[215] Once the detail design of these components has been completed, they produce general arrangement drawings, which demonstrate the final form of the design and whole product layouts, serving as the key document connecting all the design components that are created.[216] In doing so, CAD is often used as a detailing method, for it is more effective than traditional hand-drawn technical drawings, in managing and communicating the information required for assembly and production of a product.[217]

Product designers then produce prototypes for final evaluation and testing of the proposed product's aesthetics and function. In doing so, they often use the same manufacturing method as that which is intended to be used in the actual fabrication process.[218] Alternatively, they can also utilise different manufacturing processes and materials for less costs and rapid production of prototypes.[219] Rapid prototyping is one of the examples of the latter type of prototyping, and 3D printing has been used for this purpose.[220]

After the evaluation and testing, product designers modify the final concept design for further evaluation if it still needs refinement. Once this iterative process has been finished, they produce the information set, which is a full set of engineering drawings, containing all the essential information for production such as the product's form, dimensions, manufacturing processes, tolerances, materials etc., presented along with general arrangement drawings.[221]

2.2. Particularities of the Product Design Process in the Context of 3D Printing

3D printing's unique capabilities lend themselves to creation of complex and custom-designed geometries without cost penalty.[222] Small-volume production can be economically feasible with 3D printing, owing to the automated process planning and no requirements of hard tooling or fixtures.[223] Such features enable product designers to enjoy a considerably high degree of design freedom with 3D printing. As a corollary, product customisation, personalisation and co-creation are deemed to be the most promising applications of 3D printing.[224]

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[215] ibid
[216] ibid
[217] Bryden (n 209)
[218] Rodgers and Milton (n 12)
[219] ibid
[220] Bryden (n 209)
[221] Rodgers and Milton (n 12)
[222] Gibson, Rosen and Stucker (n 6) 400
[223] ibid 404–05
[224] Stephen Hoskins, *3D Printing for Artists, Designers and Makers* (2nd edn, Bloomsbury 2018) 143

Another interesting development relating to 3D printing is the increased interests in, and activities of, product designing by consumers.[225] With the advent of low-cost 3D printers, consumers have naturally started showing interests in seeking designs with which they can produce physical objects with those printers.[226] Online platforms for the purposes of providing designs for 3D printing, alternatively referred to as 3D printing marketplaces or 3D printing online platforms, have been emerging to enable them to access the provided designs.[227] For example, some of the major 3D printing online platforms, such as Thingiverse,[228] facilitate dissemination of 3D printing-related knowledge by hosting communication spaces, allowing their users to discuss any design-related questions.[229] It is also notable that a large number of designs uploaded on the 3D printing online platforms are created by their users through the reproduction, transformation and combination of the existing designs (or commons).[230]

2.2.1. Product customisation, personalisation and co-creation

For the purpose of the thesis, product customisation will be defined as the creation of different versions of products, which are produced by *consumers' choice* from several ranges of available options. Product personalisation means the production of a *bespoke* product tailored to individual consumers' needs.[231] The concept of co-creation appears to still be developing over many different fields of practices and studies, such as software development[232] or brand management.[233] However, in the context of product design, product co-creation will refer to a design process in which designers and untrained people in design *interact and work together* to produce a design, with their collective creativity.[234]

These concepts overlap to the extent that all of them involve consumers in determining the final form of the design; however, their degree of participation in the product design process varies. Of the three,

[225] Refer back to section 1.4. Discussion
[226] For example, there has been an exponential growth in number of first use of 3D printers since around 2008. See Moilanen and Vadén (n 28). And, indeed, one of the biggest 3D printing online platforms – Thingiverse – was created around the time in late 2008. See John Baichtal, 'Thingiverse.com Launches a Library of Printable Objects' (*Wired*, 2008) <https://www.wired.com/2008/11/thingiversecom> accessed 9 July 2020
[227] For more detailed account of taxonomy of 3D printing online platforms, see Rayna and Striukova (n 26)
[228] <https://www.thingiverse.com>
[229] On Thingiverse, for example, there is a comment section for each design, where the users and designers can discuss designs.
[230] A theoretical background of the concept of commons-based peer production was introduced by Benkler and Nissenbaum. See Benkler and Nissenbaum (n 161). The definition of commons and its historical development are discussed much in detail in section 2.2.2. Commons-based design process by consumers
[231] Syahibudil Abdul Kudus and others, 'Assessing the Value of 3D Printed Personalised Products' (International Conference on Mass Customization and Personalization in Central Europe, Novi Sad, Serbia, 21–23 September 2016)
[232] See Ballardini and others (n 61)
[233] For example, see Holger Schmidt and Nicholas Ind, *Co-creating Brands: Brand Management from a Co-creative Perspective* (Bloomsbury 2019)
[234] Elizabeth Sanders and Pieter Stappers, 'Co-creation and the New Landscapes of Design' (2008) 4 International Journal of CoCreation in Design and the Arts 5

the one with the lowest degree of participation is product customisation, in which consumers' inputs are not directly reflected in any stage of the design process; rather, it is confined to a selection of pre-determined options.[235] By contrast, in product personalisation, consumers' requests and personalised requirements for a bespoke design turn into individualised design problems that product designers should deal with, and in this sense their inputs are directly reflected in the PDS.[236] Lastly, product co-creation involves the highest degree of participation where consumers join product designers to provide a collective solution to a design problem beyond merely setting out design problems, such as in product personalisation.[237]

In the 3D printing environment, product customisation and personalisation has been, in fact, increasingly used by consumers.[238] Several 3D printing online platforms already provide such design services for consumers, utilising interactive interfaces.[239] Intuitive and networked CAD programs[240] and haptic input devices, such as VR,[241] are also accelerating consumer engagement in product design.[242] However, it is suggested that product co-creation is still at an embryonic stage in practice, owing to the paucity of research on co-design models involving consumers.[243]

From the IP perspective, consumer engagement in product customisation, personalisation and co-creation will create an environment where consumers are seen as co-producers of the design, and thus potentially become co-owner of IP rights subsisting in that. This change in the IP landscape could challenge the traditional ways of IP rights management in design firms, potentially causing IP issues such as conflicts between firms and consumers, in relation to ownership and further control of consumer-generated IP rights.[244] It is suggested that there is still a lack of clear understanding of IP generation and ownership in collaborative product development, making it difficult for firms to build IP management strategies.[245] As such, the thesis considers that it is crucial to understand the role of

[235] See section 2.1.1. Overview of the product design process
[236] See section 2.1.2. Problem identification (research and brief) stage
[237] However, it should be noted that consumers would not always join product designers throughout the whole design process, as their level of expertise, passion and creativity might vary. See Sanders and Stappers (n 234)
[238] Kudus and others (n 231) 140–41; William Kempton, 'A Design Sociotechnical Making of 3D Printing' in Steinar Killi (ed), *Additive Manufacturing: Design, Methods, and Processes* (Pan Stanford Publishing 2017) 42–43; Ian Campbell and others, 'Additive Manufacturing as an Enabler for Enhanced Consumer Involvement' (Proceedings of the 13th Annual RAPDASA Conference, Pretoria, South Africa, 31 October–2 November 2012)
[239] Bryden (n 209) 134
[240] Wu and others (n 22)
[241] Covarrubias and Bordegoni (n 102)
[242] Bryden (n 209) 134
[243] Michael Möhring and others, 'Enabling Co-creation in Product Design Processes Using 3D-Printing Processes' in Florian Daniel, Quan Sheng and Hamid Motahari (eds), *Business Process Management Workshop: BMP 2018 International Workshops Sydney, NSW, Australia, September 9–14, 2018 Revised Papers* (Springer 2019) (The facts that most consumers are still not familiar with complicated design processes and that they would often prefer to participate in co-creation at a time, location and manner decided by them rather than product designers make it difficult to devise an effective co-design model)
[244] Berthon and others (n 75); Antorini and Muñiz (n 75)
[245] Greer and Lei (n 77); Manzini and Lazzarotti (n 77)

product designers and consumers and their interaction in product design processes to improve the legal clarity of IP generation and ownership.[246]

2.2.2. Commons-based design by consumers

A theoretical background of the concept of commons-based peer production was introduced by Benkler and Nissenbaum.[247] In their article, they defined commons-based peer production as 'a socio-economic system of production that is emerging in the digitally networked environment'.[248] Applying the concept of commons-based peer production further to the 3D printing context, Kostakis highlighted that commons-based peer production would provide the chance to '(co-)design globally – taking from and contributing to a knowledge Commons – and produce locally responding to certain needs.'[249] In effect, the commons-based design process is built on the core idea that designers utilise (e.g. reproduce, modify and combine), as a design material, the commons that are accumulated over time.

Commons-based design is distinguished from the conventional product design processes discussed above. The latter is often associated with professional settings where product designers produce designs in the course of employment, whereas commons-based design is open to the wider public, including consumers categorising themselves as hobbyists or enthusiasts.[250] The purpose of product design processes, as part of a corporate practice, is to produce a design that fulfils the needs of consumers, with a view to commercial success.[251] However, many participants in commons-based design view their primary goal as being to create the design for either personal use or personal challenges.[252]

2.3. Use of CAD: Consumer Engagement in Product Design

CAD plays an integral role that facilitates consumer engagement in product design. CAD is:

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[246] IP generation in product design processes will be further discussed at 2.4. The Product Design Process and IP Law

[247] Benkler and Nissenbaum (n 161)

[248] Benkler and Nissenbaum explained that commons-based peer production is facilitated by the technical infrastructure of the Internet, and the primary feature of it is depicted as 'collaboration among large groups of individuals, sometimes in the order of tens or even hundreds of thousands, who cooperate effectively to provide information, knowledge or cultural goods without relying on either market pricing or managerial hierarchies to coordinate their common enterprise' See ibid., 394

[249] Kostakis and Papachristou (n 157)

[250] Mendis and Secchi (n 64)

[251] Commercial success is one of important considerations in product design and development, as mentioned at 2.1. What Is Product Design?

[252] Erin Buehler and others, 'Sharing Is Caring: Assistive Technology Designs on Thingiverse' (Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems CHI '15, South Korea, April 2015)

> the process of using computers and specialist software to create virtual three-dimensional models and two-dimensional drawings of products.[253]

This section discusses the ontology of CAD and the related concepts and how it is utilised in product design processes and commons-based design.

2.3.1. Ontology of CAD, CAD programs and CAD files

CAD is an essential design method in the design process for 3D printing. It has been used by product designers as an alternative to physical drawings and models, owing to its accuracy and convenience in the iterative process of design production.[254] The importance of CAD is even higher in the context of 3D printing, as 3D printing is a digital manufacturing method that requires digital data created in CAD for manufacturing.[255] As such, examining the use of CAD will be useful to understand, in practice, how a concept design is generated, captured, developed, detailed and finally turned into a final description, and this will also help identify types of intellectual inputs involved and how they develop over the course of the design process.

CAD software or programs are integrated design tools equipped with various functions that facilitate the process of design creation.[256] CAD programs are generally categorised into two types. A surface modeller enables product designers to define the shape of a 3D object by describing the surface boundaries of the object, whilst a solid modeller allows them to define the internal details of a 3D object.[257] For the purpose of producing physical objects with 3D printers, they use solid modellers because the well-defined internal details are necessary.[258]

There are different types of solid modellers that product designers can choose from. AutoCAD and SolidWorks are examples of the most widely used CAD programs.[259] Whilst such CAD programs are rather costly and intended for professional designers, some CAD programs as with FreeCAD or OpenSCAD are developed for non-professional users for little or no price.[260] At the same time, some design software, such as Adobe Photoshop, which has not been generally used for product design, has adopted 3D modelling functionality, enabling consumers to produce designs for 3D printing.[261]

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[253] Bryden (n 209) 11–13
[254] ibid
[255] ibid
[256] Dugan Um, *Solid Modeling and Applications: Rapid Prototyping, CAD and CAE Theory* (2nd edn, Springer 2018)
[257] Bryden (n 209) 11–13
[258] Chua and Leong (n 14)
[259] '22 Best 3D Modeling/CAD Software Tools' (*All3DP*, 20 April 2020) <https://all3dp.com/best-3d-modeling-software> accessed 9 July 2020
[260] <https://en.wikipedia.org/wiki/Comparison_of_computer-aided_design_editors> accessed 26 July 2020
[261] <https://helpx.adobe.com/uk/photoshop/using/creating-3d-objects-animations-photoshop.html> accessed 17 March 2020

A CAD file is a collective term that indicates a computer file incorporating designs created from CAD programs.[262] For the purpose of 3D printing, those designs will eventually take the form of 3D solid models as a final description. However, it is possible that they take different forms, including 2D drawings or 3D surface models, at earlier stages of the design process.[263] A CAD file can be created using different types of CAD programs, and its file extensions can vary, including .DWG, .DXF and .DGN, depending on what CAD programs are utilised.[264]

For CAD files to be fabricated into a physical object, its format should be changed to the ones that 3D printers can process. Some of the most frequently used formats include STL and OBJ.[265] Once these files are generated, the mechanical information, which instructs a 3D printer to operate, is added with computer programming language called G-code. G-code is a numerical control programming language that is used to prescribe an automated machine tool to operate in the intended course. G-code commands might be manually written, but they could also be automatically generated by proprietary or free slicing software available on the Internet, such as Cura. This process changes the design file produced in the earlier phases into a ready-to-manufacture file for 3D printing.[266]

The term 'CAD file' can be confusing, as it could mean varied forms of design produced with CAD at any stage of the design process. For example, a CAD file might mean pre-design materials that are created during concept design and design development stages, such as digital concept drawings or models. At the same time, it might refer to a final description of design or a ready-to-manufacture design. Due in part to this, in the legal literature, CAD files seem to have been equivocally defined, leading to conflicting viewpoints over their legal status. In some of the legal literature,[267] CAD files have been construed as denoting a final description of design in the form of a 3D model. In contrast, in other works of the legal literature[268] they have been recognised as being one step further ahead, as a ready-to-manufacture design, to which mechanical information and instruction is added for fabrication.

To avoid the confusion, the thesis will confine the definition of CAD files to a final description of design in the form of a 3D solid model, as it is more relevant for legal discussion in the following

[262] However, it should be noted that the term 'CAD file' is not an officially acknowledged term, and different terms, such as 3D CAD file, CAD drawings, or CAD models, are also used in the literature to denote the same thing. See, for example, Bryden (n 209) and Gibson, Rosen and Stucker (n 6)
[263] Bryden (n 209)
[264] '2020 Overview of 3D CAD File Formats' (All3DP, 27 January 2020) <https://all3dp.com/2/overview-of-3d-cad-file-formats> accessed 9 July 2020
[265] A key difference between STL and OBJ is that the latter can contain colour information of a model so that it can be used for colour fabrication, whereas STL can only contain mono colour. See '2020 Most Common 3D Printer File Formats' (*All3DP*, 13 February 2020) <https://all3dp.com/1/3d-printer-file-format> accessed 9 July 2020
[266] Bryden (n 209)
[267] Brian Rideout, 'Printing the Impossible Triangle: The Copyright Implications of Three-Dimensional Printing' (2011) 5 Business, Entrepreneurship & the Law 161; Elam (n 53)
[268] Bradshaw and others (n 17); Mendis, '"Clone Wars" Episode II' (n 15)

chapters. A final description of the design is not only the ultimate outcome of the product design process but also a master or parent design that can be turned into many different types of ready-to-manufacture design specific to particular manufacturing methods and processes. Indeed, it is notable that a recent EC report also noted and emphasised that CAD files are distinguished from ready-to-manufacture files.[269] In this sense, it seems more appropriate to view CAD files as a final description of the design.

2.3.2. Use of CAD programs in product design processes

The use of CAD programs differs depending on the users' proficiency. This section examines how CAD programs are used by professionals and non-professionals. The term 'professionals' adopted in this context encompasses skilled users of CAD programs who have received formal design education and who normally work as members of a larger design team in a company. In contrast, 'non-professionals' are novice users of CAD programs with little or no expertise in product design and they are often referred to as enthusiasts or hobbyists.

For professional users, the use of CAD may be most prominent in the detail design stage, in particular where 3D printing is utilised as a manufacturing method. Yet, as briefly mentioned above, CAD is not limited to the detail design stage but may be continuously used throughout the whole design process, such as for generating and evaluating a concept design.[270] Product designers generally utilise a combination of different CAD programs, such as 2D modellers, 3D surface modellers and solid modellers, depending on the phases they are in the design process.

In the concept design and design development stage, where detailed specifications are still undecided, product designers utilise CAD programs to depict a concept design.[271] However, it is worth noting that, in fact, most, if not all, product designers would utilise sketching as a way to start creating a concept design at the most initial stage of the design process before relying on CAD programs, as it is not only an intuitive and quick way to visualise ideas but it could often help amplify designers' imaginations as they go through the process.[272] Upon the basis of drawing conventions, which are rules and procedures that have been established and universally recognised by designers, product designers produce a sketch that anyone in the field can readily understand.

Where sketches for a concept design are prepared, CAD programs can be used to import the analogue sketches into a digital model. However, it is worth noting that product designers will produce a concept design with CAD from the outset if they prefer it. Surface modelling would normally begin

[269] Mendis and others (n 16) 21–23
[270] CAD offers huge benefits for product designers, facilitating many aspects of the design process. For more information about CAD's capabilities, see Um (n 256) 4
[271] Bryden (n 209) 15
[272] Henry (n 206) 43

with drawing lines, known as curves or splines, but, where there are existing drawings or photographs of a concept design, scans of the drawings and elevation views of the photographs could be imported into CAD programs and traced to generate surfaces.[273] Alternatively, an existing physical object might be scanned with 3D scanning devices and the data collected through 3D scanning can be used to create a 3D model. The concept design imported into a CAD program will then be evaluated and developed until it properly addresses design problems.[274]

Once the final concept design has been successfully evaluated and selected, product designers normally use CAD programs (solid modellers) to create a model with thickness and volume, and the created solid models can be used for communication and for analysis of engineering and mathematical physics of the model.[275] When employing 3D printing as a manufacturing method, solid models are imperative for 3D printers to produce physical objects without errors.[276]

A rudimentary way of creating solid models is utilising primitive solid forms provided in most CAD programs, such as spheres, boxes, cylinders, cones etc. This method is often referred to as constructive solid geometry.[277] For example, product designers may choose and load desired primitives from the toolbox of the interface of CAD program. With the modification tools, they can not only adjust the size and position of the loaded primitives but move them to overlap with each other in part to create a more complex geometry.[278] This method is convenient but, when more complex solid forms are needed, the process of solid modelling may start with using construction curves.[279] Alternatively, it is also possible that a surface model created in the preceding process is converted into a solid model via CAD programs supporting transformation tools from surface to solid models.

In contrast, the design process and use of CAD by non-professionals is far more simplified. With limited capability in design thinking and use of CAD, what is designed by non-professional designers is often quite limited to non-functional and aesthetic objects.[280] For example, a large volume of online resources and guides of 3D modelling for beginners (or entry-level 3D printing users) has been published on the Internet.[281] Shapeways provides 3D printing design guides for beginners on its

[273] ibid 16–17
[274] Bryden (n 209)
[275] However, product designers may directly take solid modelling methods in the case where geometric forms are required from the outset. Hence, it should be noted that use of CAD in design process explained in this part is general and always modifiable by product designers. See Bryden (n 209)
[276] Chua and Leong (n 14)
[277] Bryden (n 209)
[278] Samuel Bernier, Tatiana Reinhard and Bertier Luyt, *Make: Design for 3D Printing* (Maker Media 2014)
[279] Bryden (n 209) 15–18
[280] See, for example, the tutorials available on the Internet made for beginners, introduced in the footnotes below
[281] The search keyword '3D Modelling Tutorial for Beginners' on YouTube returns a large number of videos demonstrating use of various CAD programs, such as Blender, Tinkercad and FreeCAD. <www.youtube.com/results?search_query=3d+modeling+tutorial+for+beginners > accessed 9 July 2020.

website, with a number of videos that users could easily follow step by step.[282] The guide demonstrates how to design a pendant or a key holder, using two types of software: Adobe Photoshop and Autodesk Tinkercad.[283] Like the professional design process, it guides users to prepare a simple sketch of design as a starting point. But the sketch is not complex, or even 3D, but a simple orthographic 2D drawing. The guide, then, leads users to photograph the sketch to be imported onto Photoshop for digitisation. Through the guide, users learn how to extrude a 3D model from a 2D design, export the model using a basic CAD program, and utilise a basic function of Tinkercad to produce a printable 3D design.[284]

2.3.3. Use of CAD for product customisation, personalisation and co-creation

General use of CAD for product design is discussed above. This section discusses a particular use of CAD for product customisation, personalisation, and co-creation in the 3D printing context. As was discussed in Chapter 1, product customisation, personalisation and co-creation can be facilitated in the 3D printing context. In particular, the emergence of meta design is one of the most remarkable developments in this regard. Meanwhile, the employment of NUI-based devices, such as VR, while experimental, is also promising.[285] This section examines how these two are incorporated in CAD systems for facilitating product customisation, personalisation and co-creation.

2.3.3.1. Meta design

A meta design is an abstract model capable of generating a family of concrete models.[286] By nature, it is essentially a large database enabling users to exercise virtually unlimited number of choices.[287] The users can adjust the parameters and create a concrete model to their preference with interactive interface software. It appears that meta designs are not still widely adopted by major manufacturers at present, whereas it is quite popular in 3D printing communities like Thingiverse.[288]

In universities there has been ongoing research on how to conceive of an innovative consumer-focused design process by employing meta designs.[289] If product designers are to create meta designs, their nature will shift from a designer of an object to a designer of multidimensional design space that

[282] Modeling for 3D printing: A Guide for Beginners (Shapeways) <https://support.shapeways.com/hc/en-us/articles/360023915713-Modeling-for-3D-printing-A-guide-for-beginners> accessed 28 January 2020
[283] Tinkercad is a free online 3D modelling program for entry-level 3D printing users. <https://www.tinkercad.com> accessed 28 January 2020
[284] Modeling for 3D printing: A Guide for Beginners (Shapeways) <https://support.shapeways.com/hc/en-us/articles/360023915713-Modeling-for-3D-printing-A-guide-for-beginners> accessed 28 January 2020
[285] See above Chapter 1, section 1.1. Technological Developments and Capabilities of Domestic 3D Printing
[286] Kyriakou, Nickerson and Sabnis (n 148)
[287] de Mul (n 159) 96
[288] Kyriakou, Nickerson and Sabnis (n 148)
[289] Ariadi and others (n 108)

enables the production of diverse variants of design. Some of their traditional roles will also be challenged; for example, their focus will be mainly upon solving design problems relating to functionality, and aesthetic decisions will be left to individual consumers of meta designs.[290]

One of the most widely used CAD programs to create meta designs is OpenSCAD. Unlike many other CAD programs, it uses lines of code or computer language to create a 3D model, and thus its interface is close to a text editor. OpenSCAD's user manual demonstrates a basic usage of the program.[291] For example, to create a simple 2×3×4 cuboid, users type a one-line command in the editor as set out below:

```
cube([2,3,4]);
```

Another example demonstrating how to position and change the colour of an object is as follows:

```
color([1,0,0]) cube([2,3,4]);
translate([3,0,0])
color([0,1,0]) cube([2,3,4]);
translate([6,0,0])
color([0,0,1]) cube([2,3,4]);
```

These are some of the simplest commands used in OpenSCAD, and, to create a complex 3D model, the lines of code will become even longer and more complex. Owing to the steep learning curve in understanding the usage of code, it is worth noting that OpenSCAD is unlikely to be usable by users who do not have a basic knowledge of coding.

2.3.3.2. Use of virtual reality (VR)

The concept of VR is employed in a wide array of technologies, and its definitions vary.[292] Sutherland[293] elucidated in his article that VR is:

> a system that can display information to all sense of the user with an equal or bigger resolution than the one that can be achieved in a natural way so that the user cannot say that the artificial world is not real.

Later on, Fuchs et al.[294] enhanced the definition by suggesting that VR is:

[290] de Mul (n 159) 96
[291] OpenSCAD User Manual/Print version <https://en.wikibooks.org/wiki/OpenSCAD_User_Manual/Print_version> accessed 29 January 2020
[292] Thomasz Mazuryk and Michael Gervautz, 'Virtual Reality: History, Applications, Technology and Future' (1999) <www.researchgate.net/publication/2617390_Virtual_Reality_-_History_Applications_Technology_and_Future> accessed 3 February 2020
[293] Ivan Sutherland, 'The Ultimate Display' (Proceedings of the IFIPS Congress, New York, 1965)

> real-time interactive graphics with three-dimensional models, combined with a display technology that gives the user the immersion in the model world and direct manipulation.

VR has been utilised in conjunction with CAD for the past decades, as it offers CAD users the sense of the presence and a chance to interact with a virtual object, which makes the design process in CAD more flexible and intuitive.[295] In addition to this, VR has been proved to be useful in the evaluation phase of the design process in which a design in the form of a virtual prototype is examined and manipulated. This is often referred to as 'virtual prototyping'.[296]

For 3D printing purposes, VR has been implemented in CAD, as mentioned above. For example, major producers of CAD programs, including Autodesk, Dassault Systèmes and PTC Creo, recently implemented VR on their respective platforms.[297] Meanwhile, Autodesk provides an online tutorial for its users, demonstrating how to design a 3D model with VR devices,[298] with numerous introductory and instructive videos on VR sculpting being uploaded onto YouTube.[299] An increase in the volume of such tutorials may imply that VR is being recognised, albeit experimentally, as an alternative and/or a complement to conventional CAD programs.

The possibility of employing VR for product customisation and personalisation has also been explored in industry.[300] VR has the great potential to serve as a visualisation tool that could enhance consumers' experience with product customisation and personalisation. As an example, a recent study demonstrated the virtual manipulation of footwear designs using VR devices, such as 3D gloves, in conjunction with augmented reality, referred to as a magic mirror system. In using this mechanism, a camera captures a customer's image and the virtual image is created as though they were wearing the customised shoes.[301] A noteworthy limitation here is that customers are not allowed to manipulate the design themselves with the VR devices, because the magic mirror system simply allows captures the customer's image and, through its own algorithm, customises the shoe.

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[294] Henry Fuchs and others, 'Research Directions in Virtual Environments' (NSF Invitational Workshop, University of North Carolina, USA, 23–24 March 1992)
[295] Covarrubias and Bordegoni (n 102)
[296] Antonio Jimeno and Alberto Puerta, 'State of the Art of the Virtual Reality Applied to Design and Manufacturing Processes' (2007) 33 International Journal of Advanced Manufacturing Technology 866
[297] Cabe Atwell, '3D Printing and VR: A New Spin on Design and Manufacturing' (*Machine Design*, 2017) <www.machinedesign.com/3d-printing-cad/article/21835488/3d-printing-and-vr-a-new-spin-on-design-and-manufacturing> accessed 3 February 2020
[298] Autodesk provides an online tutorial available for consumers. See 'Remix the Thingiverse in Virtual Reality' <www.instructables.com/id/Remix-the-Thingiverse-in-Virtual-Reality> accessed 3 February 2020
[299] For instance, see Make Anything, 'VR Sculpting to 3D Prints with Gravity Sketch (…and Printing Iron?)' (YouTube, 2016) <www.youtube.com/watch?v=E3Rpx-3eDCE> accessed 5 February 2020; Make, 'Sculpting in Virtual Reality with Oculus Medium and 3D printing it!' (YouTube, 2016) accessed 5 February 2020
[300] In business perspective, it is said that VR could potentially bring about a mass customisation revolution. See Michele Baker, 'How VR Will Bring about a Mass Customisation Revolution' (*TDMB*, 2018) <www.thedigitalmarketingbureau.com/virtual-reality/mass-customisation-vr> accessed 3 February 2020
[301] Antonio Jimeno-Morenilla, Jose Sanchez-Romero and Austino Sala-Perez, 'Augmented and Virtual Reality Techniques for Footwear' (2013) 64 Computers in Industry 1371

Another study proposed a platform for VR-based product customisation, in which customers were given the opportunity to customise the designs uploaded on to the web platform, with the aid of VR.[302] A web configurator allows customers to choose the degree of customisation of the design. With the lower degree of customisation selected, only a few options are available to them, whereas, with the higher degree of customisation, they can customise more aspects of the design. In the proposed method, customers do not create or modify the existing design with VR devices; instead, VR complementarily provides better visualisation and immersive experience to customers.

Whilst the aforementioned studies employed VR primarily as a complementary visual tool to better interact with customers, Arrighi and Mougenot proposed a CAD system for product customisation (or co-design, as they refer to it), which involves consumers more directly in the design process, upon the basis of mixed reality – a combination of VR and augmented reality.[303] The system allows customers to make direct modifications to a design template generated by a professional designer, by which they could have a higher level of immersion and control over the virtual model than the others mentioned above.

2.3.4. Use of CAD in commons-based design process: remixes

Remixing is a term initially established within the music industry denoting the act of repurposing existing materials to produce something new – i.e. a remix.[304] The culture of remixing has also emerged and proliferated in the 3D printing community, as with Thingiverse, with designs tagged as remixes amounting to a significant proportion of the design repository.[305]

Consumption of, and contribution to, remixes is generally made by consumers of the design process, who are often defined as 'lurkers', silent participants observing and benefiting from the community. However, it was found in a study that the producers of those parent designs, which are the base designs for remixes, were supposedly people with the ability of design thinking and a certain degree of proficiency in CAD.[306]

The patterns of remixes vary, including a basic form of remix such as merging two or more designs into a remix and a more complex form of remix like turning the existing design into a meta design,

[302] Yuan Lin and others, 'VR-Based Product Personalization Process for Smart Products' (27th International Conference on Flexible Automation and Intelligent Manufacturing, Modena, Italy, 27–30 June 2017)
[303] Pierre-Antoine Arrighi and Céline Mougenot, 'Towards User Empowerment in Product Design: A Mixed Reality Tool for Interactive Virtual Prototyping' (2019) 30 Journal of Intelligent Manufacturing 743
[304] Flath and others (n 151)
[305] ibid
[306] Ali Özkil, 'Collective Design in 3D Printing: A Large Scale Empirical Study of Designs, Designers and Evolution' (2017) 51 Design Studies 66

enabling users to customise the model. In the process, designs that are already remixed could also be the object of remixing, and a new remix based on the existing remixes could be created.[307]

The process in which a remix is created is not much different from the normal use of CAD programs explained above. The only difference is that the design process begins not from the outset but from the designs that already exist. Users are expected to use a solid modeller to import the existing design and then modify it with the toolsets provided in the CAD program of their choice.[308]

2.4. The Product Design Process and IP Law

The existing literature has discussed the relationships between product design processes and IP rights from various perspectives. The relevant literature was discussed in the introduction, in relation to two aspects: IP and product design processes and firms' IP rights management. It was then established that the literature on IP rights generation, ownership, and management in collaborative product development is quite limited, especially regarding consumer engagement in the 3D printing environment.[309]

Against this backdrop, this section aims to seek clarity on IP generation in product design processes. In the 3D printing environment, consumers will have increased opportunities to decide product designs they purchase by product customisation, personalisation and co-creation. In doing so, they make intellectual contributions, to a greater or lesser extent, to the determination of the final form of the product design. Such intellect is captured in various objects created throughout the product design process, such as a PDS, design drawings, models, prototypes and final design documents, which can lead to the generation of new IPs and associated IP rights.[310] This section identifies the types of intellect afforded in the product design process and analyses whether the resulting design materials can be recognised as a protected subject matter in IP law.

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[307] Flath and others (n 151)

[308] For non-professionals, there are some tutorials are available on YouTube. See, for example, The 3D Workshop, 'How to Remix a Part from Thingiverse – CAD Design for 3D Printing' (2017) <https://www.youtube.com/watch?v=Ep7QqOFdiRI> accessed 3 February 2020

[309] See the introduction and literature review. It is also notable that the importance of incorporating IP rights education into the product design & engineering curriculum has been increasingly emphasised to increase access to information on and to improve awareness of IP rights. In particular, it is suggested that detailed accounts of up-to-date information of the relevant regulatory frameworks will help achieve this goal. See Ruth Soetendorp, '"Food for Engineers": Intellectual Property Education for Innovators' (2004) 18 Industry and Higher Education 363; Tania Humphries-Smith and Angela Adrian, 'Intellectual Property Education – Thinking outside the Box Meets Colouring within the Lines' (2012) 9 International Journal of Learning and Intellectual Capital 337; Jacquelyn Burkell and others, *Enhancing Key Digital Literacy Skills: Information Privacy, Information Security, and Copyright/Intellectual Property* (Social Sciences and Humanities Research Council of Canada, 2015)

[310] Antorini and Muñiz (n 75)

2.4.1. Knowledge and creativity as intellect

The product design process is where an idea is generated, refined and represented, upon the basis of product designers' knowledge, which is acquired by the interpretation of various information obtained throughout the product design process.[311] According to Owen and Hovárth, the knowledge is neither information nor data, but it is 'the experience with information that is acquired by experiencing and learning' and it 'ultimately means putting the information into action'.[312]

Knowledge, in respect of the study of knowledge management, is classified into two major types: formal (explicit) knowledge and tacit (implicit) knowledge. Nonaka and Takeuchi[313] distinguished the two by highlighting their primary characteristics that explicit knowledge 'can be expressed in words and numbers and can be easily communicated and shared in the form of hard data, scientific formulae, codified procedures or universal principles', whilst that tacit knowledge is 'something not easily visible and expressible [that] is highly personal and hard to formalise'.

In the context of product design, formal or explicit knowledge might be embedded in, for example, product documents, product function and structure description, and these form an essential intellectual platform for product design processes. On the other hand, tacit or implicit knowledge relates to experiences, intuition, unarticulated models or implicit rules of thumb. Tacit knowledge is crucial in product design, in that it is the key to tackling a design problem, and thus, creating new value in a product.[314]

A product designer's creativity is also essential for the development of a new product. Creativity is a convoluted concept to define in a clear manner and, in fact, there exist numerous definitions of creativity that have been proposed in the design field over the past decades. Lately, Sarkar and Chakrabarti[315] have analysed these compartmentalised definitions and proposed a common definition of creativity, stating that 'creativity occurs through a process by which an agent uses its ability to generate ideas, solutions or products that are *novel* and *valuable*' (emphases added). To put it

[311] Senthil Chandrasegaran and others, 'The Evolution, Challenges, and Future of Knowledge Representation in Product Design Systems' (2013) 45 Computer-Aided Design 204

[312] Roderick Owen and Imre Horváth, 'Towards Product-Related Knowledge Asset Warehousing in Enterprises' [2002] Proceedings of the TMCE 2002 155, 156

[313] Ikujior Nonaka and Hirotaka Takeuchi, *The Knowledge-Creating Company: How Japanese Companies Create the Dynamics of Innovation* (OUP 1995)

[314] Chandrasegaran and others (n 311). To take a rudimentary example of knowledge use, one of the factors that should be thoroughly considered in 3D modelling relates to how to effectively design the inner part of the 3D model to make it stand by itself. If a figurine that has a big upper part and relatively small lower part is being made, it is likely that the weight of the upper part is heavier than the lower part, leading the figurine either to stand unstably or not be able to stand by itself owing to the heavy weight of the upper part. In such a case, owning the knowledge for effective 3D balancing, such as making changes to the density of the lower part of the figurine in this case, is imperative to create an intended object. See Asger Christiansen, Ryan Schmidt and J. Andreas Baerentzen, 'Automatic Balancing of 3D Models' (2015) 58 Computer-Aided Design 236

[315] Prabir Sarkar and Amaresh Chakrabarti, 'Studying Engineering Design Creativity: Developing a Common Definition and Associated Measures' (NSF International Workshop on Studying Design Creativity'08 – Design Science, Computer Science, Cognitive Science and Neuroscience Approaches: The State-of-the-Art, University of Provence, 10–11 March 2008)

differently, creativity is the ability to attain these two important goals – novelty and value – for successful product development.[316]

In the context of product design, novelty denotes something new that does not resemble something that was formerly known.[317] It appears that the term 'originality' is also used interchangeably to refer to the same thing. Product designers are often required to make significant efforts to overcome design fixation[318] to create a novel design.[319] In this sense, there are many kinds of values for a successful product but value, in the product design sense, can primarily take on the meaning of utility and aesthetics.[320] Functional value is generated by conceptualisation and, more importantly, by constant evaluation of the utility of a product.[321] As seen above, product designers constantly perform functional testing and evaluation with appropriate techniques, such as models or prototypes, to ensure that the conceptualised functional value is correctly incorporated in the product. Meanwhile, product designers produce a product design of aesthetic value by conducting design research and regular feedback from clients or end users. Although the appearance of the product itself (e.g. symmetry, complexity and contrast) is one of the most important standards, aesthetic value tends to be extremely subjective, and thus end users' perceptions, such as their personal tastes and interests, are highly relevant.[322]

The knowledge and creativity afforded in product design processes is the *intellect*, and the idea or solution to the design problem, and the particular way of dealing with it, is the result arising from such intellect, which makes the subject matter of protection in IP law.[323] However, it is necessary that these intangible matters be captured in a material way to be actually protected in accordance with the statutory requirement of registration or fixation.[324] In the following section, it will be further discussed where and in what way such intellectual production of product designers is captured in product design processes.

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[316] ibid
[317] ibid
[318] Design fixation is a situation where product designers become stuck or blinded when generating an idea. An example is that they carry over specific and unhelpful features from earlier designs they created to the design that is currently being generated and developed. See Nathan Crilly, 'Fixation and Creativity in Concept Development: The Attitudes and Practices of Expert Designers' (2015) 38 Design Studies 54
[319] ibid
[320] Bo Christensen and Linden Ball, 'Dimensions of Creative Evaluation: Distinct Design and Reasoning Strategies for Aesthetic, Functional and Originality Judgments' (2016) 45 Design Studies 116
[321] ibid
[322] ibid
[323] 'Intellect' is neither a statutory term nor the term consensually agreed in the legal field. It abstractly denotes character of some of the material intellectual property law aims to regulate and protect. See Lionel Bently and Brad Sherman, *Intellectual Property Law* (4th edn, OUP 2014) 1–2
[324] For example, UK registered design rights (RDA 1949, s 1(1)), patents (PA77, s 7) and trade marks (TMA 1994, s 2) require formal registration. And, for unregistered rights, fixation is a prerequisite for protection, such as literary, dramatic or musical copyright work (CDPA 1988, s 3(2)) and UK unregistered design rights (CDPA 1988, s 213(6)). By contrast, it is notable that some IP rights, such as trade secrets or unregistered UK trade marks, do not require any registration or fixation

2.4.2. Pinpointing the locations where IP is formed in the product design process

In the product design process, a great deal of information is collected, interpreted and organised into knowledge. Based on this knowledge, numerous creative ideas are generated, captured and materialised orally, verbally and/or graphically onto various forms of media, including a physical document, drawing, model, prototype and the digital counterparts.

