# TOYETIC TOOLING: 3D PRINTING AND CONVERGENT MEDIA PLATFORMS

This thesis is submitted in partial fulfilment of the requirements for the degree of Doctor of Philosophy

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# ABSTRACT

This research addresses convergence of 3D printing with digital games and media products and outlines opportunities for development in production of media related goods including toys and merchandise. It does this principally through a field study involving participatory access to MakieLab, a start-up using 3D printing in the production of user-generated, 3D printable toys directly related to game content. This study incorporates participant observation, a survey of prospective consumers and a netnography of online 3D printing repositories. The netnography investigates user interactions with media content enabled by 3D printing and finds emerging forms of fan-production and a related economy of fan-produced, 3D printable goods. Here the research contributes to gaps in understanding of what people are making with 3D printing, providing insights into what media products people reference, what they make and why. Noting the legally ambiguous status of fan activity and research momentum aimed at creating legislative responses to inhibit such activity this research presents MakieLab as an example of a market based alternative. The research describes MakieLab as a *convergent media platform* and documents how MakieLab designed products and platforms to facilitate fan production and to co-opting or commodotise fan production. This research contributes understanding of how 3D printing may provide new revenue streams for media producers and facilitate engagement between firm and consumer. The research finds in conclusion that 3D printing in conjunction with automated translation of game, film or animation content to user editable and 3D printable formats has potential to alter relationships between media firm and consumer. In doing so it identifies *a role for 3D printing in transmedia*, *implications for evaluations of toyetic or merchandise potential, potential for between-media interactivity, in-media merchandising* and *development of convergent media platforms, commodification of fan art as well as commodification of creative making experiences.* The research concomitantly considers implications for stakeholders involved in production of media related toys and merchandise indicating that convergent media platforms are likely to have significant impact for media producers.

# ACKNOWLEDGEMENTS

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To my family without whom I may not have pursued a PhD my love and thanks. I'll forgive you someday.

Finally, I dedicate this to my wonderful partner Blaine Cook. Thank you for your tireless love, enthusiasm, encouragement and support. Love always.

# DECLARATION AND PUBLICATIONS

I declare that this thesis is my own work and has not been submitted in substantially the same form for the award of a higher degree elsewhere.

The following publications resulted from the research conducted and are related to this thesis:

Carolan, N. (2010) *Product Pirates – Intellectual property implications of post industrial manufacture* (Conference Paper) FISCAR Proceedings of the Nordic Conference on Activity Theory and the Fourth Finnish Conference on Cultural and Activity Research. Helsinki. Aalto University

Carolan, N. and Cruickshank, L. (2010) *Cutting out the middle wo(man) - the implications of co-design and digital fabrication for the design profession.* (Conference Paper) FISCAR Proceedings of the Nordic Conference on Activity Theory and the Fourth Finnish Conference on Cultural and Activity Research. Helsinki. Aalto University

Cruickshank, L. and Carolan, N. (2010) *New User-Led Design Processes for Digital Fabrication* (Conference Paper) FISCAR Proceedings of the Nordic Conference on Activity Theory and the Fourth Finnish Conference on Cultural and Activity Research. Helsinki. Aalto University

Carolan, N. and Cruickshank, L. (2011) *Understanding Design Interventions in Democratic Innovation: A Toolkit Approach.* Design Research Journal 2:10 33–38

Voss, G. and Carolan, N. (2012) *User-Led Design in the Urban/Domestic Environment* Journal of Urban Technology 19:2, 69-87

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# SECTION 1 - INTRODUCTION, LITERATURE REVIEW & METHODOLOGY

# 1.0 INTRODUCTION

This chapter introduces the doctoral study, presents the research aims, focus and goals of the research and describes the thesis structure.

## *1.1 RESEARCH STATEMENT AND TOPIC OF FOCUS*

This research notes convergence of 3D printing with digital media products such as digital games and suggests that the resultant media-product partnerships may be understood as convergent media platforms. On these convergent media platforms media consumers gain a renewed and potentially scalable ability to co-create media content and co-produce media related artefacts that may be manufactured and consumed in the form of 3D printable goods and toys. The research notes a diverse range of media related object types created as a result of user interactions with media content enabled by this convergence and with it opportunities and challenges for media producers and other stakeholders involved in media and toy production.

This research defines these media-product partnerships as "*convergent media platforms"* and describes these as platforms upon which media producing firms may elect to make available media content to users for co-creation, remix and reuse, through provision of design tools to facilitate user interactions with said content and a concurrent ability to manufacture or port for manufacture the resultant user generated content.

This doctoral research identifies and describes such one such convergent media platform - *Makies* and considers cross platform content exploitation within the toy and games industry citing the development of Makies, by MakieLab as an important early example.
This research considers then the manufacture of toys (or other physical goods) related to or inspired by digital assets created for film, game and other media products using 3D printing as a manufacturing process. It also examines user participation in creative processes made possible by this convergence and notes related participative and creative commerce opportunities.

This research finds that consumer accessible digital design tools facilitate a wide range of user interactions with 3D printable content including remix and reuse and presents evidence for this found in a netnography of 3D printing repositories and services Thingiverse and Shapeways.

This research makes contributions to understanding of the types of participation enabled by this convergence, in particular user engagement in the production, co-design and remix of toys and figurines and considers what this means for industry, users and intellectual property owners. Relatedly it investigates emerging forms of creative practice, participation and commerce that hinge upon these modes of participation and contributes understanding of how 3D printing and tools for co-creation may provide new revenue streams for media producers and engagement between firm and consumer.

## 1.2 RESEARCH ORIGINS

This research direction emerged from early research by myself relating to open innovation, user innovation and democratisation of innovation. This project, The HomeSense Project was a collaboration between Tinker London, EDF and Arduino and examined user lead development of smart home prototypes using a toolkit (Carolan and Cruickshank, 2010; Voss and Carolan, 2012). This explored what users of an open source electronics kit would do to their home if they were able to hack it. Here user motivations more typically neglected by design and innovation research at the time were uncovered. Sentiments expressed included *"I never get to play with things like this anymore"*, *"I really enjoyed making," "it was fun to make this vase"* and *"3D printing is magic"*. Alongside practical interventions and problem solving participants developed products that could be described as funny or impractical or jokes as well as items that referenced, remixed or hacked existing products and in some cases referenced popular media. Finding that participation in this relatively challenging process was not always for the practical reasons more typically noted by prior research in mass customisation and user innovation inspired questioning on the part of the researcher in relation to what people might do with democratised access to 3D printers and design tools. Relatedly where participants had essentially remixed and edited existing product designs this research inspired consideration of what they might do to existing products if a remix-able, user editable product design future became possible. Convergence of 3D printing with user accessible design tools in the digital economy, as grounding for this research facilitated both these developments and as such this research sought to explore these questions in the context of 3D printing and media content.

Alongside media hype associated with 3D printing there was usually a related acknowledgement by industry and research of opportunities associated with such a configuration of connected consumers, digital fabrication and tools and systems for co-creation (Rawsthorn, 2013; Conner *et al.*, 2014; Grace, 2014; Rayna, Striukova and Darlington, 2015; Huilgol, 2016). Within the research community there were long standing moves in fields of design, manufacturing, mass customisation and value co-creation working to establish the groundwork of what is and might be possible when consumers could create or co-create with firms and control manufacturing, where manufacturing could be sufficiently flexible to serve the needs of the individual. 3D printing seemed appropriately posed at the outset of this research to facilitate this flexible manufacturing but was under explored in research given the relatively new state of development and adoption in relation to consumer goods. This research found opportunity in timing and access and through a research partnership with MakieLab set out to contribute to understanding in this space.

## 1.3 RESEARCH CONTEXT AND MOTIVATIONS

With 3D printing still at an early stage of adoption for production of consumer goods at the outset of this doctoral research project, there were various gaps in understanding related to consumer motivations, intellectual property issues and design and implementation of services and processes. As the literature review and examination of industry trends progressed the research subsequently narrowed to focus on the toy and media industry. Indications of industry adoption of 3D printing in the toy and games industry as well as emergent discussions related to intellectual property issues associated with 3D printing also motivated this narrowing.

### *1.3.1. Adoption of 3D printing in the toy industry*

At the outset of this research there were indications on Thingiverse and Shapeways that media content was being referenced in user created 3D printable good, and while few of these were likely to have been officially sanctioned by the media owners they signalled some level of consumer interest in 3D printable media related goods. As the doctoral research emerged and progressed a series of industry partnerships between toy companies Mattel and Hasbro with manufacturing companies including Shapeways and tool designers Autodesk were noted, both validating the line of enquiry and assisting in providing industry based insight into perceived opportunities for 3D printing and industry types. Further detail on this user activity and these partnerships may be found in Chapter 5 addressing the netnography.

Collectively this looked like an interesting time for 3D printing associated with media products and toys. These announcements signalled what might be understood as intent to explore 3D printing as a manufacturing process but also as a means by which digital content could be *"made real"* and consumers could engage in the creation process. This research anticipated these opportunities and developments and while the initiation of this research predated some of these 3D printing industry moves it identified opportunities for the very firms that subsequently moved to explore possibilities associated with 3D printing.

### *1.3.2. Toyetic potential: content creators and co-creation*

Media related toys aren't unusual of course, toys, it should be understood often relate to wider intellectual property holdings and derived from media products such as films, books or games. The film and television industry supports it's margins with subsidiary toy and collector products exploring a range of revenue generating channels by creating or otherwise licensing derivative products and content from their core media. In anticipating adoption of 3D printing by media producer firms this research considered motivating factors for media producers and found that a key line of enquiry was that of how firms established the potential value of their media products by considering the value of merchandise and other derivative products that could be sold to support their profits. This calculation could be understood as toyetic potential (Murray 2005; Gurevitch 2012).

Evaluations of the potential and value of subsidiary rights and derivatives in the film industry were conducted early in the production phase and projects that demonstrated 'toyetic potential' were often fast-tracked through commissioning and production processes. (Murray 2005). Products with toyetic potential might have an associated range of toys, books and spin off media products created to bolster profits. This exploitation of intellectual property through multiple platforms and channels is sometimes understood under the terms transmedia or multimedia franchising and has historically been tied to and subsequently influenced by the mass production systems. Toyetic potential calculations have needed to account for mass production scales, minimum order quantities and tooling costs and as such licensing bodies have had to carefully select which products to manufacture so as to justify their investment in tooling and ensure sell through. This impacts decision making related to what products are selected for manufacture and limits consumer choice.

Where 3D printing disrupts initial tooling set-up costs and facilitates flexible, on-demand manufacture it could be assumed that 3D printing might disrupt toyetic potential calculations allowing merchandise production in smaller scales, facilitating exploitation of niche content and a long tail of assets from media products. Moreover where consumer accessible design tools facilitate co-creation and customisation it could also be assumed that 3D printing and associated design tools might facilitate user co-creation in relation to media products and merchandise. This research was motivated therefore to understand 3D printing in relation to production of media related products.

### *1.4.3. A Rip, mix, fabricate future?*

3D printing was described as the *"next disruptive technology to conflict with copyright law."* (Hanna, 2011)

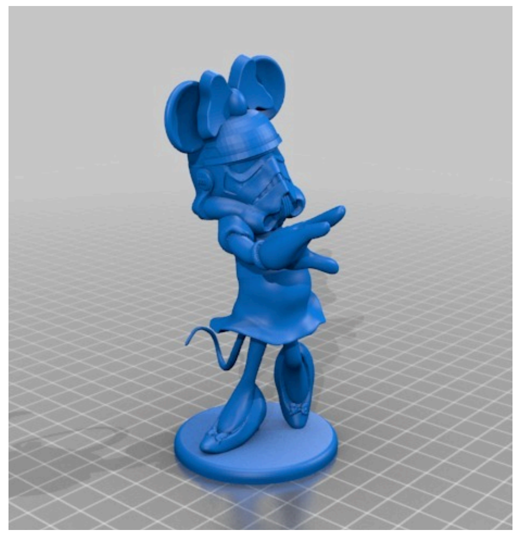


Image 1.1 Imperial Storm Trooper

At the time of initiating this doctoral research there were early examples of user generated content that could be considered in breach of intellectual property regulations. The very same examples of media related goods that inspired assumptions relating to consumer interest in 3D printable media related goods were technically intellectual property infringements.

A representative example is found in this Imperial Storm Trooper Minnie, it is not an official Disney product but at the time of writing this thesis "Desktop Disney Troopers" could be sourced as downloadable STL files on Shapeways.com to print at home on your own Desktop printer. This product remix takes two intellectual property houses (owned now by Disney) and mixes them into a new hybrid product. This product is freely downloadable, shareable and remix-able and may be 3D printed on the machine of the downloaders' preference.

Academic, legal and industry discussions emerged in relation to 3D printing and themes in such discussions were inspired by earlier observations in the music and film industry

(Burns and Howison, 2001). Here digitisation and convergence of key production and distribution technologies coupled with an increasingly connected consumer population resulted in shifts in ideas of ownership, distribution and business models but also a culture of music sharing and perceived difficulties in controlling and extracting revenue from digitally traded intellectual property such as music (Lessig, 2008a). Theorists assumed that 3D printing had similar disruptive potential in relation to products and argued that current laws were insufficient (Bradshaw, Bowyer and Haufe, 2010; Depoorter, 2014; Li *et al.*, 2014; Steeves, 2014; Harris Brean, 2015; Lewis, 2015; Mendis, Secchi and Reeves, 2015).

Academic and industry literature at this time typically framed infringing activity as a problem and called for developments in intellectual property laws to prevent or facilitate control over such activity (Bradshaw, Bowyer and Haufe, 2010; Mendis, Secchi and Reeves, 2015). This doctoral research identified a gap in understanding and was motivated to consider an alternative to this debate, considering implications for intellectual property holders who might consider opening intellectual property up to fan art practice, to remix and mash-ups and move instead to co-opt or commoditise this activity.

### *1.4.4. Creative commerce*

*"We think it will give rise to a creative commerce"* Weijmarshausen in (Kessler, 2015).

Finally, related to ideas of co-opting and commoditising remix and other user interactions with content as well as facilitating co-creation this research recognised in conjunction with research from related fields of value co-creation and mass customisation that there were opportunities relating to commerce and service design made possible by an on-demand, flexible manufacturing system. This research assumed that avatar and in game co-creation tools might also be useable in assisting user creation of physical goods and that were the production process of 3D game artists overlapped with that of industrial toy designers an opportunity from cross platform, digital to physical production of toys might be possible.

This research suggested then that 3D printing as a component process in convergent media platforms might make possible new and reconfigured channels for commerce, customisation and co-creation.

*"Looking at creative trends and the emergence of 3D printing communities, we can expect the rise of "creative commerce" (c-commerce). It will be a shift from a two-sided marketplace (BUY and SELL) to a dynamic makerplace (CREATE, BUY and SELL)."* (Charmy, 2012)

Little elaboration beyond the thought that 3D printing would disrupt production and retail narratives was available in media or research publications at the time of initiating this research and any writings that considered this were speculative. This research was therefore motivated to consider possibilities for creative commerce arising from 3D printing in more detail.

## *1.4 RESEARCH QUESTIONS*

This research asks three key questions:

1. How convergence of 3D printing with digital game (media) products presents opportunities for development in production of toys and merchandise?

Within this are **sub questions** that consider:

2. What user interactions with media content are enabled by convergence of 3D printing in the digital economy?
3. What are the implications for the various stakeholders involved in production of media related goods?

The top-level research question calls for consideration of convergence of 3D printing with digital game products and opportunities for development in production of toys and merchandise. The research contributes findings and understanding in this respect though a literature survey and a field research partnership with MakieLab. This field study spans the design, development and commercial launch of Makies by MakieLab, a toy and games platform using 3D printing to allow consumer co-creation of dolls for manufacture. Within this it considers user interactions with media content that are enabled by convergence of 3D printing in the digital economy. This research explores this activity by observing and documenting what people are making with 3D printing and does this by considering content created by users of 3D printing hosted on online repositories such as Thingiverse and Shapeways and also through a survey of prospective consumers of a convergent media platform. Finally it considers implications for various stakeholders involved in production of media related goods. It does so through a field study with MakieLab, in which it notes how 3D printing may be used to link production of toys and 3D printed artefacts from digital media assets from digital games.

## *1.5 RESEARCH PARTNERSHIP*

MakieLab was identified as an appropriate field study site and research partner. They were posed (at the beginning of this research) to develop a 3D-printed toy-from-game asset service and were considered a key player in a wider context of emergent game industry adoption of 3D printing in the production game related figurines. Toys were considered an appropriate early product which given their relatively small and simple structures and were producible despite the limited state of development of 3D printing at the time. Details of the MakieLab partnership are detailed in Chapter 3 - Methodology and Chapter 6 - MakieLab field study.

## 1.6 RESEARCH BOUNDARIES & ASSUMPTIONS

This research project did not set out to predict a future for the toy or media producing industry but rather to consider opportunities and shifts in consumer culture facilitated by the convergence noted. It considers convergence in general terms noting that the particular arrangements and integrations of 3D printing and other forms of digital fabrication will continue to develop and evolve.

The research output does not adopt a political stance on issues of ownership, copyright or intellectual property but considers user interactions facilitated by 3D printing from the perspective of those considered to be the owners of intellectual property with a reflection on the aims and agenda of those who own such intellectual property. This research therefore contributes to commercial and industrial understanding relating to the opportunity space afforded by such convergence with intent to facilitate productive discussion on creative commerce opportunities and to explore what this means for wider industry.

The central case study is that of a toy and games company, this is of relevance because the toy industry during the years during which the thesis research was conducted was considered to be one of the most appropriate verticals for co-creation and remix of IP between firm and consumer given the relative simplicity of toys as products. This research therefore primarily examines developments in consumption and co-creation of toys associated with developments in digital manufacture, it does this on a localised level with an independent toy and games company who developed and launched the first certified 3D printed toy derived from user created digital content. The toy company acted as the producer of the intellectual property, manufacturer and distributer of the toy, co-creator service and tool provider and retailer of the product. This research acknowledges then that there are limits then to the applicability or generalisability of this information to industries beyond consumer goods and toys but also points to the value of the case study as one of the first movers in the field.