In the problem identification stage, a PDS might be where IP could be generated, as all the relevant information required for the identification of design problem is captured into a PDS in the form of a document. The information in the PDS and a literary and/or artistic expression in presenting the information can be protectable matters, as long as they meet the legal requirements of the relevant IP rights.

From concept design to detail design stage, many materials can be created. To list the most relevant, there are various drawings – in the form of sketches or diagrams with or without verbal descriptions, for example – produced at concept design, design development and detail design stage. Various models for evaluation of concept designs, such as mock-ups and test rigs, as well as prototypes for evaluation of detail design, could also be produced. Where CAD is utilised, product designers would alternatively produce digital materials in varied forms, such as digital 2D drawings and 3D surface/solid models with less or more detail at different stages for different purposes. However, it is also possible that both physical and digital methods are adopted. Finally, a CAD file – a final description of the design – is created, which is essential in the 3D printing context, capturing all the functional and aesthetic values conceptualised and enhanced throughout the process.

The ideas (or solutions to the design problem) captured on the media produced at these stages could become IP once they meet the legal requirements of the relevant IP rights. It is worth noting that the ideas are of a developing nature; for example, they could be abstract as a conceptual solution at an earlier stage, but they will be enhanced, detailed and refined until product designers finally find the best solution to design problem and capture it on a CAD file. Such development of ideas will be continuously traced and possibly recorded on separate media, and the ideas at each development milestone could generate IP, independent from the existing ones. Meanwhile, the ways in which the ideas are expressed on these media are also relevant, as a particular way of expression adopted in capturing the ideas itself could engender IP separate from the ideas.

2.4.3. The CAD file at the centre of the thesis for legal discussion

Of the various media on which IP could potentially be generated, the most relevant medium that needs close examination is probably the CAD file. This is because the CAD file is the medium where the

final design solution, which consists of the most developed and detailed idea and expression, is captured. It is the final outcome that product designers will eventually aim to achieve in the product design process and is the valuable IP that they would like to hold and protect against unlawful reproduction.

Nonetheless, a CAD file is vulnerable to reproduction by its digital nature. In a heavily networked environment like the present world, with the development of computing technologies and Internet, a CAD file could be easily reproduced and disseminated over the Internet, such as through online platforms. The reproduced and disseminated CAD file is, then, likely to enable the manufacture of a physical object at a place and time chosen by individuals.[325] The physical production may take place in a private space in an inconspicuous manner, as there is no need for large facilities for mass production with 3D printing, by which unlawful reproduction of design becomes harder to detect.[326]

The CAD file is at the centre of legal issues for the reasons stated above. The point at which a CAD file is created is where product designers' intellect is captured, resulting in the potential generation of IP, and the points in which it is accessed and used are where IP protection becomes relevant. For that reason, the legal discussion in the thesis is structured and centred around the life cycle of a CAD file. In the following chapters, copyright and design-related issues will be identified and analysed with reference to CAD files, including their legal status, ownership and protection.

[325] However, the relative ease of manufacturing with 3D printing in contrast to traditional manufacturing does not imply that fabrication of a physical product does not require any knowledge or expertise. Depending on the users' knowledge and expertise, the quality of the manufactured product and the cost and time required for production could vary. This was discussed as one of barriers to domestic adoption of 3D printing in section 1.1.3. Limitations in the domestic adoptability of 3D printing

[326] Such issues have been globally identified in various legal studies. For instance, see, for EU perspectives, Ballardini, Norrgård and Partanen (n 53) and Mendis and others (n 16). For the UK, USA and Australia, see Mendis, Lemley and Rimmer (n 15)

Chapter 3

Legal Status of CAD Files and Online Platforms

Introduction

Chapter 3 discusses the legal status of CAD files in UK copyright and design laws. CAD files are an important medium where the final design solutions are captured, encompassing the outcomes that product designers aim to attain.[327] Establishing the legal status of CAD files is a prerequisite for the application of the law, such as of authorship and ownership and of infringement and exceptions, to the relevant scenarios.[328]

Meanwhile, the legal status of online platforms is also discussed in this chapter. Online platforms play significant roles; as third-party intermediaries, they facilitate consumers to access, create and use CAD files. In the 3D printing environment, the regulation of online platforms grows more important, in that such an act of facilitation by online platforms can potentially lead to widespread IP infringement.

The legal status of CAD files and online platforms are the cornerstone of legal analysis of 3D printing. The discussion in Chapter 3 is relevant to all the five scenarios and provides a legal basis for the subsequent discussions in Chapters 4, 5 and 6.

The remainder of this chapter first discusses whether CAD files are a protected subject matter in the copyright and design rights realm. In doing so, the first section examines the legal requirements of copyright and registered and unregistered design right protection. Following that, the legal status of CAD files is discussed in the following sections, with reference to copyright and UK registered and unregistered design law in turn. Finally, the last section discusses relevant IP issues of online platforms in the 3D printing environment.

3.1. Legal Requirements of Copyright and Design Rights Protection

This section identifies the legal requirements of copyright and design rights protection for CAD files. To briefly introduce, in the copyright sense, CAD files can be only protected if they are categorised within one of the subject matters laid out in UK copyright law[329] and they are original.[330] For the substantive requirements of UK registered design rights, designs must be novel and have individual character,[331] whereas they must be original in the sense that they are not commonplace in order to

[327] See section 2.4. The Product Design Process and IP Law
[328] The importance of legal clarity over the protection of CAD files was also highlighted in a recent EC report, in which a large number of the interviewees voiced that clarity over the law on the protection of CAD files would be crucially required. See Mendis and others (n 16) 23–24
[329] CPDA 1988, ss 3–8
[330] CDPA 1988, s 1(1)(a)
[331] RDA 1949, s 1B(1)

draw UK unregistered design rights protection.[332] In the following subsections, these will be elaborated in relation to CAD files.

3.1.1. Copyright law: subject matter and originality

In the UK, copyright can only subsist in eight different kinds of work: (a) literary works, (b) dramatic works, (c) musical works, (d) artistic works, (e) sound recordings, (f) films, (g) broadcasts and (h) published editions.[333] The list of subject matter is exhaustive, and thus the work must be classified as one of these categories as a prerequisite to be protected by copyright.

The most relevant categories in the discussion of CAD files are literary and artistic works.[334] A literary work is a work that is written, spoken or sung, encompassing, in particular, a computer program and a database.[335] Existing in the form of a computer file, CAD files can be closely related to computer program or a database.[336] The definition of a computer program is not provided in statute, but the Court of Justice of the European Union (CJEU) held that copyright protection lies in the expression of the computer code, such as source code or object code.[337] A database means a collection of independent works, data or other materials that are arranged in a systematic or methodical way, and are individually accessible by electronic or other means.[338]

Meanwhile, the copyright classification of CAD files could also fall within the scope of artistic works, as a 3D model stored in a CAD file is similar to digital images.[339] An artistic work means a graphic work, photograph, sculpture or collage,[340] a work of architecture (being a building or a model for a building[341]) or a work of artistic craftsmanship.[342] A work produced in a 2D form, such as a painting,

[332] CDPA 1988, s 213(4)
[333] CPDA 1988, ss 3–8. A work of any of the descriptions stated above in which copyright subsists is referred to as copyright work (CDPA 1988, s 1(2))
[334] These two categories have been the centre of legal discussion in most legal literature. This will be further elaborated in section 3.2. Copyright: Legal Status of CAD Files
[335] CDPA 1988, s 3(1)(b) and (d)
[336] See also, for similar views, Bradshaw and others (n 17); Kyle Dolinsky, 'CAD's Cradle: Untangling Copyrightability, Derivative Works, and Fair Use in 3D Printing' (2014) 71 Washington and Lee Law Council Law Review 591
[337] Case C-393/09 *Bezpečnostní softwarová asociace v Ministerstvo kultury* [2010] ECR I-13971, [28]–[42]. It is also notable that the definition of computer programs was extensively discussed by Mendis with reference to the EU Software Directive and the relevant EU and UK cases in the context of 3D printing. See Mendis, '"Clone Wars" Episode II' (n 20) 269–71
[338] CDPA 1988, s 3A(1)
[339] For example, see Lucas Osborn, 'Of PhDs, Pirates, and the Public: Three-Dimensional Printing Technology and the Arts' (2014) 1 Texas A&M Law Review 811; Elam (n 53); Malaquias (n 52)
[340] CDPA 1988, s 4(1)(a)
[341] CDPA 1998, s 4(1)(b)
[342] CDPA 1988, s 4(1)(c)

drawing or diagram, is within the definition of a graphic work,[343] whereas a sculpture and a work of artistic craftsmanship are subject matters for a 3D object.

In order for a literary and artistic work to be a copyright work, they must be original.[344] The meaning of originality is not given in the statute. However, there have been numerous cases concerning the concept of originality that establish the law of originality. A traditional test established by the courts in the UK is that (a) a work must be originated from the author in the sense that it was not created by slavishly copying others' work;[345] and (b) the author must expend labour, skill and/or judgement to create the work.[346] On the other hand, there is the EU test of originality, namely that the work is original if it is the author's own intellectual creation.[347] The concept was further developed in CJEU cases, in which it was held that the work must reflect the author's personality and express their free and creative choices.[348] As part of harmonisation, the UK was obliged to adopt the EU test of originality and the UK courts have been applying the EU test, whilst relying on traditional UK case law on originality to complement it.[349]

3.1.2. UK registered design rights: definition of a design and substantive requirements

In respect of UK registered design rights, a design is defined as:

> the appearance of the whole or a part of a product resulting from the features of, in particular, the lines, contours, colours, shape, texture or materials of the product or its ornamentation.[350]

In this context, a product means:

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[343] CDPA 1988, s 4(2)(a)

[344] CDPA 1988, s 1(1)(a). The concept of originality was briefly mentioned in Chapter 2, in respect of product designers' creativity in producing product design, as an alternative concept to novelty. In the legal sense, however, originality is clearly distinguished from novelty. Most of all, novelty is the substantive requirement of UK registered design rights, whereas originality is that of UK copyright and unregistered design rights. See section 2.4.1. Knowledge and creativity as intellect

[345] *Hyperion Records Ltd v Sawkins* [2005] EWCA Civ 565; [2005] 1 WLR 3281, [27]–[36]

[346] *Ladbroke (Football) Ltd v William Hill (Football) Ltd* [1964] 1 WLR 273 (House of Lords)

[347] The concept owes its origin to the Computer Programs Directive and Database Directive as part of harmonisation of copyright law across the EU Member States. See Council Directive 91/250/EEC of 14 May 1991 on the legal protection of computer programs [1991] OJ L122/111, art 1(3), and Directive 96/9/EC of the European Parliament and of the Council of 11 March 1996 on the legal protection of databases [1996] OJ L77/20, recital 16

[348] Case C-145/10 *Painer v Standard Verlags GmbH* [2012] ECDR 6, [87]–[92]

[349] There were debates as to the relationship between the long-standing UK test and the EU test. For instance, see *The Newspaper Licensing Agency Ltd v Meltwater Holding BV* [2011] EWCA 890 Civ; [2012] RPC 1 and *SAS Institute Inc v World Programming Ltd* [2013] EWCA Civ 1482; [2014] RPC 8. See also academic debates: Eleonora Rosati, 'Originality in a Work, or a Work of Originality: The Effects of the Infopaq Decision' (2011) 33 European Intellectual Property Review 746; Andreas Rahmatian, 'Originality in UK Copyright Law: The Old "Skill and Labour" Doctrine under Pressure' (2013) 44 International Review of Intellectual Property and Competition Law 4; Deming Liu, 'Of Originality: Originality in English Copyright Law: Past and Present' (2014) 36 European Intellectual Property Review 376

[350] RDA 1949, s 1(2)

> any industrial or handicraft item other than a computer program; and in particular, includes packaging, get-up, graphic symbols, typographic type-faces and parts intended to be assembled into a complex product.[351]

In the RDA 1949, no clear definition of an industrial and a handicraft item is given, but a number of non-exhaustive examples broadly encompass many different types of products, even including digital objects such as graphical user interfaces (GUIs).[352]

In relation to the construction of the wording 'industrial', there was a view that the design must be intended to be mass manufactured.[353] It is true that, historically, design rights protection in the UK was only provided for designs that were intended to be manufactured by industrial processes (e.g. using machines for mass production) to create more than 50 articles.[354] During the harmonisation process of design law across the EU, however, it was highlighted in the EC Green Paper on the legal protection of industrial design that such requirement is based upon the invalid notion that the number of copies manufactured would 'have any impact on the economic need for protecting the value that the designer and the producer have put into it'.[355] As a result, the amended RDA 1949, which is now harmonised with its EU counterpart, no longer requires that the design be reproduced by more than a certain number as such, and a design that is intended for the manufacture of products in limited numbers (or even a single product) qualifies as a design protectable within the RDA 1949. In the 3D printing context, it is worth clarifying this point because, in contrast with traditional manufacturing primarily intended for mass production, 3D printing is likely to be utilised to produce various customised products in small volumes.

A design must be of novel and of individual character in order for it to be protected as a registered design within the RDA 1949.[356] A design is new where there is no identical design or design whose features differ only in immaterial details which has been made available to the public before the relevant date.[357] Individual character relates to the overall impression that the design produces on the informed user. A design is deemed to be of individual character if the design's overall impression is

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[351] RDA 1949, s 1(3)
[352] For example, Microsoft successfully registered portions of a display screen with an animated image as a design. See Design No. 000217997-0002.
[353] Copyright Act 1911, s 22, and Design Rules 1920, r 89
[354] See ibid
[355] See Commission of the European Communities, *Green Paper on the Legal Protection of Industrial Design* (III/F/5131/91-EN) (European Commission, 1991), para 5.4.12.2 ('[n]ormally the number of products to which the design is applied is not relevant for the purpose of protection. However, this criterion has and played still does play an important role in the Common Law countries. It does not seem appropriate in a modern approach to this problem to make the industrial character of a design dependent upon its reproduction in, for instance, more than 50 articles. There is no valid reason for accepting that the fact that an article is produced in a very limited number of copies, or even in certain cases, in one copy only, (as might occur in the case of high-fashion dresses, jewellery, tombstones or crystal vases) should have any impact on the economic need for protecting the value that the designer and the producer have put into it')
[356] RDA 1949, s 1B(1)
[357] RDA 1949, s 1B(2)

different from that of any other designs that had been made available to the public before the relevant date.[358]

3.1.3. UK unregistered design rights: definition of design and subsistence requirements

A design within UK unregistered design law means the design of the shape or configuration of the whole or part of an article.[359] In contrast with registered design rights, UK unregistered design rights can subsist in an original design, rather than having to be novel and individual. Section 213(4) of the CDPA 1988 rather abstractly demarcates the meaning of originality, according to which a design is not original if it is commonplace in a qualifying country in the design field in question at the time of its creation. There is no further definition provided in the statute as to the meaning of originality and what is meant by commonplace. It was, therefore, the court's role to construe the scope of the requirements. The established case law interprets the provision as an added requirement to originality, and thus, in order for UK unregistered design rights to subsist in a design, the design must be both original and not commonplace.[360]

The concept of originality regarding UK unregistered design rights is fundamentally the same as that in copyright law. The UK's traditional approach, namely the test of labour, skill and judgement, has been applied to UK unregistered design cases.[361] However, a question has arisen in some recent cases[362] whether the test of originality for UK unregistered design rights should be modified to align with that for copyright, namely the harmonised EU test of originality. However, none of the courts to which the issue was referred clarified the issue, on the ground that it would not make any distinction in the respective cases whichever test is taken to assess originality. Thus, the law remains unclear.

As to the meaning of commonplace, no statutory definition is provided. The court in *C & H Engineering* held that the concept of commonplace is akin to novelty.[363] However, the requirement of commonplace is not exactly the same as that of novelty. Whilst the court must consider the whole of the design corpus in assessing novelty of registered designs, it only considers, in UK unregistered design cases, 'specifically pleaded prior art to determine what would be considered to be commonplace by notional designer in the design field'.[364]

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[358] RDA 1949, s 1B(3)
[359] CDPA 1988, s 213(2)
[360] *Ocular Sciences Ltd v Aspect Vision Care Ltd* [1997] RPC 289 (Chancery Division)
[361] *Farmer's Build Ltd v Carier Bulk Materials Handling Ltd* [2000] ECDR 42 (Court of Appeal); *Magmatic ltd v PMS International Ltd* [2013] EWHC 1925 (Pat); *DKH Retail Ltdv H Young Operations Ltd* [2014] EWHC 4034 (IPEC); [2016] ECDR 9
[362] For example, see *Whitby Specialist Vehicles v Yorkshire Specialist Vehicles* [2014] EWHC 4242 (Pat), [43]; *Action Storage Systems v G-Force Europe* [2016] EWHC 3151 (IPEC); [2017] FSR 18, [19]–[22]; *Shnuggle Ltd v Munchkin* [2019] EWHC 3149 (IPEC); [2020] FSR 22, [93]–[95]
[363] *C & H Engineering v F. Klucznik & Sons Ltd* [1992] FSR 421 (Chancery Division)
[364] *Shnuggle Ltd v Munchkin* [2019] EWHC 3149 (IPEC); [2020] FSR 22, [119]

3.2. Copyright: Legal Status of CAD Files

In the EU and UK copyright legislation, there is no explicit provision stating whether CAD files are a protected subject matter.[365] Thus, it is necessary that the law be interpreted by means of case law to clarify the copyright protectability of CAD files. Judicial decisions on this exact matter (whether CAD files are protected by copyright) are yet to be officially reported, but there are some cases dealing with similar entities to CAD files, such as computer programs and industrial drawings, that could help determine the legal nature of CAD files.

The position of CAD files in copyright law has been discussed quite broadly in the recent literature, mostly revisiting the previous decisions to find reasonable analogies between what is reviewed and CAD files. The general consensus from both the EU and the UK perspectives is that CAD files are some kind of a blueprint or instruction and that it is likely that they are protectable by copyright as long as they are original.[366] However, there is some controversy in relation to the UK copyright law, particularly relating to the category in which CAD files should be classified out of the pre-described eight subject matters. This is where much academic debate is focused.

3.2.1. Focused academic debate: is a CAD file a literary or artistic work?

There are two prominent views on the categorisation of CAD files. One view is to consider CAD files to be literary works, primarily focusing on their digital nature as well as their likeness to computer programs,[367] whilst the other view sees them as an artistic work in that CAD files look like industrial drawings.[368] It is crucial that CAD files are correctly categorised because this could actually make practical differences, in that some statutory provisions will apply to particular subject matters. For example, copyright exceptions, such as sections 50A, 50B and 50BA of the CDPA 1988, only apply in respect of computer programs.[369] If CAD files were treated as computer programs, these exceptions would apply, allowing users of the CAD files to do some acts that would otherwise be infringement.[370]

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[365] However, it is notable that the particular wording 'design document' is adopted and used in CDPA 1988 in respect of UK unregistered design rights

[366] This was affirmed in a recent EC report. See Mendis and others (n 16) 50–59

[367] To list a few, for example, see Bradshaw and others (n 17); Mendis, '"The Clone Wars": Episode 1' (n 15); Mendis, '"Clone Wars" Episode II' (n 15); Dolinsky (n 336)

[368] See Elam (n 53); Malaquias (n 52); Osborn (n 339)

[369] Furthermore, these exceptions are unable to be overridden by any contractual terms in accordance with CDPA 1988, s 296A.

[370] By these exceptions, making a back-up copy of a computer program will be allowed (s 50A). And observing, studying and testing computer programs to determine the ideas and principles underlying the program will be permitted (s 50BA). See also section 4.2. Scenario 1: Access to CAD files, where it is demonstrated that computer programs can only benefit from the principle of exhaustion

To enlarge upon the conflicting views more in detail, the view for literary work emphasises that CAD files are mainly formed of literary elements. It explains that, *inter alia*, CAD files should be deemed to be literary works since they are comprised of the program code to enable a 3D printer to perform their tasks.[371] One of the most important authorities that support this view is *Autospin (Oil Seals) Ltd v Beehive Spinning*,[372] in which the judge held that a data file in a computer that precisely defined the shape of a 3D article was a literary work, but without further explanation of what type of a literary work the data file was. For the purpose of the thesis, the view should be read carefully. As was discussed in Chapter 2, CAD files are distinguished from ready-to-manufacture files.[373] The latter are ones that incorporate G-code that dictates machine's performance, whereas the former does not. Hence, the view could be only valid where it is read in relation to a ready-to-manufacture file.[374]

Against the views above, some scholars make counterarguments; for example, Elam argued that CAD files are not computer programs in the sense that their essence lies in their drawing components rather than code components.[375] In the same vein, Malaquias emphasised that CAD files consist of 'visually significant' information that can be appreciated with the eyes.[376] Hence, they concluded that CAD files should be treated as artistic works.

A recent EC report provided an interesting view that consolidates the academic debate. By drawing an analogy with the legal protection of music and MP3 files,[377] it maintained that 3D models and CAD files can be protected as a separate subject matter.[378] According to the report, CAD files can be seen as computer programs, whereas the 3D models stored in the CAD files were deemed to be artistic works.[379]

However, it is questionable whether the strict categorisation of CAD files in only one of the subject matters is always required and justified even in cases where they obviously consist of both literary and artistic elements.[380] For example, some types of CAD software, such as OpenSCAD, purely

[371] For example, see Bradshaw and others (n 17); Mendis, '"The Clone Wars": Episode 1' (n 15)
[372] *Autospin (Oil Seals) Ltd v Beehive Spinning (A Firm)* [1995] RPC 683 (Chancery Division) at 698 ('It is possible to define any shape in words and letters. Therefore a design in a drawing can be defined equally accurately in non-graphic notation. In fact many three dimensional articles are now designed on computers. A literary work consisting of computer code therefore represents the three dimensional article')
[373] See section 2.3.1. Ontology of CAD, CAD programs and CAD files
[374] It is notable that a recent EC report also notes the difference between CAD files and ready-to-manufacture files and analyse their legal status separately. See Mendis and others (n 16) 50–59
[375] Elam (n 53) (She suggested that a designer of a CAD file does not normally write a code to dictate how a 3D printer works but creates a 3D model. A CAD file should be, thus, treated as the medium in which a copyright-protected work, such as an artistic work, is recorded)
[376] Malaquias (n 52)
[377] Music and MP3 files draw separate copyright protection. Music can be protected as a musical work, whereas MP3 files, as vessels for the music, can be protected as sound recordings within the meaning of the CDPA 1988, s 5A(1). See Bently and Sherman (n 323) 87
[378] Mendis and others (n 15) 50
[379] ibid., 50–55
[380] It is also notable that the UK's strict approach in classifying types of copyright work might be incompatible with the most recent development of EU law confirmed in *Cofemel v G-Star Raw*. See Simon Clark and Sara

utilise computer language to create CAD files.[381] In this case, the input is strictly literary, but what this literary input tries to eventually achieve is to define the appearance of a physical object, which is in nature artistic. Another example that challenges strict categorisation of CAD files is the case where CAD files are made up of a customisable 3D model (meta model).[382] CAD files (especially when configurable parameters are added) created by OpenSCAD software obviously consist of two elements, which are artistic elements (visual manifestation of the 3D model), as well as literary elements (computer language used to define the 3D model and customiser of the 3D model).

A similar situation was dealt with in a recent decision in which the court implicitly suggested that an instruction can be both a literary and an artistic work, not necessarily one excluding another.[383] In *Abraham Moon & Sons Ltd v Thornber*,[384] the claimant brought an action for copyright infringement of the design of a woollen plaid fabric called Skye Sage. The claimant argued, *inter alia*, that the defendants had copied their design and indirectly infringed the ticket stamp they had created. The ticket stamp was an instruction that recorded how to set up the machines to produce a fabric design and was created with language and some figures. In respect of the category of the ticket stamp, the court first held that it was an original literary work.[385] But, at the same time, the court emphasised that the ticket was also an artistic work on the grounds that it had 'real visual significance' that had arisen through the affordance of sufficient artistic skill by a designer to record the visual appearance.[386]

It is clear that CAD files can be of a combination of literary and artistic nature, as seen above, and in such cases their nature resembles multimedia entity. Christie defines a multimedia entity as:

> a collection of copyright and/or non-copyright materials that are textual, aural and/or visual in nature, and which are accessible in a non-linear way by the use of a computer program.[387]

As with films and videogames, where various copyright subject matters interactively coexist, forming a greater subject matter, CAD files also consist of various information or data expressed in literary and artistic forms.

In an environment where the increasing cross-breeding of types of works occurs along with rapid technological development, finding the right category of non-traditional works, including CAD files,

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Sefton, 'Cofemel v G-Star Raw (C-683/17) and Its Effect on UK Copyright Law before and after Brexit' (2020) 42 European Intellectual Property Review 141

[381] OpenSCAD <http://www.openscad.org/about.html> accessed 10 July 2020. See also section 2.3.3.1. Meta design

[382] ibid

[383] See Dinusha Mendis, '"Back to the Future"? From Engravings to 3D Printing' in Mendis, Lemley and Rimmer (n 15)

[384] *Abraham Moon & Sons Ltd v Thornber* [2012] EWPCC 37

[385] ibid., [90]

[386] ibid., [107]. For a different perspective, see also Mendis (n 66)

[387] Andrew Christie, 'A Proposal for Simplifying United Kingdom Copyright Law' (2001) European Intellectual Property Review 26

will be constantly challenging.[388] This problem has been already identified and debated for many years, in relation to other types of non-traditional works.[389] The existing research, including the most recent EC report,[390] has shown that defining a subject matter is a major difficulty in discussing 3D printing.[391] The difficulty will continue to arise when new types of CAD files and 3D printing file formats emerge, and such development is highly likely to happen considering the rapid development of 3D printing and the related technologies in recent years.[392] Therefore, more debates will be needed to find more flexible ways to accommodate non-traditional works.[393]

3.2.2. Originality of a CAD file as a derivative work

In order for CAD files to be protected by copyright, they must be original. In other words, CAD files must be the author's own intellectual creation that reflects their personality and expresses their free and creative choices.[394] In determining the originality of CAD files, it is important to note that they are of a derivate nature. CAD files are not merely the outcome of 3D modelling on CAD programs but are created, based upon other related design materials, such as physical concept drawings or models that are produced at the concept design and design development stages in product design processes.[395] This implies that CAD files are likely to originate from the existing works, and, therefore, the originality of CAD files will only arise where the processes of reproduction and of adding or changing something to the existing works express the author's own intellectual creation.[396]

This section discusses the originality of CAD files from the perspective of derivation. For this purpose, it first examines the legal status of the related design materials produced in the product design processes, such as PDS and physical drawings, models and prototypes. The benefits of this analysis

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[388] ibid., 40 (Christie argues that for that reason categorisation may be no longer useful or neccessary)
[389] See Yin Harn Lee, 'Play Again? Revising the Case for Copyright Protection of Gameplay in Videogames' (2012) 34 European Intellectual Property Review 865; Jason Haynes, 'Subject Matter of Copyright Protection in the UK: A Road Map to Effectuating Statutory Reform' (2013) 39 Commonwealth Law Bulletin 319; Neil Yap, 'The Proof Is in the Plating: Copyright Protection of Culinary Arts and Reform for the Categories of Authorial Works' (2017) 39 European Intellectual Property Review 226, and Enrico Bonadio and Nicola Lucchi, 'How Far Can Copyright Be Stretched? Framing the Debate on Whether New and Different Forms of Creativity Can Be Protected' (2019) 2 Intellectual Property Quarterly 115
[390] Mendis and others (n 16)
[391] ibid., 179
[392] A legal analysis of 3D printing based on the existing technologies, such as parametric CAD programs and STL file format, can be quickly outdated, as there is already ongoing development of new CAD programs and 3D printing file formats that are more suitable for 3D printing. For discussion of recent technological developments, see section 1.1. Technological Developments and Capabilities of Domestic 3D Printing, and section 2.3.1. Ontology of CAD, CAD programs and CAD files
[393] As one way of achieving this purpose, see, for example, James Griffin, '3D Printing: A Sui Generis Right for the Convergent Technology' (2019) 1 Intellectual Property Quarterly 25
[394] See, for discussion of law of originality, section 3.1.1. Copyright law: subject matter and originality
[395] Refer back to section 2.1. What Is Product Design?
[396] See Gillian Davies, Nicholas Caddick and Gwilym Harbottle (eds), *Copinger and Skone James on Copyright* (16th edn, Sweet & Maxwell 2016) (hereinafter, *Copinger*), paras 3-235–3-258

are that it helps identify where copyright protection can initially arise in the product design process[397] and clarify the types of inputs afforded in the subsequent creation of other design materials, which can be used to assess the originality of CAD files.

3.2.2.1. Legal status of the related design materials in copyright law

The primary purpose of a PDS is to set out design problems and the relevant limitations imposed upon product designers in solving design problems. In the copyright sense, it appears that there is no UK case law relating to the legal status of a PDS. But it seems apparent that a PDS might be classified as a literary work, owing to its being a document consisting of the above information expressed in a verbal manner.[398] At the same time, the information that is gathered, analysed and organised to produce the PDS could be a valuable and confidential asset that could possibly be protected as a trade secret, especially where information that cannot be readily acquired from inspection, such as the detailed dimensions, tolerances and manufacturing information, is recorded in the PDS.[399] Notwithstanding that a PDS is vital document that product designers should always refer to, as well as a protectable matter, potentially, by copyright or as a trade secret, it should be noted that it is not a design solution that generates an aesthetic and functional value.

A physical drawing is one of the most common materials product designers produce for design conceptualisation and development. Physical drawings, including both concept and detail drawings, have been classified as original artistic works in a number of cases. For example, dating back to the 1970s, working drawings of the elastomeric member, consisting of three concentric circles, were deemed artistic works within the meaning of section 3 of the Copyright Act 1956 in *Solar Thomson Engineering v Barton*.[400] Likewise, a concept drawing consisting of three sketches depicting a profile of an extrude frame was also held to be an original artistic work in *Ultra Marketing v Universal Components*.[401] Recently, in *Islestarr Holdings v Aldi Stores*, the court held that the claimant's designs relating to the lids of and powders in the makeup palettes were fixed when the initial concept

[397] For example, a factual evidence of the designer having created the initial concept drawing was submitted in a copyright dispute to support that the first ownership of right in the powder designs in a palette was established at the time it was conceptually created and fixed on paper. See *Islestarr Holdings Ltd v Aldi Stores Ltd* [2019] EWHC 1473 (Ch), [51]–[59]

[398] However, it could be debatable whether a PDS is an original literary work, as there is not much creative freedom to render it as an author's own intellectual creation. See section 3.1.1. Copyright law: subject matter and originality. Also see section 2.1. What Is Product Design?

[399] See, for example, *Force India Formula One Team Limited v 1 Malaysia Racing Team SDN BHD* [2012] EWHC 616 (Ch), [268] (the court held that CAD files, including precise dimensions of parts of a racing car, are confidential information akin to a trade secret, and using the CAD files in breach of contractual obligations leads to breach of confidence). See also Mendis and others (n 16), section 2.9. Protecting the 3D Printing Process through Trade Secrets

[400] *Solar Thomson Engineering Co. Ltd v Barton* [1977] RPC 537 (Court of Appeal)

[401] *Ultra Marketing (UK) Limited v Universal Components Limited* [2004] EWHC 468 (Ch), [51]

drawing was created by the claimant's employee in the course of their employment.[402] In the meantime, physical detail drawings have also been deemed to be original artistic works, such as detail drawings for replacement exhaust pipes[403] and for toy bricks.[404]

In the course of design development, it is likely that a new and revised drawing is produced, based on the existing concept drawings created at an earlier phase. As emphasised in Chapter 2, the product design process is so iterative that this reiteration of design drawings can continue many times until product designers produce a final detail drawing, whether that be in a physical or digital form.[405] In effect, similar to creation process of the related design materials, CAD files, as a final description of a design, are also highly likely derived from the earlier works that are protectable by copyright in their own right.

By contrast, models and prototypes are generally used as proof of concept. In effect, they are physical objects that reproduce designs sketched in concept design or detail design drawings in a 3D form. In that sense, examining legal treatment of these objects in copyright law could be useful for understanding the legal status of 3D-printed objects.[406]

There have been a number of cases concerning the protectability of models and prototypes as a work of artistic craftsmanship or a sculpture. Dating back to the 1970s, it was held in *Hensher*[407] that the prototype (or a mock-up) of a suite of furniture was not a work of artistic craftsmanship. The underlying rationales for the decision varied; for example, it had no value, being intended to be used as a step in a commercial operation;[408] it was not artistic;[409] it was not seen as one in perspective of artist-craftsmen;[410] and the craftsman did not intend to produce a thing of beauty for its own existence.[411]

In *Brigid Foley*, the claimant submitted that their prototype knitwear garment had been copied by the defendant and, therefore, the artistic copyright in the work had been infringed. The issue the court had to rule on here was whether prototype knitwear garment was a work of artistic craftsmanship.

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[402] *Islestarr Holdings Ltd v Aldi Stores Ltd* [2019] EWHC 1473 (Ch), [75]
[403] *British Leyland Motor Corporation Ltd v Armstrong Patents Co. Ltd* [1986] 2 WLR 400; [1986] AC 577 (House of Lords)
[404] *Interlego A.G. v Tyco Industries Inc* [1988] 3 WLR 678; [1989] AC 217 (Privy Council)
[405] See section 2.1.1. Overview of the Product Design Process
[406] In the thesis, the legal status of 3D-printed objects will not be discussed in detail in a separate subsection, as the thesis's main focus is on CAD files. But it will be still relevant where application of the design-related exception to CAD files, set out in CDPA 1988, s 51, is discussed. See section 6.3.1. Copyright implications of Scenario 4, where the relevant statutory provisions and case law are discussed for the legal status of 3D objects protected as an artistic work
[407] *George Hensher Ltd v Restawile Upholstery (Lancs.) Ltd* [1974] 2 WLR 700; [1976] AC 64 (House of Lords)
[408] ibid, 77 (Lord Reid)
[409] ibid, 82 Lord Morris of Borth-y-Gest), 87 (Viscount Dilhorne)
[410] ibid, 95 (Lord Simon of Glaisdale)
[411] ibid, 97 (Lord Kilbrandon)

Nonetheless, the court decided not to rule on the matter as there was no need to do so, due to unsatisfactory evidence having been provided by the claimant.[412]

Meanwhile, there were cases where the claimant(s) attempted to protect their prototypes as sculptures. In *J&S Davis v Wright Health*, it was held that the models and casts produced for a dental impression tray were not sculptures, as it was no more than steps in the product of the prototype or the manufacture of the tooling from which the claimant's production was secured.[413] In the *Metix* case, a manufacturing mould was held not to be a sculpture on a different ground, namely that it was not a work made by an artist's hand.[414]

In effect, models and prototypes were generally not seen as a copyright work in a number of reported cases. However, it is notable that, more recently, a prototype fabric for use in a bedlinen was held to be an original artistic work in *Ashley Wilde v BCPL*.[415] But the court did not further discuss the issue, as the defendant did not dispute the subsistence of copyright in the prototype fabric.

3.2.2.2. Originality of a CAD file: derivation

The core issue of derivation is that some form of reproduction is involved in creating a new work, and the ways in which the reproduction is made in respect of the new work will significantly matter in determining its originality.[416] The issue of derivation would be less of a concern if the creation of CAD files were carried out by the same person. This is because there would be no reproduction of others' work involved, as the existing works that were reproduced to create CAD files would all originate from the same person. However, it might be more common that multiple people are involved at different stages of the design process, and there is the possibility that the person who creates CAD files can be different from the ones who have created, for instance, concept drawings.[417] In this case, the issue of derivation becomes more significant, in terms of not only subsistence of copyright but also copyright ownership.

It was established earlier that copyright could arise at earlier stages of the design process, including in initial concept drawings, other working drawings or detail drawings. Then, the question here is whether CAD files created after the successive revision of the existing works could be original copyright works in which a new copyright subsists. To apply the law of originality, the CAD files can

[412] *Brigid Foley Limited v Ellott* [1982] RPC 433 (Chancery Division). For an analysis of this case, see also Mendis (n 66)
[413] *J & S Davis (Holdings) Limited v Wright Health Group Limited* [1988] RPC 403 (Chancery Division), 410
[414] *Metix (UK) Limited v G.H. Maughan (Plastics) Limited* [1997] FSR 718 (Patents Court)
[415] *Ashley Wilde Group Limited v BCPL Limited* [2019] EWHC 3166 (IPEC)
[416] Similar issues of derivation have been discussed. See, for example, Dolinsky (n 336) 658; Antikainen and Jongsma (n 53)
[417] The product design process can be carried out by a number of product designers who have expertise in different aspects of product design. See Rodgers and Milton (n 12) and Milton and Rodgers (n 13)

be deemed original if they are the author's own intellectual creation, which means in this context that the revision must involve making creative choices, reflecting the author's personality.

On the one hand, CAD files created based on the related design materials could be deemed unoriginal. This is because the draughtsperson would have almost little to no creative freedom in creating them, considering that choices made in the process of detailing and redrawing a concept design are most likely technical rather than creative in nature.[418] On the other hand, it is also possible to consider them original if any alteration made by the draughtsperson can be seen construed as being derived from the draughtsperson's creative choices.[419] For instance, where the existing material to which CAD files are created with reference is a physical orthographic concept drawing of the design, redrawing the design into a 3D solid model could amount to significant visual alteration to make the totality of the design look fairly different from the existing copied work. However, where the existing work referred to is already a solid CAD model and the detailing made in creating the CAD file involves minor visual alteration, such as changing dimensions, the CAD file is unlikely to be original.

3.3. UK Registered Design Rights: Legal Status of CAD Files

A 3D virtual model in a CAD file is a faithful depiction of a physical object that is normally intended to be manufactured. The model consists of lines, shapes, textures and/or colours, with which it forms the appearance of a whole or a part of a physical object. Traditionally, physical technical drawings have been used for administrative purposes in design registration and factual evidence in dispute, rather than a protectable subject matter in itself.[420] Technical drawings have been long used to represent a design for registration purposes,[421] and, for example, images of a 3D virtual model created on CAD program were also used in practice as a design representation.[422] Meanwhile, they also serve as factual evidence in court to establish the relevant date of disclosure where there is dispute regarding validity of the design.[423]

A focal point to consider in this section is about the legal status of CAD files, which are a vessel storing the 3D virtual model. The question is of paramount importance for how design activities

[418] For this view, see Thomas Margoni, 'CC-PlusDesign.eu-Or How to Apply Creative Commons Licences to 3D Printed Products in the Light of the Most Recent Developments of the European Court of Justice Case Law' in Bibi van den Berg and others (n 15); Antikainen and Jongsma (n 53)
[419] UK case law on this matter notes that a derivative work can be original if 'some element of material alteration or embellishment which suffices to make the totality of the work an original work'. See *Interlego AG v Tyco Industries Inc* (n 404), 263. On the other hand, it was argued in a recent EC report that originality of CAD files can arise in the complexities and choices that a draughtsman makes in creation of CAD files. See Mendis and others (n 16) 54
[420] The traditional role of technical drawings, including CAD files, is also highlighted in Mendis and others (n 21) 63
[421] *Sealed Air Limited v Sharp Interpack Limited* [2013] EWPCC 23, [20]
[422] See, for example, *PMS International Group Plc v Magmatic Limited* [2016] UKSC 12, where images of a 3D CAD model in monochrome were used for registration of a design of children's suitcase
[423] *Magmatic Ltd v PMS International Ltd* [2013] EWHC 1925 (Pat); [2013] ECC 29, [5]–[7]

relating to CAD files, including their reproduction, modification and/or distribution, are regulated. The answer could make a significant impact upon design rights protection and enforcement.[424] For example, some of the relevant queries are whether reproduction and distribution of CAD files storing a protected design is permissible, and whether making CAD files by way of reverse engineering of a physical object whose design is protected is permissible within the ambit of the RDA 1949.

In the RDA 1949, there is no direct mentioning of CAD files. Nor is any wording or concept wide enough to include CAD files, such as the wording like 'a design document'[425] in UK unregistered design law. Thus, it appears that design activities arising with CAD files are not regulated within the RDA 1949, unless some concepts are interpreted broadly enough to include them. Some argue that CAD files fall within the definition of 'a product'. The underpinnings of this are that CAD files could be construed as 'a graphic symbol' by making an analogy with digital objects like computer icons or GUIs being included within the definition of a product as graphic symbols.[426] The practicality of this construction is that design activities occurring in connection with CAD files could be regulated with the existing provisions in the RDA 1949; for example, the reproduction and distribution of CAD files could constitute design rights infringement, as it is possible that these activities are interpreted as amounting to the making of a product or putting on the market of a product, which is prohibited by virtue of section 7(2)(a) of the RDA 1949.

However, this argument might be prone to criticism. One reason is that the interpretation of the meaning of 'a graphic symbol' might be far too overstretched. A graphic symbol would normally be a part of a product that appears on the computer screen, such as logos appearing on the monitor when the computer is switched on or interactive layouts appearing on the panel attached to a machine like a printer.[427] In practice, a graphic symbol is not treated as a product itself; for example, moving images that Microsoft successfully registered as a design are presented as 'portions of a display screen with an animated image' rather than 'an animated image' alone.[428]

In this regard, *Apple Computer v Design Registry*[429] provides some guidance. It was an appeal that Apple Computer had made against the Comptroller General's decision that it objected to Apple's design registration application of computer icons, described as 'a set of user interfaces for computer display'. Jacob J ruled in the decision that such computer icons are not themselves 'an article' but

[424] Malaquias (n 52)
[425] See CDPA 1988, ss 226(b) and 263(1)
[426] Thomas Margoni, 'Not for Designers: On the Inadequacies of EU Design Law and How to Fix It' (2013) 4 Journal of Intellectual Property, Information Technology and E-Commerce Law 225. For other reasons to support this view, see Nordberg and Schovsbo (n 53). See also Mendis and others (n 16) 63
[427] See *Apple Computer Incorporated v Design Registry* [2002] ECDR 19 (Chancery Division)
[428] See Design No. 000217997-0002. In that sense, the wording of section 1(3) of the RDA 1949 defining a graphic symbol as a product are somewhat anomalous, as Russell-Clarke and Howe highlighted. See Martin Howe, James St. Ville and Ashton Chantrielle, *Russell-Clarke and Howe on Industrial Designs* (9th edn, Sweet & Maxwell 2016)
[429] *Apple Computer Incorporated v Design Registry* (n 441)

instead that the computer screen on which the icons appear is an article. He went on to say that the registration of computer icons should be allowable because the icons that appeared on the screen 'form part of the machine which the public buy and discover once they get the machine home and switch it on'.[430]

Therefore, the proposition that CAD files can be construed as a graphic symbol and thus a product is hard to follow.[431] Indeed, CAD files might be even unable to be categorised as a graphic symbol because a 3D virtual model stored in them is merely the replica of what an actual physical product would look like, and it is not intended to be seen on a computer screen or a panel in conjunction with a physical product while forming part of it.[432] Furthermore, it is also worth noting that section 1(3) of the RDA 1949 expressly excludes a computer program from the definition of a product.[433] As was discussed regarding the legal status of CAD files earlier, some types of CAD files can be potentially deemed to be a computer program, in which case CAD files will be obviously outside the scope of the definition of a product.

3.4. UK Unregistered Design Rights: Legal Status of CAD Files

In respect of UK unregistered design rights, a design means 'the design of the shape or configuration (whether internal or external) of the whole or part of an article'.[434] As the wording 'shape or configuration' suggests, the meaning of a design only encompasses 3D aspects of an article. It is distinguishable from the scope of registered design protection embracing 2D aspects of a product such as surface patterns and ornamentations.[435]

The scope of 'an article' is not straightforward since the meaning of it is not defined in the CDPA 1988. It seems that it would encompass most 3D objects including most consumer products, as well as artistic works such as sculptures or a work of artistic craftsmanship, which are generally protected under copyright law.[436]

To apply the law, it seems clear that product designs carried in CAD files can be within the definition of a design laid out in UK unregistered design law.[437] However, as was already noted above with UK

[430] ibid., [2]–[6] (the representative for Apple contended that the description the company had initially used was inappropriate for registration, instead of which he said that 'a computer with an operating system which displays the icons concerned' would have been more appropriate). Likewise, the moving images that Microsoft successfully registered as a design were described as 'portions of a display screen with an animated image'
[431] Elam (n 53)
[432] See *Apple Computer Incorporated v Design Registry* (n 427)
[433] Mendis and others (n 16) 62–63 (however, it is pointed out that the results of running a computer program do not fall within the definition of a computer program)
[434] CDPA 1988, s 213(2)
[435] RDA 1949, s 1(2)
[436] The wording of section 51 of the CDPA 1988 implies that an article could be an artistic work or a typeface
[437] Malaquias (n 52)

registered design rights, the essential nature of CAD files is a digital record of the designs in the form of a computer file, rather than designs themselves.

What is notable in relation to UK unregistered design rights is that there is a legal concept, called a design document, that could embrace CAD files. In the following subsections, the legal status of CAD files as design documents will be further elaborated.

3.4.1. Protectability of a CAD file as a design document

The unique concept introduced in UK unregistered design law is a design document. A design document is defined in section 263 of the CDPA 1988 as 'any record of a design, whether in the form of a drawing, a written description, a photograph, data stored in a computer or otherwise'. The wording 'design document' appears in a number of places across the CDPA 1988; for example, in section 51 of the CDPA 1988, a design document is mentioned in the context of exceptions to copyright infringement, and sections 213(6) (design rights subsistence) and 226(1) (design rights infringement) to list a few most relevant. A design being recorded in a design document is one of requirements that enable a design right to subsist in the design.[438] And making a design document could constitute primary infringement of design right if it is done for the purpose of enabling the making of articles to that design.[439]

CAD files are, in essence, a computer file recording a faithful representation of the shape of a physical object. Thus, it might be argued that CAD files fall within the definition of a design document.[440] However, there might be exceptional cases where CAD files are unable to be treated as a design document. One that might be outside the scope of this definition would be CAD files that record something that does not qualify as a design at all. For example, CAD files merely incorporating a design of 2D objects such as images or logos will not be treated as a design document, as the meaning of design in UK unregistered design rights only includes 3D shapes as noted above. More complicated is where CAD files are formed of objects qualifying as both a design (i.e. shape or configuration) and non-design (i.e. logos or images). The treatment of such CAD files will be discussed below in conjunction with the case law.

Before analysing the issue, it is worth noting that there is a disparity between the construction of the definition of a design between sections 51(3) and 213(2), and this could cause inconsistency in the scope of a design document.

Section 51(3) reads:

[438] CDPA 1988, s 213(6)
[439] CDPA 1988, s 226(1)(b)
[440] Mendis, '"The Clone Wars": Episode 1' (n 15); Malaquias (n 52)

> In this section –
>
> 'design' means the design of the shape or configuration (whether internal or external) of the whole or part of an article, *other than surface decoration*; … [emphasis added][441]

In contrast, section 213(2) reads:

> In this Part 'design' means the design of the shape or configuration (whether internal or external) of the whole or part of an article.[442]

With strict semantic interpretation, the definition of a design document is narrower in section 51(3) than in section 213(2) since surface decoration is expressly excluded. Then, the question arises whether a record of design incorporating both the shape (or configuration) and surface decoration should not be treated as a design document, or whether only the part in which the shape is depicted should be separately deemed to be a design document.

With regard to this, the High Court in *Lambretta v Teddy*[443] held that notionally dividing a record of design into parts, such as one that is treated as a design and the other as surface decoration, is not correct in that such interpretation would not have been intended by Parliament. Furthermore, this argument was enhanced in *Abraham v Thornber*,[444] where HHJ Birss QC held that the definition of a design in sections 51 and 213 of the CDPA 1988 is meant to mean the same thing as it would be bizarre if 'Parliament used the same expression in two related contexts with an intention that they mean different things'.

The above cases make it clear that the record of objects, whether it be the record of a design with or without non-design aspects such as surface decoration, should be treated as a design document as a whole. Hence, unless CAD files are for an object that is entirely outside the scope of the definition of a design, such as 2D logos or pictures, it appears that CAD files for most 3D objects are likely to be treated as design documents.

3.4.2. Protectability of a CAD file incorporating a design unable to be protected by UK unregistered design rights

From the discussions above, it was established that, except for the ones that only incorporate an object that is outside the definition of a design, CAD files could normally fall within the definition of a design document. This, then, raises the question of whether a design document incorporating a design that is unable to be protected by UK unregistered design rights is still able to be treated as a design document per se, owing to the lack of substantive requirement for design protection (i.e. the

[441] CDPA 1988, s 51(3)
[442] CDPA 1988, s 213(2)
[443] *Lambretta Clothing Co Ltd v Teddy Smith (UK) Ltd* [2003] EWHC 1204 (Ch); [2003] RPC 41, [74]
[444] *Abraham Moon & Sons Ltd v Thornber* [2012] EWPCC 37, [112]

requirement of originality and commonplaceness) or subsistence exceptions (i.e. the must-fit or the must-match exception).

To briefly look back the definition of a design document, section 263 of the CDPA 1988 states that a design document is 'any record of a design'. The wording here does not require that the design be original. Nor does it require that the design be the one to which the subsistence exceptions apply, so that UK unregistered design right can subsist in the design. Thus, the semantic analysis of the wordings of the provision provides no justification that the design in the design document should be the one in which UK unregistered design rights can subsist.

3.4.3. Protectability of algorithms to generate CAD files by UK unregistered design rights

Some rules, processes and operations could play an important role in creating a design and a physical object in the 3D printing context. To provide some relevant examples, a set of design rules, often referred to as DfAM (Design for Additive Manufacturing), enable the precise and economical design process of 3D printing.[445] Finding and setting optimal parameters in fabricating physical objects is also salient, as it could affect both the aesthetic and functional qualities of the manufactured physical objects. An algorithm and/or software is sometimes developed by a designer to enable the creation of extremely complex designs that cannot be manually devised with conventional CAD software. This is crucial knowledge and experience-based input in designing and fabricating an object.

Having said that, it is likely that design rules and algorithms are outside the protection of UK unregistered design rights since they are deemed to be a method or principle of construction. UK unregistered design rights do not subsist in a method or principle of construction,[446] by which it means 'a process or operation by which a shape is produced as opposed to the shape itself'.[447] However, it is worth noting that the alternative protection might be provided for these in either patent law or copyright law (especially with software) if these meet the legal requirements.

3.5. Legal Status of 3D Printing Online Platforms

Online platforms are emerging as one of key players in the 3D printing environment. 3D printing online platforms, being positioned at the centre of diverse actors including product manufacturers, designers and consumers, enable their users to have enhanced access to supply and demand for goods and services related to 3D printing.

[445] Gibson, Rosen and Stucker (n 6)
[446] CDPA 1988, s 213(3)(a)
[447] *Kestos Ltd v Kempat Ltd* (1936) 53 RPC 139, 151

This section discusses the legal status of online platforms, with an emphasis upon how 3D printing online platforms are defined and positioned in the regulatory framework. It should be noted that this section does not aim to provide a full analysis of legislation and case law. Rather, it surveys the legal landscape of online platforms, mapping the relevant topics raised in this section onto other chapters for further legal analysis.

3.5.1. Seeking definitional clarity on 3D printing online platforms

Defining online platforms is challenging. This is because online platforms often have hybrid business models and their form can greatly differ, based on how value is created, delivered and captured.[448] As for the value creation dimension, for example, key activity (i.e. data services, community building or content creation) and price discovery (i.e. fixed prices, set by sellers, set by buyers, auction or negotiation) can affect their classification. In the value delivery dimension, transaction content (i.e. product or service), transaction type (i.e. digital or offline) and marketplace participants (i.e. C2C, B2C or B2B), and, in the value capture dimension, key revenue stream (i.e. commissions, subscriptions, advertising or service sales) and pricing mechanism (i.e. fixed pricing, market pricing or differentiated pricing) serve as determining factors.[449]

Diversity in the business models of online platforms leads to difficulties in categorising them within traditional industry classifications.[450] Thus, it was highlighted in a report by European Commission that:

> there is no consensus on a single definition of online platforms as a clear-cut definition would likely be too narrow, or conversely apply to a very wide range of Internet services.[451]

To put it differently, the concept of online platforms is flexible, and in practice classification of online services into different types of online platforms would be only possible on a case-by-case basis.[452]

What is referred to as '3D printing online platforms' is also subject to such definitional ambiguity. As was elaborated in Chapter 1, 3D printing online platforms have no fixed business models and instead

[448] Karl Täuscher and Sven Laudien, 'Understanding Platform Business Models: A Mixed Methods Study of Marketplaces' (2018) 36 European Management Journal 319
[449] ibid., 320–22
[450] ibid.
[451] European Commission, *Staff Working Document: Online Platforms Accompanying the document Communication on Online Platforms and the Digital Single Market* SWD(2016) 172 (European Commission, 2016). See also Eva Obergfell and Alexander Thamer, '(Non-)regulation of Online Platforms and Internet Intermediaries – the Facts: Context and Overview of the State of Play' (2017) 12 Journal of Intellectual Property Law & Practice 435
[452] Bertin Martens, *JRC Technical Reports: Institute For Prospective Technological Studies Digital Economy Working Paper 2016/05 An Economic Policy on Online Platforms* (European Commission, 2016)

provide a combination of diverse services regarding product design and manufacturing.[453] In this sense, Rayna and Striukova observed that:

> 3D printing online platforms appear very much akin an 'e-business Lego,' where the same components can be put together in a different way.[454]

In legal terms, online platforms are not statutorily acknowledged, despite their wide acceptance as a general term. Instead, in the IP realm, a legal term – 'intermediaries' or 'information society service providers' – often appears as a statutory term to denote online platforms, especially in the context of liability law.[455] For instance, recital 59 to the InfoSoc Directive[456] notes the significance of infringing activities facilitated by intermediaries in the digital environment and the need for IP enforcement against intermediaries. This is also echoed in Article 11 of the Enforcement Directive,[457] ensuring that IP rightsholders in EU Member States can apply for an injunction against intermediaries involved in IP infringement. Similarly, the E-Commerce Directive approximates, *inter alia*, the liability of intermediaries between the EU Member States.[458]

However, it should be noted that the scope of online platforms, intermediaries and information society service providers are not precisely in alignment. For example, access providers[459] are included within the concept of intermediaries, whilst they are not considered to be online platforms, according to the European Commission's report.[460] The relationship between the two legal terms –intermediaries and information society service providers – is also not explicit in EU law, except that these terms are used interchangeably in some contexts.[461] Fragmentation of terminology makes it extremely difficult to demarcate the scope of these terms clearly, but online platforms and intermediaries share the common characteristics that both offer some types of information society services that can be regulated in the current legal framework.[462]

As such, there is no general law covering all types of online platforms within the current EU and UK IP framework. Rather, regulation on online platforms would be largely situational, based upon the

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[453] See section 1.2. Use of 3D Printing in Businesses and Its Impact Upon Consumers
[454] Rayna and Striukova (n 26) 165
[455] Obergfell and Thamer (n 451) 436
[456] Directive 2001/29/EC of the European Parliament and of the Council of 22 May 2001 on the harmonisation of certain aspects of copyright and related rights in the information society [2001] OJ L167/10
[457] Directive 2004/48/EC of the European Parliament and of the Council of 29 April 2004 on the enforcement of intellectual property rights [2004] OJ L195/16
[458] Directive 2000/31/EC of the European Parliament and of the Council of 8 June 2000 on certain legal aspects of information society services, in particular electronic commerce, in the Internal Market ('Directive on electronic commerce') [2000] OJ L178/1 (E-Commerce Directive)
[459] Recital 18 to E-Commerce Directive (access providers offer services consisting of transmission of information via a communication network in providing access to a communication network). Thus, ISPs, such as British Telecommunications, are within the meaning of intermediaries, as in service providers. See *Twentieth Century Fox Film v British Telecommunications* [2011] EWHC 1981 (Ch), [97]–[113]
[460] Obergfell and Thamer (n 451) 436
[461] Jaani Riordan, *The Liability of Internet Intermediaries* (OUP 2016) 27
[462] ibid., 27–28

types of activity that online platforms conduct and the contextual background in which these activities take place.

3.5.2. Impact of definitional defiance of online platforms upon IP regulation

The development of the digital platform economy is challenging conventional regulatory theory and practice. Lobel highlighted that hybrid business models of online platforms and the resulting conceptual and definitional ambiguity – in other words, the definitional defiance of online platforms – complicate the regulation of online platforms.[463]

As seen in the previous section, the concept of online platforms does not entirely fall within the legal definitions of intermediaries or information society service providers, and thus only the limited types of activities by online platforms are likely to be regulated in light of the EU Directives.[464] The issues of definitional defiance also lead to the need for the reconceptualisation of the scope of IP infringement. One of the most notable examples in this regard is the expansion of the scope of copyright infringement, in relation to communication to the public.[465] A comprehensive analysis of this provision concerning its current scope and applicability in the 3D printing environment is given in Chapter 5.[466] Thus, the focus in this section is upon sketching how this legal concept has evolved since the emergence of online platforms.

The status of online platforms involved in copyright infringement was historically regarded as that of potential secondary infringer rather than primary wrongdoer, as online platforms' role would be generally to provide their users with the means for infringement.[467] However, recent CJEU case law has expanded the notion of communication to the public, opening up possibilities that 'bad' platforms, which intentionally facilitate copyright infringement, are deemed to be primary infringers.[468] In *Stichting Brein v Ziggo BV*, the CJEU highlighted that the roles of operator of online sharing platform called the Pirate Bay (TPB) were essential in making the protected copyright works available, since without TPB's intervention, such as the incorporation of an indexing system, its users could have not

[463] Orly Lobel, 'The Law of the Platform' (2016) 101 Minnesota Law Review 87
[464] Obergfell and Thamer (n 451)
[465] CDPA 1988, s 20
[466] See section 5.3.1. Copyright implications of Scenario 4
[467] Ansgar Ohly, 'The Broad Concept of "Communication to the Public" in Recent CJEU Judgments and the Liability of Intermediaries: Primary, Secondary or Unitary Liability?' (2018) 13 Journal of Intellectual Property Law & Practice 664. For more discussion of development of secondary liability, see Richard Arnold and Paul Davies, 'Accessory Liability for Intellectual Property Infringement: The Case of Authorisation' (2017) 133 Law Quarterly Review 442
[468] Giancarlo Frosio, 'Reforming the C-DSM Reform: A User-Based Copyright Theory for Commonplace Creativity' (2020) 51 International Review of Intellectual Property and Competition Law 709, 720

shared the protected copyright works in the first instance, or, at least, it would have been extremely difficult for them to do so.[469]

The extended notion of communication to the public is now reflected in the new EU Copyright Directive in the Digital Single Market (CDDSM).[470] Recital 64 to the CDDSM states that:

> online content-sharing service providers perform an act of communication to the public or of making available to the public when they give the public access to copyright-protected works or other protected subject matter uploaded by their users.

This implies that online platforms that provide content-sharing services will be now directly liable for primary infringement by communication to the public, irrespective of whether they are considered to be 'neutral' or 'bad' platforms.[471] As the UK has left the EU, the UK government is not obliged to implement the CDDSM and, indeed, has announced that it has no plans to do so.[472] Thus, it remains to be seen how the IP landscape in the UK will be shaped in the future.

The development in legal practice discussed above will have implications for the regulation of 3D printing online platforms. To be more precise, some types of activities conducted by 3D printing online platforms, such as design hosting services, will be regulated in a similar manner to other file-sharing platforms, being regulated within the ambit of copyright law.[473] However, the existing framework may be insufficient to fully regulate 3D printing online platforms, especially where they provide more than design hosting, such as the manufacture of products with the hosted designs.[474] This can involve some form of liability in design laws and pose the same questions that have been raised in copyright law.

For example, there can arise questions whether 3D printing online platforms are either directly or indirectly liable for design rights infringement by hosting design files;[475] whether the enforcement strategy against online platforms, which has been developed in consideration of copyright law, will remain viable in grappling with design rights infringement;[476] and whether 3D printing online platforms working on behalf of individual consumers will benefit from design rights exceptions.[477] As the EC report suggested, there is no established law on EU design rights liability of 3D printing online

[469] Case C-610/15 *Stichting Brein v Ziggo BV* [2017] ECLI:EU:C:2017:456, [36]–[37]
[470] Directive (EU) 2019/790 of the European Parliament and of the Council of 17 April 2019 on copyright and related rights in the Digital Single Market and amending Directives 96/9/EC and 2001/29/EC [2019] OJ L130/92
[471] Frosio (n 468) 720
[472] Copyright: EU Action Question for Department for Business, Energy and Industrial Strategy UIN 4371 (*UK Parliament*, 16 January 2020) <https://questions-statements.parliament.uk/written-questions/detail/2020-01-16/4371> accessed 18 January 2021
[473] For IP studies focusing on this aspect, see Mendis and Secchi (n 64)
[474] Mendis and others (n 16)
[475] See section 5.3.2. Design rights implications of Scenario 4
[476] See section 5.5. Enforcement of IP Rights in the 3D Printing Environment
[477] See section 6.4 Copyright and Design Rights Issues Relating to Fabrication of Physical Objects from CAD Files (Scenario 5)

platforms and, in fact, the above questions mostly remain unresolved.[478] The thesis aims to fill the gap arising in this regard and Chapters 5 and 6 address the questions and clarify the legal status of 3D printing online platforms within the ambit of the UK design laws.

3.5.3. Paradigmatic shift in the role of online platforms: from adversaries to partners

The emergence of online platforms has transformed regulators' perspectives in their approaches to IP enforcement. According to Lobel, in recent decades there have been paradigmatic shifts in regulation, 'from command-and-control to more participatory modes of rule-making, compliance, and enforcement'; in these participatory and collaborative models of regulation, platforms are not seen as mere adversaries of the legal process but as non-governmental partners that generate norms to achieve policy goals altogether.[479]

Online platforms are an effective and credible target for IP enforcement. Whilst primary wrongdoers, such as users of online platforms partaking in unlawful activities, are not easily identifiable and often too numerous to be pursued, online platforms are fewer in number and more visible.[480] Meanwhile, online platforms have the control over their users and the flow of information, so that they can prevent potentially unlawful activities by way of monitor and surveillance in the pre-wrongdoing stage[481] and cooperate with enforcement's pursuit of infringers by providing information in litigation or prosecutions.[482] In this sense, online platforms are often described as natural chokepoints, bottlenecks or gatekeepers[483] and serve as both attractive regulatees and effective partners.

The EU directives such as those mentioned above – the InfoSoc Directive, the E-Commerce Directive and the Enforcement Directive – view intermediaries as an important regulatory target. For example, recital 59 to the InfoSoc Directive expressly states that intermediaries are best placed to bring infringing activities to an end. A legal analysis of these EU directives in the 3D printing context and the liability of 3D printing online platforms will be provided further in Chapter 5.

In other chapters of the thesis, such participatory and collaborative actions of online platforms are also discussed more in detail in the 3D printing context. The aspect of online platforms as a norm generator is discussed in Chapter 4, in relation to the contractual obligations they impose on users to regulate IP ownership, exploitation and liability.[484] Meanwhile, online platforms' voluntary

[478] Mendis and others (n 16) 4.4. Infringement Issues under Design Law
[479] Lobel (n 463) 159
[480] Uta Kohl, 'The Rise and Rise of Online Intermediaries in the Governance of the Internet and Beyond – Connectivity Intermediaries' (2012) 26 International Review of Law, Computers & Technology 185, 190
[481] ibid., 186
[482] ibid., 190
[483] ibid., 190. See also Obergfell and Thamer (n 451)
[484] See section 4.3.4. Contractual terms and copyright and design rights ownership. See also He (n 63)

implementation of the notice and takedown system and technological measures in pursuit of IP infringement is examined in Chapter 5.[485]

3.6. Summary

The legal status of CAD files in UK copyright law has been debated and clarified in a number of legal studies, but uncertainty remains. Classifying CAD files within one of the protected subject matters is found to be particularly difficult. This is because various elements of CAD files can encompass multiple subject matters, such as literary works, as in computer programs, and artistic works, as in technical drawings. CAD files can be original where they are an author's intellectual creation made by creative choices. Having examined product design processes, however, it can be established that the process of creating CAD files can be both creative and technical in nature, which leads to difficulty in assessing the originality of CAD files.

In UK design laws, a legal analysis of statute and case law suggests that virtual 3D models stored in CAD files can be generally seen as designs within both UK registered and unregistered design law. Unlike copyright law, however, it is found that there is no concept in UK registered design rights that can embrace CAD files as a protectable subject matter. On the other hand, in UK unregistered design rights, it is established that CAD files can be potentially treated as design documents.

This chapter has highlighted that the legal status of online platforms is not yet clearly established in the IP realm, owing to definitional ambiguity and defiance of online platforms. Although there is no general law that applies across to all types of online platforms, the importance of regulating online platforms has been recognised at the EU level and, in fact, some limited types of activities that online platforms conduct, such as hosting, have been regulated. The expansion of the concept of online platforms is likely to challenge the existing legal framework and divert the conventional regulatory approaches to online platforms.

Based on the analysis in this chapter regarding the legal status of CAD files and online platforms, the thesis will now examine other relevant legal issues, such as ownership, infringement and exceptions, with reference to the five scenarios presented in Chapter 1.

To reiterate these scenarios:

Type of design activity	Scenario
Access	(1) Consumers download/purchase a design on online platforms
Creation	(2) Consumers create a design with a firm
	(3) Consumers create a design based on commons
Use	(4) Consumers share/sell a design on online platforms

[485] See section 5.5. Enforcement of IP Rights in the 3D Printing Environment

	(5) Consumers fabricate a physical object at bureau services or at home

In Chapter 4, the first three scenarios, which relate to the access and creation of CAD files by consumers, will be discussed. In doing so, Chapter 4 will mainly cover issues of copyright and design rights ownership, arising in that context.

In Chapters 5 and 6, the implications of consumers' use of CAD files will be examined in relation to Scenarios 4 and 5. Chapter 5 analyses issues of copyright and design rights infringement and enforcement from the rightsholders' perspective, whilst Chapter 6 examines the applicability of copyright and design rights exceptions in these scenarios.

Chapter 4

Analysis of Scenarios 1, 2 and 3

Copyright and Design Rights Implications: Access and Creation of CAD files

Introduction

The aim of Chapter 4 is to examine the legal implication of consumer engagement in product design, with reference to the access and creation scenarios built in Chapter 1. The scenarios capture the social phenomena in the 3D printing environment, namely a shift in consumer behaviour in product consumption where consumers begin to partake in product design by accessing or creating designs of products, as follows:[486]

(1) Consumers download/purchase a design on online platforms
(2) Consumers create a design with a firm (product customisation/personalisation/co-creation)
(3) Consumers create a design based on commons (commons-based design)

This chapter mainly addresses the question of whether consumers have any right to the designs they have either accessed or created as a prosumer and, if so, how this affects the IP landscape. To this end, the law of authorship and ownership of UK copyright and design rights is first established and then applied to the scenarios. A noteworthy point about design prosumption in the 3D printing environment is that it can involve multiple participants, and thus the matter of joint authorship and co-ownership becomes extremely relevant in this context.

4.1. Law of Authorship and Ownership

4.1.1. Law of authorship and ownership in copyright law

In copyright law, an author is defined as the person who creates a work.[487] In *Kenrick v Lawrence*, it was held that the author must be 'a person who has at least some substantial share in putting the touches on to paper'.[488] This implies that, in the context of design production in CAD, an author would be the person who partakes in the 3D modelling process.

Section 10 of the CDPA 1988 provides that a work produced by collaboration between two or more authors is a work of joint authorship, provided that the contribution of each author is not distinct from that of the other author or authors. In order for a person to be a joint author, he or she must provide 'a significant creative input'[489] that contributes to the creation of the finished work.[490] In other words, the contribution must be original. However, the contribution that is made by each person does not have to be equal in terms of quality, quantity or originality.[491] And it is also notable that, however

[486] Mohajeri and others (n 28); Jiang, Ding and Leng (n 28); Cruickshank (n 127).
[487] CDPA 1988, s 9(1)
[488] *Kenrick & Co. v Lawrence & Co.* (1890) 25 QBD 99
[489] *Ray v Classic FM Plc* [1998] FSR 622 (Chancery Division)
[490] *Cala Homes (South) Limited v Alfred McAlpine Homes East Limited* [1995] FSR 818 (Chancery Division)
[491] *Bamgboye v Reed* [2002] EWHC 2922 (QB); [2004] EMLR 5

extensive the contribution might be, a contribution of a different kind will not lead him or her to be a joint author.[492]

Generally, joint authors will be first joint owners of copyright in the work.[493] The owner of copyright in a work enjoys the exclusive right to do certain acts, such as reproduction of or communication to the public of the work, set out in section 16(1) of the CDPA 1988. Where there are more than two owners of copyright in a work, an owner must either obtain a licence from or be authorised by the rest of the owners in order to do those acts.[494] Failing to do so could raise copyright infringement.

4.1.2. Law of ownership in UK registered design law

In the RDA 1949, the author of a design is deemed to be the original proprietor of the design,[495] and the author of a design is defined as the person who creates it.[496] The statutory definition of an author of a design seems to be very broadly and vaguely constructed, with no delineation of what entails creating a design. Modern legal authorities on this matter are also scant both in the UK and in the EU.[497]

The concept of an author in UK registered design law can be distinguished from that in copyright law. The latter emphasises an actual process taken in which to express an idea, whereas the former seems to relate to inventing or conceiving a design solution in a visible form. In that sense, it was held in *British Leyland v Armstrong*[498] that British Leyland's engineering drawings are artistic works but are only original in so far as they represent the skill and labour of the draughtsman; however, it was emphasised in that case that:

> the shape, configuration, dimensions and exact measurements of the exhaust pipe were contributed by the skill and labour of the design engineer not by the draughtsman.

Where there are more than two people creating a design, joint authorship and co-ownership might arise in principle. However, there is no express provision in the RDA 1949 concerning the law of joint authorship and co-ownership, and it seems there is also no case law around the issue.

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[492] *Brighton v Jones* [2004] EWHC 1157 (Ch); [2004] EMLR 26
[493] CDPA 1988, s 11(1)
[494] CDPA 1988, s 16(2)
[495] RDA 1949, s 2(1)
[496] RDA 1949, s 2(3)
[497] It appears that the authorship of a design in the context of registered design law is not as of much importance in practice as it would be in copyright law or unregistered design law. Most of all, only a registered proprietor enjoys the exclusive rights conferred in the RDA 1949, and there is no longer requirement that an applicant of a design be the person claiming to be the proprietor due to the repeal by the Intellectual Property Act 2014. Furthermore, although section 3(3) of the RDA 1949 still requires an application for the registration of a design in which national unregistered design rights subsist to be made by the person claiming to be the design right owner, the application form DF2A does not contain any formal declaration as such
[498] *British Leyland Motor Corporation Ltd v Armstrong Patents Co. Ltd* (n 417), 630

4.1.3. Law of ownership in unregistered design law

The ownership of UK unregistered design rights is first conferred upon a designer, who is a person who creates a design.[499] Comparable to UK registered design law, there are few authorities that concern the meaning of creation of a design. To introduce some key cases, in *C & H Engineering v F. Klucznik & Sons Ltd*, the court held that the person who *thought* of using a two-inch pipe on top of a commonplace form of pig fender was the creator of the design. It was held in *Fulton v Grant Barnett* that individuals who worked to another person's instructions in creating a design were not designers, whereas the person who instructed the creation of the design was.[500] Therefore, the creator of a design would usually be the person who records the design on a document, but it is not always necessary.[501]

Section 259(1) of the CDPA 1988 states that a 'joint design' means a design produced by the collaboration of two or more designers in which the contribution of each is not distinct from that of the other or others. The wording here is virtually the same as the copyright provision for joint authorship laid out in section 10(1) of the CDPA 1988. For that reason, the court in *Philip Parker v Stephen Tidball*[502] appeared to employ the approach taken in copyright case in *Cala Homes v Alfred McAlpine Homes*[503] to interpret and apply the provision as follows:

> where two or more people collaborate in the creation of a [design] and each contributes a significant part of the skill and labour protected by the [design right], then they are joint [designers].

Therefore, in the following paragraphs, joint designership in UK unregistered design rights will be discussed with reference to the law of joint authorship in copyright law.

4.2. Scenario 1: Access to CAD Files

Scenario 1: Consumers purchase/download a design on online platforms

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For the purpose of the thesis, access means 'the process of obtaining or retrieving information stored in a computer's memory'.[504] In the context of 3D printing, the most anticipated way of access is that consumers access CAD files through digital communication such as downloading or streaming from online websites.[505]

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[499] CDPA 1988, s 214(1)
[500] *A. Fulton Co. Ltd v Grant Barnett & Co. Ltd* [2001] RPC 16 (Chancery Division), [81]
[501] *C & H Engineering v F. Klucznik & Sons Ltd* (n 377)
[502] *Philip Parker and Others v Stephen Tidball and Others* [1997] FSR 680 (Chancery Division), 701–03
[503] *Cala Homes (South) Limited v Alfred McAlpine Homes East Limited* (n 490)
[504] Oxford Online English Dictionary <https://www.lexico.com/definition/access>
[505] Mendis and others (n 16)

Efroni highlighted that the ability to access preconditions the ability to obtain actual and/or potential benefits, and thus regulating access is vital to the protection of IP.[506] This view was also confirmed and further consolidated by Jiang et al., who suggested that the difficulty of defending conventional IP for digital products would lead to a significantly larger use of novel forms of IP, and that an important regulatory measure would be the regulation of 3D printing online platforms facilitating that.[507]

In the access scenario, therefore, an important discussion is about whether accessing CAD files is permitted within the ambit of copyright and design laws. Access to CAD files on the Internet involves digital transmission and reproduction of them, from one server to another, on a permanent or temporary basis.[508] In copyright law, such a reproduction is explicitly prohibited, and without the consent of the owner it will constitute to copyright infringement.[509] The issue of infringement merits further analysis, and thus will be discussed in detail in Chapter 5.

No copyright and design rights ownership will arise in the access scenario, as a person merely accessing CAD files plays a part neither in creating the design nor in making any contribution to the creation of them.[510] However, the accessed CAD files can be used as design materials for creation of new CAD files, and this will potentially lead to generation of new IP rights.

In this regard, the law of exhaustion, which was introduced into the CDPA 1988 and RDA 1949 as part of EU harmonisation, is noteworthy.[511] Section 18(3) of the CDPA 1988 states that any subsequent distribution, sale, hiring or loan of copies previously put into circulation does not amount to infringement. Similarly, section 7A(4) of the RDA 1949 states that a registered design is not infringed in relation to a product which has been put on the market in the European Economic Area by the registered proprietor or with his consent.

Interpretation of section 18(3) of the CDPA 1988 is subject to EU jurisprudence. Recital 28 to the InfoSoc Directive expressly states that 'protection under this directive includes the exclusive right to control distribution of the work incorporated in a tangible article'.[512] This implies that CAD files, as intangible objects, do not fall within the scope of the law of exhaustion.[513]

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[506] Zohar Efroni, *Access-Right: The Future of Digital Copyright Law* (OUP 2011) 125–26
[507] Jiang, Kleer and Piller (n 29) 89
[508] Mendis and Secchi (n 64)
[509] CDPA 1988, ss 16 and 17. Whilst whether this will constitute design rights infringement is unclear. This will be further elaborated in Chapter 5
[510] See above section 4.1.1 Law of authorship and ownership in copyright law
[511] The implementation was made by the Copyright and Related Rights Regulations 1996 and the Registered Designs Regulations 2001. For further discussions of principle of exhaustion and implications for 3D printing, see Mendis and others (n 16) 110–14
[512] Directive 2001/29/EC of the European Parliament and of the Council of 22 May 2001 on the harmonisation of certain aspects of copyright and related rights in the information society [2001] OJ L167/10
[513] Mendis and others (n 16) 112

However, the CJEU decision in *UsedSoft v Oracle*[514] held on the contrary that:

> the right of distribution of a copy of a computer program is exhausted if the copyright holder who has authorised, even free of charge, the downloading of that copy from the internet onto a data carrier has also conferred, in return of payment of a fee intended to enable him to obtain a remuneration corresponding to the economic value of the copy of the work of which he is the proprietor, a right to use that copy for an unlimited period.

This case opens up possibilities that CAD files can also benefit from the law of exhaustion, if they are able to be treated as computer programs per se.[515]

As for UK registered design rights, section 7A(4) of the RDA 1949 would not apply to CAD files, as the provision suggests that the law of exhaustion applies to the use of a product. There are debates over whether CAD files can be construed as a product; however, as discussed in Chapter 3, the thesis argues that they are not within the definition of a product.[516] As a result, they are outside the scope of section 7A(4) of the RDA 1949.

However, the lawful acquirer of CAD files will be entitled to use the lawfully accessed CAD files if there is an agreement between the parties. The agreement will take the form of a copyright and design rights licence contract in most cases, enabling the lawful acquirer to do some of the exclusive acts conferred upon the provider, such as reproduction.[517]

4.3. Scenario 2: Product Customisation, Personalisation and Co-creation

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Scenario 2: Consumers create a design with a firm

It was established in Chapter 1 that, owing to its technological and economic benefits, 3D printing enables consumers to partake in product design, and thus product customisation, personalisation and co-creation will become some of the most prominent applications in the 3D printing environment. To reiterate the definitions of the these, as provided in Chapter 2:[518]

- Product customisation: a process in which different versions of products are produced by *consumers' choice* from several ranges of available options;

[514] Case C-128/11 *UsedSoft GmbH v Oracle International Corp.* [2012] ECLI:EU:C:2012:407, [72]
[515] Mendis and others (n 16) 112
[516] See section 3.3. UK Registered Design Rights: Legal Status of CAD Files. For the same view, see also Elam (n 53)
[517] For discussion of the role of contractual agreements, see section 4.3.4. Contractual terms and copyright and design rights ownership. See also Martin Kretschmer and others, *The Relationship Between Copyright and Contract Law* (SABIP, 2010); Mendis and others (n 16) Chapter 5: Licensing and New Business Models in the 3D Printing Sector
[518] See section 2.2.1. Product customisation, personalisation and co-creation

- Product personalisation: a process in which a *bespoke* product is produced, tailored to individual consumers' needs;
- Product co-creation: a process in which product designers and untrained people in design *interact and work together* to produce a design.