## 1.7 RESEARCH CONTRIBUTIONS

This research makes a number of contributions to knowledge and understanding and does so with a live industry based field study conducted during a key period of adoption of 3D printing. This research documents findings from MakieLab, a first mover in this space, a firm that adopted 3D printing in a convergent way with games allowing players to co-create and remix game content into 3D printable toys. This research therefore contributes to an understanding of how 3D printing is being adopted in media and toy producing industries with a focus on those using 3D printing to facilitate production of goods directly related to their media content.

The research consequently addresses general gaps in knowledge and understanding of 3D printing in a consumer context and presents a range of insights that have been under explored in research due to limited examples of and access to media firm uses of 3D printing prior to this study. However the contributions it centres move beyond these general insights and focus upon opportunities for development in production of toys and merchandise afforded by convergence of 3D printing with media products.

In the first instance the research makes contributions to understanding of *user* or *fan activity enabled by 3D printing*. Prior to this research little academic research had considered what people were actually making with 3D printing nor the role of 3D printing in fan communities. This research highlights the importance of considering 3D printing under fan studies. Though a netnography of online 3D printing repositories I documented a range of user interactions with media content made possible by 3D printing and provide insights into fan activity enabled by 3D printing. I *document types of 3D printable media-related objects that fans and media consumers create* with reference to *intent* and *motivations* behind this activity and I note various forms of remix and reuse of media content. The research also *identifies types of media content referenced* in the creation of 3D printable fan created objects noting amongst others a selection of popular films, games and television content commonly referenced.

Importantly the research finds that much of this fan created content is made available for sale in an early form of what might be described as a fan economy. *The research contributes then early insights into fan economies of user-generated 3D printable content*. The research also acknowledges legal complications associated with such activity finding that much of this fan activity operates outside of the permissions of the media owners, but also that legislation is insufficient to adequately regulate such activity. While the research notes a range of academic and legal activity related to updating intellectual property legislation this research contributes an alternative market driven approach to harnessing this potential arguing that firms may operate (as MakieLab did) to harness and support this activity rather than stifling it.

In doing so the research documents how a media producing firm adopted 3D printing as a means of manufacturing toys directly from their games and develops the concept of *"convergent media platforms"*. Here it notes the importance of the particular form of convergence of 3D printing with media in which software processes automate translation of game assets to 3D printable formats facilitating direct manufacture of toys from game content. The research also notes other early movers in this space highlighting a range of industry activity that validate this line of enquiry. It generally positions convergent media platforms as market based responses to the remix potential that 3D printing for media producing industries. Inline with what Peter Weijmarshausen CEO of Shapeways states: *"Instead of trying to prohibit it, they're enabling it, and I think that's awesome," "By embracing this new technology, it's good for everybody. The end-user is happy because he or she gets what they want, and we don't get into a fight."* (in Harris, 2014)

Finally the research outlines a series of opportunities and challenges for media producing firms and related stakeholders highlighting: *a role of 3D printing in transmedia*, *implications for evaluations of toyetic or merchandise potential, potential for between media interactivity, in-media merchandising and development of convergent media platforms, commodification of fan art as well as commodification of creative making experiences.* With these opportunities the research summarises implications for various stakeholders related to media and toy producing industries.

## 1.8 THESIS STRUCTURE

**Section 1: Introduction, Literature Review and Methodology**

**Chapter 1:** The introduction describes the context and role of the research and explains the structure and contributions of the research.

**Chapter 2:** The literature review, discusses literature relevant to 3D printing in the toy, games and media industry.

**Chapter 3:** Methodology outlines the methodological perspective, methods, research design and operational issues.

**Section 2: Makies Field Research Findings**

**Chapter 4:** Makies survey

**Chapter 5:** Netnography of 3D printing repositories and related industry

**Chapter 6:** MakieLab field study

**Section 3: Discussion, conclusions and recommendations**

**Chapter 7:** Conclusions and summary of research, main findings, limitations and recommendations for future work.

This thesis is divided into three sections.

**Section 1** Sets up the research direction, context and methodology.

**Section 2** Collates the findings from research with Makies. These 3 chapters should be understood to be findings from interrelated research conducted during a period of embedded research with industry case example MakieLab.

**Section 3** Forms the discussion, conclusion and recommendations section of the thesis.

# 2. Literature Review

# 2.0 LITERATURE REVIEW

This chapter provides an overview of research and literature in areas relevant to the research and is divided into a number of sections. The positioning of this research at the intersection of various fields complicates the organisation of this review of literature. As such the review firstly considers 3D printing, with a brief insight into the history, context and trends related to the technology. It moves then to consider relationships between toys and media products as a means of grounding discussion of 3D printing in relation to toys and media related goods. Finally it considers research topics of relevance to consumer engagement and interaction with products and content and research related to how stakeholders move to co-opt or facilitate this activity. This chapter then concludes with a summary of gaps in literature and research statements that inform the development of research questions and strategy in the next chapter.

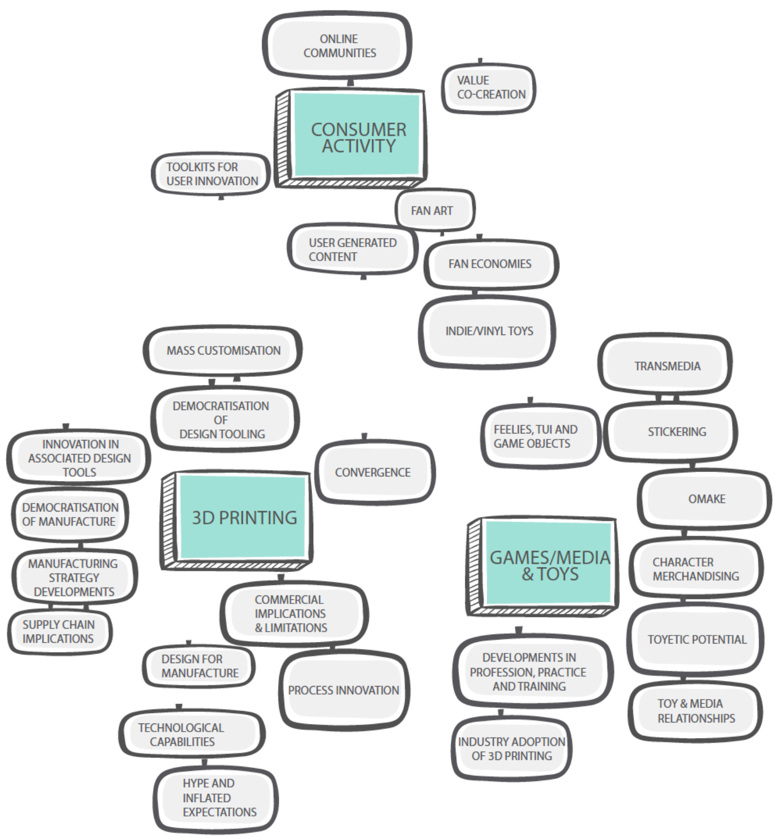



Image 2.1 Literature overview

## 2.1 3D PRINTING – DEFINITIONS, CONTEXT AND RESEARCH THEMES

### 2.1.1. DEFINING 3D PRINTING

This research uses *3D printing* as a term that should be understood to describe additive manufacture and various forms of digital fabrication. 3D printing and additive manufacture refer to a multitude of processes and at the time of writing various 3D printing processes are available to consumers and firms wishing to use 3D printing. Umbrella terms for processes involved include material extrusion, binder jetting, directed energy deposition, material jetting, powder bed fusion, sheet lamination and vat photopolymerisation. These are more generally referred to in industry as (FDM) fused deposition modelling (also known as fused filament fabrication), (SLS) laser sintering (including direct and selective sintering), stereolithography, electron beam, lamination and inkjet processes. The actual technical specifics of these processes are not critical to the understanding of this research and so will not be considered in depth in this research.

### 2.1.2. HISTORICAL CONTEXT AND PROJECTIONS

Early academic research considering 3D printing was generally limited by constrained access to 3D printing tooling; the expense of manufacture and the required skill sets or teams to test theories. Instead such research generally anticipated future possibilities of 3D printing, speculating and projecting scenarios and use cases not necessarily through observations of actual capabilities. Comparisons with and inspiration drawn from science fiction writing may be noted in such writings. Generally early academic discussions on 3D printing were theoretical and generally optimistic, suggesting that advances in digital design and fabrication technologies would cumulate in fabrication systems capable of producing almost any complete functional object. Generally these writers considered developments in 3D printing as a coming paradigm shift for manufacturing.

The first 3D printer is generally attributed to Charles W. Hull from 3D Systems Corp. though Hideo Kodama (1981) describes additive processes that predate work by Hull.

Since then various forms of the technology have been adopted by various fields including engineering, medical industry, military, construction, architecture, fashion, education and the computer industry (Pîrjan and Petroşanu, 2014).

Early academic literature referred to 3D printing as universal desktop fabrication (UDF) imagining a future in which homes would contain a universal fabricator (Gershenfeld, 2007; Malone and Lipson, 2007; Vilbrandt *et al.*, 2008). *Personal manufacturing* systems such as Fab@Home and MakerBot were considered early examples of *"desktop manufacturing"* or *"personal fabrication"* (Gershenfeld, 2007; Malone and Lipson, 2007; Vilbrandt *et al.*, 2008; Sells *et al.*, 2010; Stemp-Morlock, 2010).

As research relating to personal fabrication progressed key theorist Neil Gershenfeld moved to reject the notion of digital fabrication successfully replacing or supplanting manufacturing suggesting that:

*"The coverage of 3D printing is a bit like the coverage of microwave ovens in the 50s. Microwaves are useful for some things, but they didn't replace the rest of your kitchen,"* he said, speaking at the Royal Academy of Engineering's Grand Challenges summit. *"The kitchen is more than a microwave oven. The future is turning data into things, but it's not additive or subtractive."* Gershenfeld, in (Solon, 2013)

Researchers suggested, as time progressed that early predictions of capabilities were over optimistic with some arguing that it is unlikely we will see universal at home personal fabrication and that while noting advantages for customised products suggest that "*3D printing is very likely to remain uneconomical for mass-consumed objects"* (Rayna and Striukova, 2016).

As such, while researchers were generally optimistic about the eventual possibilities of 3D printing there was not a lot of available evidence or examples of the technology in use, nor was there consensus on the eventual progress of adoption and diffusion of the technology or the degree to which it might disrupt industry. As Schnaars (1989) suggests predictions relating to technological developments are *"one of the most difficult kinds of forecast to make accurately."*

It is not the aim of this research to make predictions or project the future of developments in 3D printing, rather the research looks at adoption of 3D printing in relation to the manufacture of toys and media related goods.

### 2.1.3. 3D Printing and Manufacture

Game or toy industry specific applications of 3D printing technology had not been widely studied in academia and at the outset of the research only a limited number of case examples of toy like objects produced for retail could be found. As a consequence limited amounts of academic research directly referencing 3D printing for the toy or games industry could be found during this period. As such the literature review identified research themes of relevance producing an overview that informs the research questions.

Discussion relating to 3D printing often describes it as disruptive, citing potential for disrupting manufacturing. Understanding why firms adopt or might adopt 3D printing and the possibilities afforded by it are key to understanding why it is considered to be potentially disruptive. This section briefly notes some of the commonly reported justifications relating to adoption of 3D printing cited by researchers.  A subsection of these examples are considered in greater detail in sections that follow.

3D printing allows for *distributed manufacturing* (Finn, Søren and Stoyan, 2014) allowing firms to manufacture goods in local or global distributed ways, in decentralised structures and with this efficiencies related to transport and distribution (Amin, 2010; Bogers, Hadar and Bilberg, 2016a). Relatedly the on-demand nature and *de-centralised manufacturing* possibilities afforded the process allows for efficiencies in warehousing facilitating on-demand or just-in-time manufacture of goods (Reeves, 2008b; Stemp-Morlock, 2010; Lipson and Kurman, 2013).

More generally researchers consider 3D printing as a key example of digitised manufacture arguing that this automated or digitally prescribed approach to manufacturing 'bits to atoms' fundamentally changes how manufacturing happens. Researchers find that 3D printing allows for *rapid manufacture* or *rapid prototyping* making it possible to quickly create early prototypes or expedite the product to market processes allowing for faster manufacturing of goods compared to mass production processes that involve tooling set-up times (Cormier, Harrysson and Mahale, 2003a; Sass and Oxman, 2006; Atkinson *et al.*, 2008). As a process it reduces the time from design concept to physical model, a process described as rapid prototyping (Sass & Oxman 2006; Rayna & Striukova 2016). It also allows for *rapid tooling* (Rayna and Striukova, 2016), allowing in some cases quicker manufacture of tooling such as moulds. Beyond this 3D printing may be used as a form of *direct manufacturing* allowing for manufacture of finished consumer ready goods (Reeves and Mendis, 2015).

3D printing allows for *flexible specialisation*, allowing firms to adapt and adjust to changing consumer needs and desires, rapidly changing production lines to respond to these shifts and also to allow for *customisation* and other interactions by the consumer (Gershenfeld, 2007; Reeves, 2008a; Sinclair, 2012; Conner *et al.*, 2014). Relatedly 3D printing *democratises innovation* (Turner, 2011) allowing people to participate in, create their own or otherwise input into manufacturing goods by and for themselves, with this it might be suggested that it *democratises manufacturing* (Mota, 2011). 3D printing from a manufacturing perspective also allows for efficiencies in manufacturing allowing for production of complex geometries (Atkinson *et al.*, 2008) not possible with subtractive or injection moulding processes as well as associated weight and space saving economies.

3D printing and associated developments in production leads to 3D printing being considered under the term *service-based manufacturing* and in doing so it situates or perhaps re-situates manufacturing in the service economy, capable of responding to individual requests rather than standardised mass manufacture. Relatedly *post-industrial manufacture* (Bell, 1973; Gershuny, 1978; Piore and Sabel, 1984) has been the focus of some discussion relating to 3D printing in manufacturing (Atkinson, 2004, 2010b; Atkinson *et al.*, 2008) and research situated in manufacturing, management and supply chain literature around *mass customisation*, *rapid manufacture*, *flexible specialisation* (James and Bhalla, 1993; Goldhar and Lei, 1995; Lei, David, Hitt, Michael, Goldhar, 1996) and *postponement theory* (van Hoek, 2001; K Moser and Piller, 2006; Atmaram, 2011; Stäblein, Holweg and Miemczyk, 2011) are considered relevant to this research topic. Each of these themes note that digital fabrication enables manufacturing with advantages related to scope and flexible specialisation over scale manufacture such as mass production (James and Bhalla, 1993; Weller, Kleer and Piller, 2015). Finally consideration has been given to the economic models and business structures made possible by 3D printing (Conner *et al.*, 2014; West and Kuk, 2014; Weller, Kleer and Piller, 2015; Bogers, Hadar and Bilberg, 2016b).

### *2.1.4. Access, Adoption and Distribution*

Outside of specialist engineering industries 3D printing tools have been adopted in and distributed across maker spaces, hack spaces, the home, print shops, educational institutions and online services (Kyriakou, Englehardt and Nickerson, 2012; Bosqué, 2015). Higher end machines are found in specialist prototyping workshops and online services. Lower-end hobbyist and consumer printers are more likely to be found in schools and homes as well as hacker and maker spaces (Burns and Howison, 2001; Gershenfeld, 2007; Malone and Lipson, 2007; Anderson, 2012). More recently retail adoption of digital fabrication tools have been noted in which a small number of brands tested or employed digital fabrication tools in store (Howard, 2014) or as part of an online service facilitating on-demand manufacture (Fox, 2009; Rischau, 2011; Wirth and Thiesse, 2014; Rayna and Striukova, 2016). Here key sites include Thingiverse and Shapeways, described as online repositories of 3D printing content. Shapeways functions as a retail-manufacturing site allowing content creators to retail content that is then manufactured on-demand. This research was conducted during a key period of distribution and widening access of 3D printing, small desktop printers reached consumer accessible price points and online services and high street spaces allowed for general access to the technology.

### 2.1.5. MATERIAL, FINISH AND PRICE

At the time of research it was possible to print in a range of materials ranging from plastics to metal and to produce products of varying quality and finish. The price, finish and quality of goods produced by these processes depended very much on the material selection and print process selected. Decision making over the selection of a process for manufacturing goods using 3D printing depends on the requirements for the finished good and is influenced by requirements relating to colour, safety requirements and price. Some technical and engineering research considered these issues from, and for, engineering practice perspectives but few academic researchers considered these approaches from consumer or commerce perspectives. Colour availability and product finish varied (Holman, 2014) but little research considers the implications of these issues researchers assume improvements will continue.

3D printing sophisticated (compared to desktop FDM) processes were generally considered expensive in so far as the goods produced using these processes were more expensive to consumers than mass produced equivalents and also that the machines themselves were expensive (Covert, 2014; Sweatman, 2015). Where mass production cost structures are shaped by tooling expenses that may be amortised over a number of production runs (Ruffo and Hague, 2007) 3D printing does not employ cutting, mould or die tooling that would allow for process-borne scale economies. As such volume throughput on 3D printing does not afford the same degree of saving or cost reduction (Baumers *et al.*, 2016).

Economic analysis of the cost-to-market of a product made using mass production methods versus a 3D printed objects vary and while 3D printing facilitates in many cases a lower cost first product or prototype, mass production at the time of writing generally still produced lower cost items at scale. Work to establish economic benefits and compromises of 3D printing in comparison to mass production processes a work in progress at the time of writing with studies by Baumers et al. (2016) and Ruffo & Hague (2007) making progress in this space.

### 2.1.6. Hype

Just as academics were optimistic during the early stages of considering 3D printing, as is quite usual with developments in technology hype relating to the possibilities of 3D printing has influenced how people think of it. 3D printing continues to be subject to hype (Allen, 2013; Daly, 2016; Shanler, 2016) and varying degrees of misunderstanding some of which has misinformed some academic research and media coverage of the technology. Importantly the pace of technological development has been somewhat slower than predicted by many theorists and industry adopters in these early research papers and 3D printing remains problematic in relation to price, speed, quality and finish (Covert, 2014; Holman, 2014; Weller, Kleer and Piller, 2015) amongst other issues at the time of this research completion. It is of course anticipated that 3D printing will continue to develop and that capabilities will continue to improve but it should be noted that hype and a mismatch in perceived ability has been key to misunderstandings and shifts in 3D printing adoption and investment profiles during the course of this research. The next sections move to consider 3D printing in relation to the toy and media industries, where there is little in the way of academic research relating to these industries the research presented below is considered applicable to these industries and the overall contribution of the research is to integrate and develop these existing research findings specific to toy and media industries.