Where multiple people are engaged in creating a work or a design, copyright and/or design rights might be jointly entitled to them, leading to co-ownership of rights. In discussing co-ownership of copyright and design rights, an important question is whether these three types of consumer engagement can be construed as 'collaboration', set out in sections 10(1) and 259(1) of the CDPA 1988, in relation to copyright and UK unregistered design rights.[519]

4.3.1. Copyright and design rights ownership in product customisation

Product customisation is the most common type of consumer engagement in product design, where consumers can choose options, including colours or materials of products. In the 3D printing context, product customisation further enables consumers to choose even the shape of products, and this has been facilitated by customisable CAD files, often referred to as meta models, that become popular in online design marketplaces like Shapeways[520] and i.materialise.[521]

To constitute joint authorship or joint designership, there must be collaboration between the parties towards the final work,[522] and the parties' contributions must not be distinct from each other. In relation to meta designs, a product designer and a consumer create two separate designs; whilst a product designer would normally create a meta model, a consumer creates a concrete model, by choosing the preferred shapes, colours, sizes and so on. There is no collaboration between them in creating either a meta model or a concrete model, and their contribution is clearly distinct. Thus, it is unlikely that joint authorship and joint designership arise in this case.

It was established in Chapter 3 that there is the potential that a meta design could be classified as a computer program, and thus a literary work.[523] Therefore, ownership of copyright in a meta design will be vested in the author who created it in an original manner. In product customisation, the author is likely to be a product designer who expends their labour, skill and judgement to make creative choices in creating the meta design.

In contrast, the UK unregistered design right might be unable to subsist in meta designs, as it appears to be a method or a principle of construction in which design right cannot subsist by virtue of section

[519] There is no regulation governing joint designer-ship in UK registered design law, and thus the thesis will focus on copyright and UK unregistered design rights
[520] Shapeways online shop <www.shapeways.com/marketplace> accessed 20 July 2020
[521] i.materialise online shop <https://i.materialise.com/en/shop> accessed 20 July 2020
[522] *Cala Homes (South) Limited v Alfred McAlpine Homes East Limited* (n 490)
[523] See section 3.2.1. Focused academic debate: is a CAD file a literary or artistic work? See also Mendis and others (n 16) 50–59

213(3)(a) of the CDPA 1988. UK unregistered design rights do not subsist in a method or principle of construction, by which it means 'a process or operation by which a shape is produced as opposed to the shape itself'.[524] For example, it was held in *Fulton v Grant Barnett* that the stitching technique that creates the outward-pointing seams on the edges and at the corners of umbrella cases is an example of a method or principle of construction.[525] However, the exception does not preclude from design rights protection a design created from a method or principle of construction, as:

> the fact that a special method or principle of construction may have to be used in order to create an article with a particular shape or configuration does not mean that there is no design right in the shape or configuration.[526]

Hence, it is still possible that the concrete design created from the meta design could be protected by UK unregistered design rights if it meets the substantive requirements for the subsistence of design rights.

The ownership of a concrete design created out of a meta design will be vested in the person who creates the concrete design. A moot point here is whether the choosing the shape by changing some parameters can be construed as the creation of a design.

In copyright, originality could even arise from the selection of elements, especially when these elements are combined to form a bigger chunk as a whole, and it results from creative choices made by an author.[527] In contrast to traditional mass customisation, meta designs enable consumers to have considerable customisation options and more creative freedom, leading them to become potentially the copyright owner in the concrete design they created.[528] As for design rights, the ownership of design rights is unlikely to be conferred upon consumers. Although they contribute to determining the final shape of the design through their choice, their contribution is unrelated to providing the design solution.[529]

4.3.2. Copyright and design rights ownership in product personalisation

Product personalisation might take place by way of consumers providing an idea of functionality and appearance of a product like size, colour and shape. It is similar to bespoke garment tailoring and could be exemplified by 3D printing design service.[530] In product personalisation, consumers are

[524] *Kestos Ltd v Kempat Ltd* (n 447), 151
[525] *A. Fulton Co. Ltd v Grant Barnett & Co. Ltd* (n 500), [70]
[526] ibid., [70]
[527] See section 3.1.1. Copyright law: subject matter and originality. See also Case C-406/10 *SAS Institute v World Programming* [2012] 3 CMLR 4
[528] For example, Li argues that customer's input in customising chocolate can be original. See Li and others (n 60)
[529] See section 4.1.2. Law of ownership in UK registered design law and 4.1.3. Law of ownership in unregistered design law, where the meaning of design creation is discussed in the context of design laws
[530] For example, a company like Dream 3D Bespoke creates a CAD file upon instructions of customers. <http://dream3dbespoke.co.uk/design-service> accessed 16 July 2020. On the other hand, Shapeways – one of

rarely involved in actual 3D modelling; instead, they set out design problems that should be dealt with by product designers.

Consumers' engagement in product personalisation is unlikely to make them joint authors in the copyright sense. The ideas provided by them might form essential part of construction of CAD files. However, merely providing such ideas is not the contribution deemed significant and original, because what matters in copyright protection is original expressions rather than ideas.[531]

However, it is possible that consumers become a joint author in some exceptional situations. For example, if consumers provide detailed instructions to CAD draughtmen in such ways as verbally guiding 3D modelling process or providing sketches that help the process, they could become joint authors.[532] However, in practice, this will rarely occur, as most consumers would lack professional knowledge in product design and CAD.[533]

As for UK unregistered design rights, consumers do not expend labour or skills to create a design in collaboration with product designers. Rather, what they offer is a set of design problems that product designers must solve, and the CAD files will be produced as the outcome of the problem-solving process, derived from the product designer's own labour and skills.

As part of product personalisation, consumers might provide the existing CAD files, requesting design improvement. Upon request, product designers could provide expert design consultation on how to improve the design and, at the same time, they could go further to refine it, as per their needs.[534]

The provision of expert consultation, in essence, seems to equate to providing ideas or instructions based on professional knowledge and experience. Those provided could be vital in improving the design. As for copyright, it is original expressions, rather than ideas, that copyright protects, as mentioned above.[535] For that reason, even if consumers improved the design by themselves and created a new CAD file with their labour and skills, following the result of consultation, they would still be the sole author and owner of the new CAD file. This is because merely providing expert consultation is unlikely to amount to original contribution, however significant it is for the improvement of the existing design.[536] On the other hand, if the ideas provided by product designers are original and significant to improve the existing design, irrespective of who actually modifies the

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the largest companies working with 3D printing – provides an online platform in which its customers can hire professional designers. <www.shapeways.com/hire/designer> accessed 16 July 2020

[531] *Ray v Classic FM Plc* (n 489)

[532] *Cala Homes (South) Limited v Alfred McAlpine Homes East Limited* (n 490)

[533] This is due to the fact that consumers will be normally untrained in product design and CAD. This is identified as one of the problems that could hinder widespread adoption of 3D printing in the domestic sector. See section 1.1.3. Limitations in the domestic adoptability of 3D printing

[534] This type of service is provided by some of online platform. See, for example, Shapeways design service (product development) at <https://shapeways.zverse.com/?lets-get-started> accessed 16 July 2020

[535] *Ray v Classic FM Plc* (n 489)

[536] ibid

existing CAD file to create the new one, it could be possible for both of them to qualify as joint designers of the design.

In contrast, where product designers go further than merely providing consultation but are actively involved in the creation of the CAD file, such as by way of 3D modelling, there is the potential that they qualify as a joint author with consumers. However, it is notable that whether they qualify as a joint author relies on the purposes and types of their involvement. In *Fylde Microsystems v Key Radio Systems*,[537] the defendant played a vital role in perfecting computer software that had been created by the claimant, by way of testing the software with extensive consultation. The court held, in response to the defendant's claim that it was a joint author, that the skill, time and effort afforded by the defendant in this case were not the right kind, because those afforded by the defendant for testing software were merely the skill of a proofreader rather than authorship skill. To apply this to the creation of CAD files, thus, if the product designers' involvement is merely for the purpose of examining and repairing the CAD file,[538] their contribution will not be the right kind that leads to joint authorship.

A noteworthy point in this context is that, even though the information given by consumers is personal (e.g. their face or body shape), neither joint authorship nor co-ownership will arise. As such, consumers cannot rely on copyright to prevent CAD files incorporating their personal and sensitive information about them from being reproduced and disseminated.[539]

In respect of protection of privacy, copyright law sets out an exception that prevents certain use of photographs and films. By virtue of section 85 of the CDPA 1988, a person commissioning[540] the taking of a photograph or the making of a film for private and domestic purposes has the right not to have (a) copies of the work issued to the public; (b) the work exhibited or shown in public; or (c) the work communicated to the public. This provision seems not to be applicable to CAD files since they are apparently neither a photograph nor a film. Nonetheless, there is, arguably, no reason that CAD files should be treated differently from a photograph or a film, for it would intrude as much on the privacy of consumers if CAD files depicting, for instance, one's face and body were able to be disseminated without restriction. Hence, it might be argued that there is a definite need to review the law to grapple with privacy issues that could potentially arise with CAD files.

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[537] *Fylde Microsystems Ltd v Key Radio Systems Ltd* [1998] FSR 449 (Chancery Division)

[538] Examples of examining or repairing a CAD file could relate to alterations to the CAD file upon the basis of engineering design, such as making alterations to a 3D model to achieve geometric balance. See Christiansen, Schmidt and Baerentzen (n 315)

[539] For further discussion of privacy issues in the 3D printing context, see Daly (n 15) 86–93

[540] Whether the form of interactions between a customer and a firm in product customisation can be construed as commissioning in terms of copyright law will be further discussed below at 4.3.4. Contractual terms and copyright and design rights ownership

4.3.3. Copyright and design rights ownership in product co-creation

In product co-creation, product designers and consumers participate in the design process together as a team. As illustrated in Chapter 2, there are no specific models of product co-creation, but it is notable that NUI-based design devices, such as VR, have been increasingly employed and tested as intuitive supportive methods for consumers in product co-creation.[541] As such, this section examines the legal implications of product co-creation in relation of VR.

The marked difference of product co-creation with product customisation and personalisation is that it involves consumers more directly in conceiving design solution and 3D modelling, leading to increased possibility that they become joint authors in copyright/design rights in the design. A vital question is then how significant their contribution should be to qualify as joint authors.

In *Martin v Kogan*,[542] the court made a distinction between the primary and secondary skills that are required to create a copyright work. HHJ Hacon in the decision held:

> 45 In the case of an artistic work for instance, the primary skill lies in the use of a pencil, brush, computer program or other means to create an image. In the case of a literary work such as a novel or screenplay, the primary skill is in the selection and arrangement of words in the course of setting them down.
>
> 46 Examples of secondary skills for, say, a painter are composition and selection of colour. For an author of a novel or screenplay, secondary skills include inventing plot and character.

He then emphasised, in respect of a person who expends primary skills to create a copyright work, that the test of joint authorship is 'whether the contribution constitutes a substantial part of the whole',[543] which is analogous to the test of substantiality in the context of infringement. Whether one's contribution constitutes a substantial part of a work is a matter of degree and the quantity as well as the quality of a part contributed to the whole work should be considered. One factor that can help determine the substantiality of contribution, particularly relating to artistic work, might be to determine how visually significant the contribution is to the whole work.[544] A person to whom the work is to be addressed to assess visual significance is the person to whom the work would normally be addressed; for example, an engineering drawing should be addressed to an engineer and not to an ordinary member of the public.[545]

To apply the law, the skills employed by consumers by way of, for example, utilising graphic devices to create CAD files are the primary skills. For example, VR enables consumers to create and make modifications to the 3D model in a manner similar to a physical pencil or brush. Therefore, if their contribution can be construed as visually significant, they can become a joint author. However, to

[541] Michele Baker, 'How VR Will Bring about a Mass Customisation Revolution' (*TDMB*, 20 February 2018) <www.thedigitalmarketingbureau.com/virtual-reality/mass-customisation-vr> accessed 8 July 2018
[542] *Martin v Kogan* [2017] EWHC 2927 (IPEC); [2018] FSR 9
[543] ibid., [48]
[544] *Interlego AG v Tyco Industries Inc* (n 404)
[545] *Billhöfer Maschinenfabrik GmbH v T.H. Dixon & Co. Limited* [1990] FSR 105 (Chancery Division)

whose eyes the contribution should come as a visual significance is somewhat tricky, according to the case law. It may be either product designers or consumers, or maybe both. In any case, the assessment of visual significance will require an assessment not of artistic quality[546] but of whether the contribution is made through exercising creative choices.

In relation to design cases, where the design of the whole article is created jointly by product designers and consumers, the latter can become joint designers of the whole article if their contributions to the design are visually significant, in a similar fashion to copyright cases. However, it would be less common to involve consumers in the design process from the outset to create a design for a whole new article or even a whole part of the article, as certain elements of the design (e.g. certain shapes, dimensions or parameters) need engineering knowledge for ensuring the functionality of the part and the interoperability of the part to the other parts. Hence, what is more likely to happen in product co-creation is that consumers design aesthetic aspects of the article under the guidance of product designers, by adding some decorative features to or modifying the existing template design, to an extent that does not harm the design's intended function and interconnectivity.[547]

In this case, to follow the established case law, it is possible that consumers become joint designers with product designers if the contribution that they make is significant and original. However, it should be noted that joint designership will only arise in relation to the parts of the design rather than the whole, where their contribution is directly reflected, as it is possible in design cases that a bundle of design rights can subsist in different parts of an article.[548]

However, consumers will be unable to become a joint designer in some cases. One is obviously where their contribution is insignificant and thus unoriginal. More importantly, this will be so if product co-creation is associated with the parts that are deemed to be surface decoration, in which UK unregistered design rights do not subsist, in accordance with section 213(3)(c) of the CDPA 1988.

4.3.4. Contractual terms and copyright and design rights ownership

This chapter has so far identified uncertainty and the associated issues on copyright and design rights ownership in relation to consumer engagement in product design. In practice, such issues are often

[546] CDPA 1988, s 4(1)(a)

[547] Killi argues that the phrase 'everyone is a designer', which is often brought up in the literature in the 3D printing context, must be read carefully. He asks whether access to tools like 3D printers and CAD programs will really enable one to create, design or make things with enough quality to actually be desired. For this rhetorical question, he argues that 'to actually perform the design, in other words, giving shape and substance to a product, some specialized skills are necessary'. See Killi (n 182) 10

[548] *Raft Limited v Freestyle of Newhaven Limited, Christopher Eric Horsnell, Highly Sprung Limited* [2016] EWHC 1711 (IPEC), 2016 WL 03626486, [8] ('where an existing design is amended is some minor way – and assuming the amendment was the product of sufficient skill and effort to generate a new original design – this may not confer a new originality on the whole of the amended design. The owner of the design right may be able to claim that the amended part is of a new original design, but not the article as a whole')

dealt with in the form of contractual agreements between firms and consumers. This section discusses the role of contracts in product customisation, personalisation and co-creation, with examples of the terms and conditions laid out by major 3D printing online platforms.

Roles of contracts in product customisation, personalisation and co-creation

Where consumers use design services from firms, various agreements are made between them, including agreements of payment and commission etc.[549] The agreement could be written or oral and the form of that could be either analogue (i.e. agreements written down on paper) or digital (i.e. agreements displayed on a computer screen). Such an agreement can become a contract, which is enforceable by law, when all parties agree that they are bound by the terms and conditions of the agreement.[550]

In the 3D printing environment, contractual agreements are often made in the form of non-negotiable terms and conditions to which consumers must agree to use services provided by firms.[551] Owing to freedom of contract, such terms and conditions can include clauses regarding ownership, licensing, and exploitation of IP rights;[552] for example, a transmission of the co-owned IP rights generated in consumer engagement in product design[553] or a waiver of moral rights[554] can be included.[555] In the following section, how such contractual terms work in practice is further discussed, with an analysis of the terms and conditions provided by major 3D printing online platforms.

Analysis of contractual terms in major 3D printing online platforms

In this section, four major 3D printing online platforms will be looked into: Shapeways, i.materialise, iMakr and Sculpteo.[556] These 3D printing online platforms offer product customisation and personalisation, by either offering design services or allowing consumers to customise the designs that

[549] Commission contracts were particularly important because the first ownership of the works/designs created under commission was vested in the commissioner under the Copyright Act 1956 and the old RDA 1949. However, that has been repealed, and the first ownership is now vested in the person who creates a work/a design
[550] Andrew Murray, *Information Technology Law: The Law and Society* (3rd edn, OUP 2016), para 18.1.1
[551] Kretschmer and others (n 517) 88 and Mendis and Secchi (n 64)
[552] Kretschmer and others (n 517)
[553] CDPA 1988, s 90
[554] CDPA 1988, s 87
[555] However, the principle of freedom of contract is not without limit. In 2014, the UK government introduced copyright exceptions that are unable to be overridden by any contractual terms, including research and private study, caricature, parody or pastiche exceptions. In contrast, there are no such restrictions in UK design laws
[556] These platforms are particularly selected out of 14 3D printing online platforms identified in the research by Rayna and Striukova, because they provide some forms of design services, which fit the description of product customisation and personalisation in the thesis. See Rayna and Striukova (n 26)

these platforms offer for sale.[557] It seems that it is less common for such platforms to provide consumers with product co-creation.[558]

Shapeways seems not to run design services with its own employees but instead it hosts and enables professional designers to customise or tailor-make 3D models. There are two channels for this: consumers buy 3D models that can be tailor-made to their order through the CoCreator platform facilitated by Shapeways,[559][560] or they can hire professional designers introduced by Shapeways.[561] In respect of the latter, Shapeways makes clear in its terms and conditions for hiring designers that it is not a party to any agreements entered into between designers and clients.[562] However, as for the former, Shapeways states that it obtains a non-exclusive, royalty-free, worldwide, transferrable licence to use, copy, modify, display and distribute the specifications, which are provided by customers for creating a CoCreator model, with the right to sublicense, for any purpose.[563] It also states that any intellectual property right of a manual CoCreator model created by the Shapeways shop owner with the use of specifications provided by customers will vest in the shop owner who created that CoCreator model.[564]

Likewise, i.materialise provides a service to connect consumers with professional designers but the company explicitly declares on its website that it takes no liability for any transactions between them.[565] Terms and conditions provided by i.materialise are only concerned with where 3D models, pictures or text descriptions are uploaded onto its website, in which case i.materialise is granted a non-exclusive, royalty-free, unlimited-in-time, worldwide licence to display and reproduce the design for marketing purposes.[566]

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[557] ibid
[558] Product co-creation with consumers is not yet phenomenal due to the lack of knowledge in structuring an effective design models. See section 2.2.1. Product customisation, personalisation and co-creation. See also Möhring and others (n 243)
[559] Terms of Service Shapeways Shops and Co-Creator (Description of Service) <www.shapeways.com/legal/shop_terms_and_conditions> accessed 29 July 2020
[560] In the CoCreator platform, a designer can either add CustomMaker (a semi-automatic tool that allows a customer to customise a 3D model within the pre-set parameters) or manually create a 3D model for the customer. See Shapeways customisation guide <www.shapeways.com/tutorials/shops/ways-to-customize-products> accessed 29 July 2020
[561] <www.shapeways.com/hire/designer> accessed 29 July 2020
[562] Designer for Hire Terms and Conditions Shapeways <www.shapeways.com/legal/hire_a_designer> accessed 29 July 2020
[563] Shapeways Terms and Conditions (7. Intellectual Property Rights of 3D Designs) <www.shapeways.com/terms_and_conditions#a-intellectual-property> accessed 29 July 2020
[564] ibid
[565] <https://i.materialise.com/en/hire-a-3d-designer/search> accessed 29 July 2020
[566] i.Materialise Terms and Conditions <https://i.materialise.com/en/legal/terms> accessed 29 July 2020

iMakr provides on-demand design services by which consumers can commission one of the company's designers to create 3D models.[567] It announces general terms and conditions of use on its website but it does not comprise any mentioning of the design services.[568]

Sculpteo offers in-house design services to aid consumers with the creation of design from scratch and with the optimisation of the existing 3D models.[569] Terms and conditions from Sculpteo provide that, with customers' acceptance of specific conditions, they grant Sculpteo a non-exclusive licence, free of charge, not only to produce 3D-printed objects to the image, drawing or design the customer owns, but to make that image, drawing or design available on Sculpteo's website for promotional purposes.[570] However, there is no particular mentioning of ownership of IP rights with regard to these design services.

To analyse the terms and conditions stated above, all of the major 3D printing online platforms studied above incorporate clauses about the user granting a non-exclusive licence for reproducing the content they upload on their websites, including images, texts and designs (3D models). Only one online platform – Shapeways – includes a clause about ownership of IP rights in relation to its CoCreator model, whereas the other three 3D printing online platforms do not provide any terms and conditions dictating the ownership of copyright or design right potentially subsisting in CAD files collaboratively created between consumers and professional designers.

The CoCreator platform, provided by Shapeways, allows product customisation and personalisation by either individual product designers, who are usually design sellers registered on the Shapeways marketplace, or the firm itself. To briefly look into this, product designers registered on the Shapeways marketplace can open an online shop in which they can sell design variants and/or tailor-made designs. Alternatively, Shapeways itself offers product personalisation services to its users, in which it helps them not only create CAD files but repair the existing CAD files for improved manufacturability. The terms and conditions by Shapeways suggest that any IP right of a manual CoCreator model created by the Shapeways shop owner with the use of specifications provided by a customer will vest in the shop owner who created that CoCreator model. This contractual term will override the general rule of joint authorship and designership in copyright and design law.

In the case of some of design services offered by i.materialise, the lack of clauses relating to copyright and design rights ownership in its terms and conditions is understandable because it only serves as an intermediary between consumers and professional designers who are in no employment relationship

[567] <www.imakr.com/en/content/100-design-on-demand> accessed 29 July 2020
[568] iMakr Terms and Conditions <www.imakr.com/en/content/3-terms-and-conditions-of-use> accessed 29 July 2020
[569] <www.sculpteo.com/en/services/sculpteo-studio/design> accessed 29 July 2020
[570] Sculpteo Terms and Conditions <www.sculpteo.com/en/terms> accessed 29 July 2020

with the companies, in which case the companies are in no place to provide contractual terms regarding the copyright ownership of 3D models.

When it comes to the other major 3D printing online platforms, a trend in the lack of clauses in their terms and conditions on copyright and design rights ownership is somewhat surprising. It might be that consumer engagement in product design in the 3D printing environment is still premature, and no conflicts regarding IP rights ownership may have arisen at a significant level.

In conclusion, it appears that most major online 3D printing platforms that either provide or facilitate as an intermediary some form of product customisation and personalisation do not set out contractual terms concerning the ownership of CAD files. Without any contractual terms in place, the general rule and established case law of joint authorship and designership and co-ownership will still apply to most product customisation and personalisation offered on the major 3D printing online platforms.

4.4. Scenario 3: Commons-Based Design

Scenario 3: Consumers create a design based on commons

One of the most remarkable social phenomena accompanying the emergence of low-cost 3D printing is that many hobbyists and enthusiasts started to create and share CAD files on online platforms, allowing other consumers to access them. This phenomenon might be categorised as one of the models of commons-based peer production or open design, the primary principles of which are collaboration and freeness (i.e. without pecuniary compensation).[571] In particular, the remix culture is noteworthy. A remix is a term first established in the music industries, but in this context it means a CAD file that is created based on other CAD files.[572]

Remixing involves the reproduction of others' works/designs potentially protected by IP rights, and therefore without the consent of IP rightsholders it can constitute infringement. Meanwhile, it also often involves the alteration of existing works/designs, which can potentially lead to the generation of new IP and the associated IP rights. In the 3D printing communities, to encourage collaboration and freeness and to secure legitimacy of remixing, open public licences, such as the Creative Commons Licence (CCL), are adopted and used by consumers.[573]

[571] Benkler and Nissenbaum (n 161); Kostakis and Papachristou (n 157). For legal implications of this, see Matthew Rimmer, 'The Maker Movement: Copyright Law, Remix Culture and 3D Printing' (2017) 41 The University of Western Australia Law Review 51
[572] Flath and others (n 151)
[573] For empirical research on this, see Mendis and Secchi (n 64); Moilanen and others (n 62)

This section discusses copyright and design rights issues potentially arising in commons-based design, with an emphasis on the remix culture, as identified above. Most notably, it analyses issues of copyright and design rights protection and ownership regarding remixes and discusses whether CCL is fit for purpose.

4.4.1. Copyright and design rights protection and ownership of remixes

For remixes to be protected as new copyright works, they must be original. In creating remixes, designers expend labour and skill to combine numerous parts of designs into one, as well as judgement in choosing what and where to incorporate those parts of designs into the new remix. This process will often require them to make creative choices in selection and combination of various elements, leading to generation of originality in the new remix.[574]

However, whether the remix is original will be decided case by case, depending upon the facts and degree of changes made to the existing works, as, in essence, remixes are derivative works, created upon the basis of existing works that need sufficient alteration or embellishment to qualify as original copyright works.[575] Therefore, if changes made to the existing works are too minor and visually insignificant, the remix will not qualify as a new copyright work.[576]

Remixes can be protected by UK registered design rights if they are novel and have individual character and by UK unregistered design rights if they are original in the sense that they are not commonplace. A noteworthy point is that remixes are created based on commons, which in nature are already widely seen, known, or circulated in the design field and the public. Indeed, remixes look fairly like the existing designs in most cases, which raises the question of whether they can be deemed novel or not commonplace.[577]

In *Rolawn v Turfmech*, the defendant argued that design rights do not subsist in the claimant's design of a lawnmower as it was commonplace. The court held that:

> [w]hile a lot of the individual elements of the actual designs of the Rolawn mower can be found elsewhere in the design field, there is nothing in the relevant design field that looks like the actual mower in the particular configurations in relation to which design right is claimed. Thus it is (I find) commonplace to have staggered cutters, and commonplace to have a box structure made up of triangular sections. However, the particular combination of those

[574] Flath and others (n 151)
[575] See section 3.1.1. Copyright law: subject matter and originality
[576] See *Interlego A.G. v Tyco Industries Inc* (n 404)
[577] For example, when the original key hook and tray with a remix uploaded on Thingiverse are compared, there is only a slight difference between the two in the look of the back of the holder. See the original design at <https://www.thingiverse.com/thing:3598949/remixes> and the remix design at <https://www.thingiverse.com/thing:4037213>. For the current practice of remix creation by consumers being capable of affecting the test of individuality in EU design law, see Mendis and others (n 16) 66

> features that one sees making up the overall designs of 'the whole' in its extended, semi-retracted and fully retracted positions is not commonplace.[578]

As such, according to the case law, it is possible that remixes are protected by design rights if they are seen, as a whole, not to be commonplace, owing to combination of commonplace features of other designs. However, as Malaquias put it, obtaining design rights protection of remixes will be still more difficult than obtaining copyright protection, owing to the extra requirement of commonplaceness.[579]

Although remixes are protected by copyright and design rights and owned by the creators of the remixes, it is still possible that they are liable for copyright and design rights infringement unless they have acquired the consent of the owner or have any other legitimate reason allowing them to reproduce the existing designs. To avoid potential infringement issues, online platforms require their users to employ public open licences.[580] The next section will discuss how CCL, one of the most popular public copyright licences, has been utilised on 3D printing online platforms and whether it is fit for purpose.

4.4.2. The Creative Commons Licence in the 3D printing context

The Creative Commons Licence or Creative Commons Copyright Licence is an open and standardised licence scheme that grants copyright permission to do certain acts prohibited by copyright law.[581] CCL aims primarily at a flexible copyright regime in which to encourage the sharing, remixing and reuse of creative work, by providing a legal platform for digitally enabled creative culture. Served as an alternative to the traditional 'all rights reserved' licence, CCL has been said to have had a significant impact upon the digital content industry, in that it has enabled the legitimate sharing and reuse of copyright work rather than unauthorised reproduction and communication.[582]

CCL provides a number of modes, allowing the licensors to customise their licensing model for the most appropriate one for their own purposes. To briefly introduce the modes:[583]

- BY (Attribution): The most basic mode, which allows the licensee to use the licensor's copyright work even for commercial purposes, provided that the licensor is credited for their creation.

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[578] *Rolawn Ltd v Turfmech Machinery Ltd* [2008] EWHC 989 (Pat); [2008] RPC 27, [89]
[579] Malaquias (n 52)
[580] For example, one of the 3D printing online platforms, Thingiverse, obliges its users to adopt one of the open-source licence schemes in the list provided by the website, such as Creative Commons Licence, GNU General Public Licence or Berkeley Source Distribution (BSD) licence
[581] <https://creativecommons.org/licenses>
[582] Chunyan Wang, 'Creative Commons Licence: An Alternative Solution to Copyright in the New Media Arena' in Brian Fitzgerald and others (eds), *Copyright Law, Digital Content and the Internet in the Asia Pacific* (Sydney University Press 2008) 318-19. See also Jessica Coates, 'Creative Commons – The Next Generation: Creative Commons Licence Use Five Years On' (2007) 4 Script-ed 72
[583] <https://creativecommons.org/licenses>

- BY-SA (Attribution-ShareAlike): The licensee can do what is allowed in the basic mode (BY). But the licensee is additionally obliged to employ the same mode of licence for their new copyright work to let others further use it.
- BY-ND (Attribution-NoDerivs): The licensee can do what is allowed in the basic mode (BY). But the licensee is prohibited to create a new copyright derivative work based on the licensor's copyright work.
- BY-NC (Attribution-NonCommercial): The licensee can do what is allowed in the basic mode (BY). But the licensee is only capable of using the licensor's copyright work for non-commercial purposes.
- BY-NC-SA (Attribution-NonCommercial-ShareAlike): The licensee can do what is allowed in the basic mode (BY). But the licensee can only use the licensor's copyright work for non-commercial purposes and is bound to adopt the same mode of licence for their new copyright work.
- BY-NC-ND (Attribution-NonCommercial-NoDerivs): As the most restrictive mode, the licensee can only reproduce and communicate the licensor's copyright work for non-commercial purposes.

CCL has been adopted and used widely on 3D printing online platforms. This is backed by empirical data collected in recent legal studies. According to Mendis and Secchi, across the 17 online platforms, CCL and the related variant licence schemes were utilised in relation to uploaded CAD files on the 3D printing online platforms, taking up around 30% in total of the uploaded CAD files between 2008 and 2013.[584] Considering that almost 65% of the uploaded CAD files were left with no license scheme whatsoever, CCL and the related variant licence schemes turned out to be the most popular choice amongst the users on 3D printing online platforms.[585] Moilanen et al. also found, in relation to one of the largest 3D printing online platforms, Thingiverse, that around 90% of the uploaded CAD files between 2009 and 2013 were shared with CCL, with modes BY (36%), BY-SA (36%), BY-NC (10%), and BY-NC-SA (8%).[586] The findings above indicate that CCL has been one of the most popular open licence schemes adopted and used by the users of 3D printing online platforms.

4.4.3. Limitations and potential legal issues of CCL in the 3D printing context

As with other digital content, CCL seems to have served as a legal safeguard for consumers to reuse the existing CAD files shared on 3D printing online platforms. However, CCL has limitations in the context of 3D printing.

[584] Mendis and Secchi (n 64). At the time of research in 2015, the 17 online platforms made a exhuastive list
[585] ibid., 29–30
[586] Moilanen and others (n 62)

Most of all, the fact that CCL is merely designed for *copyright* could make it inappropriate and insufficient to fully cover the issues with the related other IP rights, such as design rights.[587] The nature and purpose of CAD files are somewhat different from other digital content, like music, photographs or films, in that they are a design document intended to be manufactured into a physical product rather than to remain as a digital object to be enjoyed as if it were a digital visual art. As noted earlier, design rights can also subsist in CAD files, and therefore the physical reproduction of the design may give rise to design rights infringement without the consent of the owner or any legitimate reason.[588] CCL is not a blanket licence but merely grants permission for exploitation of the copyright in CAD files. This implies that a person who has lawfully downloaded and modified CAD files to create a remix, owing to CCL, could still become a potential infringer when the person has physically produced the remix. In that sense, CCL appears to be unsuitable in the 3D printing context.[589]

Copyright licence is the permission given by the owner of copyright to the licensee to do certain acts that would otherwise be infringement. Therefore, in principle, the rightful owner of the copyright has the exclusive right to grant a licence. The principle will also apply to CCL, as it is one form of copyright licence. A problem with the current practice of CCL in the 3D printing context is that everybody is just licensing their work without knowing or verifying that they are the lawful owner of copyright in the work.[590] As seen above, not all remixes can be considered new copyright works, and therefore copyright ownership will not always arise. Nevertheless, remix creators upload their creation with CCL attached anyway, and others further create other remixes upon the basis of the licence. CCL could create a false impression that the person lawfully acts within the scope of the licence, but the reality is that it is completely uncertain.

4.5. Summary

Chapter 4 has discussed the copyright and design rights issues that can arise where CAD files are accessed and created. When it comes to access to CAD files, no copyright or design rights ownership would arise, as it involves no activities that can construed as creation of a design. On the other hand, where consumers create CAD files with a firm or based on commons, it is established that joint

[587] Margoni (n 418)
[588] RDA 1949, s 7, and CDPA 1988, s 226. Design rights infringement will be further discussed in Chapter 5
[589] The same issue was also identified in the most recent EC report. Because of such problems of CCL, the need for other types of licences that can be better suited to the 3D printing context, such as the GNU public license, is suggested. See Mendis and others (n 21) Chapter 5: Licensing and New Business Models in the 3D Printing Sector
[590] For example, operators of 3D printing online platforms often ask a person who uploads a CAD file to tick the box stating that the person is the lawful owner of the CAD file. But ticking the box does not actually make any difference to the ownership of copyright. It might be only useful for the operators to avoid any potential liability caused by infringement by their users

authorship and co-ownership can be raised, but this will depend upon the fact and degree of participation.

The next chapter will discuss copyright and design rights issues relating to use of CAD files. It will focus on identifying potential issues of copyright and design rights infringement and enforcement, with reference to Scenarios 4 and 5. The relevant scenarios are as follows:

- Scenario 4: Consumers share/sell a design on online platforms
- Scenario 5: Consumers fabricate a physical object at bureau services or at home

Chapter 5

Analysis of Scenarios 4 and 5

Copyright and Design Rights Infringement: Use of CAD files

Introduction

The aim of Chapter 5 is to discuss copyright and design rights implications in relation to the use of CAD files, depicted in Scenarios 4 and 5. Whilst Chapter 4 mainly discussed authorship and ownership of copyright and design rights where CAD files are accessed and created, this chapter focuses upon analysing the issues of copyright and design rights infringement and enforcement where CAD files are used.

Use of CAD files means two different activities in this chapter. One is that CAD files are shared or sold by consumers; the other is that they are fed into 3D printers for physical fabrication. As was established in Chapter 1 (Contextual Framework), these activities will take place in different contexts. Sharing or selling CAD files mainly occurs via 3D printing online platforms facilitating such activities. On the other hand, physical fabrication can happen wherever 3D printers are, but bureau services, which produce physical objects on behalf of their customers for fees, are likely to play a major role in physical fabrication. Considering this, the thesis presents Scenarios 4 and 5 as follows:

- Scenario 4: Consumers share/sell a design on online platforms
- Scenario 5: Consumers fabricate a physical object at bureau services or at home

Chapter 5 consists of three parts. The first part explains the law of copyright and design rights infringement, with reference to relevant statutory provisions and case law. The second part applies the law to Scenarios 4 and 5, with an emphasis on examining the liability of not only consumers but also the facilitating third parties such as online platforms and bureau services. The last part discusses enforcement issues relevant to the scenarios.

5.1. Law of Copyright Infringement

Copyright owners have the exclusive right to their copyright works, and thus anyone that uses them without the consent of the owners or any other legitimate reasons infringes the copyright.[591] The acts exclusively permitted for the owners encompass copying the work;[592] issuing copies of the work to the public;[593] renting or lending the work to the public;[594] performing, showing, or playing the work in public;[595] communicating the work to the public;[596] and making an adaptation of the work or doing any of the aforementioned acts in relation to an adaptation.[597]

[591] CDPA 1998, ss 2(1) and 16
[592] CDPA 1988, s 17
[593] CDPA 1988, s 18
[594] CDPA 1988, s 18A
[595] CDPA 1988, s 19
[596] CDPA 1988, s 20
[597] CDPA 1988, s 21

Similar to other digital files, such as music and films, there is the potential that CAD files are also readily reproduced and disseminated over the Internet, potentially leading to the outbreak of digital design piracy.[598] In this sense, this section focuses on examining the scope of sections 17 (copying of copyright works) and 20 (communication of copyright works to the public) of the CDPA 1988.

5.1.1. Copying of copyright works (section 17 of the CDPA 1988)

Copying means reproduction of copyright works, mainly including a literary, dramatic, musical or artistic work, in any material form.[599] In relation to artistic works, making a 3D work from a 2D work, and vice versa, constitutes copying the work.[600] For instance, it will be most likely considered to be copying within the CDPA 1988 where a person reconstructs the existing 2D technical drawings into a 3D virtual form by way of using CAD programs. Within the scope of the copying, transient or incidental reproduction is also included.[601]

5.1.2. Communication of copyright works to the public (section 20 of the CDPA 1988)

Communication to the public is a restricted act set out in section 20 of the CDPA 1988. In subsection 20(2), communication to the public is defined as (a) the broadcasting of the work; or (b) the making available to the public of the work by electronic transmission in such a way that members of the public may access it from a place and at a time individually chosen by them.