## *2.2 ADOPTION OF 3D PRINTING IN THE TOY AND GAMES INDUSTRY*

Industry activity and press releases considered during the later parts of this research indicated that toy and media corporations were beginning to look to the possibilities of 3D printing for manufacture of toys and goods related to game content. Limited academic research was however available on toy and game industry specific activity.

Dr Phil Reeves published a paper in 2008 describing rapid manufacturing of user selected and user defined content, in this paper he pointed to the possibilities of manufacturing user generated content relating to digital games. He also described participation in the development of a project focusing upon the development of distributed manufacturing and licensing platform a *"...RM fulfilment model based on the development of both a licensing portal and GRID-RM fulfilment network. The objective of the licensing portal is to provide a 'wrapper' that can integrated with existing content creation programs and where the content owner receives a licensing fee for all content that is realised from the virtual into real world."*

Here Reeves (2008) describes an early example of what might be described as convergence of 3D printing with digital media products and an associated licensing platform upon which manufactured goods related to media content, designed or described by users may be produced, and associated licensing deals and structures that could compensate media owners for the use of their content.

Here he suggested that 3D printing had become a viable technology for the rapid manufacturing of user selected and user defined content, and argued that a number of successful business models had been established to exploit the technology for the realisation of entertainment and recreational products (Reeves 2008). This paper may be considered amongst the first to consider 3D printing at scale alongside media products and is considered a precursor to the field study subject MakieLab considered here.

More widely academic research in design, legal and innovation fields tended at the time of research instead to predominantly focus on speculative implications of 3D printing without grounding it in particular industries or against particular product types. Alternatively it focused on design tooling and software processes relevant to these industries primarily from a technical focus. As the section considering 3D printing and manufacture noted implications relating to scope, scale and distribution of manufacturing are frequently cited in projections related to 3D printing but few researchers had actually worked with firms using 3D printing in live commercial contexts. As such research was limited by lack of access to consumer, industry data and live examples. This had a lot to do with the limited stage of diffusion and adoption of 3D printing as a technology and the expense and complexity involved with 3D printing meant that it was not strongly embedded as a manufacturing process. In part this was also because during this early stage of adoption some of these firms and ventures had not actually progressed beyond a trial or press release, as such there was little direct research available. The next sections of the literature review consider research themes of relevance to these industries drawing links where relevant and highlighting gaps in the literature.

### 2.2.1. 3D Printing and Process Innovation

3D printing and digital fabrication are considered by scholars to have disruptive potential for manufacturing and various business models (Baumers *et al.*, 2016; Rayna and Striukova, 2016). While few researchers have considered this disruptive potential with specific regards to toy or media industries it might be assumed disruptions would apply in these disciplines also. Researchers generally anticipate that 3D printing will reorder and disrupt traditional routes to manufacturing and manufacturing structures and with this a range of opportunities related to customisation, economies of scope and scale as well as new avenues for delivery will emerge (Hunt, 2005; Lipson and Kurman, 2013; Geelhoed, 2014).

Rayna and Striukova (2016) indicate that adoption of 3D printing occurs or may be seen to occur in four successive phases: *rapid prototyping*, *rapid tooling*, *digital* *manufacturing* and *home fabrication* and that each of these corresponds to a different level of involvement of 3D printing in the production process. Rapid prototyping, rapid tooling, direct manufacture and home fabrication are useful ways of describing different ways in which firms might adopt and deploy 3D printing in the development and production of media related goods and toys.

*Rapid prototyping* may be understood as a group of techniques or processes facilitating rapid fabrication of a scale or representative model of a physical part or assembly using 3D printing and CAD, this is typically employed in design or engineering labs and studios as a process for rapidly progressing through the early stages of designing physical objects. It is described as rapid prototyping because unlike mass production processes there is a more rapid development/fabrication cycle allowing rapid iteration of samples in the design and testing stages. Rapid prototyping has been widely adopted in media related disciplines including stop motion and animation (Jaremko-Greenwold, 2015; Clarke, 2016).

*Rapid tooling* may be understood as a process that combines rapid prototyping with conventional/mass/batch tooling practices in the production of moulds. Here the process of making a mould is expedited using 3D printing either in production of the mould itself or a negative (an example of the item that will be produced via the mould). This process would historically have involved hand forming of parts or subtractive processes in the creation of mould components. 3D printing reduces the time for production of tooling that may then be used in batch or mass production processes. This has implications for toy production processes related to both mass manufacture and batch production including vinyl toys.

*Direct manufacture* may be understood as using 3D printing directly in the manufacture of goods for sale or use by consumers or firms or businesses. 3D printing has been widely used in manufacture of goods and components for aerospace and other heavy engineering fields as well as jewellery and as this research shows, it has also been explored in the production of toys (Whitbrook, 2015) and media related consumer goods.

*Home fabrication* refers to 3D printing in the home of the user or consumer, initiated by the user or consumer and is generally considered in research as a location or a delivery mechanism and considered in research examining democratisation of manufacture and distributed manufacture. Where toys are relatively simple objects that may feasibly be manufactured in home printers, and a range of design software and content is easily accessible and useable by consumers there is an observable opportunity for toy and media firms in relation to home fabrication and themes of customisation, co-creation and fan art facilitated by democratised access to 3D printing.

These stages or strategies present adjustments or alternatives to more traditional manufacturing structures and it can be assumed that these may disrupt some of the design, prototyping and manufacturing processes involved with media related goods such as toys allowing for innovation in business models and strategy. These developments have not at the time of writing been subject to significant academic inquiry in relation to media and toy industries. To integrate these developments in academic research of relevance a number of key themes are relevant.

### 2.2.2. Profession, Practice and Training

Within the media industry adoption of 3D printing has been noted in relation to stop motion, here 3D printing has allowed for process innovation in how stop motion models are produced (Jaremko-Greenwold, 2015; Clarke, 2016). With any new tooling set up, manufacturing process or shift in manufacturing paradigm related practice, profession and training developments and changes may be noted. This section notes research of relevance to design and manufacturing practice, not all of which is specifically geared towards the toy or media industries but is in many cases still of relevance.

Where toy and games designers often emerge from product and industrial design backgrounds discipline specific research from product and industrial design fields considers how digitisation of manufacturing technology might impact design processes, the profession, and nature of the design product (Burns and Howison, 2001; Cormier, Harrysson and Mahale, 2003a; Bonanni, Parkes and Ishii, 2008; Ferrara, 2011). Relatedly research considers how digital fabrication technology impacts education and training of those who go on to design products for manufacture via 3D printing (Huang, Do and Gross, no date; Unver, Paul and Dave, 2006; Atkinson, 2010b; Bell *et al.*, 2010; Artzi and Kroll, 2011)

Cormier, Harrysson, & Mahale (2003b) indicate design practice developments made possible by digital fabrication technologies including *customisation*, *whole product fabrication*, *differential product cycles*, *complex geometries* and *generative or computational design processes* (Atkinson *et al.*, 2008; Dean, 2008) each of which have implications not only for the manufacture of media related toys and merchandise but also the design of said items.

Related research on digitisation of supply chains indicates better connections between business-to-business actors and developments in relationships between manufacturers and consumers (Fletcher *et al.*, 2016). The increasingly permeable channel between manufacturers and consumers enables mass-customisation and influences demand-side dynamics in production by facilitating communication between manufacturer and consumer (Warkentin, Bapna and Sugumaran, 2000; Jia *et al.*, 2016).

Citing a blurring in the divide between digital and physical Jamer Hunt compared such developments to the '*Cut, paste, remove, save, find, replace, blend, insert, save as...'* culture that has been previously observed in corresponding digital fields of code, graphic design and web design as well through the increasing digitisation of the music and film industries. He suggested that '*more and more design will be a code and a set of parameters. That code will then be let loose in an electronic ecosystem so that it can be manipulated, changed, improved, hacked, and produced in multiple variations in myriad places'* (Hunt, 2005).

Here comparisons can be drawn to what is now understood as open design, generative design and what this research indicates may be of value to consider, remix. Here designers of toys and merchandise may shift from designing toys or media related product to designing and building systems or tools that allow consumers to create, customise, personalise or otherwise interact with the item before manufacturing it.

Research related to FutureFactories' presents as a key example of this and research in this domain considers digital tools and generative methods influenced by developments in digital technologies (Atkinson, 2004; Atkinson, Marshall and Unver, 2007; Unver, Atkinson and Marshall, 2008). Research here focuses on the technical development of the tool and fabrication requirements, discussion as to user experiences are offered but are limited in scope as the design and fabrication interface was not on demand and was fragmented by the long lead time on fabrication.

### 2.2.3. Design Tooling

Where the previous section considers that the role of the designer may shift towards facilitator and tool creator any consideration of 3D printing must also consider tools that interface with 3D printing. Early research considering design tooling for 3D printing looks at digitisation and considers automation, computer aided manufacturing approaches (CAM) and computer numerically controlled activity (CNC) in production lines and manufacturing techniques since the early 1940s (Corser, 2010). Development of computer aided numerically controlled manufacturing systems is generally attributed to John Parsons, "father of the second industrial revolution" (Olexa, 2001) or traced to PRONTO in 1957 by Dr. Patrick J. Hanratty (Waurzyniak, 2010). This was followed by the emergence of CAD in 1963 with the development of Sketchpad, also known as 'Robot Draftsman' by Ivan Sutherland. Sketchpad is considered the ancestor to modern CAD systems influencing how users and developers think about computer aided design in contemporary times according to Blackwell and Rodden (2003) in (Sutherland, 2003).

Research on development of design tools intended to interface with digital fabrication primarily considered the development of CAD tools for professional designers (Zeng, Chen and Ding, 2003). Most interfaces catering to design for digital fabrication remain focused within the graphical user interface (GUI) paradigm (Willis et al. 2011) and such tools were primarily designed for the professional designer with a human-machine interface limited to a mouse, spaceball or graphics tablet. As tools, they required significant training and an understanding of the design domain; they presented as a barrier to users without the requisite CAD or design training.

More recent research in digital design tools explores alternative modes of human machine interaction including, sketch based modelling (Saul *et al.*, 2011), spacial and gestural sketch interfaces (Willis *et al.*, 2010) and haptic interfaces (Sener and Van Rompuy, 2005). While these approaches explore the concept of embodied input in the construction of the digital design file, some also consider embodied input in conjunction with embodied output also known as real time interactive fabrication and direct manipulation a notable system being that of Frazer's Flexible Intelligent Modelling System (Frazer 1995; Shneiderman 1983; Willis et al. 2011). The embodied mode of interaction is cited by some as a more user friendly approach to designing and making (Badham, 1991; Willis *et al.*, 2011). Research also notes generative design systems situated alongside research with 3D printing to be understood as code-driven, and algorithmic approaches to fabrication. Researchers including Atkinson et al. (2007); Dean et al. (2005) and Unver et al. (2008) explored the development of tools enabling user participation in the design process. Such systems have been modelled on natural phenomenon (such as cell division) and generate evolving forms, often bounded within designer specified functionality constraints. Again, research around such approaches has been primarily restricted to user testing and technical considerations.

The consensus with much of this research was that facilitating differing modes of interaction might reduce barriers to participation in design but such research sometimes neglected to consider that new interaction models did not necessarily precede the design and successful function of a physical product. Where historically these tools were created for experts with engineering or industrial design knowledge giving such tools to general consumers presents tool designers with a new set of requirements. As Saul et al. (Saul, C. Xu and Gross, 2010) indicated, fabrication processes impose differing constraints but most CAD systems did not permit users to specify and incorporate constraints of specific fabrication processes into a design rendering successful production difficult. Furthermore this research neglected, in many cases to discuss in flight-testing or physics and other means by which users might be able to determine the appropriateness of their design and it's likely performance after manufacture. If a product is designed poorly it may not function, for example, a chair designed in a CAD system may be unbalanced and fall over when it is eventually manufactured and constructed. Traditionally CAD tools were been built assuming a certain level of prior knowledge of the designer but where design tools are developed intending to facilitate participation of a wider, non-professional user base some codification of this prior, professionally held knowledge could be considered critical to the design of a successful tool or service for users.

Researchers that did go on to explore the possibility of codifying and embedding design knowledge into the CAD tools were motivated to ensure prevention of production of dangerous or structurally dysfunctional products to allow the user to both communicate and respond to the constraints of the fabrication process involved and test the functionality of the product prior to fabrication. Saul, C Xu, et al. (2010) developed and tested a sketch chair system that enabled users of the tool to sketch, test and fabricate functional chairs. While others explored how 3D models can be converted to generate the parts and connectors required to build the corresponding physical object (Mori, 2007; Lau *et al.*, 2011; Saul *et al.*, 2011).

3D printing and associated consumer accessible design tooling that emerged alongside goes some way to change this. As theorists like Saul, C Xu, et al. (2010) note, this increasing focus on engaging users may have been inspired by increasing discussion related to the potential for 3D printing to democratise access to and participation in manufacturing. Furthermore Saul et al. (2010) and others indicate that use of 3D models by non-professionals has become widespread in recent years, as users can download them from the internet or create their own 3D models (Shilane et al. 2004, Igarashi & Igarashi 2009). This is evidenced by the growth of content on 3D printing repositories.
A variety of design tools have since been created specifically to allow a range of users including non-professionals to engage in the creation of 3D printable content and a

wealth of research related to tool development is available. Some of these enable creation of products fully imagined and sculpted by the user. Some bound the design space or provide pre-determined part libraries that assist user in creating content while others provide base content that the user may edit like product specific tools for user co-creation of dolls by MakieLab. These may be web-based tools like those offered by TinkerCad and Shapeways, or mobile applications by Sculpteo. Some related work is on going in VR and AR spaces as well as some testing of haptic tools.

Relatedly *in-game tools* are an emergent trend noted by this research and cited in media but neglected more widely in academic research in which games like Kerbal Space Program or Makies FabLab allow players to create 3D printable content during the normal course of gameplay (Hermans, 2013; Whitbrook, 2015). Many of these design tools bound the designs space and employ various ways to assist users in creating content. Given the early state of development there has been very little academic examination of these tools in a commercial, consumer context.

### 2.2.4. Digitisation and Convergence

*"Today we are in the middle of a new media revolution – the shift of all culture to computer-mediated forms of production, distribution and communication."*
Manovich (2001)

Adoption of 3D printing noted in this research in the toy/games industry marks, in some cases, what might be described as convergence of 3D printing with consumer accessible design tooling and/or media products such as digital games. This research at a macro level considers implications then that relate to *digitisation* and *convergence*.

Overall 3D printing may be understood as a progressive form of digitisation of manufacture, where the design product is digitally transmissible and manufacturing is controlled digitally (Gershenfeld, 2007). 3D printing is in simple terms a form of digitised manufacture, extending computer numerical control (CNC) and computer aided manufacturing (CAM) work. Digitisation for 3D printing renders products or goods (prior to manufacture) as a form of transmissible media or content similar to music or film media and the related ability to share, cut, copy and paste, remix and reuse such content are evident (Carolan and Cruickshank, 2010).

Relatedly media products have also undergone digitisation and implications relating to this have been widely noted and explored (Diakopoulos *et al.*, 2007; Lessig, 2008b; Collins, 2010; Fagerjord, 2010; Ferguson, 2010; Hill and Monroy-Hernandez, 2012). Researchers and industry commentators considering developments in 3D printing draw comparisons between this digitisation of manufacture and digitisation in music, film and media industries when considering future implications for intellectual property ownership and distribution. Digitisation has been central to reshaping of media landscapes of publishing, music, film and graphic design and has affected diverse areas of these industries including production practices, distribution, storage and consumption (Negroponte, 1995; Bolin, 2007). Few researchers have considered the implications of convergence of digitised manufacture with digitised media products.
The adoption of 3D printing in the production of media related goods it might be argued marks a form of convergence in which we observe 3D printing employed as a component process in user co-production of media related products and the emergence then of convergent media platforms as this research will argue.

Convergence is a complex term and is understood and employed in academic research in a multitude of ways. As a technological term, convergence is often understood as the technical capability of a technology to converge or merge with or into another. This approach is often understood as the 'black box' fallacy where multiple functions are made available collectively in a device that was once specifically designed to serve one function. Henry Jenkins understands convergence as '*the flow of content across multiple media platforms, the cooperation between multiple media industries, and the migratory behaviour of audiences...'* (2004). While Hugh Dubberly (2011), building on Negroponte's models of convergence suggests that;
*'Convergence has become shorthand for a series of arguments. First, all media will become digital. Second, the analog-to-digital transition will transform media production*

*and distribution, creating opportunities and disrupting existing businesses. And third, and perhaps less obvious in 1980, once media are digital, boundaries between media types will blur and opportunities for interaction will grow, creating new ways for us to make arguments, explain ideas, and tell stories.*' Dubberly (2011)

It is perhaps most appropriate consider convergence as a consequence of what digitisation permits. As Bolin (2007) indicates, the consequences of digitisation and convergence of the technologies transcend the mere technological in their impact and to reiterate what Dubberly points out "…*once media are digital, boundaries between media types will blur and opportunities for interaction will grow, creating new ways for us to make arguments, explain ideas, and tell stories.*" Dubberly (2011)

Discussion surrounding convergence primarily emerges from media studies disciplines and is primarily media centric. This has historically discounted the applicability and slowed uptake of this research theme across research disciplines examining design or manufacture of physical goods. Where this research considers media products like digital games and considers convergence of design tooling with 3D printing in the context of a digital consumer culture the theme of convergence has wide ranging applicability to the research. Mostly unexplored in academic discussions is that of the possibility of convergence of 3D printing with media products and by association media content. Gaps in research related to opportunities associated with convergence for the toy, game, publishing and film industries may be noted. Just as digitisation and convergence impacted media industries by democratising access to content creation it also lowered barriers to content manipulation/editing, remix and consumption and wider cultural changes were also observed (Lessig 2008). Peer to peer sharing, peer recommendation, participatory and collaborative cultures have also developed in relation to these developments and it might be suggested that the same may be evident and possible with 3D printing.

### 2.2.5. Democratisation

The 3D printing ventures considered in this research are emerging in the context of internet-enabled consumers and a consumer base that interacts with various forms of digital media and an awareness of participation and experience of digital distribution. Where these tools and services invite and facilitate player and user participation in design, customisation and production of toys and media related goods democratisation becomes a key theme to consider.

As noted earlier, *democratising access to manufacture* and facilitating wider participation in creation and manufacture of objects and products is cited as a key possibility relating to 3D printing. Often repeated in academic discussion of 3D printing are the possibilities for design and manufacture by users or non professionals (Stemp-Morlock, 2010; Peacock, 2014; Rayna, Striukova and Darlington, 2015). Research considering, or relevant to such possibilities are found in domains including open design, peer production and user innovation. These often highlight Fab Labs and community based accessible maker spaces as key to such processes. The origins of this work may be traced to the Fab Labs research group at MIT and work by Gershenfeld (Mikhak *et al.*, 2002; Gershenfeld, 2007). Here research focused on the social and economic implications of democratising innovation and manufacture and consideration of sustainable business models for community Fab Labs (Troxler and Schweikert, 2010) and community workshop spaces (Kohtala and Bosqué, 2014; Wolf *et al.*, 2014). This research was occupied with consideration of the value of FabLabs and other community manufacturing spaces for communities, spaces, and the possibilities for innovation arising from them (Troxler, 2014; Wolf *et al.*, 2014; Bosqué, 2015).

Democratisation research is not restricted to communities and individuals but considers also the implications of 3D printing on design practice for design professionals and also for firms. Research notes emergence of networked, collaborative, community, co-design and user design approaches (Weller, Kleer and Piller, 2015).

Decentralised and distributed models are considered in relation to organisational culture and practice with focus on democratised (von Hippel, 2004), distributed, decentralised and dispersed approaches (Qin *et al.*, 2004). Literature also considers temporal and geographic distribution of labour and knowledge, vertical disintegration of corporations (Pavitt, 2002) new entrepreneurialism, communities of practice (Füller *et al.*, 2004; Kyriakou, Nickerson and Sabnis, 2016), open design (Sinclair, 2012; Kyriakou, Nickerson and Sabnis, 2016), open innovation (West and Kuk, 2014), customisation (Malone and Lipson, 2007; Landay, 2009; Sinclair, 2012), co-design, entrepreneurialism as well as firm boundaries (Brusoni, Prencipe and Pavitt, 2001), capabilities and organisational structure. With adoption of 3D printing, each of these themes is likely to be of relevance to toy and media industries with immediate possibilities for user customisation of toys and media related artefacts and shifts in organisational structures processes already noted with toys including fan art and user customisation of goods.

## *2.3 TOYS AND MEDIA – RELATIONSHIPS*

It is useful to consider relationships between media products and toys as a means of providing context and grounding for the research aims of considering 3D printing convergence with media products. 3D printing of toys or media related goods is generally under explored in academic research but a number of research themes of relevance are explored in this section. Collectively these relationships are considered of relevance to consideration of developments in relationships between toys and media products associated with 3D printing.

Harvey (2016) suggests that the "*evolution of licensed toys is the product of multiple, convergent histories. Guiding these histories are developments in industrial processes as well as interrelated cultural, social and economic changes.*"

Media themed toys or media commodities are relatively commonplace in contemporary toy marketplaces and mark one of the most recognisable relationships between toys and media. Large studio film releases typically coincide with merchandise releases in which a supporting range of clothing, accessories, toys, figurines and other licensed products are produced to support the profit margins of the central media product. Various terms and are deployed by practitioners and academics in attempts to describe and categorise such relationships including *character merchandising* (Peters, 2014), *trans-media* (Jenkins, 2003), *media servility, synergy and convergence* (Jenkins, 2006; Deuze, 2007; Fagerjord, 2010; Booth, 2016). Such relationships between media products/content and toys are complex and have been subject to research in various fields of academia but few have considered these relationships in the context of 3D printing.

The following sections of the literature review present some other notable relationships that may be observed between media content and toys or commodities and considered research related to these. In doing so this exploration provides context for the research conducted in this research.

### 2.3.1. OMAKE: INCENTIVISING PURCHASE OF COMMODITIES

A historically recognisable relationship is that of ***Omake***. Omake is a Japanese term that means *extra* or bonus and in the context of anime and animation this might refer to an added extra or give away in the form of a free item such as a sticker, toy or figurine attached to soft drinks or confectionary. A more westernised context would use this term to in reference to extras, outtakes or “the making of” features of DVDs or in reference to a small toy contained in a cereal packet or confectionary as a giveaway item.

This practice which has since been defined as omake culture (Kitahara 2003) typically involved a confectioner distributing character stickers as an omake or freebie inside their packaging as a means of incentivising purchase of their chocolate. Ezaki Ri’ichi founder of Glico, an Osaka based confectionary company included toy-like omake in boxes of caramels as early the 1920s. The objects they elected to include were chosen based on size, availability and price and examples include animal figurines made from clay, medals, toy vehicles, baseball figurines and other small playful objects[1]. Meiji Seika later experimented with marketing to post war children and did so through the design of the chocolate and packaging, here they tailored their advertising practices to appeal to children, sponsoring popular televised children’s anime series. Their televised marketing campaign featuring Atomic boy (Atomu) is now regarded as being a key *“tipping point in the development of trans media relations in postwar Japanese visual culture”* (Steinberg, 2012). Kusakawa Shō argued this shift marked a change in the relationship between commodities and advertising practice (Kusakawa 1981). Various models of freebies, omake and token collections for larger prizes are still commonplace in consumable goods and marketing strategies aimed at children.

It might be suggested that 3D printing makes possible a reordering or reworking of how omake


Image 2.2 3D Mr Snuffleupucus

[1] A catalogue of Glico omake is available in Kitahata.T. (2003) ‘Omake’ no hakubutushi (A Natural

might be produced or distributed, should we for example consider this 3D printable Mr Snuffleupacus (Grunewald, 2014; Howard, 2014) created in partnership with MakerBot and Sesame street as a form of digitised omake? A gap in research related to 3d printing and it's potential for disrupting omake style objects exists.

### 2.3.2. *Stickering and Development of Media-Commodities*

Where Glico incentivised using an assortment of fairly random collectable items Meiji evolved this strategy to use the image of a popular comic or animation character on stickers and in doing so captured the attention of the existing audience of Atomu (Atomic Boy). Steinberg (2012) describes this campaign as the emergence of *character merchandising* and considers it a means of selling commodities:

*"Whereas traditionally the method of selling a product was to advertise and sell a product based on its content, after Tetsuwan Atomu companies would advertise and sell products by overlapping the commodity image with a character image."*

This image-on-commodity strategy can be traced (to an extent) to these low cost omake stickers. The accessibility, size and adhesiveness of the stickers allowed them to be affixed to anything and they then accompanied the fan or user across their daily routines as part of these objects. Where these stickers affixed to objects common to children this meant that stationary, schoolbags and other objects were augmented or branded by the character image in the sticker. In short, the stickers *mutated* or standard commodity goods traditionally valued for their use-value into image based media-commodities or differentiating them from standard product offerings. They also allowed the character and media product to perform in ways that were temporally and spatially mobile by releasing the character from the page or from the screen keeping the user engaged with the media content between episodes. Stickering of commodity goods can also be linked to the development of media-commodity goods and is perhaps better understood as an early form of character merchandising. These early relationship developments, it might be argued lead to the development of media related toys and merchandise.

### 2.3.3. CHARACTER MERCHANDISING AND TOYETIC POTENTIAL

The World Intellectual Property Organisation defined character merchandising as;

*"…the adaptation or secondary exploitation, by the creator of a fictional character or by a real person or by one or several authorised third parties, of the essential personality features (such as the name, image or appearance) of a character in relation to various goods and/or services with a view to creating in prospective customers a desire to acquire those goods and/or to use those services because of the customers' affinity with that character."*

Character merchandising in this general sense refers to the licensing, production, marketing, and consumption of goods and media products based on or derived from the image of a character. Historically there are a number of key examples of media producers and media products from which the practice of supporting media content with merchandise and toys became common practice; Disney is known for it's pioneering work in this respect.

Character merchandising involves deriving income through sale or lease of the rights to use a character image. The viability of character merchandising as revenue model depends firstly on the enforcement of the intellectual property laws that support it and secondly on the consumer appeal of the character. Ensuring the viability and manufacturability of a character as a merchandise product is a process that begins early in the development of media products. Disney is often cited as one of the earliest western media producers to create animated television shows and research shows that they recognised the merchandising value of their characters and in processes of developing content remained mindful of how their characters and content would translate to media commodities or toys (Anderson, 2000).

This strategy was also adopted, developed and refined across Japanese media production where merchandising important to generating supporting revenue for media producers but also, in some cases is likely to have been key to ensuring the actual development and release of certain media products (Ito, 2001, 2007, 2014; Steinberg, 2012). As an example Atomic Boy producer Tezuka strategically agreed to prices per episode that did not cover the development costs both to placate TV stations sponsors but also to pre-emptively undersell any future television animation competitors.

*"If merchandising (the sale and the copyright income from character goods) was to disappear, we would not be able to cover the costs of production — no matter how high the viewer ratings might be — and the program would no longer be able to continue"* (Imada Chiaki, former president of Toei Animation, 1986 in Steinberg, Anime Media Mix). As Steinberg (2012) summarises he ensured that anime would become a *transmedial commodity system* dependent on active consumption across media iterations.

This process of developing media content in such a way as to ensure or maximise the value of possible character merchandising revenue and licensing deals may be understood as evaluating or ensuring the *toyetic potential* of a media product.

The selection of screenplays, books for adaption or development of media content may be driven by or influenced by the requirement or benefit of making a film or media product "toyetic" (Wasko, 1994). In this way media producers anticipate or speculate over the ability to derive income from merchandise and toy sales (Murray, 2005; Gurevitch, 2012) and in doing so they consider early in the process the commercial potential of derivative goods, merchandise and toy sales electing to develop only those media products that will return most value.

These assessments of toyetic potential have historically assumed mass production processes for production of toys and merchandise and therefore assume associated mass production minimum order quantities, tooling costs, warehousing and retail costs. Research has neglected to consider the implications of 3D printing in such assessments.

### 2.3.4. TRANSMEDIA AND TOYS

When we speak of relationships between media product and toys it is necessary also to consider transmedia. This research area is diverse but theorists working in this area generally suggest that transmedia *"storytelling represents a process where integral elements of a fiction get dispersed systematically across multiple delivery channels for the purpose of creating a unified and coordinated entertainment experience"* (Jenkins, 2010). Other terms used in this field include *"multiple platforms"* (Jeffery-Poulter, 2003), *"intertextual commodity"* (Marshall, 2004), *"transmedial worlds"* (Klastrup and Tosca, 2004), "transmedial interactions", (Bardzell *et al.*, 2007) and *"multimodality"* (Kress and van Leeuwen, 2001). Collectively these form a rich and evolving research area.

*"At the most basic level, transmedia stories are stories told across multiple media"* (Scolari, 2009) and*"…each medium does what it does best — so that a story might be introduced in a film, expanded through television, novels, and comics, and its world might be explored and experienced through game play."* (Jenkins *et al.*, 2006)

Star Wars 1976 is often cited as one of the early and most significant transmedia strategies with a pioneering approach to merchandise and supporting products. Raybourn, (2014) indicates here the development of a transmedia strategy and notes that a publishing group produced and promoted a range of products, games, toys, cartoons, books and comics associated with the film with an objective to *"create a fan base that followed the transmedia experience across different media so as to not miss out on any part of the story"*. Though this practice is now relatively commonplace it was at the time a shift in practice and has been noted for it's success as a strategy (Jenkins, 2004; Kapell *et al.*, 2006).

When research considers transmedia practice it tends to focus on how transmedia stories are built and practical implementation relating to co-ordination, balancing requirements for each source to contribute to a central narrative but also stand alone as a source in itself, and to support various entry points and enhance the experience of people engaging deeply in the narrative. This means that audiences or consumers of stories have various points upon which they can enter into a story, and the various mediums make different but often supporting contributions to the telling of a story and there is no, singular source where a consumer can get all of the information needed to complete or fully understand a story. Here terms and research areas relating to non-linear narratives, additive comprehension (Young in Jenkins 2006: 279), media mix (Steinberg, 2012) and transmedia strategies are of relevance. On considering organisation and operational aspects to transmedia researchers consider issues relating to shifting balances of control over author or artist storytelling and collaboration and co-creation as well as the various forms of licences and franchising that make such collaborations possible.

Relatedly transmedia researchers consider the economics of transmedia (Scott, 2009; Ilhan, Otnes and Kozinets, 2013), noting that media producers are incentivised to spread its content or brand across as many different media platforms as possible to maximise profits. This activity is often considered under terms including synergy (Ilhan, Otnes and Kozinets, 2013) and related to toyetic potential (S Murray, 2005) and media merchandising. Media producers are generally driven to maximise profits of media products though multi channels distribution, and expand potential markets by providing different points of entry.

Transmedia storytelling functions by *expanding* or *extending* what might be known about a particular fictional, providing a diverse set of sources and channels that support a core narrative (Evans, 2008; Jenkins, 2010; Simons, 2010). This shifts consumption practices meaning that consumers are driven to seek multiple sources and in many cases collaborate and co-ordinate efforts in finding, acquiring, documenting and processing this dispersed or distributed information. Around transmedia products wikis and other collaborative and communicative practices may be observed with consumers participating in various forms of debate and discussion in the process of understanding and consuming transmedia stories and the world in which they exist. Here researchers assess this activity under terms including collective intelligence (Lévy, 1997), and research relating to peer production, communities of practice is also of relevance here. Relatedly as fan fiction and other forms of user generated content are often found alongside transmedia products, where fans, perhaps incentivised by the gaps in non-liner or multi channel stories have space and community in which they create content to bridge, or fill gaps.

Where Jenkins considers transmedia functions described as textual activators, that is "setting into motion the production, assessment, and archiving information" he also argues that transmedia *"provides a set of roles and goals which readers can assume as they enact aspects of the story through their everyday life* and points to costumes and role playing games that allow for immersion in the narrative as well as performative play with toys and media related figures and costumes and role playing games that allow for immersion in the narrative (H. Jenkins, 2007).

Collectively then relationships between transmedia content or media products and toys may be observed in so far as toys may be employed by media producers as a channel though which content may be consumed. Toys and games allow for immersion in the narrative and support role-play and performative play, forms of participation in story telling and consumption of the media product. Relatedly, toys related to media products are a known profit supporting strategy (Murray, 2005; Steinberg, 2010; Gurevitch, 2012; Gulden, 2015). Consideration of the implications of 3D printing for transmedia is under explored and it might be suggested that there is value in considering this in further research.

### 2.3.5. *Designer, Indie and Vinyl Toys*

Outside of mass-produced toys or the licensing deals considered in the prior sections is a category of toys that are referred to as designer, vinyl or indie toys. "Designer Toys" also known as "Urban Toys, Urban Vinyls or Art Toys" are products that according to Atılgan (2014) are products of "*an artistic and design movement which has become widespread and developed with the help of Web 2.0 and shaped with information and production exchange over electronic media."*

Designer toys, according to Phoenix (2006) first emerged in East Asia around 1997 in Hong Kong with the work of Eric So and Michael Lau and in Tokyo with Hikaru Iwanaga's Bounty Hunter. They then spread to the UK, North America, and Southeast Asia (Budnitz, 2006; Phoenix, 2006).

Designer toys are distinct from but related to fan art, and are usually pitched at collectors rather than children and understood to be "*a kind of collectible art object in toy form"* (Steinberg, 2010). They come in various forms, and within the descriptor "designer toys" there are two key variants, some are large, expensive, limited-edition objects, while others are smaller and produced in larger numbers, perhaps as part of a series or a grouping of toys into sets including KidRobot, Play Imaginative, Toy2R and Medicom sets (Steinberg, 2010).

Some designer toys relate to media products such as films and game, much like merchandise or media derivative but designer toys are in many cases *"singular pieces, which blend 'art, graphic design, and toys to create original items that come from a personal sensibility, rather than the direct result of merchandising from television or film spin-offs, comics, or video games"*' (Jeremyville, 2007).

*"The platform is a three-dimensional character-like shape and form to which particular artists or design firms are invited to contribute graphic designs."*

(Steinberg, 2010)

Designer toys are sometimes produced as series, with releases of new toys or sets of toys curated or designed different artists, in many cases these all retain a similar core form (likened to a blank canvas) and artists or designers work only on the surface treatment. In some cases a core toy or form is also released as a "blank" to facilitate do it yourself activity by consumers, in this way a blank acts as a platform for user customisation or a form of unfinished product allowing consumer participation. In both of these cases by retaining the same base form the *"character maintains a degree of self-sameness, consistency and ease of recognition across its incarnations"* (Steinberg, 2010). Steinberg describes this approach as platforms. Other toy companies have since adopted this approach with further examples including ‘Qee’, Kidrobot and ‘Dunny’.

Designer toys are not usually sanctioned or permitted by the media corporations they reference and so they may in some senses be considered as a form of fan art. In many cases they technically present as a form of commercial infringement. These have been largely ignored by media owners given the small-scale nature of such ventures. These toys are described as ‘limited edition, relatively expensive figures aimed at niche collectors’ (Phoenix, 2006) and may include vinyl or collectable toys. Designer toys are typically produced in small batches, sometimes hand made. They may be associated with an individual creator or a small merchandising group or studio. Manufacturing processes range from the hand made, rotocast vinyl, resin, plush and wood (Jeremyville, 2004).

Convergence of 3D printing with this activity has been noted but is not yet considered widely in academic research, as such an opportunity exists to consider implications of, and the role of 3D printing for designer toys. 3D printing could technically facilitate scaling, digital distribution and distributed manufacture of such objects subverting many of the legal controls that exist today.

### 2.3.6. *Feelies – Game Objects*

Where this research considers 3D printing in relation to media products including digital games this section of the review considers relationships between games and physical goods in order to provide context for the research that considers 3D printing in relation to digital game and media content. Board games and digital games sometimes come packaged with objects that a particular line of academic inquiry refers to as feelies.