The provision being originated from the EU law,[602] the relevant principles have been established by the CJEU, and these are well summarised in the UK case *Paramount v British Sky Broadcasting*.[603] To reiterate some of the most important principles: (a) '[i]t is sufficient for there to be "communication" that the work is made available to the public in such a way that the persons forming that public may access it whether or not those persons actually access the work'; (b) '"[t]he public" refers to an indeterminate number of potential recipients and implies a fairly large number of persons'; and (c) '[i]n considering whether there is communication to "the public", it is not irrelevant that the communication is of profit-making nature'.[604]

Owing to the territoriality of copyright, it is noteworthy that liability by the provision will only arise where the act of communication is targeted at the public in the UK.[605] As Birss J suggested in *Warner*

[598] Mathew Appleyard, 'Corporate Responses to Online Music Piracy: Strategic Lessons for the Challenge of Additive Manufacturing' (2015) 58 Business Horizons 69
[599] CDPA 1988, s 17(2)
[600] CDPA 1988, s 17(3)
[601] CDPA 1988, s 17(6)
[602] InfoSoc Directive, Art 3
[603] *Paramount Home Entertainment v British Sky Broadcasting* [2013] EWHC 3479 (Ch); [2014] ECDR 7
[604] ibid., [12]
[605] *EMI Record Ltd v British Sky Broadcasting Ltd* [2013] EWHC 379 (Ch); [2013] ECDR 8

v Tunein, it is given that the Internet is international, and thus users accessing it can gain access to websites all over the world, but IP rights are territorial.[606] However, as emphasised in *Merck v Merck*,[607] the mere fact that a website can be accessed by local consumers is insufficient to establish a territorial link. Instead, various factors are to be considered, such as the appearance of the webpages, primary languages or currencies used on them, their national top-level domain names and the nature and size of the service provider's business etc.[608]

5.1.3. Infringing acts in relation to substantial part of copyright work

Such copying and communication to the public do not always have to take place in relation to the copyright work as a whole, but such acts done in relation to any substantial part of it are sufficient to constitute infringement.[609]

As to the meaning of substantiality, guidance was provided in *Designers Guild v Russell Williams*.[610] Lord Scott of Foscote held that copying of a substantial part could take place (a) 'where an identifiable part of the whole, but not the whole, has been copied', and (b) 'where copying has not been an exact copying of the copyright work but a copying with modifications'.[611]

However, what is taken must be qualitatively important to the copyright work as a whole; therefore, merely copying an unimportant part does not constitute infringement. And copying will not amount to infringement if alterations made are sufficiently extensive.[612]

5.2. Law of Design Rights Infringement

The registered proprietor of a design enjoys the exclusive right to *use the design* and any design that does not produce a different overall impression on the informed user.[613] The meaning of use of the design is described as 'the making, offering, putting on the market, importing, exporting or using of a product in which the design is incorporated or to which it is applied'[614] or 'stocking such a product for those purposes'.[615] A product here means any industrial or handicraft item except a computer

[606] *Warner Music UK Ltd and others v Tunein Inc.* [2019] EWHC 2923 (CH), [12]. The law was established by the CJEU in earlier trade mark and copyright cases. See, for example, Joined Cases C-585/08 and C-144/09 *Pammer v Reederei and Hotel Alpenhof v Heller* [2010] ECR I-12527; Case C-324/09 *L'Oréal v eBay* [2011] ECR I-06011 and Case C-173/11 *Football Dataco v Sportradar* [2012] ECLI:EU:C:2012:642
[607] *Merck KGaA v Merck Sharp& Dohme Corp & Ors* [2017] EWCA Civ 1834; [2018] ETMR 10
[608] *Warner Music UK Ltd and others v Tunein Inc.* (n 589)
[609] CDPA 1988, s 16(3)(a)
[610] *Designers Guild Limited v Russell Williams (Textiles) Limited (Trading as Washington DC)* [2001] ECDR 10 (House of Lords)
[611] ibid
[612] ibid
[613] RDA 1949, s 7(1)
[614] RDA 1949, s 7(2)(a)
[615] RDA 1949, s 7(2)(b)

program.[616] Performing any of the aforementioned acts without the consent of the registered proprietor infringes the right in the registered design,[617] and the registered proprietor could claim remedy, such as damages or injunctions, against the infringer.[618]

The owner of a UK unregistered design right has the exclusive right to reproduce the design for commercial purposes.[619] It is not only making articles to that design[620] but also making a design document recording the design for the purpose of enabling such articles to be made[621] that is included within the meaning of the reproduction.[622] The reproduction does not always need be the exact copying of a design; rather, copying of the substantial part of a design suffices to trigger the provision.[623] Without legitimate grounds, such as the consent or licence of the rightholder, a person who performs any of the acts exclusively permitted for the rightholder or authorises others to do those infringes the unregistered design right.[624]

A UK unregistered design right is only infringed where a design is reproduced for *commercial purposes*. It is distinguishable from copyright and UK registered design rights infringement, which does not require such requirements. Section 263(3) of the CDPA 1988 defines 'an act being done in relation to an article for commercial purposes' as 'its being done with a view to the article in question being sold or hired in the course of a business'.

Section 227(1) of the CDPA 1988 prohibits some types of acts, including having an article in one's possession for commercial purposes,[625] as well as selling, letting for hire, or offering or exposing for sale or hire an article,[626] provided that the article is an infringing article, and that the person doing these acts knows or has reason to believe it is an infringing article.

In respect of the relationship with copyright, copyright domain almost always takes precedence over UK unregistered design rights where both rights coexist in relation to the same design. Section 236 of the CDPA 1988 states that,

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[616] RDA 1949, s 1(3)
[617] RDA 1949, s 7A(1)
[618] RDA 1949, s 24A(1) and (2)
[619] In addition to primary infringement, set out in section 226 of the CDPA 1988, secondary infringement might take place where a person who does the restricted acts laid out in section 227 of the CDPA 1988 with the knowledge that or reasonable belief for the person to know that the article the person is dealing with is an infringing article.
[620] CDPA 1988, s 226(1)(a)
[621] CDPA 1988, s 226(1)(b)
[622] In relation to making a design document, a person who makes a design document should have an actual subjective purpose rather than objective purpose. See *Società Esplosivi Industriali SpA v Ordnance Technologies (UK) Ltd* [2007] EWHC 2875 (Ch); [2008] RPC 12, [62]. See also Howe, St. Ville and Chantrielle (n 428) 238
[623] CDPA 1988, s 226(2)
[624] CDPA 1988, s 226(3)
[625] CDPA 1988, s 227(1)(b)
[626] CDPA 1988, s 227(1)(c)

> where copyright subsists in a work which consists of or includes a design in which design right subsists, it is not an infringement of design right in the design to do anything which is an infringement of the copyright in that work.

It follows that, if a person is the owner of both copyright and a UK unregistered design right in the design in question, the person will have to choose the copyright domain where there are grounds to sue for both copyright and UK unregistered design rights infringement. It is problematic where the owner of copyright and UK unregistered design right is different persons.[627] In this case, the owner of a UK unregistered design right will have considerably limited power to protect their design.

5.3. Scenario 4: Issues Relating to Share/Sale of CAD Files

Scenario 4: Consumers share/sell a design on online platforms

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In this section, the copyright and design rights implications of sharing and selling CAD files on online platforms are discussed. There are three relevant parties in this scenario as follows:

(1) a person who *shares or sells* designs on online platforms
(2) a person who *downloads or purchases* designs on online platforms
(3) an intermediary (online platform) which *facilitates* the sharing and sale of designs

5.3.1. Copyright implications of Scenario 4

Liability of a person who shares or sells designs on online platforms

Where a person who shares or sells CAD files on online platforms is not the owner of copyright in the designs, or does not have any legitimate reason, such as consent or licence, a liability issue for copyright infringement could arise.

Sharing CAD files on the Internet through online platforms can amount to the act of communication, as the act of sharing in this scenario seems to fall within the definition of communication to the public in section 20(2)(b) and in the established case law.[628] First, the act of sharing is essentially to make CAD files available by electronic means to whomever could access the online platforms on which they are shared. Second, the public in this context is a fairly large and indeterminate number of

[627] For example, it is quite common that people on 3D printing online platforms create varied derivative versions of CAD files on the basis of an original CAD file initially uploaded, such as by modifying the shape, size or colour of the object, or by shifting the format of the CAD file from concrete design to meta design to add customisable features. In so doing, it is probable that there would appear new owners of copyright in those derivative versions of CAD files, which could divide the ownership of copyright and that of UK unregistered design right in the same design into two different persons.
[628] Mendis, '"The Clone Wars": Episode 1' (n 15); Malaquias (n 52)

consumers with seeking designs for 3D printing.[629] As for sale of CAD files, it is also arguable that the same analysis as the above could be applicable in the sense that a person must upload CAD files on online platforms first to enable potential buyers to access them.[630]

The act of communication must be targeted to the members of the public in the UK, in order for the sharing/sale of CAD files to be construed as an infringing act of communication of copyright work to the public by virtue of the established case law.[631]

To take an example of Thingiverse, the main language employed on the website is English, from which it could be inferred that the website is expected to be used by users in countries whose language is English, such as the USA, the UK, Australia and so on. According to Alexa site info,[632] the approximate proportion of visitors to the website for the 30 days up to 18 February 2020 who were from the UK amounted to 4.9%, compared to the United States (35.8%) and Germany (6.4%).[633] The proportion of the UK visitors was rather small compared to that of the US visitors, but it still sat in the top three. Although there is no definite number of UK visitors here, this implies the website is quite popular with UK visitors. Since it is the website hosting CAD files for free, there is no price tag attached to the uploaded CAD files, but an advert shown on the top of the main page promotes a set of 3D printers with US dollars. And the top-level domain is .com, which is an open top-level domain that any person or organisation in the world can use, which means the website is not particularly targeted to certain countries.

All the aforementioned factors being considered, it appears that sharing CAD files on Thingiverse could be construed as the act of communication being targeted to the public in the UK. Although the evidence here is not decisive, as factual evidence collected through web searching is quite limited, it seems the primary users of the website include the UK public: UK visitors are the third most common and the primary language of the website is English.

Liability of a person who downloads or purchases designs on online platforms

Downloading CAD files onto one's computer is likely to amount to copying as set out in section 17 of the CDPA 1988, as it is reproduction of them from the servers where they were hosted to the local

[629] Similarly, in *ITV v TVCatchup*, where the defendant live-streamed copyright works over the Internet to people who had TV licences and Internet connections, it was held that the streaming was targeted to an indeterminate and impliedly large number of potential recipients. See Case C-607/11 *ITV Broadcasting Ltd v TVCatchup Ltd* [2013] ECDR 9, [24]–[27]
[630] Mendis and others (n 16) 132
[631] See above 5.1.2. Communication of copyright work to the public (section 20 of the CDPA 1988)
[632] Alexa site info is a website that provides an automated analysis of websites, such as website traffic statistics. <www.alexa.com/siteinfo>
[633] Audience Geography <https://www.alexa.com/siteinfo/thingiverse.com> accessed 18 February 2020

storage in the computer. Purchasing CAD files also amounts to reproduction here, as it essentially involves downloading them onto one's computer for a fee.

In the case of streaming CAD files, which does not allow the designs to be stored on a permanent basis on the computer, it still is deemed transient reproduction, which is prohibited by section 17(6) of the CDPA 1988. Hence, a person who freely downloads, purchases or even utilises the 3D designs in the form of streaming could infringe copyright in the 3D designs, unless there is legitimate reason or exceptions are applicable.[634]

Liability of an intermediary facilitating the sharing and sale of designs

Operators of online platforms serving as an intermediary to host CAD files for the purposes of sharing/sale and downloading/purchasing could also become liable for copyright infringement by communication to the public if their act of facilitating is of more than a passive nature. In *Twentieth Century Fox v Newzbin*, for example, the court held that providing a service to enable identification of films with cataloguing and indexing system, which could help reduce time for searching films, is beyond passive.[635]

To take an example of Thingiverse, the website hosts CAD files that are freely downloadable by its users. The main page of the website is sectioned with adverts on the top and a few subcategories below, such as 'Global Feed', 'Featured Collections', 'Recently Made' and 'Customizable Creations'. There is a search box on the top-right corner of the website, which enables its users to search CAD files of their choice. Following through the Explore tab on the top, the users can see many design files uploaded and listed. On top of the list, there are more selectable categories for the users. For instance, these include '3D Printing', 'Art', 'Fashion', 'Gadgets' and 'Hobby', to name a few, within which there are more subcategories such as '2D Art', 'Art Tools' and 'Coins and Badges'. The existence of index system like this would massively help the users reduce time in searching for particular designs on the website and, considering the degree of categorisation, it is likely that the website is seen as acting beyond a passive facilitator.

[634] Similarly, a user of the websites who downloads and copies a torrent file (sound recordings) onto their computer was held to infringe copyright in it. See *EMI Record Ltd v British Sky Broadcasting Ltd* (n 588), [24]–[27]

[635] *Twentieth Century Fox Film Corp v Newzbin Ltd* [2010] EWHC 608 (Ch); [2010] FSR 21, [125]. A similar ruling in the CJEU: Case C-610/15 *Stichting Brein v Ziggo BV and another* [2017] Bus L R 1899, [38] ('It is clear from the order for reference that that platform indexes torrent files in such a way that the works to which the torrent files refer may be easily located and downloaded by the users of that sharing platform. … [I]n addition to a search engine, the online sharing platform TPB offers an index classifying the works under different categories, based on the type of the works, their genre or their popularity, within which the works made available are divided, with the platform's operators checking to ensure that a work has been placed in the appropriate category')

Yeggi[636] is another example of an intermediary that facilitates the sharing and sale of 3D designs. By contrast, it is not an online platform hosting CAD files on their server, like Thingiverse, but a search engine providing a list of designs with the hyperlinks to the websites where those are hosted.

Whether hyperlinking amounts to communication to the public has drawn heated academic debate[637] following the *Svensson* case[638] where the CJEU ruled that the provision of hyperlinks to the public who are not authorised to access the copyright works would amount to the communication to the public. In *Paramount v British Sky Broadcasting*, Arnold J held, while considering the academic debate and the relevant precedents, that the mere provision of a hyperlink is not sufficient to constitute communication to the public and there would be no difference if the hyperlinking results in framing. But he went on to say that, if the provision of hyperlinks makes it much easier for the public to find what they want, it will constitute communication to the public.[639]

Returning to Yeggi, the website provides a large number of hyperlinks to CAD files hosted on numerous online platforms. The website immensely reduces the time it takes for consumers to search particular designs, and thus it appears that the website could be liable for copyright infringement by communication to the public.[640]

Alongside primary liability that could arise by communication to the public in section 20 of the CDPA 1988, accessory liability by authorisation can also arise for intermediaries.[641] This will be further elaborated in the sections below.

5.3.2. Design rights implications of Scenario 4

Liability of a person who shares or sells designs on online platforms

In UK registered design law, there is no infringement provision that clearly applies to sharing or selling CAD files. In respect of primary infringement, section 7A of the RDA 1949 prohibits the use of a design, and examples of the use of a design are provided in section 7(2) of the RDA 1949, which seems to, intended or not, narrow down the scope of it. First, a design here in the provision appears to

[636] <https://www.yeggi.com>

[637] For example, a group of European academics at the European Copyright Society opined that hyperlinking, including both deep-linking and framing, does not amount to communication to the public within Art 3 of Directive 2001/29. See European Copyright Society, 'Opinion on the Reference to the CJEU in Case C-466/12 *Svensson*' (ECS, 15 February 2013) <https://europeancopyrightsocietydotorg.files.wordpress.com/2015/12/european-copyright-society-opinion-on-svensson-first-signatoriespaginatedv31.pdf> accessed 29 February 2020

[638] Case C-466/12 *Svensson v Retriever Sverige AB* [2014] ECLI:EU:C:2014:76

[639] *Paramount Home Entertainment v British Sky Broadcasting* (n 603), [32]–[34]

[640] Of course, the other requirements, such as whether the website is targeted at the UK public, must be met. From the brief look on *Yeggi*, it appears that the website is targeting at the UK public since its main language is English and, more decisively, there are a number of adverts displayed on the website in which diverse products and services are offered for sale in GBP

[641] For example, see *Twentieth Century Fox Film Corp v Newzbin Ltd* (n 635) and *Dramatico Entertainment Ltd v British Sky Broadcasting Ltd* [2012] EWHC 268 (Ch); [2012] 3 CMLR 14

be construed as meaning a tangible object ('a product'),[642] and the use of the design is exemplified as 'making, offering, putting on the market, importing, exporting or using of' or 'stocking' the product.[643] Therefore, if the meaning of 'use of a design' is strictly interpreted with reference to section 7(2) of the RDA 1949, a person who shares or sells CAD files on online platforms will not be liable for primary infringement of a UK registered design right, as CAD files are not tangible objects that can be classified as products.[644]

Sharing or selling CAD files on online platforms is essentially to enable the reproduction and manufacturing of the designs by the recipients or purchasers, leading to primary infringement of UK registered design rights by these people. In other types of IP law, this may constitute secondary or contributory liability; for example, in patent law, sharing or selling 3D designs could be deemed to be providing the essential means to put the invention into effect by virtue of section 60(2) of the Patents Act 1977.[645] However, there is no provision for secondary infringement in UK registered design law. The consequence is that sharing or selling 3D designs on online platforms will not raise any secondary liability.[646]

This then raises a question over whether there is any way at all to prevent sharing or selling CAD files on online platforms within the ambit of UK registered design law, because it is important that rightsholders have control over the circulation of design files to pre-empt a wide volume of physical reproduction of protected designs, which amounts to primary infringement.[647]

A possible and conceivable solution to this might be to interpret the meaning of 'use of a design' more broadly than 'use of a product'.[648] Section 7(2) of the RDA 1949 reads:

> For the purposes of subsection (1) above and section 7A of this Act any reference to the use of a design *includes* a reference to— [emphasis added]

The provision employs a word 'includes' rather than 'means'. It allows for a wider interpretation of the meaning of 'use of a design', implying that the acts provided as examples in this provision are not exhaustive.[649]

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[642] RDA 1949, s 7(2)(a). The meaning of 'a product' is set out in section 1(3) of the RDA 1949 (product means 'any industrial or handicraft item other than a computer program') See Chapter 3 for the discussion of whether a CAD file could be considered to be 'a product'

[643] RDA 1949, ss 7(2)(a) and 7(2)(b)

[644] On the contrary to this, there is an argument that a digital object like CAD files could be deemed to be 'a product' on the basis of the fact that design of digital objects like graphic user interfaces are registrable. See Margoni (n 418), Nordberg and Schovsbo (n 53), and Mendis and others (n 16) 63. Refer back to section 3.3. UK Registered Design Rights: Legal Status of CAD Files

[645] Bradshaw and others (n 17); Rosa Ballardini and others, 'Enforcing Patents in the Era of 3D Printing' (2015) 10 Journal of Intellectual Property Law & Practice 850

[646] Mendis and others (n 16) 141

[647] This point was raised in various legal literature, such as in Bradshaw and others (n 17); Mendis, '"The Clone Wars": Episode 1' (n 15); Mendis, '"Clone Wars" Episode II' (n 15); Malaquias (n 52)

[648] Mendis and others (n 16) 137

[649] Malaquias (n 52) 330

Yet, it appears that there is no reported UK case law in which the meaning of use of a design is interpreted beyond the limited scope set out by section 7(2) of the RDA 1949 or ever challenged.[650] However, a German case that employed a broader interpretation of the provision is noteworthy.[651] The German court in *Deutsche Bahn v Fraunhofer-Gesellschaft* expanded the scope of use of a design into including reproduction of design of the product into an image, by ruling that portraying an image of a product and using the depiction in a brochure for marketing purposes infringes the claimant's design right in the product.[652] The German case law may not be directly relevant to sharing/selling CAD files on online platforms. However, it opens the possibility that sharing/selling CAD files can be construed as use of a design. It remains to be seen whether such views are judicially accepted in the UK.[653]

Similarly, no provision in UK unregistered design law expressly prohibits sharing or selling CAD files on online platforms. Infringement provisions laid out in sections 226 and 227 of the CDPA 1988 appear to be constructed much more strictly and narrowly than their counterparts in UK registered design law, leaving little, if any, room for wider interpretation. To illustrate the point, section 226(1) of the CDPA 1988 reads:

> The owner of design right in a design has the exclusive right to reproduce the design for commercial purposes—
>
> (a) *by* making articles to that design, or
>
> (b) *by* making a design document recording the design for the purpose of enabling such articles to be made [emphases added]

The wording adopted in section 226(1) of the CDPA 1988 confines the scope of reproduction to those two acts above, with the use of the preposition 'by', which exhaustively specifies means of achieving something.[654] Hence, the meaning of prohibited reproduction here should be interpreted only with reference to subsections 226(1)(a) and (b). Meanwhile, section 226(3) of the CDPA 1988 sets out that a person authorising another to do anything that is prohibited by virtue of section 226 is also liable for infringement.

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[650] ibid., 331, citing Darren Smyth, 'How Is the Scope of Protection of a Registered Community Design to Be Determined?' (2013) 8 Journal of Intellectual Property Law & Practice 270

[651] Due to EU harmonisation of design law, UK and German registered design law are virtually the same. For that reason, it is possible and meaningful to compare German jurisprudence with the UK's

[652] Case I ZR 56/09 *Deutsche Bahn v Fraunhofer-Gesellschaft* [2012] GRUR 12/2011 (Bundesgerichtshof, 7 April 2011) 1117 in David Stone, *European Union Design Law: A Practitioners' Guide* (2nd edn, OUP 2016) 470

[653] Discussing the German case *Deutsche Bahn v Fraunhofer-Gesellschaft*, Malaquias also argues that 'if third parties were allowed to exploit 3DPFs in a world where 3D Printing technology is easily and widely accessible, the reward for the designer's creativity would be deeply affected, resulting in reduced incentives for future innovation in designs.' See Malaquias (n 52) 331. See also Efroni (n 506), emphasising the importance of regulating access

[654] In contrast, it is notable that section 7(2) of the RDA 1949 adopts a verb 'include', which non-exhaustively provides an example. The disparity in wording the infringement provisions in UK registered and unregistered design law would lead to a different scope of freedom in interpreting them

To apply the law, a moot point is whether 'making a design document' can be construed broadly as including other types of activities such as selling or sharing CAD files, and whether such selling or sharing CAD files can also be seen as 'authorisation of infringement' for people who can access them.

With regard to the meaning of section 226(1)(b) of the CDPA 1988, there seems to be no authority in enlarging upon the meaning of 'making'. The legislation differentiates between the use of the words 'make' and 'import' or 'sell', in relation to infringement arising with an article. As primary infringement, 'making an article' is prohibited,[655] whereas 'importing' or 'selling' the article is separately regulated as a prohibitive act as secondary infringement.[656] From this legislative construction, it might be inferred that the meaning of 'make' adopted in section 226(1) is intended to be construed as being confined to creation or reproduction rather than sale occurring afterwards.[657] Thus, it is reasonable to read the meaning of 'making a design document' within section 226(1)(b) in the same manner as section 226(1)(a), namely that it only means creating or reproducing a design document, excluding selling or sharing it. Sharing or selling CAD files is, therefore, not an act that constitutes infringement in UK unregistered design law.[658]

Sharing or selling CAD files on online platforms is also not within the scope of secondary infringement in section 227 of the CDPA 1988. Section 227(1)(c) of the CDPA 1988 makes a person who sells or exposes for sale an infringing article in the course of a business liable for infringement, with the knowledge requirement. If the meaning of an infringing article could embrace CAD files, it is then possible that selling CAD files on online platforms could be infringing. However, section 228(6) of the CDPA 1988 explicitly states that a design document is not included within the meaning of 'infringing article'. As was established earlier, it is likely that most CAD files can be considered to be design documents,[659] and, as a result, sharing or selling CAD files on online platforms would not be infringing by secondary infringement.

Lastly, it is then questionable whether sharing or selling CAD files can be interpreted as authorising another person to make articles to the design stored in the CAD files.[660] Authorisation means the grant

[655] CDPA 1988, s 226(1)(a)
[656] CDPA 1988, s 227(1)
[657] Malaquias (n 52)
[658] ibid
[659] See section 3.4. UK Unregistered Design Rights: Legal Status of CAD files
[660] It should be noted that the thesis takes a different angle to discuss the law of authorisation to the mainstream approach. The law of authorisation has been recently relied upon mostly to discuss intermediary liabilities, such as peer-to-peer protocols or online websites that facilitate online copyright infringement. This approach is, in part, taken by rightsholders to pursue online intermediaries, considering that it is economically and ethically more viable to pursue the intermediaries than individual infringers. However, this part applies the law of authorisation to discuss whether sharing/selling CAD files by consumers can constitute UK unregistered design right infringement, in the absence of provision of primary infringement. For discussion of copyright infringement by authorisation and intermediary liabilities, see Min Yan, 'The Law Surrounding the Facilitation of Online Copyright Infringement' (2012) 34 European Intellectual Property Review 122; Paul Davies, 'Costs of Blocking Injunctions' (2017) 4 Intellectual Property Quarterly 330. See also Recital 59 of the Information Society Directive

or purported grant of the right to do the act complained of, whilst it does not include mere enablement, assistance or even encouragement of the infringement.[661] In distinguishing authorisation from mere enablement, the court in *Thelma Madine v Leanne*[662] held that the existence of a contractual agreement in which the defendant was seen as having the right to exercise some control over the design in question and the fact that the defendant provided a photograph to the other defendant *specifically* to make the article embodying the design in question was the act of authorisation.

First of all, it is undeniable that the provision of CAD files will serve as crucial means for raising potential infringement, as those who access CAD files can readily fabricate physical objects for commercial purposes after obtaining them.[663] It appears that people selling or sharing CAD files would naturally look legitimate, having the right to exercise some control over the design carried in CAD files. Where CAD files are sold or shared on online platforms by consumers, there is often the required process in which they must claim that they are the rightful owner of the CAD file, by ticking in the box stating so, for example. Consumers are often obliged to do this, according to the terms and conditions set out by the website operators, or otherwise they cannot continue to use the website.[664] In effect, owing to such an obligatory declaration, it is generally presumed that CAD files have been uploaded on the website by the legitimate owners. Furthermore, the use of open-source licences that often accompany the uploaded CAD files could even more create an impression that the further use of the CAD file will be lawful.[665]

Having said that, in most cases sharing or selling CAD files on online platforms might not be intended specifically for somebody to do infringing acts. This is different from when a person directly asks someone else to make an article, like in the *Thelma* case.[666] The essence of the act of sharing or selling CAD files is to enable the users of the online platforms on which they are being shared or sold to use them for their own purposes, which include physical fabrication or design reproduction and modification. In doing so, some of the users might actually go on fabricating a physical object to the design carried in the CAD file, with a view to selling or hiring it out to other people, which can fall

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[661] *Thelma Madine (t/a NICO), Camal Enterprises Limited T/A the English Ladies Co, v Leanne Phillips (T/A Leanne Alexandra), Pauline Phillips & others (stayed)* [2017] EWHC 3268 (IPEC), [70]

[662] ibid

[663] In the case of authorisation by supply, whether the equipment or other material supplied constitutes the means used to infringe plays an important role. See *Twentieth Century Fox Film Corporation v Newzbin* (n 635), [90]

[664] For example, see terms and conditions of i.materialise – one of the major 3D printing online platforms: 'i.mateiralise contractually prohibits its users from using the service to order and/or sell products that infringe third party intellectual property rights (including among others copyright, trademark, design and model, patent, trade dress and right of publicity, etc.)' and 'You may not post, transmit, share or allow to be shared User Content on the Site that you did not create or that you do not have permission to post'. <https://i.materialise.com/en/legal/terms#intellectualProperty> accessed 12 May 2020

[665] It was suggested in Chapter 4 that public copyright licences, such as CCL, can mislead consumers into believing that use of CAD file, including physical fabrication, can be lawful. However, CCL is only relevant to copyright, and thus it has no practical effects on design rights cases. See section 4.4.3. Limitations and potential legal issues of CCL in the 3D printing context

[666] *Thelma Madine* (n 661)

squarely within the scope of infringement of UK unregistered design rights.[667] On the other hand, some of them might use CAD files for purely personal use and some not use them at all. Without specific instructions, such as to let the users do the prohibited acts, it will be entirely their decision whether to do the infringing acts.

This argument could be supported by a number of copyright cases concerning authorisation. In *CBS v Amstrad*,[668] Lord Templeman held that the defendant did not authorise but merely conferred on the purchaser the power to copy by selling record machines. On the other hand, later in *Twentieth Century Fox v Newzbin*,[669] the defendant was held to authorise its members to copy films provided on its website by facilitating its users to access copyright works, whilst not installing any kind of filtering systems to prevent infringement. Similarly, in the *Dramatico* case,[670] the operators of the Pirate Bay website were held to authorise their users' infringing acts by their promoting the website to users by saying that they could freely download music whatever copyright law might have to say about it. Arnold and Davies argued that the disparity in these rulings can be reconciled in the sense that the machines sold in the *CBS* case[671] were:

> both capable of, and used for, substantial non-infringing use, whereas the websites in both *Newzbin* and *Dramatico* were almost exclusively concerned with infringing content.[672]

Therefore, it might be argued that merely sharing or selling CAD files to indefinite and unspecified users on online platforms may only amount to mere enablement rather than authorisation, as the situation with 3D printing online platforms seems similar to that in the *CBS* case.

Liability of a person who downloads or purchases designs on online platforms

UK registered design law does not provide any form of liability for dealing with CAD files, and thus downloading or purchasing them on online platforms would not constitute infringement within the established interpretation of the law.

Nevertheless, if the scope of section 7(2) of the RDA 1949 were interpreted broadly, as with the analysis above, there is the potential that downloading or purchasing CAD files on online platforms could also fall within the definition of 'use of a design' and amount to infringement. Downloading or purchasing CAD files essentially equates to the reproduction of them, which could directly lead to physical manufacture. Therefore, it seems not unreasonable to grant the owner the right to prevent reproduction of design.

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[667] CDPA 1988, s 226(1)(a)
[668] *CBS Songs Ltd v Amstrad Consumer Electronics Plc* [1988] AC 1013 (House of Lords)
[669] *Twentieth Century Fox Film Corp v Newzbin Ltd* (n 635)
[670] *Dramatico Entertainment Ltd v British Sky Broadcasting Ltd* (n 641)
[671] *CBS Songs Ltd v Amstrad Consumer Electronics Plc* (n 668)
[672] Arnold and Davies (n 467) 455

Likewise, liability for downloading or purchasing CAD files will be determined by the assessment of whether the act constitutes 'making a design document' within section 226(1)(b) of the CDPA 1988. It is uncertain whether the act of downloading or purchasing CAD files can be construed as that of making a design document, owing to the paucity of authority. But it could be argued that it would be so because downloading and purchasing CAD files on online platforms normally involves their reproduction from the servers to the person's computer storage, and in doing so the person who downloads or purchases the CAD file brings into existence another CAD file, which can be further utilised to produce an article.

However, it should be noted that downloading or purchasing CAD files alone will not make the act infringing. Additionally, the purposes of downloading or purchasing CAD files must be not only for enabling an article to be made to the design stored in the CAD files[673] but also commercial.[674] An infringer must have the intention at the time of downloading or purchasing CAD files that an article is enabled to be made by this.[675] If the act is done for other purposes (e.g. modifying the CAD files, reverse engineering the CAD files to study the design for product development, or on some rare occasions making a wall decoration with the design as an artwork[676]), it will not amount to infringement.

Meanwhile, the intention to use an article commercially in the course of business must also exist. The meaning of commercial purpose here is not clear, as section 263(3) of the CDPA 1988 sets out the definition only in relation to an article, but not a design document.[677] Nonetheless, it could be argued that downloading or purchasing CAD files that is done for purely personal use will be unlikely to make the person doing so liable for infringement. In conclusion, infringement of UK unregistered design rights could take place where a person downloads or purchases CAD files, but only under restrictive circumstances.

Liability of an intermediary facilitating the sharing and sale of designs

Within the current scope and established interpretation of UK registered design law, intermediary liability is unlikely to arise, as there is no provision of contributory infringement in UK registered design law as in UK patent law.

[673] CDPA 1988, s 226(1)(b)
[674] CDPA 1988, s 226(1)
[675] *Società Esplosivi Industriali SpA v Ordnance Technologies (UK) Ltd* (n 606), [56]–[62]
[676] ibid., [60]
[677] The meaning of commercial purpose within the scope of infringement of UK unregistered design right will be further elaborated below in section 5.3.2. Design rights implications of Scenario 4. See further 6.3.2. UK registered design rights implications of Scenario 4 for the meaning of commercial purpose in respect of the private and non-commercial use exception

In the same vein, there is no provision in UK unregistered design law that could be directly applicable to intermediaries. It could be of relevance to discuss whether the act of facilitation can amount to the act of authorisation. According to the analysis preceded above,[678] intermediaries' role in facilitating the sharing and sale of CAD files appears to be mere enablement rather than authorisation, as they are not in a position where they claim they are the owner of the design right in the CAD files, and therefore it is impossible for them to grant or purport to grant a right.

5.4. Scenario 5: Issues Relating to the Fabrication of Physical Objects from CAD Files

Scenario 5: Consumers fabricate a physical object at bureau services or at home

5.4.1. Copyright implications of Scenario 5

The fabrication of a physical object from CAD files can be interpreted as copying that is prohibited by section 17 of the CDPA 1988. This is because copying in relation to a literary or artistic work, into which a CAD file could potentially be categorised, means reproducing the work in any material form.[679] In addition, section 17(3) of the CDPA 1988 sets out that, in relation to an artistic work, copying includes the making of a copy in three dimensions of a 2D work. Where a person produces a physical object, a 3D model depicted in a CAD file in the form of computer data is reproduced into a physical form. Therefore, producing a physical object will amount to copyright infringement unless there is legitimate reason.

Where a person uses a bureau service to fabricate a physical object, the person does not directly copy CAD files. But the person could still be liable for copyright infringement by the authorisation set out in section 16(2) of the CDPA 1988. The meaning of authorisation here is virtually the same as that in UK unregistered design rights, explained above.[680] The key consideration is then whether the act of commissioning physical fabrication to a bureau service can be seen as granting or purporting to grant the right to do the act complained of.

There were cases where a similar issue was dealt with. For example, in the *Standen* case the fact that a dealer placed with a manufacturer supplier an order for the supply of spare parts for sugar beet harvesters was held to be authorisation of reproducing drawings of these products.[681] Similarly, the

[678] Refer back to section 5.3.2. Design rights implications of Scenario 4
[679] CDPA 1988, s 17(2). See also Bradshaw and others (n 17), Mendis, '"The Clone Wars": Episode 1' (n 15) and Malaquias (n 52)
[680] See section 5.3.2. Design rights implications of Scenario 4
[681] *Standen Engineering Ltd and Another v A. Spalding Sons Ltd and Others* [1984] FSR 554 (Chancery Division)

defendant having ordered security doors was held in *Pensher v Sunderland* to be liable for infringement by authorising reproduction of the drawings depicting the design of the doors at issue.[682] These cases clarify that placing an order for the physical fabrication of a design document can be considered to approve and sanction the making of a physical object to the design, and further to supply the element of causation derived from the relationship formed between the authoriser and the infringer.[683]

To apply the law, a person could be liable for copyright infringement by providing CAD files and placing an order with a bureau service to fabricate a physical object out of them. This is because this act is almost identical to the aforementioned facts that were held to be authorisation in the previous cases discussed above.[684]

A bureau service fabricating a physical object on behalf of its customer could be liable for copyright infringement, along with the customer possibly being liable for copyright infringement by authorisation. This is because, as noted above, the fabrication of a physical object from CAD files can be interpreted as copying, which is prohibited in section 17 of the CDPA 1988.

As primary infringement, reproduction of copyright work does not require knowledge that the alleged infringer is copying a copyright work without consent.[685] Thus, copying a copyright work by a bureau service that claims that it did not know that it was infringing the copyright in the work will not serve as a defence. This was affirmed in *Sony v Easyinternetcafé*,[686] where the defendant that operated a business in which it provided customers with CD burning service in return for a fee was held to be liable for copyright infringement by reproducing sound recordings onto a CD at the request of its customer. The defendant argued that it merely facilitated the infringement by providing the means by which the copy was made, and furthermore it did not know that there arose infringement by this process. The court, however, refused this argument and held that liability for infringement under sections 17 and 18 of the CDPA 1988 is strict, and therefore it is no defence for a person copying an item to assert that they did not know they were infringing a copyright.[687]

However, it should be noted that copyright infringement arising from physical reproduction will be subject to the design-related exceptions such as section 51(1) of the CDPA 1988. Owing to the exceptions, the scope of copyright infringement is limited to where the physical object reproduced from CAD files can be categorised as an artistic work. A difficult question is, then, how to determine

[682] *Pensher Security Door Co. Ltd v Sunderland City Council* [2000] RPC 249 (Court of Appeal), 276–79
[683] *RCA Corporation v John Fairfax Sons Ltd* [1982] RPC 91 (Supreme Court New South Wales)
[684] Having said that, it should be noted that the law of authorisation has been mostly relied upon and applied in a particular context to deter facilitation of copyright infringement by supplying an essential means, such as in *CBS v Amstrad* (n 668), *Twentieth Century Fox v Newzbin* (n 635), or *Dramatico v British Sky Broadcasting* (n 641). See above section 5.3.2. Design rights implications of Scenario 4
[685] CDPA 1988, s 17
[686] [2003] EWHC 62 (Ch); [2003] ECDR 27
[687] ibid., [33]. See also Mendis, 'Back to the Future' (n 383) 72

whether they are for an artistic work or not. The law is not clear on this point, which would bring about significant uncertainty in the application of law in the 3D printing context. This will be analysed later in detail in Chapter 6.

5.4.2. Design rights implications of Scenario 5

UK registered design rights

In contrast with legal complexity regarding the use of CAD files, design rights liability relating to the manufacture of physical objects is rather straightforward, as physical fabrication is seen as a typical way of infringement.[688] Without legitimate reasons, consumers who fabricate physical objects whose designs are protected can be liable for infringement of UK registered design rights.

However, the liability of consumers using bureau services that are not directly involved in the infringement is less straightforward, with the UK registered design law having no statutory provisions regarding authorisation, secondary or contributory infringement.[689] That said, as was discussed above, there is the potential that consumers' contributory acts might be construed as primary infringement, depending on the scope of section 7 of the RDA 1949.[690]

UK unregistered design right

By virtue of section 226(1)(a) of the CDPA 1988, the manufacture of objects whose design is protected by UK unregistered design right is prohibited. What is notable here is, however, unlike UK registered design rights and copyright, such physical reproduction must be carried out for commercial purposes to amount to infringement. Section 263(3) of the CDPA 1988 lays out that:

> [r]eferences in this Part to an act being done in relation to an article for 'commercial purposes' are to its being done with a view to the article in question being sold or hired in the course of a business.

The definition of commercial purposes given by the statute seems quite restrictive, according to the choice of wording adopted in the provision. The upshot is that a person who fabricates a physical object for any reasons other than selling or hiring it out will not infringe UK unregistered design rights.[691]

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[688] RDA 1949, s 7(2)(a)

[689] See Nordberg and Schovsbo (n 53). Being wary of potential issues arising from 3D printing, recent EC reports on 3D printing proposed that there is the potential need for introducing secondary infringement into the EU design legislation. See Dumortier and others (n 56) 133; Mendis and others (n 16)

[690] On the same view in relation to Community design rights, see Nordberg and Schovsbo (n 53) 298

[691] The restricted construction of the definition of commercial purposes may cause some commercial acts, such as reproduction for promotional purposes or even for producing tools as capital equipment for further commercial use, to be non-infringing within the meaning of section 226 of the CDPA 1988. It should be

Hence, a person who fabricates a physical object at home will be liable for infringement of UK unregistered design rights only if the person intends to sell or hire out the object, and this implies that the liability will not arise where the person intends the object for personal use.[692] A bureau service commissioned to fabricate a physical object for its customer obtains commercial gain, such as a service fee for manufacturing an object and for materials used in the manufacturing process. Nevertheless, the commercial gain is technically not derived from selling the object the bureau service manufactured but in return for providing a manufacturing service to its customer. Moreover, it would be the intention of the bureau service that it fulfils the order placed by its customer, which is the production of a physical object with the provided CAD file, rather than selling or hiring out the object to its customer. As a result, the bureau service will not also be liable for infringement in a case where it produces a physical object on behalf of its customer, owing to the lack of commercial purposes within the meaning of section 226(1) of the CDPA 1988.[693]

A person who provides CAD files and commissions a bureau service to produce a physical object from CAD files whose design is protected by a UK unregistered design right may be liable for infringement by authorisation. It is already established that placing an order for manufacturing could be construed as the act of authorisation in the copyright sense, and it would not be unjust to apply the same analysis to the case of UK unregistered design right.[694] However, there is an extra point that should be clarified in advance for section 226(3) of the CDPA 1988 to apply in this scenario. Liability by authorisation only arises where a person is authorised to do anything that by virtue of section 226 of the CDPA 1988 is the exclusive right of the design right owner.[695] Therefore, the order made by the person must be construed as authorising a bureau service to make articles to the design carried by the CAD file *for commercial purposes*, in order for the authorisation to raise liability.

An issue is then who must possess such subjective requirement of commerciality, with regard to which there appears to be no authority. According to the strict interpretation of 226(3) of the CDPA 1988, a bureau service must be authorised not just to produce physical objects whose design is protected by a UK unregistered design right but to do so with a view to selling or hiring out the physical objects they produced. This is because, without such commercial purposes, production of the physical object is permitted within UK unregistered design law and authorising permissible acts should not be deemed infringement. It is, however, hard to conceive in what ways such a state of mind can be authorised. Moreover, it would be common as just discussed above that a bureau service has no intention of selling or hiring out the physical objects they produced for its customer under the usual

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compared with the scope of commercial purposes within the private and non-commercial exception. See Chapter 6 for further discussion

[692] Malaquias (n 52)

[693] However, it should be noted that the result can differ depending on the definition of commercial purpose. For example, see ibid

[694] See above 5.4.1. Copyright implications of Scenario 5

[695] CDPA 1988, s 226(3)

commissioning contract, in which a bureau service manufactures physical objects with the CAD file provided by its customer for a price.

On this matter, UK courts have been silent. Indeed, there have been a number of cases where the court held that a person was responsible for authorising the manufacture of an article[696] but there was no reference to the requirement for commercial purposes. It is rather understandable, in relation to authorisation in copyright cases, that acts such as copying or communication to the public are those which are exclusively conferred upon the copyright owner without any subjective requirement. Hence, in determining whether there is authorisation, it is irrelevant whether the copying or communicating to the public copyright works is done for commercial purpose. However, it is different in the case of UK unregistered design rights, as the owner of a UK unregistered design right has the exclusive right to reproduce the design only for commercial purposes.

If the court's approach is followed, a problem may arise. A person who places an order with a bureau service for manufacturing a physical object will be almost always deemed to be granting authorisation and, thus, liable for infringement of UK unregistered design right. It could engender a bizarre consequence, discriminating between the person using a bureau service from the person producing a physical object at home for themselves. The latter would not be liable if the manufacture were done for non-commercial purposes, such as for their own use, whereas the former would be so by authorisation.

A possible solution to the problem is to consider the state of mind of the person who grants authorisation. It has been suggested that the rationales for accessory liability –authorisation, in this case – may essentially rest upon the principles of responsibility and culpability.[697] In other words, a person who gives authorisation becomes liable, as the person was responsible for infringement by participating in the primary wrong, and culpable in that the person acted with a certain mental element. In that sense, it seems important and relevant to consider the authoriser's state of mind in determining authorisation where assessing subjective requirements is necessary. If an authoriser has no intention to sell or hire out the physical object that the authoriser commissioned a bureau service to produce, it is not unreasonable to treat the authorisation as non-infringing the same way as the person producing a physical object for themselves. However, if there were such commercial purposes, the law can catch the person as liable for infringement by authorisation.

[696] See, for example, *Standen* (n 681), *Pensher* (n 682) and *Thelma Madine* (n 661)
[697] Arnold and Davies (n 467) 443

5.5. Enforcement of IP Rights in the 3D Printing Environment

This section discusses IP enforcement landscape in the 3D printing environment. First, it examines enforcement challenges arising as a result of uncertainty of UK copyright and design laws in the 3D printing context. Following that, it looks into a number of enforcement strategies, including the pursuit of individual infringers and intermediaries and the adoption of technological measures, and assesses their viability in the 3D printing context.

5.5.1. Impact of uncertainty of law on the enforcement landscape

This chapter has so far established that there is uncertainty about the scope of infringement in relation to the use of CAD files.[698] The situation with the UK design laws seems especially obscure, as it remains highly debatable whether dealing with digital design documents, such as CAD files, is within the scope of infringement.[699] Mendis emphasised the importance of reconsidering UK design laws and the business models adopted by toy/hobby manufacturers in the growing 3D printing environment.[700] The EC reports on 3D printing highlighted that the lack of clarity on the protection of CAD files and the scope of EU design rights infringement, including indirect infringement and intermediary liability, can lead to challenges to EU design rightsholders.[701] Meanwhile, Anti Copying In Design (ACID)[702] noted the lack of criminal infringement provisions in UK unregistered design law and its potential detrimental impact on criminal enforcement in the UK design sector.[703]

Uncertainty of law can lead to barriers to IP enforcement because, as Weatherall et al. highlighted, the enforcement of IP rights can only begin where the scope of IP rights is clearly defined so that the law grants 'meaningful exclusivity to the innovations, brands, or creations'.[704] The Online Copyright Infringement Tracker also noted that ambiguity around regulation has been one of the key enablers of online copyright infringement.[705] As such, it is important to note that clarity of law is of great relevance to the enforcement landscape, and, therefore, seeking clarity on the protection of CAD files and other relevant provisions, which the thesis aims to achieve, is vital to reduce potential IP infringement and to strengthen the enforcement framework in the 3D printing environment.

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[698] See Chapters 1 and 2 for more details about features and particularities of the design activities, and Chapter 3 for discussion of the legal status of CAD files

[699] See section 5.3. Scenario 4: Issues Relating to Share/Sale of CAD Files. For the EU perspectives, see *Factual Summary report on the public consultation on the evaluation of EU legislation on design protection (Ref. Ares(2019)497430)* (30 July 2019) 128, cited in Mendis and others (n 16) 137

[700] Mendis, '"The Clone Wars": Episode 1' (n 15) 164. See also Elam (n 53) for EU design laws

[701] Mendis and others (n 16). See also Jos Dumortier and others (n 44)

[702] ACID is one of the leading UK organisations representing designers. <www.acid.uk.com>

[703] UKIPO, *IP Crime and Enforcement Report 2018-19* (UKIPO, 2019) 22–23. For 3D printing campaigns by ACID, see 'IP & 3D Printing Safeguarding the Future! A Debate' (*ACID*) <www.acid.uk.com/ip-3d-printing-safeguarding-future-debate> accessed 4 February 2021

[704] Kimberlee Weatherall, Elizabeth Webster and Lionel Bently, *IP Enforcement in the UK and Beyond: A Literature Review* (SABIP, 2009) 8–9

[705] UKIPO, *Online Copyright Infringement Tracker: Latest Wave of Research (March 2019)* (UKIPO, 2020) 5

5.5.2. Viability of enforcement against individual consumers in the 3D printing context

The most basic enforcement strategy for IP rightsholders is to pursue individual consumers who allegedly commit infringement by unlawful use of protected CAD files, or manufacture of physical objects whose design is protected by IP rights, such as by bringing an action for infringement against them.[706] This section discusses the viability of this enforcement strategy in the 3D printing context.

The development of the Internet, online platforms and consumer 3D printers creates a favourable environment for consumers to readily access designs and produce physical objects, as well as an environment where IP infringement can, therefore, easily take place.[707] The fact that there is a wealth of content available for consumers on the Internet and that accessing such content through illegal routes is relatively easy entices them to partake in infringing activities.[708]

IP infringement in the 3D printing environment is based on anonymity and mutuality of infringers;[709] it arises anonymously in the individual's home, reducing the personal impact of the violation and moral opposition, and is facilitated by other individuals in online communities.[710] Such features can make the pursuit of individual infringers extremely challenging in the 3D printing environment.

The music industry confronted similar challenges that IP rightsholders would have now with 3D printing, due to the development of disruptive peer-to-peer (P2P) file-sharing technology.[711] An empirical analysis of individual file-sharing behaviours indicated that users were more willing to disseminate files if reciprocal acts were expected from other users, and that costs had a negative impact on file-sharing.[712] Based on this observation, the music industry sued individual users who shared copyright-protected music files on P2P networks, anticipating that it would increase the costs of participating in P2P file-sharing and thus reduce willingness to share.[713]

However, it was proved that this enforcement strategy ended up as a failure.[714] The Gowers Report highlighted that legal actions against individual infringers undertaken by the UK entertainment

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[706] For relevant provisions regarding available remedies for copyright and design rightsholders, see CDPA 1988, ss 96–115 (copyright); RDA 1949, ss 24A–25; CDPA 1988, ss 229–235 (UK unregistered design rights)
[707] Bradshaw and others (n 17); Mendis, '"The Clone Wars": Episode 1' (n 15)
[708] UKIPO, *Online Copyright Infringement Tracker* (n 705) 5
[709] Stefan Larsson and others, 'Law, Norms, Piracy and Online Anonymity: Practices of De-identification in the Global File Sharing Community' (2012) 6 Journal of Research in Interactive Marketing 260
[710] Appleyard (n 598)
[711] Peter Alexander, 'Peer-to-Peer File Sharing: The Case of the Music Recording Industry' (2002) 20 Review of Industrial Organization 151
[712] Jan Becker and Michel Clement, 'Dynamics of Illegal Participation in Peer-to-Peer Networks – Why Do People Illegally Share Media Files?' (2006) 19 Journal of Media Economics 7
[713] ibid
[714] However, pursuing individual infringers is still considered to be an important measure in the criminal prosecution of IP infringers. See Neil Natanel, 'Impose a Noncommercial Use Levy to Allow Free Peer-to-Peer File Sharing' (2003) 18 Harvard Journal of Law & Technology 1, 18

industry had failed to deter other online users from further engaging in unlawful file transfers.[715] It is also submitted that pursuing individuals is not cost-effective, in that specifying claims and defendants for each infringement is often a burdensome process that costs much time and money, and the obtainable rewards are not worth as much as the effort and cost that are expended for the infringement action.[716] The past experiences will likely have practical implications on enforcement of IP rights in the 3D printing environment, especially in relation to dealing with the illicit dissemination of CAD files.[717]

Against a backdrop of such pitfalls, enforcement strategy has evolved into involving intermediaries in the legal process.[718] On the one hand, intermediaries are attractive enforcement targets for IP rightsholders, in that not only is enforcement against intermediaries more cost-effective than pursuing individual infringers but it also allows claimants to avoid the bad publicity potentially generated from lawsuits against consumers.[719] On the other hand, intermediaries are increasingly viewed as a partners in IP rights enforcement, in that intermediaries' ability to control third-party actions makes them effective gatekeepers for the prevention of IP infringement.[720] However, concerns also arise in relation to the legal development, such as that privatisation of law enforcement can undermine fundamental rights and the procedural safeguards of due process.[721] The next section will discuss the implications of the involvement of intermediaries for IP enforcement in the 3D printing environment.

5.5.3. Intermediary liability in the 3D printing context

Injunctions and notice and takedown procedures

One of the crucial legal developments in the EU and UK relating to the IP enforcement landscape is the introduction of injunction against intermediaries whose services are used by third parties to infringe IP rights.[722] Legal grounds for this remedy are enshrined in a number of the EU directives[723] and UK national legislation, such as the CDPA 1988. In the UK, implementation was made in 2003,

[715] Andrew Gowers, *Gowers Review of Intellectual Property* (Stationery Office, 2006) 101–03
[716] Paul Davies, 'Costs of Blocking Injunctions' (2017) 4 Intellectual Property Quarterly 330; See also Ruth Soetendorp and others, *Research into Designs Infringement: Attitudes and Behaviour of Design Rights Owners towards Infringement* (UKIPO, 2018)
[717] Bradshaw and others (n 17); Mendis, '"The Clone Wars": Episode 1' (n 15)
[718] Lobel (n 463)
[719] Yan (n 660)
[720] Kohl (n 480) 190–91
[721] European Commission, *Public Consultation on the Evaluation and Modernisation of the Legal Framework for the Enforcement of Intellectual Property Rights: Summary of Responses* (European Commission, 2016) 48
[722] Eleonora Rosati, 'Intermediary IP Injunctions in the EU and UK Experiences: When Less (Harmonization) Is More?' (2017) 12 Journal of Intellectual Property Law & Practice 338
[723] The relevant provisions in the EU Directives are article 8(3) of the InfoSoc Directive, recital 40 to the E-Commerce Directive and Article 11 of the Enforcement Directive

only in relation to copyright and related rights,[724] and this led to uncertainty of the scope of the injunction in the UK.[725] In 2014, the High Court in *Cartier v Sky* finally addressed the issue, whereby Arnold J clarified that the court had the jurisdiction to grant injunctions against intermediaries in relation to infringement of IP rights other than copyright, based on the interpretation of national laws.[726] As a result, the scope of injunctions in the UK has become clearer, enabling not only copyright holders but also other IP rightsholders to seek injunctions against intermediaries.[727]

Injunctions are powerful tools to deter IP infringement. The scope of injunction is broad: IP rightsholders can utilise injunctions not only to repress existing IP infringement but also to prevent further infringement.[728] The fact that Internet service providers (ISPs), such as British Telecommunications, are within the scope of intermediaries against which the injunction can be sought provides large benefits to IP rightsholders.[729] It is often the case that ISPs are relatively easily identifiable in most jurisdictions, and thus targeting ISPs can be highly effective and pragmatic choices for IP rightsholders.[730] Furthermore, injunctions are even able to be sought against innocent intermediaries.[731] In this sense, the injunctive liability of intermediaries is characterised as the derailment from the tracks of tort law, such as from pursuing wrongdoers to pursuing those who have the resources and factual and legal means to deter IP infringement,[732] leading intermediaries to bear enhanced responsibility and accountability for unlawful activities by their users.[733]

At the same time, notice and takedown (NTD) procedures provide an important route to enforcement against intermediaries. NTD procedures enable a third party to file a complaint ('a notice') to the operator of intermediaries and request the operator to remove ('takedown') illicit content uploaded by

[724] For the additional knowledge requirement added to the UK version of injunction, see Althaf Marsoof, 'The Blocking Injunction – A Critical Review of Its Implementation in the United Kingdom in the Context of the European Union' (2015) 46 International Review of Intellectual Property and Competition Law 632, 635
[725] *L'Oréal SA v eBay International AG* [2009] EWHC 1094, [2009] RPC 21, [447]–[454]
[726] *Cartier International AG v British Sky Broadcasting Limited* [2014] EWHC 3354 (Ch), [92]–[138]
[727] For more discussion on developments of intermediary injunctions in the UK domestic law, see Jane Cornwell, 'Injunctions and Monetary Remedies Compared: The English Judicial Response to the IP Enforcement Directive' (2018) 40 European Intellectual Property Review 490
[728] Case C-324/09 *L'Oréal v eBay International AG* [2011] ECR I-06011
[729] The scope of the notion of intermediary is fairly broad. Apart from ISPs, online marketplaces and social networking platforms are also examples of intermediaries within the scope of the Enforcement Directive. For more discussion, see Folkert Wilman, 'A Decade of Private Enforcement of Intellectual Property Rights under IPR Enforcement Directive 2004/48: Where Do We Stand (and Where Might We Go)?' (2017) 42 Entertainment Law Review 509, 520–23
[730] Marsoof (n 724)
[731] Case C-494/15 *Tommy Hilfiger Licensing LLC v Delta Center A.S.* [2016] ECLI:EU:C:2016:528, [22]; Case C-324/09 *L'Oréal v eBay International AG* [2011] ECR I-06011, [127]
[732] Martin Husovec, 'Injunctions against Innocent Third Parties: The Case of Website Blocking' (2013) 4 Journal of Intellectual Property, Information Technology and E-Commerce Law 4
[733] See Martin Husovec, *Injunctions against Intermediaries in the European Union: Accountable but Not Liable?* (CUP 2017). See also Giancarlo Frosio and Martin Husovec, 'Accountability and Responsibility of Online Intermediaries' in Giancarlo Frosio (ed), *The Oxford Handbook of Online Intermediary Liability* (OUP 2020)

its users.[734] The E-Commerce Directive incentivises intermediaries to employ NTD procedures,[735] by introducing a safe harbour that exempts the pecuniary and criminal liability of intermediaries under certain circumstances.[736] However, there are no EU and UK statutory regulations directly governing NTD procedures; instead, the procedures are dictated on a contractual basis between the operator of an intermediary and its users in the form of terms and conditions.[737] In contrast with injunctions, NTD procedures offer a more immediate solution for IP rightsholders, but the benefit of immediacy can be potentially offset by erroneous use of NTD and the lack of transparency, as will be further discussed.[738]

There is growing evidence that unlawful reproduction and dissemination of CAD files has been occurring in around online platforms in a similar fashion to online music piracy.[739] However, as Mendis emphasised, the scale of infringement in the 3D printing context is likely to be much wider, involving not only copyright but also other types of IP rights.[740] In comparison with music piracy, where a large number of ordinary Internet users are mostly implicated in illicit file-sharing, online infringement in the 3D printing environment will possibly involve even larger commercial actors who wish to access CAD files for the purposes of unlawfully manufacturing IP-protected products, which can lead to the infringement of design rights, patents or trade marks.[741]

For example, a conventional practice of design rights enforcement is mainly concerned with the prevention of manufacture and distribution of products protected by design rights. It involves, *inter alia*, pursuing those who infringe the rights on a large scale, especially with manufacturing capabilities, and to control the border to prevent import of infringing articles where they are manufactured outside the jurisdiction.[742] 3D printing will challenge this conventional enforcement strategy. Online platforms will enable potential infringers to access a large number of protected designs, facilitating the protected designs to be manufactured locally and discreetly wherever the protected designs can be accessed (e.g. small factories or homes).[743] The manner in which

[734] Knud Wallberg, 'Notice and Takedown of Counterfeit Goods in the Digital Single Market: A Balancing of Fundamental Rights' (2017) 12 Journal of Intellectual Property Law & Practice 922
[735] Marsoof (n 724)
[736] E-Commerce Directive, arts 12–15. In the UK, the E-Commerce Regulations 2002 implemented the E-Commerce Directive and provides legal grounds for NTD
[737] Wallberg (n 734)
[738] European Commission, *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions: A Digital Single Market Strategy for Europe COM(2015)192 final* (European Commission, 2015) 12
[739] Mendis and Secchi (n 64) state that there is growing evidence of IP infringement. See the conclusion
[740] Mendis, '"The Clone Wars": Episode 1' (n 15)
[741] Birtchnell and others (n 16) 24
[742] Deven Desai and Gerard Magliocca, 'Patents, Meet Napster: 3D Printing and the Digitization of Things' (2014) 102 The Georgetown Law Journal 1691
[743] Bradshaw and others (n 17); Mendis, '"The Clone Wars": Episode 1' (n 15). See also Joseph Storch, '3-D Printing Your Way Down the Garden Path: 3-D Printers, the Copyrightization of Patents, and a Method for Manufacturers to Avoid the Entertainment Industry's Fate' (2014) 3 New York University Journal of

infringement takes place will become smaller in volume and more sporadic in time,[744] causing the identification of the infringement to be elusive.[745] Even if the infringement is detected, pursuing individuals will not be cost-effective, as already noted in the preceding section. In this sense, the importance of pre-emptive actions against online platforms becomes greater to deter such widespread infringement from taking place in the first place.[746]

In this regard, injunctions and NTD procedures will be useful enforcement measures to prevent infringement occurring in and around 3D printing online platforms. Where online platforms intentionally instigate unlawful distribution of protected CAD files, IP rightsholders may seek injunctions against ISPs to block the websites.[747] They could also rely on injunctions to compel online platforms to remove protected CAD files illicitly uploaded by their users and further to take technical measures, such as filtering, to prevent further infringement to an extent that does not amount to imposing a general monitoring obligation to the online platforms.[748] Additionally, NTD procedures can be relied upon to request online platforms to expeditiously remove protected CAD files.

Having said that, injunctions and NTD procedures are subject to some limitations in the 3D printing context. Most of all, lack of clarity on the scope of protection of CAD files and design rights infringement can potentially prevent design rightsholders from utilising any of the measures mentioned above. The High Court decision in *Cartier v Sky* adds clarity on the scope of injunctions and its applicability by other IP rightsholders potentially including design rightsholders.[749] Despite the availability of injunctions against intermediaries, it is still uncertain if design rightsholders can, in fact, rely on them, as the scope of design rights infringement currently remains unclear (e.g. whether sharing CAD files can be construed as infringement).[750]

There are also other general issues with these enforcement measures relevant to enforcement against 3D printing online platforms. For instance, it is submitted that technological mechanisms behind blocking injunctions against ISPs can be always circumvented by infringing website operators and by

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Intellectual Property and Entertainment Law 249; Ben Depoorter, 'Intellectual Property Infringements & 3D Printing: Decentralized Piracy' (2014) 65 Hastings Law Journal 1483

[744] Infringement in low volume can be still economically viable for infringers due to technological advantages of 3D printing. See section 2.2. Particularities of the Product Design Process in the Context of 3D Printing

[745] Storch (n 743)

[746] Mendis and others (n 16) 156–62

[747] See the key cases where such blocking injunctions are granted against ISPs: *Twentieth Century Fox Film Corporation and Others v British Telecommunications* (n 459); *Dramatico Entertainment Ltd v British Sky Broadcasting* (n 641); *EMI Records Ltd v British Sky Broadcasting Ltd* [2013] EWHC 379 (Ch); *Football Association Premier League Ltd v British Sky Broadcasting Ltd* [2013] EWHC 379 (Ch); *Paramount Home Entertainment v British Sky Broadcasting* (n 603)

[748] Case C-70/10 *Scarlet Extended SA v SABAM* [2011] ECR I-11959; Case C-360/10 *SABAM v Netlog NV* [2012] ECLI:EU:C:2012:85

[749] However, it should be noted that this case was concerned with the availability of injunctions for trade mark owners. See *Cartier International AG v British Sky Broadcasting Limited* [2014] EWHC 3354 (Ch), [92]–[138]

[750] Lack of clarity of the scope of design rights infringement is established in section 5.3.2. Design rights implications of Scenario 4 and section 5.4.2. Design rights implications of Scenario 5. On the same observation, see Mendis and others (n 16) 137–44

determined Internet users, by utilising, for example, encrypted virtual private networks (VPNs).[751] The absence of obligations or proper sanctions for intermediaries that do not comply with court orders can be a stumbling block for the effective use of injunctions.[752]

A number of issues with NTD procedures by intermediaries have been also highlighted. It is suggested that intermediaries lack an independent and unbiased mechanism to determine the legality of content, and this could lead to the erroneous use of NTD procedures.[753] In fact, a majority of 3D printing online platforms hosting CAD files, such as Thingiverse, GrabCAD, Pinshape and CGTrader, do not publish public transparency reports, whilst Shapeways provides them only with limited information on decisions regarding NTD procedures.[754] Shapeways published four reports annually between 2015 and 2018. The reports provide data showing the key trends in each year, such as the total number of NTD requests, types of the involved IP rights and the number of counternotices. However, the reports merely provide the results of NTD procedures and significantly lack procedural aspects, such as the decision-making processes that lead to the results. This, arguably, leads to uncertainty as to whether NTD procedures are executed fairly for the interests of both IP rightsholders and users.[755]

Another important criticism relates to the fact that no procedural safeguards of due process have been yet established.[756] This encourages the situation where a notice is issued by rightsholders and intermediaries take an immediate takedown action to avoid the risk of losing safe harbour rather than advocate for users' lawful rights.[757] This might greatly hinder not only freedom of expression but also the chances of innovation led by users. Users of online platforms often reuse each other's designs to make new designs that offer better aesthetics or sometimes even better functionality.[758] This user-driven innovation is often facilitated by open design space with minimal legal and technological restrictions where they are allowed to freely communicate and be inspired to perform numerous experiments.[759] Without the established legal process of verifying the legitimacy and fairness of NTD procedures, this open design space might no longer exist.

[751] Marsoof (n 724)
[752] European Commission (n 721) 17
[753] Marsoof (n 724)
[754] Transparency Report (Shapeways) <www.shapeways.com/legal/transparency> accessed 19 February 2021
[755] For the need for standardised voluntary transparency reports, see Christopher Parsons, 'The (In)effectiveness of Voluntarily Produced Transparency Reports' (2019) 58 Business & Society 103
[756] European Commission (n 721) 48
[757] Kristofer Erickson and Martin Kretschmer, '"This Video Is Unavailable": Analyzing Copyright Takedown of User-Generated Content on YouTube' (2018) 9 Journal of Intellectual Property, Information Technology and E-Commerce Law 75
[758] Flath and others (n 151)
[759] Cruickshank (n 127)

Use of automated filtering systems by intermediaries

An important trend in the IP enforcement landscape is intermediaries' employment of automatic detection and filtering technologies to prevent potential IP infringement occurring in their websites.[760]

At the EU level, the European Commission encourages EU-based online platforms to adopt voluntary and proactive automatic detection technologies for the detection and removal of illegal content.[761] In this regard, Article 17 of the CDDSM is noteworthy. Article 17 of the CDDSM requires online content-sharing service providers to make best efforts, in accordance with high industry standards of professional diligence, to ensure the unavailability of unlawful content, by way of their expeditious blocking and removal, and prevention of future uploading.[762] The provision does not expressly require the adoption of automated technologies to prevent copyright infringement; however, there are concerning views that it will eventually do so.[763]

For example, Senftleben argued that Article 17 of the CDDSM would eventually compel online platforms to employ automated monitoring and filtering systems to meet the high standards of professional diligence required by the CDDSM.[764] Frosio also opined that, whilst general monitoring obligations cannot be imposed by courts, in accordance with Article 17(8) of the CDDSM, voluntary engagement of online platforms in the general monitoring of content uploaded by their users will be unable to be precluded.[765]

Against this backdrop, online platforms hosting CAD files will most likely be under pressure to employ some forms of automated monitoring and filtering systems for safe business conducts in the EU. 3D printing online platforms may begin with legacy systems that have been employed by some of the major online platforms, such as YouTube, Tumblr or Facebook. However, there is a risk that online 3D printing platforms are confronted by the technical and legal issues that the existing systems have experienced.

[760] Sabine Jacques and others, 'Automated Anti-piracy Systems as Copyright Enforcement Mechanism: A Need to Consider Cultural Diversity' (2018) 40 European Intellectual Property Review 218
[761] European Commission, *Tackling Illegal Content Online: Towards an Enhanced Responsibility of Online Platforms COM(2017) 555 final* (European Commission, 2017) 12–13
[762] CDDSM, Article 17(4)(b) & (c)
[763] The original proposal made reference to effective use of technologies in preventing copyright infringement, but this was omitted in the final version of the Directive due to the potential inconsistency of this reference with no general obligation provision having been provided in Article 15 of the E-Commerce Directive. See, for more discussion, Giancarlo Frosio, 'To Filter or Not to Filter? That Is the Question in EU Copyright Reform' (2018) 36 Cardozo Arts & Entertainment Law Journal 101
[764] Martin Senftleben, 'Bermuda Triangle: Licensing, Filtering and Privileging User-Generated Content under the New Directive on Copyright in the Digital Single Market' (2019) 41 European Intellectual Property Review 480
[765] Frosio (n 468)

The existing monitoring and filtering systems have technical flaws. Artificial intelligence (AI)-based filtering systems are prone to errors and often falsely block access to and remove lawful content.[766] More problematic is the systems' lack of ability to make qualitative judgements on the legality of the use of protected works under copyright exceptions.[767]

Where misidentification is made, users are generally required to make complaints about the online platform's decision to recover the unfairly removed content. Frosio warned that such an *ex post* mechanism can harm the fundamental rights of users, arguing that:

> In IP enforcement, it is rightholders who claim infringement, rather than reusers who assert the use of an exception or limitation in court after their content has been filtered by virtue of a private order. Of course, this is a heavy burden on nonprofessional creators and UGC as the transaction costs of litigation will usually be too high for those creators, who will predominantly choose not to seek any legal redress even if the blocking or take-down has apparently been bogus.[768]

Moreover, where online platforms' internal rules underlying the monitoring and filtering systems are not in agreement with the perimeters of the relevant law, users can be unfairly prejudiced by the private enforcement of online platforms.[769] As noted above with NTD procedures, the establishment of procedural safeguards and increased transparency will be needed to strike a fair balance amongst rightsholders, online platforms and users.[770]

5.5.4. Technological enforcement measures in the 3D printing environment

IP rightsholders can rely on technological measures to prevent IP infringement. Such technological measures are often referred to as technological protection measures (TPM) or digital rights management (DRM) and defined as:

> any technology, device or component that, in the normal course of its operation, is designed to prevent or restrict acts, in respect of works or other subject-matter, which are not authorised by the rightholder.[771]

To ensure the efficacy of TPMs, the law provides a legal protection against the deliberate circumvention of TPMs. Legal grounds of anti-circumvention measures are provided, primarily in relation to copyright, in both international treaties, such as the WIPO Copyright Treaty and the WIPO

[766] Stephen Blythe, 'Copyright Filters and AI Fails: Lessons from Banning Porn' (2020) 42 European Intellectual Property Review 119
[767] Bernd Jütte, 'The Beginning of a (Happy?) Relationship: Copyright and Freedom of Expression in Europe' (2016) 38 European Intellectual Property Review 11; Jacques and others (n 760)
[768] Frosio (n 468) 725
[769] Hayleigh Bosher, 'Key Issues around Copyright and Social Media: Ownership, Infringement and Liability' (2020) 15 Journal of Intellectual Property Law & Practice 123
[770] European Commission (n 721) 48
[771] InfoSoc Directive, Article 6(3)

Performances and Phonograms Treaty, and EU directives, such as the InfoSoc Directive.[772] In the UK, in the course of implementing the InfoSoc Directive, the CDPA 1988 introduced anti-circumvention measures that provide civil and/or criminal remedies for copyright owners against people who deliberately circumvent TPMs.[773]

There are varieties of TPMs that IP rightsholders can adopt to protect IPs, but the most widely used technology to prevent reproduction/dissemination of digital content is access control technology that restricts users' accessibility to protected content by way of, for example, encryption and/or scrambling of the content.[774] Various TPMs have been already adopted in the product design sector, such as TPMs based on the encryption of CAD files throughout the design process that allow only authorised people to access the CAD files via approved applications.[775] At the same time, digital watermarking schemes have also been employed to protect CAD files in industry.[776] Most recently, industry stakeholders interviewed in the 2020 EC report suggested that TPMs improving the traceability of CAD files, such as blockchain or watermarks, would be particularly useful to protect IP in the 3D printing environment.[777]

However, there are also critiques of the effectiveness of TPMs.[778] From technological perspectives, TPMs cannot provide permanent security, as they are subject to potential technological breaches. Some argue that it is only a matter of time and computing power that such TPMs are eventually circumvented.[779] Indeed, there have been cases of TPM failures over the past decades, including the CSS (Content Scramble System) – a TPM for preventing reproduction of DVDs – being cracked by unknown hackers, giving birth to a decryption tool called DeCSS.[780] It is also submitted that TPMs can be cracked by even a small fraction of users and the unprotected content can be easily distributed

[772] Vantsiouri Petroula, 'A Legislation in Bits and Pieces: The Overlapping Anti-circumvention Provisions of the Information Society Directive, the Software Directive and the Conditional Access Directive and Their Implementation in the UK' (2012) 34 European Intellectual Property Review 587
[773] CDPA 1988, ss 296 and 296ZA–296ZF
[774] IFPI, 'The WIPO Treaties: Technological Measures' (2003) <https://www.ifpi.org/content/library/wipo-treaties-technical-measures.pdf> accessed 21 August 2019. See also Simon Stokes, *Digital Copyright: Law and Practice* (4th edn, Hart Publishing 2014) 179
[775] See Suk-Hwan Lee and Ki-Ryong Kwon, 'CAD Drawing Watermarking Scheme' (2010) 20 Digital Signal Processing 1379
[776] Patrick Wolf, Martin Steinebach and Konstantin Diener, 'Complementing DRM with Digital Watermarking: Mark, Search, Retrieve' (2007) 31 Online Information Review 10 (digital watermarking is a process in which a digital information is embedded in a digital content in a discreet manner, serving as proof of ownership of rights and/or means for tracking illegitimate reproduction or dissemination in networks)
[777] Mendis and others (n 16) 175–76
[778] For concise discussion of scholarly debates on the effectiveness of TPMS, see Birtchnell and others (n 16) 25
[779] Paula-Mai Sepp, Anton Vadeshin and Pawan Dutt, 'Intellectual Property Protection of 3D Printing Using Secured Streaming' in Tanel Kerikmäe and Addi Rull (eds), *The Future of Law and eTechnologies* (Springer 2016)
[780] Janko Roettgers, 'DRM FAIL: Five Broken Copy Protection Schemes' (*GIGAOM,* 17 September 2010) <https://gigaom.com/2010/09/17/drm-fail-five-broken-copy-protection-schemes-2> accessed 21 March 2021

over the Internet or P2P networks.[781] As such, the music industry abandoned the DRM schemes and shifted their business models after experiencing massive DRM failure.[782]

There are outstanding legislative pitfalls of anti-circumvention measures. The CDPA 1988 provides different remedies for computer programs and other subject matters; in relation to computer programs, there are only civil remedies available,[783] whilst, for other copyright works, both civil[784] and criminal remedies[785] are available. Furthermore, complaint procedures that users can rely on to remove TPMs to use copyright work based on copyright exceptions are only available for copyright works other than computer programs.[786] Disparities in the available remedies and complaint procedures between different subject matters provided in the CDPA 1988 cause uncertainty over the scope of anti-circumvention measures in relation to CAD files, as the classification of CAD files is apparently situated somewhere in between computer programs and artistic works.[787]

From the user's standpoint, there is the potential that excessive use of TPMs can hinder users' rights to the lawful use of copyright works permitted by a number of exceptions, and thus impair freedom of expression and user-centred innovation.[788] This would be, in part, due to the lack of clarity of and the time-intensive and complex nature of complaint procedures.[789]

5.6. Summary

In Chapter 5, copyright and design rights implications have been discussed in relation to Scenarios 4 and 5, with the emphasis upon copyright and design rights infringement and enforcement.

Applying the established law to Scenarios 4 and 5, it was found that the scope of copyright infringement was well established to regulate the use of various digital content and, therefore, the

[781] Stuart Haber and others, 'If Piracy Is the Problem, Is DRM the Answer?' in Eberhard Becker and others (eds), *Digital Rights Management* (Springer 2003)
[782] Monika Roth, 'Entering the DRM-Free Zone: An Intellectual Property and Antitrust Analysis of the Online Music Industry' (2007) 18 Fordham Intellectual Property, Media and Entertainment Law Journal 515
[783] CDPA 1988, s 296
[784] CDPA 1988, ss 296ZA, 296ZD and 296ZE
[785] CDPA 1988, ss 296ZB (criminal offences) and 296ZC (search warrants and forfeiture)
[786] CDPA 1988, ss 296ZE and 296ZEA. See also UKIPO, *Guidance on the Technological Protection Measures (TPMs) Complaints Process* (UKIPO, 2015)
[787] See section 3.2. Copyright: Legal Status of CAD Files
[788] Rychlicki Tomasz, 'An Opinion on Legal Regulations on Reverse Engineering and Technological Protections Measures' (2007) 13 Computer and Telecommunications Law Review 94
[789] UKIPO (n 786) (the user is mandated to contact the copyright owner to resolve the issue first, prior to initiating an official complaint procedure prescribed by sections 296ZE and 296ZEA of the CDPA 1988. Once the complaint has been made, the UKIPO starts an initial review of the complaint to make a decision whether to proceed to a second stage, where it starts communicating with the relevant rightsholders and all interested parties to help the Secretary of State to make a decision about the complaint. A problem is that the procedure is quite time-consuming. The initial and second stages of the procedure, of which the UKIPO is in charge, could take up 40 working days, and thus the whole procedure, including the time required for the user to contact the copyright owner and for the Secretary of State to make a final decision, would take more time)

unlawful sharing/selling of CAD files and physical fabrication can constitute copyright infringement within the established framework. However, much uncertainty remained with the scope of design rights infringement regarding regulation of CAD files, potentially leaving design rightsholders unprotected against dissemination of CAD files.

This chapter has found that the existing enforcement strategies and measures adopted in the copyright and design rights domain to prevent unlawful file-sharing would be still relevant in the 3D printing environment. Regulation of 3D printing online platforms would be particularly important to pre-empt the unlawful dissemination of CAD files. The adoption of technological protection measures would also help protect CAD files. However, technical and legal flaws identified in these enforcement measures could be a stumbling block for effective enforcement in the 3D printing context, and thus selective adoption of these enforcement strategies through careful review would be useful.

Chapter 6

Analysis of Scenarios 4 and 5

Copyright and Design Rights Exceptions: Use of CAD files

Introduction

In Chapter 6, copyright and design rights exceptions are discussed in relation to use of CAD files. To that end, Scenarios 4 and 5 are referred to, based on which the relevant copyright and design rights issues, in particular, of exceptions will be identified and analysed.

In the previous chapter, it was established that copyright infringement could take place in Scenarios 4 and 5 where a person does the acts in these scenarios. It was also identified that doing the acts in these scenarios could amount to infringement of UK registered design rights and unregistered design rights. However, it is important to note that the infringement will arise only where the infringing acts are carried out without the consent of the owner of the copyright, of the registered proprietor of the design, and of the owner of the UK unregistered design right, and there is no legitimate reason that exempts the alleged infringer from infringement.

This chapter discusses the cases of the latter. There are numerous statutory exceptions laid out in copyright and design law. Those exceptions share common features in that they provide exemption of infringement, but they work restrictively under specific circumstances. Hence, one of the aims of this chapter is to identify the most relevant exceptions in the 3D printing context, especially in relation to the use of CAD files, and to apply them to Scenarios 4 and 5.