In the context of digital gaming Karhulahti refers to feelies as: *"...materialisations of story world entities that are distributed with game packaging, here referred to as feelies, as props that support narrative elements in story-driven digital games"* (Karhulahti, 2012).


Image 2.3 Examples of Feelies included in Hitchhikers Gallery
Image from Infocom Gallery (http://gallery.guetech.org/hhgttg/hhgttg.html)

The term feelie was inspired by Aldous Huxley's Brave New World (1932) in which Huxley referred to a cinema-like form of entertainment that provided *"sensations of touch and smell in addition to sight and sound"* (Karhulahti 2012). Feelies then may be understood as physical items such as maps, props and other items packaged within a game or supplied as part of a game or to be consumed alongside the game.

Research discussing these objects primarily focuses on 1980s text based adventure games (Peters, 2014) but they are not specific to 1980s digital games and examples are still included with contemporary games, books and films and media products. As games have become increasingly digitised feelies have developed and evolved concurrently. Though it is not typical to refer to the items collected and interacted with in digital games as feelies it might be argued these in game items are digitised versions of feelies. There has not been much in the way of consideration of 3D printing and the implications for feelies.

Researchers have primarily considered feelies in relation to their roles and functions for games, games companies and game producers. These may be categorised into general themes including sales and marketing, intellectual property and game play.

Feelies direct players in *game interpretation* (Wolf, 2001) assisting players in understanding the necessary context or information needed to support game play, this might be through *provision of story related information* (maps, posters, newspapers), or as props to *assist with or intensify immersion* (Karhulahti, 2012), in some cases they *facilitate cheating* or *rule breaking,* or a means of *narrative pacing*. Veli-Matti Karhulahti (2012) suggests that they perform as *"props that support narrative elements in story-driven digital games..."* and that this narrative support operates on various levels, globally immersive effects enhance imaginative immersion in the story world, while locally immersive effects intensify immersion via player character or avatar. Alternatively some argue that the tactility of feelies may also degrade imaginative immersion suggesting that tactile interaction with physical objects may degrade player immersion in games (Ryan, 2001; Calleja, 2007b).

In some cases feelies are designed so as to be *critical to completion* of a game by performing essential tasks such as providing clues or information that make the game playable while others are less essential to the game but *extend the narrative of the game* (Varney, 2006). It is suggested that tactile aspects of feelies may aid in player immersion by allowing the player to touch an embodied part of the game world. Gordon Calleja (2007a) discusses this under *the packaged experience of the game*, and suggests that they offer players' involvement or affective involvement. Conway (2010) extends this suggesting that feelies *expand the magic circle of the game*, *expanding the ludic sphere into the world* beyond the screen by embodying the game world outside of the screen or gaming device.

In cases where feelies were vital to the game play the generally un-reproducible nature of these objects (pre-3D printing) prevented easy copying or onwards scaling or distribution of copies or bootlegged games. Where each game play would need access to that corresponding feelie but reproducing physical artefacts was sufficiently difficult to as to render this a control mechanism and undermine any attempts at copying. In this way inclusion of feelies gave game developers a mechanism to control the central intellectual property.

Game developers have of course moved to control intellectual property by various other means. However in the context of this research 3D printing and 3D scanning and wider democratised access to manufacture presents opportunities for reproduction of feelies and widened distribution potential and as such there may be a case for an argument that 3D printing and related technologies undermine intellectual property functions of feelies.

Historically feelies were understood as a means of differentiating one game product from others and in some cases were deployed to incentivise purchase of those particular games over competitors without feelies (Karhulahti, 2012; Kocurek, 2013; Peters, 2014). More recent games place feelies as items within special or collector's editions of a game, incentivising or enticing purchase of these special edition releases. Linked to added value and differentiation developers also indicate that the material quality or richness of feelies is curated to inform consumer perceptions of the worth, value or quality of the game (Scott, 2010; Green, 2012). There is however little actual data consulted in research commenting on performance or success of feelies. Researcher claims seem to have been informed more by statements relating to motivations from designers and developers rather than testable or consumer reported data.

Game merchandising assisted by feelies is frequently cited as a means of differentiating and incentivising selection of particular games. Historically games were primarily sold in bricks and mortar stores and in physical packaging. Feelies presented opportunities for marketers and packaging designers to create game packages that were appealing and differentiated from others through the objects included within (Kocurek, 2013; Peters, 2014). As games have undergone increasing digitisation the means by which games are sold, distributed and consumed have shifted and alongside these shifts feelies have also evolved. Marketers recognising revenue opportunities have developed feelie type toys or merchandise that rather than being included in game packaging are sold alongside games as optional additional purchases (Kocurek, 2013). Industry figures cited across marketing and academic reports suggest that examples such as Webkinz in which real-world purchases of stuffed toys and accessories are linked to, playable as or replicated as in-game items and characters (Ogles, 2007) have been successful for firms in financial terms.

Much research conducted relating to feelies or toys and merchandise as a means of capturing new players focuses on older games and their packaging and accessory inclusions as means of *differentiating products on shelves*, *indicating value* or *incentivising purchase*. More recent research looks at products such as Skylanders and other hybridised game play and considers the interactive play figures that often look like figurines or toys but function also as feelies.

As previously noted Webkinz.com was launched as a hybridisation of digital content and physical merchandise and in this way which real world purchases of stuffed toys and accessories were linked to, playable as or replicated as in-game items and characters. Webkinz was an important example of evolution of feelies and the marketing and distribution practices. The stuffed toy functioned in relation to game play by also presenting as an entry point for new players. In this way feelie-toys function as a means of exposing the game to people in store who may go on to become new players. Related to feelies and merchandise as means of user acquisition or entry points the presence or display of these feelie objects in the bedroom or games room of a player perform player authentication roles and also expose visitors to the game. Though there is little discussion of these approaches in research this strategy may be understood as a form of user acquisition and positions physical products as entry points for acquiring and on boarding new players. This literature review suggests that further research is required in this space to consider more fully the function of feelies as a means of user acquisition.

Production costs of feelies contribute to the overall production costs of games and as such researchers note tension between the potential value of including feelies, the quality and sophistication of feelies selected and requirements to ensure that the items be economically viable to include in the game and small enough to fit inside the packaging. Many of the insights reported in research relating to the economics of feelies comes from industry reports or statements from the game developers themselves. There is little research that considers in depth the development of feelies development, selection process or value to the game.

Research notes that with digitisation of games and digital distribution beginning with CDroms in the 1990's (Toivonen and Sotamaa, 2010; Toivonen, 2011); Toivonen 2011) and progressing towards full digital distribution with platforms such as Steam progressive dematerialisation or digitisation of feelies may be noted. Digital equivalent of feelies are deployed as assets within game narratives and players interact with such items in a digital or play context, referring to maps, keys and other items that may have previously been supplied as a physical artefact. Where game companies do develop feelie-type objects they create special edition premium or limited edition releases and as seems to be a trend are increasingly separating feelies from the game purchase, creating feelie-toy or feelie-collectable items that are retailed in addition to games.

Noting also fan art and other user created content generated in relation to media products including games (Lee, 2011; Noppe, 2011; Hemmann, 2015) there appears to be a gap in research relating to user activity in relation to feelies. As this research notes in examination of user generated 3D printable content a range of activity that results in the production of feelie like goods may be found on 3D printing repositories and with 3D printing production and distribution of such items may be able to scale (See Netnography chapter).

With continued evolution of games and feelies there also remains a lack of research on newer instantiations of feelies and possibilities for evolution in what feelies are, how they are produced or by whom. While research does note progressive dematerialisation or digitisation of feelies can be noted there has been little consideration of opportunities associated with 3D printing and possibilities for digital distribution of feelies as well as versioning, growth and evolution of feelies. This research indicates value in researching the implications of 3D printing and related tools for feelies. Noting that this could that allow user engagement or co-creation of feelies, re-materialisation of feelies, digital distribution of feelies, on-demand/in-game printing of feelies and a range of game play narrative opportunities associated with 3D printing.

## 2.4 3D PRINTING AND CONSUMER INTERACTIONS WITH MEDIA CONTENT

Where the research considers how convergence of 3D printing with digital game (media) products presents opportunities for development in production of toys and merchandise it necessitates consideration of consumer issues. In particular where it considers user interactions with media content enabled by convergence of 3D printing it is relevant to consider research relating to consumption and participation. This section of the literature review considers research relating to consumption and related consumer and user activity of relevance to media products. While there has been little direct consumer orientated research on 3D printing in relation to media products there is a wide range of consumer and user orientated research that informs this research. In the first part of this section research relating to consumers and consumer behaviour is considered. Following this, literature considering relationships and interactions between producers, firms and consumers are considered.

### 2.4.1. CONSUMER BEHAVIOR

Relationships between consumer activity and the prevailing cultural and economic attitudes of the era in which the consumer exists are an important factor in understanding consumer behaviour. Consumers engaging with MakieLab (the field study subject examined in this research) or those engaging with Shapeways or Thingiverse exist in a connected, digital consumer culture. Literature surrounding contemporary consumer culture and behaviour indicates a somewhat collective embrace by marketers, industry and academics of the concept of a newly empowered, entrepreneurial, and liberated consumer (Moor, 2003). Here a widely perceived transformation from consumers as passive recipients to active interpreters and makers is noted (Prahalad and Ramaswamy, 2002; von Hippel, 2005; Jenkins, 2006; Tapscott, Williams, 2008).

This transformation is considered in research from various perspectives and is discussed under terms and descriptors including *"experience economy", "creative classes", "value co-creation" and "prosumerism"*. These received increasing intention in consumer research temporally aligned with web 2.0 and thematic relationships to activity enabled by 3D printing may be noted. Pine and Gilmore (1999) suggest that industrialised nations have reached a period that can be described as an *"experience economy"*, suggesting increasing focus on engaging and memorable consumer experiences to help differentiate business offerings from competitors. Pine and Gilmore (1999) and Florida (2002) suggest that the essence of being a consumer has changed; consumer focus has shifted from simply buying goods and services towards an increasing concern with engaging experiences.

Richard Florida (2002) notes the rise of what he terms a *creative class* positing creativity as a driving force of economic growth today. Suggesting *"Many increasingly define the quality of their lives by the quality of experiences they consume"* he indicates that this is a factor responsible for the increase of *personalised product creators*. Members of the creative class he describes include designers, artists, writers, musicians as well as scholars, scientists, entrepreneurs, computer scientists and engineers. Creativity is a key factor in the creative class's professional role they are likely to engage in complex problem solving, independent judgment and possess a high level of knowledge or education. Relating to lead user innovation theory Arvidsson, (2005, 2006) indicates a *"consumer proletariat"* characterised by a "natural state of alienation and defiance" that he suggests fuels a desire to create oppositional forms of consumption through creative labour. The non-identification with commodities available in the market, he suggests, results in the emergence of creative labour valuable to companies.

This shift from passive to active and participatory consumer affords shifts in consumption behaviour and alters the relationship between producer and consumer and can be seen to be of particular relevance in relation to Makies consumers who participate in the production of media content and associated toy objects, as well as the consumers and producers found on Thingiverse and Shapeways.

### 2.4.2. Consumption in the Digital Economy

Consumers considered in this research are considered in the context of a digital economy. These consumers engage with 3D printing services in creative ways that involve interacting with digital tools that may be web interfaces, applications or digital games. Some simply consume their own content or standard content from producers, others create content and share it, some remix content from brands and media content or from other user-creators. In order to understand digital consumer culture and consumer behaviour attempts at profiling consumers and categorising behaviour have emerged from researchers across various disciplines. These are considered here.

Ann Marie Fiore (2008) presents a profile of the digital consumer with four characteristics including *digital shopper, digital content creator, digital personalised product creator* and *digital experience seeker.* She profiles consumers on the basis of their consumer activity characterising digital consumers according to their consumption activities. She defines the *digital shopper* as a digital consumer that searches for products, acquires information and completes multi-platform purchases online. She also indicates that digital consumers participate in more than just consumption suggesting they are *digital content creators*, creating content about products and brands via blogs, comments, websites, reviews and commercials. Fiore also suggests that content creation can progress to personalised product creation, and that some digital consumers act therefore as *personalised product creators* using digital technology to help create either images of product combinations (example fashion or interior design) or actual products matching their specific likes or wants (Fiore, 2008). Importantly Fiore also indicates that digital consumers expect *'engaging, enjoyable experiences'* when shopping for products and can be considered as *digital experience seekers* (Fiore, 2008), this theme of experience seekers seems particularly important in the context of this research.

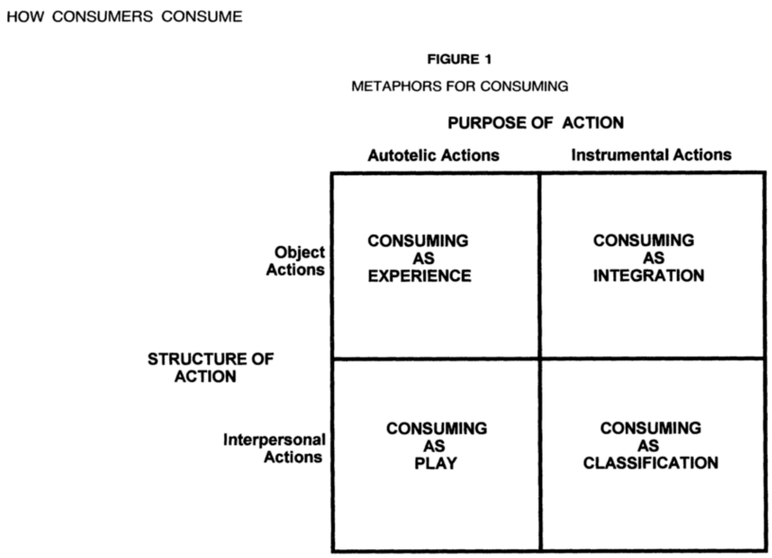



Image 2.4 Metaphors for consuming (Holt 1995)

Relatedly Douglas Holt (1995) in "How Consumers Consume" explores four metaphors to describe consuming; *consuming as experience*, *consuming as integration*, and *consuming as classification* and *consuming as play.* See image 2.3.

1. According to Holt, *consuming-as-experience* underlies subjective and emotional reactions to consumption. Such perspectives tend to view consumption as a psychological phenomenon highlighting emotional states arising during consumption and can be attributed to Holbrook & Hirschman (1982) whose research examined experiential, hedonic, aesthetic, autotelic and subjective dimensions of consuming. Prahalad and Ramaswamy (2000) additionally suggest that consumers desire to seek and shape their own experiences, whether individually or with others. Pine and Gilmore (1999) also comment on consumer experience, suggesting experiential value as a mechanism of competition and differentiation for businesses. They define experiences in terms of *educational, esthetic, entertainment, and escapist.*

2. *Consuming-as-integration* references methods used by consumers to enhance the perception that a valued consumption object is a constitutive element of their identity according to Holt (1995) or self-concept (Rosenberg 1979). Noting consumption practices including *self-extension processes* Belk (1988), *personalising rituals* McCracken (1986), *consumption ritual*s Rook (1985) and

*sacralising processes-consumers* Belk et al.'s (1989) *consuming-as-integration* is based on the ability of consumer to integrate self and object, thereby allowing themselves access to the object's symbolic properties.

3. *Consuming as classification* research situates consuming as a process in which objects act to classify consumers in relation to others (Holt, 1995). This approach focuses on how meanings are structured and interpreted in relation to certain groups or consumption categories.

4. In terms of *purpose*, consumer actions may also be considered as autotelic actions – those are *ends in themselves* and/or instrumental actions or a *means to an end*. *Consuming as Play* indicates that the interpersonal dimension of consuming can be deconstructed into autotelic and instrumental components. Playing captures the autotelic dimension as *"interaction for interaction's sake"* and can be further fragmented into communing and socialising (Holt, 1995).

Nuttavuthisit (2010) also offers a typology of four categories of consumption practices *participation-for-self, creation-for-self, participation-for-others,* and *creation-for-others*. Nuttavuthisit suggests that *acquisition of value* drives consumer *co-creation* and *participation*, and this may be categorised into two types: for *self,* and for *others*.

1. *Participation-for-self* is rooted in basic consumer motivations to gain the best fit to their demand; that is, the consumer gets as close as possible to achieving exactly what he or she wants whether in the form of personalised products, differentiation, or lower costs. This relates to mass customisation research that suggests that best fit principles are a key driver and outcome for people engaging with these approaches. It may also be practiced as *participation-for-self* in a *"self service context"* for example, banking via ATM instead of human-attended counter. By doing so, they participate in a transfer of work from the company to the consumer (Meuter *et al*., 2003). Situating design and manufacture as a *'self service economy'* (Gershuny, 1978)is relevant to this research, research and literature in this respect is limited.

2. *Creation for others* with the rise of communications infrastructure, namely the

Internet Web 2.0 - consumer co-creation creates value distributed among multiple stakeholders, consider Wikipedia as an example. Value associated with co-creation for others is indicated as social bonds, revival of rituals and traditions, a sense of moral responsibility, and economic rewards from the shared resources and developments (Gloor & Cooper 2007)

3. *Creation-for-self* is reflected in prosumer, pro am and maker cultures, *creation-for-self* practice results in a proactive role in learning and co-creating value. It also implies further consumer involvement in the co-creation process.

4. *Participation-for-others* refers to peer to peer practice, of peer recommendation, and refer to the practices of consumers who actively engage with the company's provided resources for the benefit of others for example sharing both positive and negative experiences to aid others in their buying decisions. It also includes the motivation to support the company.

There are therefore a number of related themes in consumer culture and studies of consumer motivations and behaviour that assist in understanding consumers and their consumption practices. These insights may assist in informing understanding of engagement with customisation or 3D printing services such as those identified in this research. Collectively there is a range of emergent-from-community ways in which consumers interact with content and strategic ways in which firms may engage with consumers to facilitate or otherwise co-opt their creative activity. The following section considers research exploring these themes. In the first instance it considers research from a marketing perspective considering value co-creation and service dominant logic. These perspectives bridge consumer research and understanding of the consumer and link to business and innovation theory perspectives.