In the following section, the law of copyright and design rights exceptions are first analysed. In doing so, the most relevant are identified and chosen for the purpose of the thesis. The second part of the chapter applies the exceptions to Scenarios 4 and 5.

- Scenario 4: Consumers share or sell designs on online platforms
- Scenario 5: Consumers fabricate a physical object at bureau services or at home

6.1. Law of Copyright Exceptions

There are roughly 65 copyright exceptions in the CDPA 1988, which permit a person to exercise all or some of the rights that are exclusively conferred upon a copyright owner. Of those exceptions, some are particularly relevant and worth examining for the purpose of the thesis, and these are:

(1) Exceptions relating to design document (section 51 CDPA 1988); and
(2) Exceptions relating to research and private study (section 29 CDPA 1988)

It is true that there are some other copyright exceptions that could apply in the 3D printing context where 3D printing is used for specific purposes. For example, where 3D printing is adopted in museums for the conservation of cultural heritage such as to restore ancient artefacts,[790] the related

[790] The IP implications of such aspect are dealt with in the project led by Dinusha Mendis. See *Going for Gold: 3D Scanning, 3D Printing and Mass Customisation of Ancient and Modern Jewellery*

copyright exception, such as section 76A of the CDPA 1988, could be relied upon by museums. In addition, where 3D printing is used to produce a piece of object in the context of activism,[791] the criticism and/or parody exceptions respectively set out in sections 30 and 30A of the CDPA 1988 could be relevant.[792] For the purpose of the thesis, where the implications of the use of 3D printing for product design are discussed, however, these exceptions are probably less relevant.

6.1.1. Exceptions relating to design document (section 51 of the CDPA 1988)

Section 51(1) reads:

> it is not an infringement of any copyright in a design document or model recording or embodying a design for anything other than an artistic work or a typeface to make an article to the design or to copy an article made to the design

It was established in Chapter 3 that CAD files could, albeit still debatably, fall within the definition of a design document. Therefore, provided that the CAD files do not embody a design for an artistic work or a typeface, producing a physical object to the design or reverse engineering a physical object will not constitute copyright infringement. A difficult question is, then, how to determine whether or not a design embodied in CAD files is for an artistic work.[793]

Further, section 51(2) states that, *inter alia*, it is not infringement of copyright to communicate to the public anything the making of which was, by virtue of subsection (1), not an infringement of that copyright. The provision allows a person to communicate to the public an article made to the design, as well as anything created as a result of the reproduction of the article, such as CAD files storing the design that is copied from the article.

Although copyright infringement does not occur by virtue of section 51 of the CDPA 1988, it should be noted that reproducing surface decoration would still be copyright infringement. This is because the definition of design in this provision expressly excludes surface decoration,[794] so that the provision only applies to the document representing the shape or configuration of an article.

<https://microsites.bournemouth.ac.uk/cippm/2015/11/12/cippm-awarded-rcuk-funding-to-carry-out-further-research-into-the-ip-implications-of-3d-printing>

[791] For example, Allahyari and Rourke use the term 'additivism' by combining additive manufacturing and activism, exploring the possibility of 3D printing being used to realise and remodel thoughts and ideas into shapes for the purpose of activist movement. <https://additivism.org/about>

[792] Parody, pastiche and caricature exception was introduced into UK copyright law in 2014. For policy background for the introduction, see Kris Erickson, *Evaluating the Impact of Parody on the Exploitation of Copyright Works: An Empirical Study of Music Video Content on YouTube* (UKIPO, 2013); Dinusha Mendis and Martin Kretschmer, *The Treatment of Parodies under Copyright Law in Seven Jurisdictions: A Comparative Review of the Underlying Principles* (UKIPO, 2013); Kris Erickson, Martin Kretschmer and Dinusha Mendis, *Copyright and the Economic Effects of Parody: An Empirical Study of Music Videos on the YouTube Platform and an Assessment of the Regulatory Options* (UKIPO, 2013)

[793] This issue will be elaborated in detail below in section 6.3.1. Copyright implications of Scenario 4

[794] CDPA 1988, s 51(3)

6.1.2. Exceptions relating research and private study (section 29 CDPA 1988)

Fair dealing with a work for the purposes of non-commercial research[795] and for non-commercial private study[796] could exempt users' liability from infringement. The exception is not overridable by any contractual terms.[797]

Regarding the meaning of research and private study within this provision, neither statute nor UK case law provides the definition. In *De Garis v Neville*, an Australian Federal Court decision, research was defined as a systematic inquiry into a question in order to discover facts or principles, following its ordinary dictionary meaning.[798] Similarly, the meaning of study was also construed in this case, according to its dictionary meaning. Of the suggested definitions, some that might be most relevant in the 3D printing context are 'application of the mind to the acquisition of knowledge, as by reading, investigation or reflection' and 'a particular course of effort to acquire knowledge'.[799] The study must be private, the meaning of which is generally construed as the study having to be carried out for one's own use.[800]

Research and private study must be for non-commercial purposes. The definition of commercial purposes is also not provided in the statute. In *Copinger*, it was suggested that any research or private study that, at the time it is conducted, is contemplated or intended should be ultimately used for a purpose that has some commercial value will not fall within the scope of the exception.[801]

In addition, there are more requirements and conditions to be met for the exception to operate. First, when fair dealing with a work, sufficient acknowledgement must be accompanied unless it is impossible for reasons of practicality or otherwise.[802] Second, it is deemed not to be fair dealing if a person other than a researcher or a student doing the copying knows or has reason to believe that it will result in copies of substantially the same material being provided to more than one person at substantially the same time and for substantially the same purpose.[803] Lastly, the dealing must be fair. Fairness is assessed by the objective standard of whether a fair minded and honest person would have dealt with the copyright work in the manner that the infringer did, for the purpose of the relevant current events.[804] The relevant criteria to consider in assessing fairness have been established in case law, and the most important ones are: (a) the degree to which the alleged infringing use competes with

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[795] CDPA 1988, s 29(1)
[796] CDPA 1988, s 29(3). See also CDPA 1988, s 178 ("private study" does not include any study that is directly or indirectly for a commercial purpose)
[797] CDPA 1988, s 29(4B)
[798] *De Garis v Neville Jeffress Pidler Pty Ltd* (1990) 18 IPR 292 (Federal Court of Australia)
[799] ibid., [32]–[33]
[800] Bently and Sherman (n 323) 236
[801] *Copinger*, para 9-37. See also *The Controller of her Majesty's Stationery Office v Green Amps Limited* [2007] EWHC 2755 (Ch), [23]
[802] CDPA 1988, s 29(1) and (2)
[803] CDPA 1988, s 29(3)(b)
[804] *Hyde Park Residence Ltd v Yelland and Others* [2000] 3 WLR 215; [2001] Ch 143 (Court of Appeal)

exploitation of the copyright work by the owner; (b) whether the work has been published or not; and (c) the extent of the use and the importance of what has been taken.[805]

6.2. Law of Design Rights Exceptions

There are different sets of exceptions laid out in UK registered and unregistered design law. This section identifies and discusses the most relevant exceptions for the purpose of the thesis.

In relation to UK registered design rights, this chapter focuses upon the following exceptions:

(1) Exceptions relating to spare parts (section 1B(8) RDA 1949)
(2) Exceptions relating to repair (section 7A(5) RDA 1949)
(3) The must-fit exception (section 1C(2) RDA 1949)
(4) The private and non-commercial use exception (section 7A(2)(a) RDA 1949)

As for UK unregistered design rights, the following exceptions will be considered:

(1) The must-fit and must-match exception (section 213(b) CDPA 1988)
(2) Exception for a method or principle of construction (section 213(3)(a) CDPA 1988)
(3) Exception for surface decoration (section 213(3)(c) CDPA 1988)
(4) The private and non-commercial use exception (section 224A(a) CDPA 1988)

6.2.1. UK registered design rights exceptions

The spare part exception

Section 1B(8) of the RDA 1949 provides an exception by which a certain design is counted as not being of novelty and individual character, and thus a right is not able to subsist in the design.[806] A design of a component part is deemed to be new and have individual character if it remains visible during the normal use of the complex product, once it has been incorporated into the complex product,[807] and if those visible features of the component part are in themselves new and have individual character. Section 1B(9) of the RDA 1949 defines 'normal use' as use by the end user, not including any maintenance, servicing or repair work in relation to the product.[808]

It seems that there is no case law in the UK relating to section 1B(8) of the RDA 1949, but the rulings of the CJEU about the interpretation of the counterpart provision, which is Article 4 in the

[805] *Ashdown v Telegraph Group Ltd* [2001] EWCA Civ 1142; [2002] RPC 5 (Court of Appeal)
[806] Novelty and individual character are substantive requirements for a registered design. These are already discussed elsewhere. Refer back to Chapter 4
[807] A complex product is defined in section 1(3) of the RDA 1949 as meaning that 'a product which is composed of at least two replaceable component parts permitting disassembly and reassembly of the product'
[808] RDA 1949, s 1B(9)

Community Designs Regulation,[809] are noteworthy. In *Kwang Yang Motor v OHIM*,[810] the General Court held that the internal combustion engine of the lawnmower fell within the definition of a component part. It went on to say that, during normal use, the end users stand behind the lawnmower and are able to see the upper part of the engine, and thus the only visible part, which is the upper side, is protectable if it is new and has individual character.

The repair exception

The repair exception states that 'the right in a registered design of a component part which may be used for the purpose of the repair of a complex product so as to restore its original appearance is not infringed by the use for that purpose of any design protected by the registration' in accordance with section 7A(5) of the RDA 1949. It was implemented and transposed from the Community Design Directive into the 1949 Act to preclude manufacturers from monopolising aftermarkets, such as for spare parts.[811]

The scope of a component part in the provision is not any component part but that which is dependent on the appearance of the complex product. Although the dependency requirement is not expressly worded in section 7A(5) of the RDA 1949, it was adopted by the UK courts following the established case law decided in the CJEU for harmonised interpretation of the law across the EU.[812] And the meaning of the repair is strictly interpreted, so that use of a design must be only for restoring the original appearance rather than for upgrading or improving the existing appearance of a complex product.[813]

The must-fit exception

Similar to the must-fit exception in UK unregistered design rights,[814] a right in a registered design does not subsist in features of appearance of a product that must necessarily be reproduced in their exact form and dimensions so as to permit the product in which the design is incorporated or to which it is applied to be mechanically connected to, or placed in, around or against, another product so that either product may perform its function in accordance with section 1C(2) of the RDA 1949. However, this exception does not apply to a design serving the purpose of allowing multiple assembly or

[809] Council Regulation (EC) No 6/2002 of 12 December 2001 on Community designs [2001] OJ L3/01
[810] T-10/08 *Kwang Yang Motor Co, Ltd v Office for Harmonisation in the Internal Market (Trade Marks and Designs) (OHIM) (with intervention from Honda Giken Kogyo Kabushiki Kaisha)* [2012] ECDR 2 (First Chamber)
[811] The Registered Designs Regulation 2001, implementing Directive 98/71/EC of the European Parliament and of the Council of 13th October 1998 on the legal protection of designs
[812] *Bayerische Motoren Werke AG v Round & Metal Ltd* [2012] EWHC 2099 (Pat); [2013] FSR 18
[813] ibid
[814] CDPA 1988, s 213(3)(b)(i). The must-fit exception exists in both UK registered and unregistered design law. More discussion will be made in detail below in section 6.2.2. UK unregistered design right exceptions

connection of mutually interchangeable products within a modular system.[815] Hence, the scope of the exception provided by 1C(2) of the RDA 1949 is more limited than the must-fit exception in UK unregistered design rights.

The private and non-commercial use exception

The private and non-commercial use exception exempts liability arising from infringement where a design is used privately and for non-commercial purposes.[816] The scope of the exception will be largely dependent upon how the meaning of 'private use' and 'commercial purpose' are defined. Nevertheless, there has been little judicial discussion on the definition of these terms in the case law, partially because it has been rare to see a situation where manufacturing facilities are owned and used by domestic users for personal use.[817]

To complement this gap, various academic commentaries have been made on the scope of the private and non-commercial use exception in the 3D printing context. Most notably, a recent EC report demonstrated that the meaning is understood fairly differently in the Member States.[818] These academic views will be further elaborated below with an analysis of the law in Scenarios 4 and 5.

6.2.2. UK unregistered design rights exceptions

The must-fit and must-match exceptions

The must-fit exception prevents from design rights protection certain features of shape or configuration of an article that enable the article to be connected to, or placed in, around or against, another article so that either article may perform its function.[819] For example, the shapes of the top and base panels of a plastic container box that allow one box to be stacked stably over another were held to fall within the scope of the must-fit exception.[820] The shapes of a case for mobile phones, which are determined by the shape and size of the mobile phones for them to fit in the case, are another everyday example.[821] Another relevant area where the must-fit exception might play an important role is where an article is intended for use in connection with a part of human body. In *Ocular Sciences v Aspect Vision*, the court held that the features of shape of contact lenses that fit the

[815] RDA 1949, s 1C(3)
[816] RDA 1949, s 7A(2)(a)
[817] The situation is much the same in respect of the private and non-commercial exception provided in patent law as well. See Rosa Maria Ballardini and Nari Lee, 'The Private and Non-commercial Use Defence Revisited: The Case of 3D Printing Technologies' in Rosa Maria Ballardini, Marcus Norrgård and Jouni Partanen (eds), *3D Printing, Intellectual Property and Innovation: Insights from Law and Technology* (Wolters Kluwer 2017)
[818] Mendis and others (n 16)
[819] CDPA 1988, s 213(3)(b)(i)
[820] *Action Storage Systems Ltd v G-Force Europe.com Ltd* (n 362), [69]–[71]
[821] *Philip Parker and Others v Stephen Tidball and Others* (n 502)

surface of human eyes are excluded from design rights protection by virtue of the must-fit exception.[822]

The must-match exception is the aesthetic counterpart of the must-fit exception.[823] By virtue of the exception, UK unregistered design rights do not subsist in:

> features of shape or configuration of an article which are dependent upon the appearance of another article of which the article is intended by the designer to form an integral part.[824]

The concept of dependency is elusive; for example, in some cases determining dependency is more obvious, such as body parts of cars,[825] but in others less so, which eventually requires a value judgement of the court.[826] The High Court in *Dyson v Qualtex*[827] ruled that the wand handle design of a vacuum cleaner of the claimant (Dyson) was not excluded from design rights protection by the must-match exception on the ground that the handle lacks dependency.

Exception for a method or principle of construction

UK unregistered design rights do not subsist in a method or principle of construction,[828] by which it is meant 'a process or operation by which a shape is produced as opposed to the shape itself'.[829] For example, it was held in *Fulton v Grant Barnett* that the stitching technique that creates the outward-pointing seams on the edges and at the corners of umbrella cases is an example of a method or principle of construction.[830] Owing to the exception, a method or principle of construction is outside the scope of design rights protection even though it is still possible to protect it in other domains such as patent law. However, the exception does not preclude from design rights protection a design created from a method or principle of construction, as:

> the fact that a special method or principle of construction may have to be used in order to create an article with a particular shape or configuration does not mean that there is no design right in the shape or configuration.[831]

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[822] *Ocular Sciences Ltd v Aspect Vision Care Ltd* (n 360), 425–28. However, note that some commentators view that the correctness of the case is open to doubt. See Howe, St. Ville and Chantrielle (n 428), para 4-022
[823] Howe, St. Ville and Chantrielle (n 428), para 4-029
[824] CDPA 1988, s 213(3)(b)(ii)
[825] *Ford Motor Company Limited v Iveco Fiat SpA's Design Applications* [1993] RPC 399 (Registered Designs Appeal Tribunal)
[826] *Dyson Ltd v Qualtex (UK) Ltd* [2006] EWCA Civ 166; [2006] RPC 31, [64]
[827] *Dyson Ltd v Qualtex (UK) Ltd* [2004] EWHC 2981 (Ch); [2005] RPC 19, [79]–[82] (the court adopted a test of dependency to consider 'whether there is dependency of the kind, or to the extent, which would make the overall article in question (Article 2) radically different in appearance if article 1 were not the shape it is')
[828] CDPA 1988, s 213(3)(a)
[829] *Kestos Ltd v Kempat Ltd* (n 447), 151
[830] *A. Fulton Co. Ltd v Grant Barnett & Co. Ltd* (n 500), [70]
[831] ibid., [70]

Exception for surface decoration

Surface decoration is one of the aspects of a design in which UK unregistered design rights do not subsist.[832] As its name suggests, surface decoration is a layer of decorative things, such as patterns or ornaments, applied onto the surface of an object. It is not limited to 2D decoration such as pictures or logos; 3D features with a certain height, such as beading and grooves on kitchen units, are also included within the meaning of surface decoration.[833] As a result, confusion is often caused as to the boundaries between shape or configuration in which design rights can subsist and 3D surface decoration in which they cannot. Some guidelines could be found in the Court of Appeal decision in *Dyson v Qualtex*,[834] where Jacob LJ held that surface features that have significant function should not be treated as surface decoration, and in this case the ribbing of a kettle was, therefore, excluded from the scope of surface decoration.[835] In effect, deciding whether an aspect of a design is surface decoration requires a case-by-case value judgement of the court on the basis of the facts of the case.[836]

However, it is worth noting that surface decoration could be protected in other domains. In respect of UK registered design rights, as was discussed above, the definition of a design already covers what it is excluded from UK unregistered design rights protection as surface decoration. Hence, a design including surface decoration either in 2D or in 3D could be protected if it is registered. Surface decoration is also protectable by copyright.[837] Two-dimensional decorations such as pictures or logos may well be categorised as artistic works, and, if they are original, they will be protected by copyright.[838] In contrast, the copyright protectability of 3D decorations is less obvious, as it appears that there is no right classification for such 3D objects.[839]

The private and non-commercial use exception

Comparably with UK registered design right, section 224A(a) of the CDPA 1988 provides for exceptions for UK unregistered design rights infringement in relation to an act that is done privately and for purposes that are not commercial. As noted in the explanatory notes to the Intellectual Property Act 2014,[840] the private and non-commercial use exception mirrors that in UK registered

[832] CDPA 1988, s 213(3)(c)
[833] *Dyson Ltd v Qualtex (UK) Ltd* (High Court) (n 827)
[834] *Dyson Ltd v Qualtex (UK) Ltd* (Court of Appeal) (n 826)
[835] ibid., [83]
[836] ibid., [81]
[837] For example, fashion designers, such as Diane von Fürstenberg and Anna Sui, used copyright to protect their designs that are surface decoration. See Iona Silverman, 'Optimising Protection: IP Rights in 3D Printing' (2016) 38 European Intellectual Property Review 5
[838] CDPA 1988, s 4
[839] In copyright law, 3D objects must be classified as either a sculpture or a work of artistic craftsmanship, but it is uncertain whether 3D surface decorations can fall within the definition of these subject matters. See, for the definition of a sculpture and a work of artistic craftsmanship, section 6.3.1. Copyright implications of Scenario 4
[840] This can be found at <www.legislation.gov.uk/ukpga/2014/18/notes/division/5/1/4>

design law. In implementing this, the private and non-commercial use exception in UK unregistered design law is worded exactly the same as that in UK registered design law.[841]

6.3. Scenario 4: Copyright and Design Rights Issues Relating to Share/Sale of CAD Files

Scenario 4: Consumers share or sell designs on online platforms

In this section, the copyright and design rights implications of sharing and selling 3D designs on online platforms are discussed in relation to exceptions. There are three relevant parties in this scenario as follows:

(1) a person who shares or sells designs on online platforms
(2) a person who downloads or purchases designs on online platforms
(3) an intermediary (online platform) which facilitates the sharing and sale of designs

6.3.1. Copyright implications of Scenario 4

Liability of a person who shares or sells designs on online platforms

It has already been established that sharing and selling CAD files on online platforms without the consent of the owner of the copyright or without legitimate reason could amount to copyright infringement by communication to the public, as the act of sharing and selling can be construed as the act of communication within section 20 of the CDPA 1988, and it is also possible, through the investigation of some of the major online platforms as a case study, to draw the conclusion that sharing and selling CAD files on major online platforms could be generally seen as targeting the UK public.[842]

Such sharing or selling of CAD files could be exempted from copyright infringement if there are applicable copyright exceptions. The relevant exceptions worth discussing in this scenario might be, most notably, the design-related exception and the research and private study exception. In the following paragraphs, these exceptions will be discussed and applied to the scenario in turn.

Design-related exception: the design-related exception set out in section 51(2) of the CDPA 1988 is particularly relevant in this case, as the provision explicitly exempts liability for communicating to the

[841] Whether the scope of the private and non-commercial use exception in UK unregistered design law will be the same as that in UK registered design law is debatable. This will be discussed below in sections 6.3.2. and 6.4.2.
[842] See above 5.3.1. Copyright implications of Scenario 4

public anything the making of which was, by virtue of section 51(1), not an infringement of copyright. It has already been established that the meaning of 'anything the making of which was by virtue of section 51(1)' includes a design document or a CAD file recording the design.[843] Thus, by virtue of the exception, sharing or selling CAD files might be exempted from copyright infringement by communication to the public.

However, not all CAD files will qualify, as section 51(2) of the CDPA 1988 only operates upon the basis that a design recorded in a design document is for anything other than an artistic work or a typeface. A difficult question is, then, how to determine whether CAD files are for an artistic work or not.[844] In *Copinger*, it is argued that the intentions of the designer play a definitive role in determining whether a design document is for artistic work or an industrial item.[845] However, this proposition seems somewhat insufficient to provide clear guidance for the applicability of the provision. This is because at present the concept of a sculpture and a work of artistic craftsmanship (relevant subject matter for 3D objects) is less clear, as will be illustrated in the paragraphs below.

The meaning of a sculpture was discussed in the *Lucasfilm* case[846] where the question was asked, *inter alia*, whether the Stormtrooper helmet worn in the *Star Wars* film was a 3D artistic work, such as sculpture or a work of artistic craftsmanship.[847] In order to draw a line between a sculpture and a non-sculpture, Mann J set out guidelines, the most important of which is that, in order for an object to be a sculpture, the main purpose of it must be 'enjoyed as a visual thing'.[848] He then went on to say that the Stormtrooper helmet was not a sculpture because the purpose of it being made had been mainly utilitarian, that is, to be functionally used rather than to be visually enjoyed.

A leading authority on the matter of a work of artistic craftsmanship is the House of Lords' decision in *Hensher v Restawile Upholstery*,[849] where their lordships opined extensively about the definition of a work of artistic craftsmanship with reference to the Copyright Act 1956. The definitions provided by their lordships were quite varied and in some cases contradictory; for example, Lord Reid argued that a work of artistic craftsmanship is a durable useful handmade object, which its owner values on account of its artistic character, whereas Lord Simon of Glaisdale maintained that a work of artistic craftsmanship need not be handicraft as long as the special training, skill and knowledge that a craftsman is supposed to have are expended for the production of the work. Whilst Lord Morris of Borth-y-gest pointed out that the aim and purpose of the author of a work should not be given decisive

[843] Mendis, '"The Clone Wars": Episode 1' (n 15); Malaquias (n 52)
[844] A product design carried in a CAD file is normally the depiction of a 3D object. In copyright law the relevant classification of subject matter to protect a 3D object is an artistic work, such as a sculpture and a work of artistic craftsmanship
[845] *Copinger*, para 13-351
[846] *Lucasfilm Ltd v Ainsworth* [2008] EWHC 1878 (Ch); [2008] ECDR 17
[847] For discussion of section 51 CDPA 1988 and the *Lucasfilm* case in the 3D printing context, see Mendis, '"The Clone Wars": Episode 1' (n 15); Mendis, '"Clone Wars" Episode II' (n 15)
[848] *Lucasfilm Ltd v Ainsworth* (n 846), [118]
[849] *George Hensher Ltd v Restawile Upholstery (Lancs.) Ltd* (n 407)

weight in assessing whether a work is one of artistic craftsmanship, Lord Simon of Glaisdale emphasised that 'the intent of the creator and its result' would determine that a work is one of artistic craftsmanship.

Most recently, HHJ Hacon in *Response Clothing v Edinburgh Woollen Mill*[850] consolidated the definition of a work of artistic craftsmanship, by following the *Bonz* case[851] decided in the New Zealand High Court. He suggested a two-step test that, in order for a work to be seen as a work of artistic craftsmanship, the person who created the work must be (a) a craftsman in that they made the work in a skilful way, taking justified pride in their workmanship, and (b) an artist in that they used their creative ability to produce something that has aesthetic appeal.[852] However, he showed disapproval of the requirement that the object created must be handicraft, pointing out that using a high-technology machine will not make the person using it less creative.[853] He then held that the claimant's jacquard fabrics for clothing, whose design consisted of multiple lines in a wave pattern, was a work of artistic craftsmanship.

The leading cases above would have a significant impact on the interpretation and application of section 51 of the CDPA 1988.[854] The *Lucasfilm* case[855] may significantly limit the scope of a sculpture. Indeed, the test suggested in the case is likely to be extremely difficult to apply to the growing cases where a product is intended by a product designer to occupy both aesthetic and utilitarian value.[856] The caveat is that it could potentially lead almost all CAD files for an item of practical use to be within the effect of section 51 of the CDPA 1988.

More elusive is the determination of whether an object is a work of artistic craftsmanship or an industrial item. The definition of an artistic craftsmanship is too fragmented and therefore unclear to provide practical guidance on what is a work of artistic craftsmanship.[857] For example, if a work of artistic craftsmanship is required to be a handicraft item, a physical object that is intended to be manufactured via 3D printing will not be a work of artistic craftsmanship. On the other hand, there is

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[850] *Response Clothing Ltd v Edinburgh Woollen Mill Ltd* [2020] EWHC 148 (IPEC), [33]
[851] *Bonz Group (Pty) Ltd v Cooke* [1994] 3 NZLR 216
[852] *Response Clothing Ltd v Edinburgh Woollen Mill Ltd* (n 850), [36]
[853] ibid., [38]
[854] On the same view, see Mendis, '"The Clone Wars": Episode 1' (n 15); Mendis, '"Clone Wars" Episode II' (n 15)
[855] *Lucasfilm Ltd v Ainsworth* [2011] UKSC 39; [2012] 1 AC
[856] It is worth noting that there has been a growing importance of product aesthetics and its influence on consumer behaviours and brand strength. Product designers expend as much time and effort in creating aesthetically satisfactory designs as functionally satisfactory designs. See Robert W. Veryzer. Jr., 'The Place of Product Design and Aesthetics in Consumer Research' (1995) 22 Advances in Consumer Research 641; Henrik Hagtvedt and Vanessa M. Patrick, 'Consumer Response to Overstyling: Balancing Aesthetics and Functionality in Product Design' (2014) 31 Psychology and Marketing 518. See also Simon Clark, 'Lucasfilm Ltd and Others v Ainsworth and Another: The Force of Copyright Protection for Three-Dimensional Designs as Sculptures or Works of Artistic Craftsmanship' (2009) 31 European Intellectual Property Review 384
[857] For further discussion, see Patrick Masiyakurima, 'Copyright in Works of Artistic Craftsmanship: An Analysis' (2016) 36 Oxford Journal of Legal Studies 505

the possibility that it is deemed to be a work of an artistic craftsmanship, according to the most recent approach in the *Response Clothing* case[858] without the handcraft requirement.[859]

In conclusion, it is uncertain whether the liability arising from sharing or selling CAD files without the consent of the owner of copyright in it will be exempted by virtue of section 51(2) of the CDPA 1988. On the one hand, almost all CAD files consisting of product designs intended for 3D printing will be subject to section 51(2) of the CDPA 1988, resulting in the act of sharing or selling CAD files being exempted from liability. This is because CAD files consisting of product design intended for being manufactured by 3D printing will be unable to be classified as design documents for an artistic work, owing to the established case law.[860] On the other hand, rulings in the *Response Clothing* case[861] might lead only specific kinds of CAD files to be within the scope of this exception. For example, only CAD files for parts of a product that would be not of aesthetic appeal, such as functional component parts that are not visible when assembled into a product, might benefit from the exception.

Research and private study exception: the other exception that could be relevant is the research and private study exception set out in section 29 of the CDPA 1988 and its applicability to the act of sharing and selling CAD files on online platforms without the consent of the copyright owner as part of research and private study.

It appears that sharing or selling CAD files will not benefit from the exception in this scenario for a number of reasons. The exception is designed to apply to research and private study for non-commercial purposes, and therefore selling CAD files on online platforms with a view to commercial gain is clearly outside the scope of the exception.[862] Furthermore, where members of the general public, who would not necessarily be researchers or students,[863] are involved, section 29(3)(b) of the CDPA 1988 will come into effect. It will most likely exclude the sharing or selling of CAD files from the scope of fair dealing, as the person doing so will generally know or have reason to believe that they will be provided to more than one person.[864]

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[858] *Response Clothing Ltd v Edinburgh Woollen Mill Ltd* (n 850)
[859] However, it should be noted that an appeal to this decision is pending. It remains to be seen whether the law will still be valid
[860] For this view, see Bradshaw and others (n 17); Mendis, '"The Clone Wars": Episode 1' (n 15); Malaquias (n 52)
[861] *Response Clothing Ltd v Edinburgh Woollen Mill Ltd* (n 850)
[862] CDPA 1988, s 29(1), (1C) and s 178
[863] There is no definition provided in either statute or case law, as to what renders a person a researcher or a student. For brief discussion of the meaning of research and private study, See Bently and Sherman (n 323)
[864] See also C-117/13 *Technische Universitat Darmstadt v Eugen Ulmer KG* [2014] EU:C:2014:2196. The CJEU held that it is allowed for a library to reproduce textbooks for digitisation, but making it available to its users in such ways as allowing them to print or download onto a USB stick is not permitted within the research and private study exception laid out in Article 5(3)(n) of the InfoSoc Directive

Liability of a person who downloads or purchases the 3D designs on online platforms

Downloading or purchasing CAD files onto one's computer will amount to copying as set out in section 17 of the CDPA 1988, and therefore infringement if done without the consent of the owner or other legitimate reason, as was analysed above at 5.3.1.

Design-related exception: where liability arises from the reproduction of CAD files, section 51(1) of the CDPA 1988 could be relevant. Section 51(1) of the CDPA 1988 states that it is not an infringement of any copyright in a design document or model recording or embodying a design for anything other than an artistic work or a typeface to make an article to the design or to copy an article made to the design. In *Copinger*, it is suggested that the meaning of copying an article made to the design includes producing own design drawings copying articles made to the design document rather than directly copying someone else's design drawings.[865] In effect, reverse engineering a physical object to obtain CAD files will be covered by this provision.[866] Reproduction taking place by way of downloading or purchasing CAD files will not involve the direct copying of an article made to the design carried in the CAD files. It is rather close to directly copying someone else's design drawings. In that sense, it appears that the exception would not apply to downloading or purchasing CAD files.

Research and private study exception: whether downloading or purchasing CAD files without the consent of the copyright owner can be exempted from liability by the research and private study exception will depend upon, most importantly, the following two questions. The first question is whether it is possible that the definition of research and private study can embrace the acts of downloading or purchasing CAD files for the purposes of the product design process and the related design study, such as reverse engineering or other experiments performed, with a view to solving one's own design problems. The other is whether the act of downloading or purchasing CAD files is fair.

As noted above, there is no judicial authority on the definition of 'research' and 'private study'.[867] However, Arnold J in *Forensic Telecommunications v West Yorkshire*[868] held that section 29(1) of the 1988 Act must be construed in conformity with Article 5(3)(a) of the Information Society Directive, and therefore the words 'for the purposes of research' must be narrowly interpreted as meaning 'for the purposes of scientific research'. And then he ruled that reproduction of a copyright work for the forensic purposes of enabling themselves and others to extract data from mobile phones for use in criminal investigations did not amount to scientific research. Since the judge did not go further to

[865] *Copinger*, para 13-356
[866] Malaquias (n 52)
[867] A leading CJEU case on this matter relates to a library relying upon this exception to digitise textbooks and allow the library users to print or store on a USB stick to take it from the library. See C-117/13 *Technische Universitat Darmstadt v Eugen Ulmer KG* [2014] EU:C:2014:2196
[868] *Forensic Telecommunications Services Ltd v Chief Constable of West Yorkshire* [2011] EWHC 2892 (Ch); [2012] FSR 15, [109]

describe what can be within the scope of scientific research, it is still unclear what entails scientific research. From the underpinnings of the ruling, however, it appears that the judge considered the purpose of the research to be a relevant factor and the result would have been, arguably, different if the primary purpose of the research in this case had been to obtain facts, principles or knowledge, rather than pursuing other purposes.

The definition of scientific research provided in the US law might be helpful to further understand the meaning of research and the reasoning of the judgment above. Article 33 of 42 U.S. Code § 12511[869] states that principles of scientific research mean principles of research that:

> apply rigorous, systematic, and objective methodology to obtain reliable and valid knowledge relevant to the subject matter involved.

The above definition is constructed with two parts: there must be (a) application of appropriate research methodology and (b) the purpose of research being to obtain knowledge. As for the relevant methods, it further lays out a number of examples, such as the use of systematic, empirical methods that draw on observation or experiment; use of data analyses that are adequate to support the general findings; or acceptance by a peer-reviewed journal or critique by a panel of independent experts through a comparably rigorous, objective and scientific review. Returning to *Forensic Telecommunications v West Yorkshire*,[870] it might be submitted that the defendant adopted and applied a systematic research method in its criminal investigation.[871] But, as noted by the judge, the aim intended by the defendant was not to pursue the acquisition of knowledge or principles.

On the other hand, it appears that the concept of private study is understood to include broader arrays of activities that might be outside the scope of research. Bently and Sherman pointed out that with its ordinary meaning the private study exception could encompass any copying by a student, for example when preparing for a seminar or to assist in the writing of an essay.[872] Even further, they argued that the exception could be applicable to a case in which a person copies a copyright work for non-academic purposes, such as to decide what type of stove to buy.[873]

According to the preceding analysis, design study accompanied in the product design process might be unable to be generally seen as scientific research for the same rationale as in the *Forensic*

[869] However, it is worth noting that the relevant provision is provided within the context of national and community education rather than IP law
[870] *Forensic Telecommunications Services Ltd v Chief Constable of West Yorkshire* (n 868)
[871] Merely adopting and applying a research method will not suffice to make it scientific. It was argued by researchers in the education sector that 'the design of a study does not make the study scientific … To be scientific, the design must allow direct, empirical investigation of an important question, account for the context in which the study is carried out … and disclose results to encourage debate in the scientific community.' See Richard Shavelson and Lisa Towne (ed), *Scientific Research in Education* (National Research Council 2002) 6
[872] Bently and Sherman (n 323) 236
[873] ibid

Telecommunications case.[874] The methods adopted and applied in the study could be rigorous and systematic to an extent, and yet, if the study is for the purpose of enabling the solving of personal design problems and the production of CAD files for personal use with the improved design, it might be difficult to render the reproduction made in advance for this purpose as being done for a scientific research. However, there is the possibility that the design study is construed as private study where it is done for personal and non-commercial use, according to Bently and Sherman's definition of private study.[875]

Even if the reproduction of CAD files for the aforementioned purpose can fall within the meaning of private study, it must meet the requirement of fairness so that the exception can finally operate. As for the assessment of fairness of dealing with a copyright work, a number of criteria could be considered.[876] It might be argued that no competition interfering with the exploitation of the work by the copyright owner will take place between the copyright owner and the user. This is because the scope of the private study exception is already confined to non-commercial and personal use. However, if the motives of the user were to merely dress up the infringement in the guise of private study, such use would not be fair dealing.[877] In the end, the test of fairness will be a matter of fact and impression,[878] and thus the fairness of the reproduction made by way of downloading or purchasing CAD files will have to be decided case by case, considering the motives of the user and the following activities with the CAD files after the reproduction. In short, the research and private study exception will not provide blanket exception to liability potentially arising from downloading or purchasing CAD files.

Liability of an intermediary who facilitates the sharing and sale of designs

Operators of online platforms serving as intermediaries hosting 3D designs for the purposes of facilitating sharing/selling and downloading/purchasing could become liable for primary infringement by communication to the public and contributory infringement by authorisation of it to their users.

Design-related exception: the same analysis above with section 51(2) of the CDPA 1988 will be applicable to operators of online platforms acting as more than passive facilitators, whereby exemption of liability will be dependent upon the interpretation of the scope of a work of artistic craftsmanship. As for liability for authorising infringement, it only arises where the primary actor, in this case the users using the online platforms to share/sell or download/purchase CAD files, could

[874] *Forensic Telecommunications Services Ltd v Chief Constable of West Yorkshire* (n 868)
[875] Bently and Sherman (n 323) 236
[876] The three important criteria were discussed earlier. See *Ashdown v Telegraph Group Ltd* (n 805)
[877] *Time Warner Entertainments Company LP v Channel Four Television Corporation Plc* [1994] EMLR 1 (Court of Appeal), [2]
[878] *Ashdown v Telegraph Group* (n 805)

themselves be guilty of infringement,[879] as authorising is a tort only if the act authorised is an act restricted by the copyright.[880] It implies that the liability of operators of the online platforms will be determined again by the applicability of section 51(2) of the CDPA 1988 to the users.

6.3.2. UK registered design rights implications of Scenario 4

Liability of a person who shares or sells designs on online platforms

Sharing or selling on online platforms CAD files carrying designs protected by UK registered design rights could amount to infringement upon the construction of section 7 of the RDA 1949, albeit there have yet been no precedents made in the UK.[881] However, where there are applicable exceptions, liability arising from sharing or selling CAD files could be exempted.

Spare part and must-fit exceptions: the spare part exception applies to a design of a component part, which is invisible when assembled during normal use by the end user.[882] The most relevant types of designs to which the spare part exception might apply is mechanical parts of industrial items. For instance, CGTrader hosts CAD files under the category of 'Mechanical parts', many of which could be within the scope of the spare part exception.[883] A repair gear design for the Tefal Rondo 500 mini chopper uploaded on Thingiverse could also be an example.[884] At the same time, the must-fit exception set out in section 1C(2) of the RDA 1949 could apply to certain features of a design. To take an example of the above Tefal Rondo gear, the gear is shaped to mechanically fit into other parts of the chopper machine, in which case the must-fit exception could apply to this particular shape of the gear.