### 2.4.3. *Value Co-creation & Service Dominant Logic – Firm/Consumer Relations*

Where this research considers firms that facilitate co-creation of media content and toy objects it is relevant to consider research examining firm-consumer relations and co-creation practices and motivations. From a marketing perspective, in response to the conceptualisation of the consumer as participants in production with various aims, motivations and agendas redefined business philosophies have emerged from marketing perspectives to capture consumer created value. These include *"value co-creation"* (Zwick et al. 2008; C.K. Prahalad & Ramaswamy 2004; Prahalad & Ramaswamy 2004; Prahalad & Ramaswamy 2002; Ramaswamy 2011; Prahalad & Ramaswamy 2000), and a *"service-dominant logic of marketing"* (Vargo and Morgan, 2005; Ballantyne and Varey, 2007; Vargo and Lusch, 2008).

Both of these approaches or strategies are based on the premise that serving the creative, autonomous consumer requires business mechanisms that facilitate and harness consumer activities in ways desirable to business. (Zwick, Bonsu and Darmody, 2008). Negus (2002) and Zwick et al. (2008) suggest that these latest management and marketing schemes are a consequence of producers aiming to reduce the distance between production and consumption. They also suggest that by involving consumers in mutually beneficial production processes, companies are simultaneously exploiting consumer labour and reducing the risk of consumer behaviour evolving in ways other than prescribed by the company (Lury, 2004). Zwick et al. (2008) indicate that this suggests two business related challenges: firstly, to attract and retain consumers, and second, to provide an open communications environment in which consumers can *apply and enhance their knowledge for the benefit of everyone* (Tapscott, 1995; Thrift, 2005). The market effectively becomes a participation platform in which a culture of exchange and company offered resources enable consumer creation activity transforming the market into a channel through which "human intelligence" renews its capacity to produce (Terranova, 2000).

*"From this perspective, customers are configured as uniquely skilled workers who, for the production of value-in-use to occur, must be given full rein to articulate their inimitable requirements and share their knowledge (Prahalad and Ramaswamy, 2004b) as inputs to the manufacturing process..."*

In relation to the co-creation perspective Stephen Vargo and Robert Lusch (2004) argue that the economy evolved to be *"service-dominant"* as opposed to being *"goods-dominant"*. Suggesting that goods are 'products' that consumers use as 'appliances' in value-creation processes (Vargo and Lusch, 2004). Arvidsson (2005; 2008; 2006) also highlights the growing dependence by companies on the *immaterial labour of consumers to manufacture trust, affect, and shared meanings.* Arvidsson's argument theorises that all communication, *even 'looking'* may be configured as part of the productive labour process (Jhally and Livant, 1986). Zwick at al. suggest that *"by inserting potentially the entire universe of commodity production in all spheres of life, market structures are effectuated to demand and capture more and more of consumers' attention, knowledge, and affect, or what Arvidsson (2005) calls 'ethical surplus', for the creation of economic value."*

Some researchers suggest that this constitutes free labour, Terranova (2004) that value production is unwaged and exploited. This free labour suggestion is based on a supposition that such approaches *'puts the consumer to work'* (Zwick et al. 2008; Ritzer, 2004; Terranova, 2000; Reed, 2005). Relations to *self service economies* indicated by Gershuny (1978) can also be drawn. Here consumers are not generally paid for what they contribute to the production process and typically pay a premium for the fruits of their own labour as the use value provided by co-created commodities is said to be higher. For example the work undertaken by customers to customise their own commodities ends up increasing the price they pay for their creation on the basis of uniqueness.

Literature on value co-creation consequently centres around the idea that control and harnessing of consumers and markets can best be achieved by providing platforms for consumer practice (Lury, 2004). With the widening adoption of internet connectivity in the lives of consumers, companies explore various ways to extract *"free labour"* from the consumer (Terranova, 2000; Zwick, Bonsu and Darmody, 2008). In what Arvidsson (2006) calls *"platforms for action"*, *"increasingly complex production systems around technology and machinery mediate social interaction in such a way that the workers' cognitive, social, and affective competences become integral to the labor process"*

(Zwick et al. 2008). Various mechanisms and strategies are pursued as means to facilitate and harness this consumer potential. Examples include user-generated websites, LEGO Group's Mindstorms and LEGO Factory applications and Build-a-Bear Workshop (Prahalad, 2004).

The applicability of this research to the aims of this doctoral research considering the emergence of convergent media platforms aimed at co-opting emergent user activity facilitated by convergence of 3D printing with digital design tools and media products is obvious. The next sections consider community and business approaches to value co-creation.

### 2.4.4. Online Communities

Online communities have been studied from management and innovation theory perspectives. Online communities that centre on common interests attract engaged and active consumers, (Fuller, Jawecki and Muhlbacher, 2007) drawn together by shared interests online communities create an environment where shared interests, product know-how, knowledge and insight can be collectively pooled, often resulting in innovation (Morrison and Roberts, 2002; Verona, Prandelli and Sawhney, 2006)

Many studies of online communities consider development of *open source software* (Hemetsberger and Pieters, 2001; Von Krogh, Spaeth and Lakhani, 2003; Lakhani and Wolf, 2019) and *gaming* (Jeppesen and Molin, 2003; Prügl and Schreier, 2006). Research examining the development of physical consumer goods tends to focus on offline communities (Shah, 2000; Franke and Shah, 2003; Luthje and Lüthje, 2004), according to Fuller et al. (2007)*'so far, no empirical study has considered physical product development in online communities as a subject for analysis.*' While this claim is dated and is no longer accurate much of the research considered in relation to online communities does focus on digital products.

The reasons for this gap in study have been attributed to the difficulties in producing and distributing physical goods. In software multiple iterations can be developed, tested, shared and refined in the online community in real time but product design and physical products are significantly more difficult to work with in this way. *'At best, joint development activities of tangible products on the Internet may result in animated virtual models, manuals and 3D-data that allow the members to make a physical product'* (Füller et al. 2007). Furthermore Füller suggested that products require investments in production capabilities that *normally lie beyond the reach of consumer communities* (von Hippel, 2007). They also suggest that members of *online communities that develop physical products will hardly ever be able to immediately benefit from using "their" innovation*. However with the continued growth in on demand, distributed, accessible manufacturing as indicated in earlier sections, this research suggests that a renewed ability for online communities to engage in innovation associated with physical product design is possible and that this is an area indicated as valuable for further study.

### 2.4.5. Toolkits for User Innovation

Toolkits for user innovation (Thomke and Von Hippel, 2002; von Hippel and Katz, 2002; Zwick, Bonsu and Darmody, 2008; Carolan and Cruickshank, 2010) and user led design (Dahan and Hauser, 2002) have been a key feature in innovation research. The concept of toolkits for user innovation and user design are based on a proven ability according to von Hippel (2008) to enable users to design their own products. With a relationship to consumer studies of value co-creation and on demand design and manufacture, toolkits have received significant consideration in manufacturing, management, innovation and design research and are considered under areas including open innovation, lead user innovation, outlaw innovation, co-design, customisation and user design. Significant contributions to the development and understanding of toolkits as a research area can be attributed to Eric von Hippel in Democratising Innovation (2004) as well as Nikolaus Franke and Frank Piller (2004). Overlaps in design literature can be seen in the increasing focus and perceived value of including and engaging the user in the design process. Computing literature that examines this in a physical product domain is engaged more in the design of the tools through the codification of design assumptions and knowledge in a HCI and interface design approach.

Toolkits for user innovation can be understood as *'a design interface that enables trial-and-error experimentation and gives simulated feedback on the outcome*' (Franke & Pillar, 2004). It is suggested that in this way, users are enabled to experiment iteratively until the optimum product design is achieved (von Hippel & Katz 2002). Toolkits for user innovation emerged in the 1980s in the field of custom integrated circuit (IC) design and manufacturing. A motivation for their development was that of costs incurred by not fully understanding user needs, here the toolkit served then to transfer user needs more clearly to designers and manufacturers (von Hippel, 2001). Toolkits have been refined and tested in various fields since and while much of the research on toolkits is situated in software development, toolkits focusing on the design and manufacture of physical goods can be found in areas ranging from computer chips to footwear, toys (Igarashi and Igarashi, 2009b) and furniture (OH *et al.*, 2006; Lau *et al.*, 2011; Saul *et al.*, 2011). Despite the variety of fields toolkits are studied in, the basic rationale underlying the toolkit is that of enabling the customer to take an active part in the design and development, and at times manufacture of the product.

Eric von Hippel (2001) postulates that *'that user toolkits for innovation will eventually spread to most or all producers creating custom products or services in markets having heterogeneous customer needs.'* Importantly he also suggests that they will *'provide the 'design side' that is currently missing for users and producers of mass-customised products.'* This statement is best understood as toolkits enabling user design rather than user customisation which has been the focus of mass customisation and many of the previously explored toolkits, which limited the user to configuring from a limited range of options of simple surface treatments. *In effect, user toolkits for innovation can provide users with true design freedom – as opposed to the mere opportunity to choose from lists of options that is currently offered by mass-customisers.'* Toolkits have been implemented and researched as an approach to enable access to 'sticky' user information and achieving faster, better and cheaper 'learning by doing' (von Hippel, 2005). Furthermore as Carolan & Cruickshank (2010) indicate, toolkits may be employed in a cultural probe context to enable communication of user needs and wants while facilitating co-creation. A relationship with co-creation of value literature is therefore indicated. Toolkits for user *design* are therefore a mechanism by which designers and organisations might enable users to participate in on demand design and manufacture.

Toolkits (facilitating design/production of physical goods) have been limited in research as convergence with manufacturing approaches has not, until very recently reached a point at which on demand design and manufacture could be facilitated in a reasonable way in a consumer setting. Much research relating to toolkits for user design has been limited by an inability to manufacture in a reasonable way the designed artefact, which was then only available as a digital file or made available sometime after the design process. 3D printing closes some of these disconnects, allowing for on-off manufacture in a reasonably consumer acceptable timeline. Toolkits employing 3D printing may then be a relevant way in which firms may engage users in design and innovation activity.

### 2.4.6. Mass Customisation

Mass customisation is a design and manufacturing approach in which the consumer is able to customise to various extents the product or service they wish to consume (Kotha and Pine, 1994; Kotha, 1996; Von Hippel, 2007). Mass customisation is perhaps the most closely related design and manufacturing approach to those examined in this research with Makies and in relation to the tooling provided by Thingiverse and Shapeways and is therefore of relevance to the research.

*"…the most creative thing a person will do twenty years from now is to be a very creative consumer… Namely, you'll be sitting there doing things like designing a suit of clothes for yourself or making modifications to a standard design, so the computers can cut one for you by laser and sew it together for you by NC machine"* (Toffler, 1980)

Davis coined the term "mass customisation" in Future Perfect (Davis, 1987) with reference to earlier statements by Alvin Toffler. The term was later developed into a business approach and ins considered in research by theorists including Pine (1993) Wind and Rangaswamy (2001); Duray, (2002) and Franke and Piller, (2003). Mass customisation is acknowledged as an established ecommerce format (Lee, Barua and Whinston, 2000) and refers to configuring and producing goods and services in line with individual customer needs attempting to preserve mass production efficiency (Jiao and Tseng, 2004). Academia and business research has explored this topic widely, primarily from manufacturing, management, supply chain (Salvador, Rungtusanatham and Forza, 2004) and consumer perspectives. Related approaches from design and computing fields consider the development of tools and customisable products.

Duray (2002) suggests there are four mass customisation archetypes: *fabricators, involvers, modularisers* and *assemblers,* each representing differing levels of flexibility on the part of the consumer to customise. Fabricators represent the highest level of engagement in the design and manufacturing process, enabling customisers early in the process when unique designs can be realised or major revisions can be made in the products, fabricators are therefore most closely related to the research topic. *Involvers* and *modularisers* on the other hand incorporate customer involvement in product design during the design and fabrication stages but use modularity in the assembly and design stages, while assemblers are closest to the idea of standard mass manufacturing practice.

Joseph Pine, perhaps the most widely known theorist on mass customisation also offers a typology. Here four types of types are indicated, *collaborative customisation* is understood as co-creation where consumer and firm interact in the creation of the item. For example some clothing companies will manufacture jeans to fit an individual customer. *Adaptive customisation* is a process in which firms produce a standardised product but this product is customisable in the hands of the end user. *Transparent customisation* - firms provide individual customers with unique products, without explicitly telling them that the products are customised. In this case there is a need to accurately assess customer needs. Finally *cosmetic customisation* in which firms produce a standardised physical product, but market it to different customers in unique ways.

Within mass customisation services customers are integrated into value creation by defining, configuring, matching, or modifying their individual solution from of a list of options and pre-defined components; consequently an overlap with co-creation of value practices can be inferred. Research explores issues of demand for customised products (Kotha, 1995; Klaus Moser and Piller, 2006; Bonney, Herd and Moreau, 2010), willingness to pay (Franke, Keinz and Steger, 2009; Bonney, Herd and Moreau, 2010), satisfaction, (Kamali and Loker, 2002; Piller, 2005; Altonen, 2011; Ristov and Ristova, 2011) complexity, paradox of choice and mass confusion, (Huffman and Kahn, 1998; C. K. K. Prahalad and Ramaswamy, 2004; Franke and Piller, 2004; Piller *et al.*, 2005) modularisation (Langlois, 2002; Qiao and Lu, 2006; Baldwin, 2007), influences affecting consumer choice in whether or not to participate in different mass customisation processes (Fletcher, 2006; Nambisan and Baron, 2009), generative design, individualised production and innovation in custom design tooling (Atkinson, 2004; Dean, 2008) and designing and configuring tooling to support consumer activity (Herd, 2012; Sinclair, 2012) website and configurator design and impact on user satisfaction and site efficiency (Sinclair and Campbell, 2009; Herd, 2012; Sinclair, 2012)

3D printing and the tools and services considered in this research can be compared in many ways to mass customisation approaches and so research examining customisation is relevant to the research aim of understanding how firms might move to co-opt user or facilitate user engagement with content. Where mass customisation looks at how firms may facilitate customisation or co-creation it typically operates from a firm as service provider perspective. Though this is useful perspectives from fan studies also have much to contribute to this from a peer production and commodification perspective. The following section introduces a case example of how democratisation of content creation through the development of sound software seeded the emergence of a peer produced globally recognised phenomenon Hatsune Miku.

### 2.4.7. Peer Production and Commodification of User Produced Content

Earlier sections of the literature review noted fan produced 3D printable content and some business models and strategies emerging to exploit such activity, while there is little available research on those specific examples researchers have examined fan produced content in other industries. This section considers commodification of peer produced fan content and considers related themes including peer production, creative control by brand or media owners and emergent fan economies. It begins firstly with an industry-based case study that demonstrates how peer production of content facilitated by democratised sound production tools grew into a global phenomenon.


Image 2.5 – Hatsune Miku

This section describes the development of a vocaloid software product designed to allow a range of people to create their own songs and musical products.

At first glance Hatsune appears to be a characterful anime pop star, but this descriptor alone over simplifies. Hatsune Miku has been described as a pop star, musical avatar and a globally distributed franchise and she may perhaps be understood as peer-produced creative franchise, the sum of creative contributions from a distributed network of artists, users and audiences in conjunction with her owners Crypton Future Media, Inc. Originally the image of Hatsune Miku appeared as box art on a voice synthesizer software tool. An anime-style image by Japanese illustrator Kei was printed on the software's packaging to provide a visual representation for the type or tone of the synthesized voice.

This software allowed creators to drag and drop phonemes on specific musical notes, which could then be used in the construction of words and melodies to form the particular software's singing voice (Leavit et al. 2016) in short democratising the creation of songs, voice and musical content. Since then songs and melodies that are now associated with, performed by or attributed to Hatsune the performer have been created by various musicians, composers, and lyricists using these software tools.
These user-creators are often non-commercial and operate outside of the professional music production field; their work may in many cases be understood as fan art or user generated content. Following the success of the vocaloid tool Hatsune, various other tools emerged that allowed people to make matching music videos, game avatars, costumes and content and each of these things cumulatively assisted in the development of what we now know as Hatsune.

Crypton, in response to the emergence and development of this economy repositioned to control the Hatsune Miku franchise, distributing licenses, acquiring and curating content and producing Miku's concerts. They identify popular fan produced content, choosing to platform only content that fits with their style guide or content guidelines. In some cases the more successful or popular versions of this content are curated and distributed by Crypton on their digital platforms or via concerts. Thus since her origins as box art and theme for a particular instantiation of vocaloid software Hatsune has become a character, a singer and performer. What we now recognise globally as Hatsune Miku is the sum of a wide range contributions by tool and content creators, curation decisions by Crypton and a vast range of user generated and grass roots production of content by a globally distributed audience who participate both in the production and consumption of Hatsune Miku products and content. This distributed creative peer production allowed many participants to contribute to the creation and distribution of media (Leavit et al. 2016) that was then collated selectively by a centralised organisation aimed at managing Hatsune as a character or media figure.

The context in which Hatsune emerged is relevant to understanding her development as a peer produced character and franchise. Hatsune emerged in Japanese markets and was platformed on social media and video sharing platforms in a context in which personal computing was ever more accessible and powerful, internet accessibility was wide and a history of dōjinshi (or self publishing) was strong. This culture allowed people to remix and reimagine Miku creating songs, videos and art for non-commercial sharing while otaku (or obsessive/deep) fandom and wide spread availability of inexpensive but increasingly home computing hardware and video sharing websites such as Niconico and YouTube provided willing and engaged audiences and co-creators.

It is the context in which Hatsune and similar examples emerged that provoked the initial shaping of this research project. Without the Japanese media mix consumer culture of remix and self publishing and the supporting infrastructure of video and music platforms such as YouTube Hatsune may not have developed into the phenomenon we now know and recognise. Just as Hatsune emerged from a software tool aimed at facilitating creation of songs and music, in a wider context of participation and co-creation by consumers of Hatsune content 3D printing and the various design tools that have emerged since also facilitate creation by a range of users while file sharing and content hosting platforms and services such as Shapeways and Thingiverse fulfil the platforming and distribution requirements.

Where Hatsune emerged from and supported by a Japanese culture of remix and self publishing in forms of dōjinshi supported by otaku, a culture of deep consumption and engagement with media content this research emerged from considerations as to whether the conditions or consumer culture that assisted in the emergence of Hatsune might be present for a similar emergence of a hybrid creative economy in media related physical goods assisted by 3D printing? There is of course tension, where the democratising and distribution potential of consumer accessible tools and platforms invite and enable new participants in the production and distribution of media products traditional models may recognise such developments as threats or undermine established models.