The upshot of the spare part and must-fit exceptions is that UK registered design rights will not subsist in the design falling within the scope of these exceptions, and therefore the use of the design in any form will not amount to infringement.[885] Thus, where sharing or selling a CAD file that stores a design to which the spare part and/or must-fit exception could apply will not result in infringement.[886]

Repair exception: the repair exception applies to design of a visible component part, allowing a person to use a protected design to restore the original appearance of a product.[887] Owing to the dependency requirement, the repair exception only applies to the limited case in which:

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[879] *William Nelson v Mark Rye* [1996] FSR 313 (Chancery Division), 337
[880] *Abkco Music & Records Inc v Music Collection International Limited* [1995] RPC 657 (Court of Appeal) 660
[881] This was discussed in section 5.3.2. Design rights implications of Scenario 4
[882] RDA 1949, s 1B(8)
[883] <https://www.cgtrader.com/3d-print-models/mechanical-parts>
[884] <https://www.thingiverse.com/thing:2950131>
[885] Bradshaw and others (n 17); Mendis, '"The Clone Wars": Episode 1' (n 15)
[886] For further discussion of impacts of the spare part exception in the 3D printing context, see Mendis and others (n 16) 107–08
[887] RDA 1949, s 7A(5)

> the owner of the product has no realistic alternative to replacing the part with one of the same design if the original part becomes damaged.[888]

As an example, there are replacement parts for Ray-Ban Folding Wayfarer sunglasses,[889] Ikea closet handles[890] and various designs of door knobs that go with particular furniture makes.[891] Body panels, bumpers and windows of motor cars are also component parts to which the repair exception can apply, whereas alloy wheels were held to be outside the scope of the repair exception as there were arrays of realistic alternatives available to consumers.[892]

The repair exception is dissimilar to the spare part or must-fit exception, in terms of their effects. The latter, as the exception to design right subsistence, will permit for any purpose use of the design to which it can apply, whereas the former works more restrictively, only enabling one to use the design for a specific purpose of repair. The meaning of repair is strictly understood as restoring the original appearance of a product, and, for example, anything other than restoring, such as upgrading or improving the existing appearance of a product, will not be allowed by the exception.[893] The act of sharing or selling CAD files on online platforms in that sense is unlikely to benefit from the exception because it is rather clear that these activities are hardly necessary and not even remotely relevant in repairing a product.

The private and non-commercial use exception: the exception applies where design is used privately and for non-commercial purposes. With a paucity of literature, as well as little judicial attention drawn to the exception, the applicability and interpretation of the exception have not been much discussed, leading to the meaning of wordings like 'private' and 'non-commercial' being less clear in scope in design law. To discuss the application of the exception, establishment of the scope of the exception will be a prerequisite. Therefore, the possible interpretation of the exception will be explored in the following paragraphs, with reference to the established case law in other IP domains and academic literature.

Section 60(5)(a) of the Patents Act 1977 provides the private and non-commercial use exception, which is worded exactly the same as that in design law. The meaning of 'private' and 'commercial purposes' of section 60(5)(a) was discussed in *Smith, Kline & French Laboratories v Evans Medical*, where Aldous J ruled that the meaning of 'done privately' refers to 'for the person's own use' rather than done 'secretly' or 'confidentially'.[894] The judge further elaborated upon the concept of commerciality, holding that the word 'commercial' does not need explanation and clearly includes any commercial purpose, and that the fact that the information acquired through the use was of

[888] *Bayerische Motoren Werke AG v Round & Metal Ltd* (n 812), [78]
[889] <https://www.thingiverse.com/thing:1503625>
[890] <https://pinshape.com/items/41592-3d-printed-ikea-closet-handle>
[891] <https://www.cgtrader.com/3d-models?keywords=door+knob>
[892] *Bayerische Motoren Werke AG v Round & Metal Ltd* (n 812), [78]
[893] ibid
[894] *Smith, Kline & French Laboratories v Evans Medical* [1989] FSR 513 (Patents Court)

commercial use or benefit to the user will not preclude the act from benefiting from the exception, as long as the purpose of the use was non-commercial.[895]

The wording 'commercial purposes' also appears in UK unregistered design law, in which the concept is understood rather specifically and narrowly. Section 263(3) of the CDPA 1988 states that:

> an act being done in relation to an article for "commercial purposes" are to its being done with a view to the article in question being sold or hired in the course of a business.

However, it is unclear if the definition is intended to provide an overarching concept that could stretch to understanding the concept of commerciality in the private and non-commercial exception.

Stone argued that the private and non-commercial exception only applies to 'private individuals in their personal, non-commercial capacities, doing acts privately'.[896] Ballardini and Lee expanded upon the meaning of 'private' and opined that it may not be limited to meaning a private person only but possibly extends to embrace the members in the private sphere, such as their family or friends.[897] On the other hand, Mimler highlighted that the meaning of 'private' might have to be strictly construed as meaning a private individual because the private use exception would not protect an alleged infringer who operates in a manner to satisfy the needs of others, for example, by sharing CAD files on the Internet.[898] Most recently, Mendis et al. in the 2020 European Commission report attempted to consolidate the definition of private use in EU Member States, by submitting that private use refers to the form of use carried out solely for one's personal use, and sometimes for friends or family, but not for the benefit of the public at large.[899]

The scope of private and non-commercial use exception is, as analysed above, not straightforward. Nonetheless, it seems likely that sharing or selling CAD files on online platforms will not benefit from the private and non-commercial use exception. Most of all, the act of sharing or selling is not of a private nature. Furthermore, it is obvious that the purpose of selling CAD files is to obtain commercial gain.

Liability of a person who downloads or purchases designs on online platforms

Reproduction made by way of downloading or purchasing a CAD file could amount to infringement of UK registered design rights, with the broader interpretation of section 7(2) of the RDA 1949.[900]

[895] ibid., 518. See a conflicting view by Mendis and others (n 16) 98 ('Non-commercial use … refers to use devoid of economic benefit for the user')
[896] Stone (n 652), para 20.63
[897] Ballardini and Lee (n 817)
[898] Mimler (n 48)
[899] Mendis and others (n 16) 98
[900] See section 5.3.2. Design rights implications of Scenario 4

Spare part and must-fit exception: the same analysis as above will be applicable to this case. Downloading or purchasing a CAD file that carries a design that can fall within the scope of the exceptions will not constitute infringement, as UK registered design rights cannot subsist in such designs.

Repair exception: in contrast with sharing or selling CAD files, the act of downloading or purchasing them could be more relevant and possibly necessary in producing a physical object that can be used for repair. In that case, the exception could exempt infringement arising from the downloading or purchasing of CAD files.

The private and non-commercial use exception: downloading or purchasing CAD files could also be within the private and non-commercial use exception, and thus the liability arising from it might be exempted in some cases. Theoretically, where CAD files are reproduced onto one's own personal computer by the act of downloading or purchasing them, it might be possible that the private and non-commercial use exception kicks in, as long as the purpose is non-commercial. However, if the reproduction is made onto a computer or any other device that can be shared by other people, the applicability of the exception could be challenged. Where CAD files are reproduced onto public computers open to public usage, it might be argued that the private and non-commercial use exception cannot be relied upon. More difficult is the case where CAD files are reproduced onto a computer providing limited access to, for example, family members or a group of friends. The result in that case will differ depending on the interpretation of 'private use'.

6.3.3. UK unregistered design rights implications of Scenario 4

Liability of a person who shares or sells designs on online platforms

Sharing or selling CAD files on online platforms will not constitute infringement of UK unregistered design rights. It was established that the construction of the infringement provision will not embrace the act of sharing or selling CAD files within primary or secondary infringement. Infringement by authorisation will also be unlikely to arise. For that reason, there is no room for the exceptions in UK unregistered design law to come into play in this scenario.

Liability of a person who downloads or purchases designs on online platforms

Downloading or purchasing CAD files, resulting in the reproduction of a design protected by UK unregistered design rights, could be infringement under specific circumstances where it is done to enable an article to be made to the design stored in the CAD files and for commercial purposes.

Must-fit and must-match exception: an area in which the must-fit exception could matter significantly is where parts are fabricated for either repair or replacement of the existing original parts.

This is because spare parts have to fit the main objects to function properly, and those features of shape or configuration fitting each other are exactly where the exception applies. The must-match exception is similar to the repair exception in registered design law.[901]

The must-fit exception is, however, not a blanket exception to all spare parts, as with the spare part exception in UK registered design law. As such, the must-fit exception could only apply to certain features of a design. To take an example of a typical mobile phone case, consisting of the cover that surrounds the mobile, with some logos, images or 3D ornamentations attached to the back, downloading or purchasing CAD files for the design of such mobile phone cases will not constitute infringement in respect of the design of covers by virtue of the must-fit exception.[902]

Method of construction and surface decoration: UK unregistered design rights will not subsist in a process or operation by which a shape is produced as opposed to shape itself. A meta design might be one of the relevant items that can be affected by the method of construction exception. As already noted in Chapter 2, a meta design is an abstract design with the capability of producing numerous concrete designs, such as a design file with a customiser created with OpenSCAD.[903] Where a person downloads or purchases a meta design on online platforms, the person will not be liable for infringement, owing to the method of construction exception. Nonetheless, where a protected design is reproduced by way of a concrete design being extracted and produced from the meta design, infringement could still take place.

UK unregistered design rights will also not subsist in surface decoration. Where CAD files are for a design including surface decoration, a person who downloads or purchases the CAD files will not be liable for infringement in relation to a part of the design that is surface decoration. But, as far as the rest of the part is concerned, infringement could still arise. In contrast, where CAD files are for a design of part of an article that can be, in itself, fully within the scope of surface decoration, the surface decoration exception will exempt any liability arising from the act of downloading or purchasing the CAD files. However, as was emphasised earlier, distinguishing 3D surface decoration, in which design rights cannot subsist, from protectable shape or configuration could be unclear.[904]

The private and non-commercial use exception: the exception in UK unregistered design law is worded exactly the same way as it is in UK registered design law, and thus the analysis carried out above can also apply to this scenario. However, a noteworthy point is that in UK registered design law the definition of ‘commercial purpose’ is provided in relation to an article in section 263(3) of the CDPA 1988, which would significantly narrow the meaning of commerciality. As noted above, it is

[901] RDA 1949, s 7A(5)
[902] When it comes to logos and images as such, the surface decoration exception could be applicable, and this will be further elaborated in the section below
[903] Refer back to section 2.3.3.1. Meta design
[904] See section 6.2.2. UK unregistered design rights exceptions

unclear whether the definition should be understood as dictating the concept of commerciality in the private and non-commercial use exception, as well as in relation to a design document.[905]

Additionally, it is also notable that the private and non-commercial use exception can be futile in respect of UK unregistered design rights, as infringement only arises with commercial purposes, implying that, without the need of the private and non-commercial use exception, one is permitted to use protected designs in any ways unless the use is for commercial purposes.[906]

6.4. Copyright and Design Rights Issues Relating to Fabrication of Physical Objects from CAD Files (Scenario 5)

Scenario 5: Consumers fabricate a physical object at bureau services or at home

6.4.1. Copyright implications of Scenario 5

The fabrication of physical objects from CAD files is seen as copying that is prohibited under section 17 of the CDPA 1988, and thus it could amount to copyright infringement in the absence of the consent of the copyright owner or other legitimate reason. Where a bureau service fabricates physical objects on behalf of its customer, the customer can also be liable for infringement by authorisation.[907]

Design-related exception: however, section 51(1) of the CDPA 1988 could exempt copyright infringement arising in relation to CAD files. The provision expressly states that 'to make an article to the design' is not an infringement of copyright in a design document subject to the design being for anything other than artistic work or a typeface. Where the exception successfully operates, not only will a person or a bureau service that directly fabricates a physical object from CAD files be exempted from copyright infringement but also a customer who commissions the fabrication. However, the applicability of the exception will be largely dependent upon the definition and scope of an artistic work. Currently, the law on this matter is less obvious and the uncertainty will again become a barrier to understand fully the applicability of the exception.[908]

6.4.2. UK registered design right implications of Scenario 5

A person or a bureau service that fabricates physical objects whose design is protected by registered design rights will be liable for infringement without the consent of the proprietor. However, the

[905] See section 5.3.2. Design rights implications of Scenario 4
[906] Howe, St. Ville and Chantrielle (n 428)
[907] Refer back to section 5.4.1. Copyright implications of Scenario 5
[908] See section 6.3.1. Copyright implications of Scenario 4, where the scope of a sculpture and a work of artistic craftsmanship is discussed

liability of a commissioner is less certain, with no statutory provisions. Nevertheless, it might be argued that, with the interpretation of section 7 of the RDA 1949, the act of encouraging and providing means such as CAD files for infringement could be seen as some form of use of a design, leading to infringement.[909]

Spare part, must-fit and repair exceptions: where the design of physical objects fabricated by a person or a bureau service is that which can fall within the scope of spare part or must-fit exception, the liability will not arise. However, the applicability of the repair exception might be more complex in this context, as there is the subjective requirement that must be met, namely that the use of design is done for repair purposes. It seems that a person who fabricates a protected object for repair purposes, either by themselves or by commissioning others, could be exempted from liability. However, a particular point of issue is whether a bureau service working on behalf of its customer can also benefit from the exception, even if it does not fulfil the subjective requirement.

The CJEU in *Acacia v Pneusgarda* held that the manufacturer or seller of a component part of a complex product can benefit from the repair exception if they fulfil a duty of diligence, ensuring the component part is used by the downstream user in compliance with the repair exception.[910] By analogy, it appears that a bureau service could, arguably, be able to benefit from the exception if they perform due diligence, such as asking customers about the purpose of fabrication and having customers sign contractual terms that prohibit them from using the protected object outside that purpose.

The private and non-commercial use exception: where a person privately fabricates a physical object for non-commercial purposes, the person will not be liable for infringement. However, privacy and commerciality here is a convoluted and debatable concept, as noted earlier, and, therefore, more judicial authorities should be needed to clarify uncertainty in the application of law to certain situations. These situations encompass, for example, where a person commissions a bureau service to fabricate a physical object as opposed to at home by themselves, or where a person fabricates a physical object for someone else. It is also questionable whether a bureau service can benefit from the private and non-commercial use exception where a person who commissions the fabrication is within the exception. The result will also be dependent upon how privacy and commerciality are defined. The academic views on this seem to be divided, most submitting that the private and non-commercial use exception cannot apply to the use of protected design by a bureau service owing to its publicity and/or commercial nature.[911]

[909] Infringement of UK unregistered design rights in this regard was discussed earlier. Refer back to section 5.4.2. Design rights implications of Scenario 5
[910] C-397/16 *Acacia Srl v Pneusgarda Srl* [2018] Bus L R 927, [79]–[89]
[911] Mendis and others (n 16)

6.4.3. UK unregistered design rights implications of Scenario 5

In contrast to UK registered design rights, infringement of UK unregistered design rights could only take place where the fabrication of physical objects is for commercial purposes. And the meaning of commercial purposes here is quite specific, as already noted above.[912]

Must-fit, must-match and surface decoration exceptions: the whole or part of a design to which these exceptions apply is not protected by UK unregistered design rights, and therefore a person or a bureau service fabricating a physical object whose design is within these exceptions will not constitute infringement of UK unregistered design right.

The private and non-commercial use exception: the construction of the provision is the same as that in UK registered design law, and therefore similar issues like above could arise in relation to the application of law. However, as already highlighted, the infringement of UK unregistered design rights only arises where the prohibited acts are done for commercial purposes, and the meaning of commerciality given by the statute is specifically confined to the case where an article made is sold or hired in the course of a business.[913] It will lead to a divergence that some of the acts – those that are outside the scope of the private and non-commercial use exception in UK registered design law – will be permitted in relation to UK unregistered design rights. It will also make the requirement of privacy practically futile, as proving non-commerciality is sufficient to render the act in question non-infringing.

For example, within the ambit of UK unregistered design law, the liability of a bureau service commissioned to fabricate a protected object will draw a discussion wholly different from that in UK registered design law. As already discussed earlier, it is likely that the act of the bureau service will not amount to infringement in the first place.[914] This is because, within the limited interpretation of commercial purpose, commercial involvement of the bureau service, namely charging a fee for fabrication to its customer, will not be deemed to be within the concept of commerciality.

6.5. Summary

Chapter 6 has discussed issues with copyright and design rights exceptions in relation to use of CAD files depicted in Scenarios 4 and 5. Overall, this chapter demonstrated that that the scope of the relevant exceptions is unclear.

In the copyright realm, the most notable issue was interpretation of the design-related exception set out in section 51 of the CDPA 1988, in relation to sharing/selling and downloading/purchasing CAD

[912] CDPA 1988, s 263(3). See also 5.4.2. Design rights implications of Scenario 5
[913] CDPA 1988, s 263(3)
[914] See section 5.4.2. Design rights implications of Scenario 5

files. The application of the provision is largely dependent upon the interpretation of an artistic work, namely as a sculpture or a work of artistic craftsmanship. This chapter found that their definition is unclear.

In relation to UK registered and unregistered design rights, the scope of the private and non-commercial exception was found to be equivocal. In particular, the definitions of commercial purpose provided in statute and case law are not harmonised, leading to uncertainty in the application of the exception to the 3D printing context.

Conclusion

Conclusion

The thesis investigated the implications of 3D printing and product design for UK copyright and design rights, with the employment of the 'law in context' methodology. It comprised six chapters. Chapter 1 provided the contextual framework and scenarios for a legal analysis of 3D printing. Chapter 2 examined product design processes and discussed the relationship between product design and IP law. Chapter 3 established the legal status of CAD files and online platforms in UK copyright and design laws. Chapters 4, 5 and 6 scrutinised UK copyright and design laws in the context of 3D printing, by application of the laws to the constructed scenarios.

Contextual Framework and Product Design

The thesis formulated a contextual framework for the legal analysis in Chapter 1. In doing so, it discussed the technological, business and societal development of 3D printing. It found that consumers would have increased opportunities to participate in design activities to create individualised product designs and to access and use CAD files – the final outcomes of the design activities – for digital sharing and physical fabrication. It was also found that 3D printing online platforms would play a significant role in facilitating such activities. Based upon this, the thesis constructed five scenarios for legal analysis, as follows:

Access	(1) Consumers download/purchase a design on online platforms
Creation	(2) Consumers create a design with a firm (3) Consumers create a design based on commons
Use	(4) Consumers share/sell a design on online platforms (5) Consumers fabricate a physical object at bureau services or at home

Chapter 2 examined product design processes and established that the creation of product designs requires considerable intellectual inputs based upon knowledge and creativity. It was found that the required knowledge and skills can differ in each stage of the product design process, and that the final description – CAD files – is the outcome driven by diverse intellectual contributions of product designers and/or consumers throughout the product design process, potentially leading to the generation of IPs and the associated IP rights.

Examining product design processes for the legal analysis of 3D printing was an original approach that none of the existing legal scholarship has taken. As opposed to most of the literature, which has delved narrowly into 3D modelling processes on CAD programs, the thesis took a holistic view of the whole product design process and provided fresh insights into the legal nature of CAD files.

Uncertainty in Copyright and Design Rights Status of CAD Files

The legal status of CAD files in UK copyright and design laws was discussed in Chapter 3. It was the foremost point that needed to be established prior to further legal analyses in other chapters. In doing so, unlike other existing studies on 3D printing, the thesis considered the legal status of CAD files in the context of product design whilst focusing on their derivative nature.

The thesis found that CAD files consist of both literary and artistic elements, and thus they can be possibly considered one type of non-traditional works such as multimedia entities. It demonstrated that classifying non-traditional works like CAD files is challenging, especially where a closed list of protected works is provided for, such as in UK copyright law. It was found that assessment of the originality of CAD files under the established originality test is also complex, owing to the creative and yet technical nature of the creation of CAD files.

In the design realm, it was found that a 3D model depicting the appearance of a product can be within the definition of a design in UK registered and unregistered design law. However, the thesis found that CAD files – the vessels that carry the 3D models – would not be protected in UK registered design law. On the other hand, in UK unregistered design law, CAD files can fall within the definition of a design document, and therefore are protected.

In conclusion, Chapter 3 established that the legal status of CAD files in copyright and design law is not entirely clear and that this, in turn, causes uncertainty in all other aspects of law, such as ownership, infringement, exceptions and enforcement in relation to CAD files.

Copyright and Design Rights Implications Relating to Access and Creation of CAD Files (Scenarios 1–3)

As the literature review suggested, IP generation and ownership in co-creation (or collaborative product development) were relatively unexplored areas of IP law in both 3D printing and product design. Based upon the systematic understanding of co-creation in product design processes, which was demonstrated in Chapter 2, the thesis examined the copyright and design rights implications of consumer engagement and contributed to seek clarity on copyright and design rights generation and ownership arising in that context in Chapter 4.

The legal requirements of ownership in these rights differ, but the first ownership is normally vested in the author of a work or a design. In that sense, clarification of the law on authorship became most relevant in this chapter.

In clarifying the law on authorship, the interpretation of the meaning of creation laid out in the relevant provisions took priority. This is because the requirement that the relevant laws have in common is that an author be the person who *creates* a work or a design. It was observed from the existing case law that the meaning of creation is understood differently in copyright and design law. The key difference appeared to be that, in the copyright sense, creation means an actual involvement in materialising a work, whereas for design rights it means conceiving of a novel or original idea in the production of a design.

Where multiple people create a work or a design, joint authorship and the resulting co-ownership can arise, such as where product designers and consumers collaboratively create a design. However, it was found that there is no statutory provision for UK registered design rights, and therefore it is uncertain if joint authorship and co-ownership can arise with those rights. For copyright and UK unregistered design rights, by contrast, statutory provisions set out the requirements, which are worded in the exact same manner for both rights, that there must be collaboration between the people in creation of a work or a design and their contribution must be significant.

Based upon the analyses, Chapter 4 established that different types of intellectual inputs are required for the generation of copyright and design rights. For copyright, the key question to address is how consumers are involved in 3D modelling to materialise CAD files; in contrast, for design rights, it is how they are involved in providing design solutions in producing CAD files.

Discussion of copyright and design rights relating to access to CAD files (Scenario 1)

Chapter 4 discussed whether a person who gains access to CAD files can have any right to them. It was clear that, as consumers do not create but only access CAD files, there is no possibility that authorship and ownership arise here.

It was also discussed whether a lawful acquirer of CAD files can benefit from the principle of exhaustion. The thesis found that the principle of exhaustion will not apply to CAD files in relation to UK registered design rights. However, there is a possibility that the principle of exhaustion applies to CAD files in the copyright sense, especially where they are deemed computer programs. This is a good example that reminds us of the importance of clarity over the legal status of CAD files, as the applicability of this cases depends on copyright classification of CAD files.

Discussion of copyright and design rights relating to design creation with firms (Scenario 2)

A legal analysis of this scenario demonstrated that the types of contribution that product designers and consumers make differ in product customisation, personalisation and co-creation. The only model in which consumers can be potentially involved in 3D modelling and/or providing design solutions to

produce a design is product co-creation. In product customisation, on the other hand, consumers' contributions are typically making a choice from a number of the given options, which bears no connection with 3D modelling or providing design solutions. In product personalisation, consumers contribute to provide design problems rather than solution without involvement in 3D modelling.

The findings led to a conclusion that joint authorship and co-ownership of copyright and UK unregistered design rights in CAD files can only arise theoretically in product co-creation. However, to become joint authors and co-owners of the rights, consumers must contribute to 3D modelling and design solution provision, and the contributions must be quantitatively and qualitatively significant. Consumers are likely to be faced with technical difficulties in 3D modelling and providing design solutions at present, without formal education in 3D modelling techniques and product design. However, it was observed that the possibility of intuitive 3D modelling devices, such as VR, has been increasingly studied, and that younger generations have started receiving product design education at school. This could equip consumers with better knowledge and skills in the future and open up more opportunities for them to become joint authors and co-owners.

Another interesting finding was the use of meta design in product customisation and its implications for copyright and design law. Meta design is distinguishable from traditional product customisation, in that it could provide customisation of almost unlimited options, including shapes of products. In applying the law, the most relevant, and convoluted, question arose here over whether making choices from numerous options can equate to the materialisation of CAD files by 3D modelling; whether it can be considered to provide design solutions; and therefore whether, by making such choices, consumers can become the authors of the CAD files created out of the meta design.

The thesis maintained that making choices could amount to the creation of a work in the copyright sense where selectable options are so numerous that consumers can have a certain degree of creative freedom. The more options there are for consumers, the more likely they are to have greater creative freedom. However, a greater difficulty will lie in the judgement of how to define the numerosity of customisable options and of how many options will be considered to suffice to give them as much creative freedom as typical ways of 3D modelling. On the other hand, consumers are less likely to generate design solution by selecting options, and thus making choices will not be deemed to be the creation of a design in the design rights perspective. This is because, in most cases, the scope of customisable options will be predefined by product designers by considering various factors, including the manufacturability, functionality and aesthetics of the design.

Discussion of copyright and design rights relating to commons-based design creation (Scenario 3)

A legal analysis of this scenario showed that one of the most relevant activities that can arise in the context of commons-based design is creation of remixes by consumers. Remixes are created based

upon the existing designs, and thus reproduction of the whole or a part of them is inevitably involved. This raises the question of whether a person who creates remixes can be the author and owner of copyright and/or design rights in them, despite such reproduction.

The thesis found that a person who creates remixes can become the author and owner of copyright in them if the person makes creative choices in the creation process such that the created remixes are original. However, where the changes made to the existing works are so minor that they are visually insignificant, the remixes will not be original. Joint authorship and co-ownership of copyright in remixes are unlikely to arise because the act of drawing upon the existing copyright works does not amount to collaboration within UK copyright law.

It was also found that authorship and ownership of UK registered and unregistered design rights in remixes could arise if the requirements of novelty, individual character and originality are met. A noteworthy point here was that the commons, based upon which remixes are created, can form part of prior art. The upshot of this was that remixes that are not substantially different from the original design will not obtain design rights protection. That said, it was notable that remixes produced as a result of combination of such commonplace elements are not necessarily deemed to be always commonplace. The thesis found that, similar to copyright, the joint authorship and co-ownership of design rights will not also arise in remixes for the same reason that there is no collaboration involved in the production of remixes.

Finally, the thesis demonstrated that CCL, the most widely used open-source licence on 3D printing online platforms, is not feasible for commons-based design owing to a number of limitations. Most importantly, the coverage of CCL is only limited to copyright. As such, there is the possibility that infringement of other types of IP rights, such as design rights in remixes, can still arise with CCL. As highlighted in the most recent EC report, GNU may well be an alternative option to complement this.

Copyright and Design Rights Implications Relating to the Use of CAD Files (Scenarios 4 and 5)

The issues of IP rights infringement and exceptions in the 3D printing environment were apparently one of the most debated topics in the legal literature. In Chapters 5 and 6, the thesis discussed implications of copyright and design rights infringement relating to use of CAD files.

In these chapters, the thesis consolidated the existing literature. It is important to note that, in doing so, not only did the thesis examine general issues of copyright and design rights infringement and exceptions, but it also identified and scrutinised relatively unexplored subject areas in the legal literature, including consumers' and intermediaries' liability arising from the authorisation of design rights infringement, the design-related exceptions (section 51 CDPA 1988), and copyright exceptions

for research and private study. As a result, the thesis provided further insights into copyright and design rights infringement and exceptions in the 3D printing environment, contributing to the IP literature on 3D printing.

Discussion of copyright and design rights infringement in Scenarios 4 and 5

Chapter 5 found that the law of infringement appears to be relatively well established in copyright law. Applying the established law, it was found that consumers who share/sell or download/purchase CAD files on online platforms will be liable for infringement if such acts are done without the consent of the copyright owner or any other legitimate reason. It was also clear that intermediary liability can also arise where, for example, operators of 3D printing online platforms more than passively facilitate these acts. The physical fabrication of objects to the design stored in CAD files can amount to copyright infringement. As such, a person or a bureau service fabricating physical objects by using protected CAD files can constitute primary infringement. Where a bureau service infringes by manufacturing physical objects on behalf of its customer, it seems that the customer can also be liable for that infringement by authorisation.

On the other hand, whether such digital use of CAD files can be regulated within UK registered design law was rather uncertain. A legal analysis of statutory provisions and established case law indicated that sharing/selling and downloading/purchasing CAD files can be deemed to constitute infringement where the relevant provision is broadly interpreted. However, it was found that there are no precedents in UK courts that employ such an approach. Where CAD files are used to fabricate physical objects, a person or a bureau service that does so without the consent of the registered proprietor or any other legitimate reason can be liable for infringement. However, unlike copyright, there is no provision for secondary or contributory infringement in UK registered design law, and thus it is uncertain whether liability arises for a person who commissions a bureau service for physical fabrication.

As for infringement UK unregistered design rights, the thesis focused upon analysing statutory provisions and established case law concerning a design document. It was found that sharing/selling and downloading/purchasing CAD files can amount to infringement, but this is only possible in limited cases where such acts are done not only, of course, without the consent of the owner of the UK unregistered design right, but also for commercial purposes. It was problematic that the meaning of commercial purposes is not clear in relation to the use of design documents. The thesis found that physical fabrication from CAD files can be construed as infringement within UK unregistered design law, and therefore a person or a bureau service that manufactures physical objects without the owner's consent can become liable for UK unregistered design rights infringement. It was also found that a person who commissions a bureau service to fabricate physical objects can also be liable for

infringement by authorisation, like in copyright law. However, the requirement of commercial purposes will significantly limit the scope of infringement, and thus physical fabrication for personal use will not be deemed infringement.

Discussion of copyright and design rights exceptions in Scenarios 4 and 5

Chapter 6 analysed issues of copyright and design rights exceptions in Scenarios 4 and 5. In doing so, the most relevant copyright and design rights exceptions for the purpose of the thesis were selected and discussed in detail. In copyright law, the thesis found that the design-related exception and the research and private study exception are most relevant for the purpose of the thesis. As for UK registered and unregistered design law, for example, the spare part and repair exception, the must-fit and must-match exception, and the private and non-commercial exception were particularly chosen for discussion in this chapter. A summary of the findings in relation to these exceptions will be discussed below in turn.

The thesis identified that CAD files are within the scope of the design-related exception, and that the exception possibly comes into play to exempt copyright liability that arises from sharing/selling, downloading/purchasing and physical fabrication of CAD files. However, the exception does not operate if the 3D models carried in the CAD files are for artistic works, such as a sculpture or a work of artistic craftsmanship. An analysis of the relevant case law suggested that the scope of the exception and its applicability to CAD files are uncertain. This is because the definitions of a sculpture and a work of artistic craftsmanship provided in case law are not clear enough to clarify the scope of the exception in relation to CAD files. A recent Intellectual Property Enterprise Court decision in *Response Clothing v Edinburgh Woollen Mill*[915] attempted to clarify the definition of a work of artistic craftsmanship. However, an appeal is pending to the decision and thus it remains to be seen whether the Court of Appeal upholds the decision.

The impact of the design-related exception can be massive. The purpose of the exception is often said to prevent industrial designs from being protected by copyright, whose protection lasts significantly longer than UK unregistered design rights. Instead of certain acts being exempted from copyright infringement, UK unregistered design law covers them within the design realm. An issue is that, as found in an analysis of copyright and design rights infringement in Chapter 5, it is not straightforward whether liability arises for sharing/selling and downloading/purchasing CAD files in UK unregistered design law. Without clarity over the scope of the design-related exception and infringement of UK unregistered design right, there is a risk that CAD files are left unprotected.

[915] [2020] EWHC 148 (IPEC)

The applicability of the research and private study exception was also discussed in relation to the use of CAD files. An analysis of the relevant cases showed that sharing or selling CAD files will not be within the scope of the exception, but it is possible that downloading/purchasing CAD files for the purposes of design studies that are carried out for non-commercial purposes and for one's own use might be permitted as private study. However, more clarity is still needed over what types of design studies can fall within the scope of private study.

As for UK registered design rights, the spare part and must-fit exceptions will exempt the use of designs within the scope of the exception, such as mechanical parts which are fitted inside a product when assembled. In the light of the exceptions, liability that arises from sharing/selling, downloading/purchasing and physical fabrication of CAD files for such parts will be exempted. In contrast, the scope of the repair exception was found to be more restrictive than the spare part and must-fit exception. The repair exception will only come into play where relevant designs within the scope of the exception are used only to enable restoring the original appearance of a product rather than upgrading or improving it. This will lead the exception to be inapplicable to sharing/selling CAD files, as the act is apparently irrelevant to the purpose of repair. However, the repair exception could possibly exempt liability that can arise from downloading/purchasing and physical fabrication of CAD files.

Chapter 6 demonstrated that the scope of the private and non-commercial use exception is not clear; views are divided on the meaning of private use and non-commercial purposes. A result of the legal application of the private and non-commercial use exception can vary, depending upon the definition of private use and commercial purpose. The thesis found that sharing/selling CAD files is likely to be outside the scope of the exception, whereas downloading/purchasing CAD files might benefit from the exception where it is done for personal use. Where a person fabricates a physical object at home for their own use, the private and non-commercial exception most likely applies but it is questionable whether a bureau service that fabricates it on behalf of its customer can also benefit from the exception.

For UK unregistered design rights, it was found that there is no blanket exception for spare parts, justlike in UK registered design law. However, the must-fit and must-match exception will exempt use of design of a part to which these exceptions can apply in a similar fashion to the must-fit exception in UK registered design law. In addition, method of construction is also outside the protection in UK unregistered design law. The thesis found that meta design falls within the definition of method of construction. The private and non-commercial use exception also exists in UK unregistered design law. However, the impact of the exception can be minimal, as infringement of UK unregistered design rights only arises where infringing acts are done for commercial purposes.

Growing Importance of Regulating Online Platforms in IP Rights Enforcement

The growing importance of regulating online platforms in the 3D printing environment was demonstrated in Chapters 3 and 5. The importance of regulating online platforms has already been raised and discussed in the IP field for the past few decades, in relation to the proliferation of illicit reproduction and dissemination of music, films and software, for example. The thesis highlighted that 3D printing online platforms would similarly enable unlawful activities relating to CAD files, and thus regulating them would be crucial to preclude potential massive IP rights infringement.

It was observed that the legal status of 3D printing online platforms would not be as mere adversaries in the legal process, but as voluntary participants and partners for IP rights enforcement. Whilst there are no reported UK and EU enforcement cases on 3D printing online platforms at present, it was found that voluntary measures, such as NTD procedures, had already been placed on some major 3D printing online platforms and relied upon by IP rightsholders to remove infringing designs.

However, the private enforcement of 3D printing online platforms was found to have the potential to harm consumers' lawful use of designs. Currently, there are no regulations governing due process of such private enforcement, leading to a lack of sufficient procedural transparency in practice. With the stringent measures against online platforms newly introduced in the CDDSM, the situation could become more complicated.

Thoughts for the Future: Recommendations

Overall, the thesis suggests that there is a need for a review of the existing law and for further research to address the identified issues concerning:

- the lack of clarity on regulation of design activities in the 3D printing environment; and
- the lack of clarity on regulation of 3D printing online platforms, in terms of enforcement

Need for clarity on the legal status of CAD files

In line with the majority of previous studies, the thesis proposes that clearly defining the legal status of CAD files is crucial. As with the latest judicial and scholarly debates in relation to copyright, classifying CAD files as both artistic and literary works seems convincing and reasonable. However, the thesis identified the potential pitfalls of dual classification of CAD files, namely that it can have detrimental effects on coherence and determinacy of the law without further clarity on the scope and applicability of subject-matter-specific provisions in UK copyright law.

Therefore, the thesis suggests that it is recommended to review the scope of subject-matter-specific provisions and their implications for legal treatment of CAD files, whilst more discussion is made on

the feasibility of dual classification of CAD files. The relevant provisions encompass, most notably, copyright exceptions exclusive to computer programs (sections 50A, 50B, 50BA and 50C of the CDPA 1988) and the circumvention of technological measures (sections 296–296ZF of the CDPA 1988). Seeking clarity on these is important, as these will have a significant impact on the legal landscape of consumer engagement and use of 3D printing.

Meanwhile, it is also recommended that policymakers consider the feasibility of revising the law to enable the flexible accommodation of multimedia entities as with CAD files. For example, this may take the form of introducing a new provision that explicitly acknowledges the possibility of multiple classification of copyright works and clarifies their legal treatment in relation to subject-matter-specific provisions existing across in UK copyright law. The reform will be beneficial, in that it can not only contribute to provide clear guidance on the treatment of multimedia entities, including CAD files, but also prevent further potential poor coordination arising from a piecemeal approach taken by courts.

The thesis suggests that the legal status of CAD files in UK design laws should be also clarified. Most of all, the reproduction and dissemination of CAD files containing designs protected by design rights should be capable of being regulated by design rightsholders. For this, first, it is important to seek more judicial clarity on whether CAD files can be accommodated, especially within the ambit of UK registered design law. In connection with this, the scope of copyright and design rights infringement and exceptions should be also reviewed. This is further elaborated below.

Need for clarity on the scope of copyright and design rights infringement and exceptions

The thesis established that the scope of copyright and design rights infringement and exceptions is unclear in the 3D printing environment. In particular, the lack of clarity over the scope of section 51 of the CDPA 1988 and the absence of regulation of CAD files in UK registered and unregistered design laws can prejudice rightsholders. As such, the thesis proposes that there is the need to review the scope of section 51 of the CDPA 1988 and the design laws.

First, the scope of section 51 of the CDPA 1988 should be clearly defined for clarity. Most importantly, the definition of artistic works and the relationship between copyright and design rights in the protection of designs should be reviewed. As was highlighted in the thesis, the binary approach taken by courts to determine the scope of artistic works is outdated and unable to capture the recent trend of the crossover culture between art and industrial design, and 3D printing facilitates this. Therefore, the thesis asserts that, in reviewing the scope of section 51, there should be an update on the changing landscape of product manufacturing and design in the 3D printing environment, via public consultation with relevant stakeholders, including artists, designers and manufacturers.

At the same time, the thesis recommends that policymakers ensure that legal measures are available for design rightsholders to have control over the unauthorised reproduction and dissemination of CAD files. This is consistent with the purpose of section 51 of the CDPA 1988. Where copyright infringement by reproduction and dissemination of CAD files is exempted by virtue of section 51 of the CDPA 1988, design rightsholders should have a way to preclude reproduction and dissemination of CAD files in the design domain. This will help reduce difficulties of design rights enforcement in the 3D printing environment, where the detection of infringement is extremely difficult owing to localised and decentralised manufacturing facilitated by 3D printing.

Need for review of enforcement regulatory framework for online platforms

Finally, the thesis argues that further research is required for the review of the current regulatory framework for 3D printing online platforms to inform policymaking.

For the interests of rightsholders, seeking clarity is crucial on the availability of various enforcement measures that are already in place, such as blocking injunctions and NTD procedures, in the 3D printing context. Judicial precedents on online design rights enforcement are limited at present, as are comprehensive and up-to-date studies on online design rights enforcement. To fill the gap, further research on the design rights enforcement landscape in relation to 3D printing will be useful.

At the same time, the expansion of private enforcement and its adverse impact on consumers should be also reviewed. Most notably, the misuse of NTD procedures and automated systems that lack consideration of consumers' lawful rights to use copyright works has been increasingly identified, in relation to various online platforms, such as Facebook, YouTube and Tumblr. Although there is yet no clear evidence that this trend is currently a phenomenon on 3D printing online platforms, it is reasonable to anticipate this will be so if the absence of regulations governing due process of online platforms' private enforcement remains. The thesis suggests that further research will be required to survey issues in the growing private enforcement.

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