*“Sometimes, corporate and grassroots convergence reinforce each other, creating closer, more rewarding relations between media producers and consumers. Sometimes, these two forces are at war.”*
(Jenkins, 2006)

Where the research considers convergence Hatsune Miku is considered by theorists including Leavit, Knight and Yoshiba (2016) as “one of the most successful cases of convergence, at least in the Japanese media industry, in the twenty-first century.” They suggest that Hatsune Miku represents a new form of media production that involves a huge number of globally distributed, yet often collaborating creators and producers alongside corporate sponsorship and partnerships (Leavit et al. 2016). They suggest in line with Lessig (2008) that these collaborators exist in a hybrid creative economy.

Research relating to the emergence of Hatsune Miku examines topics including media mix, convergence, digitisation and developments in web 2.0. Peer production activity is considered under various research themes including (as the previous section mentions) fan art, peer production, user lead design, open source, user generated content, produsage (Bird, 2011; Sousa, 2016) and communities of practice. In some cases mass customisation research is of relevance also. Commercialisation, commodification and control of the resulting content and collective enterprise is considered under topics including intellectual property, commodification of fan art, and remix and through related fields of open innovation, democratising innovation and value co-creation. In many cases these are research domains that emerge from related schools of thought that do not typically work together so there is opportunity in cross-pollinating this research.

While the genesis of Hatsune was user accessible vocaloid software and the software producers evolved to manage the emergent ‘pop star’ there remain questions over how to manage peer production, how to commodify fan art, how to control collaboratively produced content. Leavitt, Knight and Yoshiba, (2016) begin to consider these questions and provide strong insights in the case of Hatsune. These insights are of central importance to research related to this research and future work is recommended in this space, with a particular focus on peer production of physical goods. Might the 3D printing – media producer collaborations noted in this research facilitate the emergence of a 3D printable equivalent to Hatsune? Should the West (the context in which this research is primarily situated) continue to pursue the traditional protectionist intellectual property approaches to media ownership and control or explore more open interaction between consumers and content creation? However this might develop, consumer and user engagement with media content has been observed on online 3D printing repositories and activity by firms indicates some level of interest in facilitating user interactions with their media content, in some cases through the provision of toys and service and in others by platforming and commodifying 3D printable fan art.

### 2.4.8. *Fan Art and Fannish Economies*

Where the Hatsune section previous to this considered peer production and economies emerging from this this section considers how fans and consumers of media products engage in production of goods, artefacts and media products that may be understood as fan art and the concurrently possibilities for fannish economies.

Traditionally examples of fan art were predominantly considered in relation to music via sampling and remix, text and anime via dōjinshi or fan-created comics, digital games by games modders and remix of sound and vision products. Some fans created physical figurines; models or toys derived from media products and in doing so some sparked the development of the vinyl toy market.

Early fan studies tended to examine the activity, motivations and relationships between fans, fan art consumers and media owners as peripheral activities to media production. With digital developments the accepted centrality of fandom, fan art and fan economies to media and cultural studies has evolved over time with more recent studies accepting the fan as inherently central to media and cultural production. Jenkins (2006) suggests, "*Convergence Culture describes a moment when fans are central to how culture operates. The concept of the active audience, so controversial two decades ago, is now taken for granted by everyone involved in and around the media industry"*

Fan studies consider academic and industry work from Japan, one of the most vibrant creative peer production economies in the world. From this perspective researchers consider *the media mix* (Ito, 2001; Eiji and Steinberg, 2010; Steinberg, 2012), and trends such as *dōjinshi*, or dōjin understood as self-published comics, magazines, or novels, that typically emerge from and circulate within fan communities (Arai and Kinukawa, 2013; Hemmann, 2015). Dōjin also includes video games and music and is often hosted on websites (like Pixiv, similar to DeviantArt) and video sharing sites (like Niconico, similar to YouTube) (Galbraith and Karlin, 2016; Jørgensen, Vitting-Seerup and Wallevik, 2017).

Researchers indicate that that developments in digital media in the context of Web 2.0 alter interactions with media and relationships towards media production (Nightingale and Dwyer, 2007). Researchers note that the digital revolution has impacted fandom *changing relationships between producers and consumers* (Pearson, 2010; Lee, 2011; Galuszka, 2014), *facilitating new forms of cultural production* (Jenkins, 2004; Jenkins, 2006; Ito, 2014), *involving new actors in production and distribution* as well as enabling *developments in fannish economies* (Pearson, 2010a; Noppe, 2011) and conditions for scalable commercial exploitation of fan art and fan production by fans and corporations alike.

More recent studies of fandom consider *fan behaviour* and *fannish consumption* and production of media and media products from economic perspectives, focusing on the economic and market development opportunities for media owners. In considering such opportunities for media owners theorists present a number of options, some suggest that fannish production may be understood as a *gift economy* pointing to freely provided and freely distributed nature of fan produced texts and artefacts. Scott (2009) notes that free sharing of such artefacts allow fan art to avoid commercial aspects of many copyright restrictions and allows for copyleft approaches. Scott (2009)extends this line of enquiry to suggest that, gift economies and commodity culture cannot actually be considered as disparate systems while Noppe (2011) asks if fan art should be commodified and considers possible implications for fan communities of doing so. Noppe suggest that where digital technology facilitates fan production of high quality media that renders fan produced content economically viable even in comparison to professionally produced content any separation between sharing and commercial economies is losing significance (Noppe, 2011).

*"While no producer has as yet actively encouraged piracy, many producers now actively seek ways to benefit from fan pro-sumers by indirectly monetising user-generated content for the purposes of promotion."* (Pearson, 2010)

Researchers consider how firms and media owners might move to derive value from such fan activity, moving beyond passive fan art towards thoughts of producer solicitation of user-generated content. Just as Lessig speaks of possibilities for a *hybrid economy* scholars have worked to explore how fan produced content might be integrated into or supported by commercial cultural economies (Lessig 2008; De Kosnik 2009; Arai & Kinukawa 2013; Pearson 2010b).

Where research considers commodification of fan art, it necessarily considers intellectual property legislation and research surfaces thoughts of regulatory developments aimed at co-production. Beyond this research considering issues relating to fandom and fan produced content query how fans might react to commodification of fan produced content, how fans might receive sufficient benefits and control over their creations and what partnerships might look like between media owners and fans. A useful example are these by Lang, Di Shang and Zicklin, (2007) who consider two possible development opportunities for media owners wishing to capitalise on fan production activity suggesting;

1. A market offering products with content access and transmutation rights to consumers that facilitates personalisation of products in the post-purchase environment.
2. Open source production models in which producers can trade content access rights allowing other producers to reuse their content in their own production process.

This thinking is of key relevance to this doctoral research where it considers opportunities afforded to various stakeholders related to convergence of 3D printing with media products and where it considers how people use 3D printing to interact with and co-produce 3D printable media content. These two examples are entirely appropriate for this research.

A later section of this research examines content found on 3D printing repositories finding a range of fan-produced artefacts. In doing so it also points to the emergence of platforms that host or sell 3D printable fan art and in some cases incentivises or solicits remix of media content (with permission of the media owners) towards the production of saleable fan art. While these are early approaches to soliciting fan produced objects and in a precarious stage of development this research points to these examples of 3D printing-media partnerships as examples of fan economies. There has however been little consideration in research of the implications of 3D printing for fan production. Where physical objects were created by fan artists before 3D printing the scalability of such fan production was limited, theoretically it may be suggested that 3D printing allows for distributed and scalable manufacture of such objects and in doing so questions are raised as to the implications for media producers.

### *2.4.9. Role of Social Media in Convergence of Fandom with Games*

Speaking of fandom in the digital economy requires consideration of the Internet and social media and their role and influence with online fan communities and audiences. Fandom, fan spaces and fan activity has evolved inline with developments in communication and networking tools. Where fan clubs historically involved in-person meetings or mail order fan club subscriptions it has evolved over time from online mailing lists, internet relay chat groups and web forums to, social media platforms (both media sanctioned and independent (Facebook, Twitter…) as well as live streaming platforms such as Twitch.

As earlier sections noted consumers, fans and audience members of media products sometimes participate in fan production or co-production of content. In some cases fans participate in *'fan subbing'* subtitling or translating content (Lee, 2011) , *fan art production* (Yang, 2009; Lamerichs, 2011; Galuszka, 2014), *dojinshi* (Lam, 2010; Arai and Kinukawa, 2013), and other forms of fan-production. Research considering fandom and social media tends to consider a range of themes including *"industry control of consumption habits"* (Burkart and McCourt, 2006; Morris, 2011) *industry based attempts at incorporating or responding to fan tastes and pressures* (Chapple and Garofalo, 1978 in Galuszka, 2014) *issues relating to authenticity,* (Marshall, 2003) and *control* (Pearson, 2010). Relatedly intellectual property and related legal issues (Jenkins, 2006; Tushnet, 2007; Hetcher, 2009) are considered with growth in consideration of *fan economies and fan labour* (Milner, 2009; Noppe, 2011a; Galuszka, 2014)

Researchers find that social media plays a role in enabling this work and the subsequent distribution and exposure of such fan produced products.

*"…online fan clubs have taken on a new dynamic: marked by the appearance of a more direct form of dialogue between artist and fans and a more regular, even daily, ability to connect both artists with fans and fans with one another, fan clubs are now regarded as a new kind of "community" by some and a new source of revenue by others."* (Theberge, 2006)

Twitter can be considered a central site for some of this activity, it has as a social media platform has been studied in the context of second screen or back channel audience communication around television content (Lochrie and Coulton, 2012), while Twitch (video streaming) is considered in relation to live gaming (Hamilton, Garretson and Kerne, 2014; Burroughs and Rama, 2015; Rank *et al.*, 2016). Studies of media and fandom often view the web then as a space where viewing or media consumption experiences may be enhanced, situating social media as a back channel of sorts, facilitating fan participation in discussions sometimes with the effect of creating subtle shifts in how media producers consider and react to fans.

Researchers have tracked developments associated with development in internet and social media technologies suggesting that the rapid growth of new media technologies has turned the average media user into a savvy, intense consumer (Wood and Baughman, 2012). Theberge (2006) and Galuszka (2014) suggest that social media provides an unprecedented degree of access as well as new opportunities for performing fandom, and potential for reaching large audiences.  Social media, in short provides a broad spectrum of ways in which fans and audiences may collectivise, engage, express opinions, discuss media developments and share fan produced content. In response media producers have responded with their own fan orientated strategies and branded fan spaces. Research has considered how to engage fans, how to monetize and otherwise commodotise fandom.

Perhaps of most relevance to the topic under study here is fan participation and interactivity enabled by social media. Patryk Galuszka, (2014) provides a useful way of categorising fan-media producer relationships and power dynamics. He suggests that, beyond audience, consumer or player fans may be also considered as *sponsors, co-creators, stakeholders, inves*tors and *filters* a range of internet based technologies and social media sites and spaces enable these relationships. Crowd-funding platforms like Kickstarter and other artist supporting sites like Patreon enable fans to sponsor, invest or otherwise support or direct future developments by essentially voting with their money and financially supporting development of new content or media products (Booth, 2015; Scott, 2015; Toma, 2017; Fanea-Ivanovici, 2019). Various media producers have created sites that enable co-creation or seed communities with tools, content and sometimes incentives such as competitions to seed and inspire fan co-creation (Jarvenpaa and Lang., 2011; Galuszka, 2014). Hatsune is supported by such activity and both Radiohead (Literat, 2012) and Nine Inch Nails are known for their attempts to support and leverage co-creation. In speaking of *filters* Galuszka refers to netlabes and fan operated musical labels in which fans promose, distribute and otherwise distribute content from producers they appreciate performing various roles of promoter, distributer, reviewer and curator.

IN all of this there is little consideration of the role of social media in enabling or supporting fan produced 3D printable contennt or toys. This research considers online repositories of 3D printable content and a question arises then as to whether these might be considered under the scope of some of these internet based fan spaces. Where the content in these repositories is fan art and an economy of such content may be noted, is this therefore an example of fan production enabled by 3D priting and online repositories? Is MakieLab an example of a firm moving to co-opt this activity?

## 2.5 GAPS IN LITERATURE AND RESEARCH STATEMENTS

A number of gaps in literature and research were uncovered during the course of this research. Drawing on insights gained from this literature review in combination with an early research phase to elicit research areas for investigation a number of statements or arguments are outlined in this section. A sub section of these form the foundation of the research in this study and inform the development of the research questions which are considered in the following chapter.

**Few researchers have considered the implications of convergence of digitised manufacture with digitised media products.** Where there has been little opportunity in academic circles to research such industry based adoption of 3D printing related to the media industries there is however evidence of emerging **industry based 3D printing and media firm partnerships in which media producing firms are partnering with 3D printing firms or adopting 3D printing as new avenues for co-production, customisation and manufacturing.** These developments have primarily emerged (in a commercial context) since the initiation of this research but few researchers have noted their existence or had the opportunity to study them. As the literature survey shows, though there is little research that directly considers these partnerships there is however historical precedent and related research that may be drawn upon to inform research examining these partnerships. This PhD research considers these partnerships and resultant services.

**Some academics, practitioners and firms note concerns about 3D printing and**

**implications for intellectual property ownership, controls and regulations.** Examination of research that notes intellectual property infringement supported by 3D printing however demonstrates little evidence of actual infringement referenced in these papers and a more general lack of understanding about what people actually make when they use 3D printing.

As researchers consider 3D printing and cite possibilities for copying, remix and other infringing activities legal scholars addressing the intellectual property implications of 3D printing point to a need for legislative developments (Bradshaw et al. 2010). Yet little consideration is given to findings from related research on innovations and positive implications of democratising access to production and distribution as found in the music industry (Lessig, 2008a), innovation theory (von Hippel, 2004) or the economic analysis of Dōjinshi as associated with Manga (Lam, 2010; Arai and Kinukawa, 2013). This research notes the work of Noppe (2011) and Lessig (2008) **and suggests that there is potential value in considering alternatives to legislative approaches and rather seeking opportunities related to new production, distribution and market developments.** However until this activity is better-understood and viable business and commercial models are established these alternatives are difficult to justify to firms perceiving intellectual property risk from 3D printing. As such further inquiry in this space is likely to be of value to the research and industry community concerned with these developments.

This **convergence of 3D printing with media products such as digital games presents opportunities for development in production and distribution of toys and merchandise**. Just as Lessig (2008b) noted in relation to the development of video editing technologies, convergence of 3D printing with web accessible design tools and media content appears to **democratise the ability to create, remix and distribute fan-produced 3D printable media content**. Yet there is little research that considers what people are making with 3D printing and less still on fan production or remix associated with 3D printing. There also appears to be **an emerging economy of fan-produced 3D printable, media related content as evidenced by activity on online 3D printing**

**repositories** but again, little academic examination of this activity. This research argues that there is value in considering such activity and will make contributions in this respect.

## 2.6 SUMMARY

In summary just as media industries were impacted by the digitisation and the democratising potential of the internet, widening participation, disrupting old business models and upending established hierarchies researchers are now considering the disruptive potential of 3D printing. This chapter offered an overview of research and literature in areas relevant to the research, considering 3D printing research in relation to toy and media industries. Firstly the chapter considered 3D printing and general history, context, trends as well as design tooling and practice-based context to provide insight into the state of practice and academic consideration of such trends. Then it moved to consider relationships between toys and media products in order to justify and ground consideration of 3D printing in relation to toys and media related goods. Research topics of relevance to consumer engagement in co-production and research related to how stakeholders may move to co-opt or facilitate this activity were also considered. The chapter then concluded with a summary of gaps in literature and research statements that inform the development of research questions and research strategy outlined in the next chapter. In doing so it pointed to topics and themes that are under explored in research and highlighted areas of relevance for exploration and continued research. The next chapter introduces the methodology and the research partnership developed in the course of this research.

# 3. Methodology

# 3.0 METHODOLOGY

This chapter addresses the methodology employed in the course of this research. It introduces the philosophical underpinning of the research, the research questions followed by the methodological selection and justification. It also introduces the researcher and considers practical issues associated with working with an industry partner. Three chapters that each address the implementation and execution of the research and describe the findings follow this chapter.

## *3.1 PHILOSOPHY, KNOWLEDGE AND BELIEFS*

Clough and Nutbrown define a "good" methodology as *"a critical design attitude to be found always at work throughout a study, rather than confined in a brief chapter called 'Methodology'"* (Clough and Nutbrown, 2012).

Creswell (2013b) argues the researcher must establish what *"philosophical assumptions"* underpin the research and what *"strategy of inquiry"* will assist in answering the research questions and that they must then choose methods that are suitable for the research and facilitate suitable collection and analysis of the data.

Beyond the research question the worldview that informs the research and the subsequent design of research and selection of research methods is central to understanding research design. The type of question asked is likely to be influenced by the philosophical perspective or worldview of the researcher and both the research question and philosophy will influence the research strategy.

The epistemological backing of a research project is key to understanding the nature of knowledge, justification and rational behind the research. There are a number of epistemological approaches commonly encountered in academic research. Epistemology is defined as *"theories of knowledge and perception in science"* (Flick, 2011). Understanding the worldview of a researcher and their epistemological approach is useful in understanding the theories of knowledge that underpin their research and drive their research design. Creswell (2013) provides an initial sorting of epistemological approaches common to social research into four research paradigms or *"philosophical worldviews"* including positivism or post-positivism, constructivism, pragmatism and advocacy/participatory or critical. These are somewhat influenced by the research discipline that the researcher ascribes to and the disciplines the research is intended to be communicated to. The literature review and background research informing the development of this research was underpinned by research that emerged from various schools with differing methodological perspectives and philosophical backgrounds.

This research is complicated by it's emergence from a cross disciplinary perspective and while some researchers actively outline their philosophy and state their theory of knowledge and belief system some disciplines are less likely to do so. In cross-disciplinary research, such as this project, the methodology employed needs to satisfy expectations of rigor from different disciplines and also to be able to communicate knowledge to a wider public than a research confined to one disciplinary field. Research in a cross-disciplinary context requires balancing of perspectives and selection of methods that will be accepted by the fields the research is intended for. Where this research emerged from a cross-disciplinary study grounded in computing, design and innovation theory this involved balancing a contrasting range of perspectives.

The literature review surfaced research from a range of fields; research that could be categorised as generally belonging to manufacturing, consumer studies or game, media and toy studies. Manufacturing research is generally underpinned by engineering and business focused research approaches and research methods typically used in such studies capture primarily quantitative data (Da Silveira, 2001; Herd, 2012). Consumer studies and marketing is examined from different theoretical perspectives including service science, innovation and technology management, marketing and consumer research (Galvagno and Dalli, 2014). Innovation research draws from business, innovation and economic theory and a range of similar, quantitative methods are employed though qualitative approaches are accepted. Toy game and media studies also capture a range of data including qualitative and quantitative, and research spans from technical studies such as those found in game development or software development to qualitative user studies of game related activity.

Satisfying the requirements for rigor and appropriate methodological selection according to each sector of these fields is further influenced by the research topic and question under examination. In each of these disciplines, the type of research employed hinges on the research question under examination yet there is support for and examples of studies that break from discipline norms and deploy research methods that are better suited to answering the question at hand. As an example, where the focus is on user activity or motivations versus the subsequent economic value of the user innovation research methods are generally selected on the basis that such knowledge is tacit and context specific. Mixed methods including case studies, interviews, questionnaires and archival data (qualitative and quantitative) are therefore selected in development of the research methodology (Bogers, Afuah and Bastian, 2010).

It is generally accepted across such disciplines that some research approaches are better suited to dealing with certain problems and certain questions, so the selection of best approach and method tends to be influenced by the research questions and research purpose and is considered through the lens of the researcher discipline and background and their intended audience. The next section of this chapter addresses research questions considering their wording, aim and subsequent selection of methods suited to addressing them.

## *3.2 RESEARCH QUESTIONS*

Defining the research focus and outlining adequately stated research questions at the outset of a research project is considered key to building a good research design even if the questions are subsequently redefined or modified through the research process (Mason, 2002). Establishing research questions informs the subsequent research methodology because as the previous section determined different types of questions require different methods, frameworks and approaches (Robson, 2011, Yin, 2009). This section considers the development and framing of the research question, relatedly it considers the research aims.

Flick (2011) advises that a research question should be specific, while Gillham (2000) argues that it is important that the question may actually be answered through research and that the question is in fact a question, not simply a statement. There are three categories of questions according to Blaikie (2010) who identifies how, what and why questions. Blaikie suggests that 'what' questions produce descriptions while 'why' questions lead researchers to discover reasons and 'how' questions were linked to developing understanding of changes or developments.

The research questions considered in this research emerged from a top-level exploratory research position that considered, *the implications of 3D printing within a digital consumer culture.* Also, inspired by EPSRC and HighWire objectives of producing industry relevant research output I sought to situate the research in industry and to attempt to ensure that the research would remain relevant to industry partners.

Noting during my early exploratory research, activity by Alice Taylor in securing early funding for MakieLab in 2011 and some examples of media related content on online repositories I updated this research to include *with a focus on media related fields and in particular the games industry.* The literature review and importantly this early exploratory research assisted in identifying gaps in research and knowledge and aided in the refining of this line of enquiry into the research questions underpinning this research.

The research questions evolved into the following:

**Primary research question:**

1. How convergence of 3D printing with digital game (media) products presents opportunities for development in production of toys and merchandise?

Within this are **sub questions** that consider:

2. What user interactions with media content are enabled by convergence of 3D printing in the digital economy?
3. What are the implications for the various stakeholders involved in production of media related goods?

The top-level research question calls for identification of opportunities for development in production of toys and merchandise associated with 3D printing. This calls for exploration of convergence of 3D printing with game/media related goods and an uncovering of opportunities associated with this.

The second question is a sub question that addresses user interactions with media content that are enabled by 3D printing within the digital economy. This second question emerged from exploratory research and the netnography and is central to assisting in providing insights related to the first research question. This question requires *identification of user interactions with media content* that are facilitated by 3D printing.

The third research question is also a sub question to the top-level research question and it requires that the researcher identify implications for relevant stakeholders related to 3D printing for those adopting it in the production of goods and merchandise related to game/media products.

The research described in this doctoral research was conducted at an early stage of industry adoption of 3D printing as a means of production for consumer goods. As such there were few examples of similar products available on the market and little reporting or evidence of examples that had scaled beyond prototypes. Qualitative research approaches were therefore considered most appropriate in uncovering and understanding the development and emergence of such products. That is research approaches that capture descriptive and in depth accounts aimed at answering *what*, *how* and *why* questions.

At a later point it is anticipated that it may also be considered valuable to test each of these questions on a secondary level, when data relating to types of interactions, strategies, sales figures and other data sets become available. However, at this early stage of industry development and adoption of 3D printing in production of consumer goods it would be have been premature to approach the research primarily in this way because there is not sufficient development. This research therefore predominantly employs qualitative research and cross references data and quantitative sources where relevant towards a rich understanding.

## *3.3 AIMS AND OBJECTIVES*

The phrasing of research questions also facilitates establishment and communication of research *aims*. Where the underpinning research disciplines are grounded in pragmatic and explanatory epistemologies and value dissemination of research across related industrial and business contexts research aims that are pragmatic and relate to these disciplinary agenda underpin this research project. This research therefore aimed to:

- Develop an understanding of opportunities for developments in production of toys and merchandise associated with convergence of 3D printing with media products.
- Document and categorise what people are making with 3D printing in relation to media products.
- Consider various stakeholder implications associated with adoption of 3D printing in production of media related goods.

## 3.4 RESEARCH DESIGN

The research design for this doctoral project was influenced in part by the cross-disciplinary spread of the literature survey in which relevant fields of related research that could be categorised as generally belonging to manufacturing, consumer studies or game, media and toy studies fields. These disciplines employ a variety of methods derived from various epistemological backgrounds and captured both qualitative and quantitative data interchangeably as appropriate.

Motivations commonly driving research design in these fields relate to research aims to develop understanding, communicate pragmatic and explanatory research findings of relevance to the research discipline that can be communicated both within academic circles but also disseminated for wider use by business, policy and industry bodies. As such, pragmatic, explanatory, descriptive and inductive approaches and methods of research analysis and dissemination were considered appropriate for this research.

A methodology that both satisfied the requirements of the background disciplines and aligned with relevant belief systems and philosophies was necessary in order to ensure that the research output would be considered relevant in the fields in which it was intended to be communicated. Relatedly the methodology was required to satisfy the requirements of the start-up who in the course of the research controlled access to the relevant research subjects and were able to provide access to research populations that were not accessible to researchers external to the organisation. The research was also intended to be relevant to, and communicable to industry. Finally, the research questions and related aims underpinning this research necessitated a range of related research approaches and methods.

This research therefore employs **methodological pluralism** combining a range of research methods to examine the research questions posed in the course of this research. This is understood as **a mixed methods** approach to research in which more than one research method is employed in the course of a research study, capturing where and when appropriate, a range of qualitative and quantitative data relevant to the research questions under examination (Johnson & Onwuegbuzie 2004:17).

As Muskat et al. (2012) and Johnson and Onwuegbuzie (2004) argue, methodological pluralism enables researchers to increase both the *scope* and the level of possible analysis and reduce researcher bias (Muskat, Blackman and Muskat, 2012). Benefits of employing methodological pluralism include an ability to *triangulate* results and findings by comparing and corroborating results from different methods, *elaborating, enhancing* or *clarifying* findings through *complementary* methods and expansion of the *breadth* of research by using different methods for different inquiry components. Mixed methods are considered useful in initiating research and reframing research by *"discovering paradoxes and contradictions"* that lead to a re-framing of the research question. Furthermore given the multi stage approach to research mixed methods allow for development in a way similar to action research using the findings from one method to help inform or initiate the next or other method (Greene et al. 1989:259).

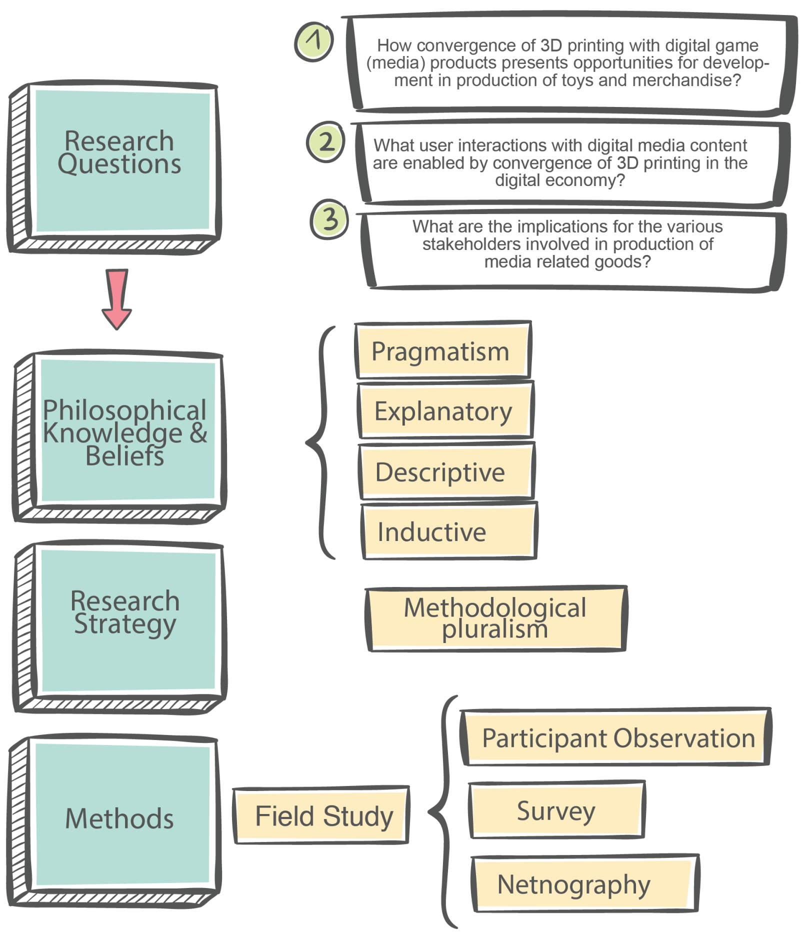



Image 3.1 Research design

The research was designed then as a **field study** with MakieLab, a start-up working with 3D printing in the production of toys from game media content. This field study consisted of a longitudinal period of engagement primarily involving **participant observation** and was supplemented by a **survey** and a **netnography**

Where the research aimed to consider **how convergence of 3D printing with digital game products presents opportunities for development in production of toys and merchandise** and **to identify implications for stakeholders** a field study with a start-up enabled by convergence of 3D printing within this domain was considered a key location to conduct this research.

Where the research considered **user interactions with media content enabled by convergence of 3D printing in the digital economy** a **survey** of prospective Makies consumers and a **netnography** focused on user activity on online 3D printing repositories and fan activity surrounding MakieLab were conducted as part of the larger field study.

## 3.5 RESEARCH MAP

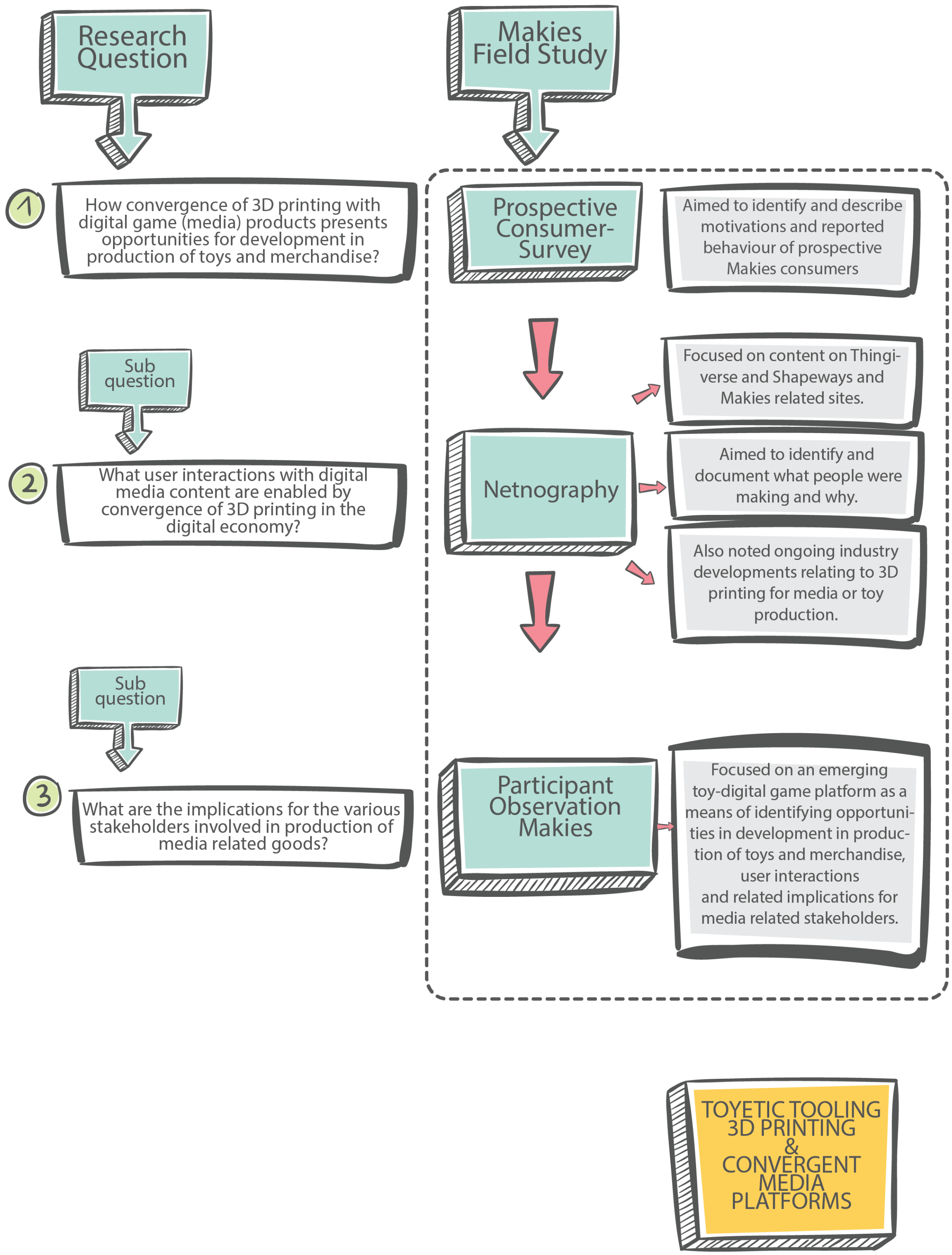



Image 3.2 Research map

## 3.6 METHODS

This section introduces each method employed in this doctoral research with justification of their selection. Firstly the *MakieLab field study* is described; this is comprised of three supporting methods; *participant observation*, a *survey* and a *netnography.* These are considered in the sections that follow.

## 3.7 FIELD STUDY

The research that underpins this doctoral project takes the form of an exploratory field study with MakieLab in which methods including *participant observation*, *survey* and *netnography* are employed as part of a mixed methods approach. As Chipchase (2017) notes there are six types of field study, *exploratory, foundational, generative, communicative, evaluative* and *applicative.* The fieldwork underpinning this research may be understood to be exploratory, assisting in generating insights into opportunities, developments associated with adoption of a manufacturing technology in an media industry setting in a way in which it has not been used very much before.

A field study may be understood as, *'research in the field'* that is research conducted outside of the laboratory, studio or university setting. In this case of this research the field may be considered to be in, and with, MakieLab, the organisation that informs this research. Consideration is also paid to the greater context in which MakieLab operated and so the field research involved participating in MakieLab as a participant observer, while maintaining a view on the wider context in which MakieLab operated via a survey and a netnography of online 3D printing activity and consumer activity relating to Makies as well as industry developments situated in the toy and media producing industries.

### 3.7.1. SELECTION OF FIELD STUDY PARTNER

This first step of this research was identification of relevant industry examples and this involved tracking industry and media reporting on 3D printing relating to media producing industries. The aim was to find an example of a firm moving to exploit 3D printing in relation games or digital media products and to build a research partnership. So as to allow for research engagement and capture of relevant insights the firm or industry body selected would ideally be at a sustainable level of development but at an early stage to allow for capture of early insights. Furthermore given the UK funding and location of the researcher a UK based partner would be most easily accessed.

MakieLab initially came to my attention at a NESTA event in 2011 in which founder and CEO Alice Taylor presented [2] her start-up idea. At this stage, MakieLab was pre-funding and existed only as a blog at www.makielab.com, a sign-up page at www.makie.me and was present on social networks including Twitter and Facebook. MakieLab had applied for Technology Strategy Board funding (now Innovate UK) and was raising family and friend funding and was at an early stage of development.

Within a few months of this MakieLab had secured funding and seemed to be on track to go live as a relevant example in time for this doctoral research. Moreover, the team behind MakieLab seemed well posed to be able to navigate the 3D printing for the games industry. They were already, individually, key persons in the games industry, backed by a solid group of investors and supported widely in the games, technology and news media. As such it was anticipated that MakieLab would be an ideal research candidate.

### 3.7.2. MakieLab

MakieLab was a toy and games company that operated from London from 2011 until March 2016. MakieLab had a unique proposition that was at the time unmatched in a commercial sense by other toy-game companies. You could, as a game player, choose to have your customised-in-game-avatar 3D printed and shipped to you as a 9-inch pose-able doll and create and print in game items and accessories. MakieLab adopted 3D printing in the production of toys and accessories directly derived from their digital game assets. MakieLab was, as this research notes, moving to explore the possibilities related to convergence of 3D printing with digital games and in the manufacture of toys and goods related to their game products. This was their key point of differentiation from other game companies and was central to its business proposition and ability to fundraise as a technology company. MakieLab was from the outset a key early example of a company exploring convergence of 3D printing with digital media products and a research partnership with MakieLab meant the field study described in this chapter was

[2] Alice Taylor presenting at NESTA https://vimeo.com/19033716

conducted in what might be considered as ‘ground zero’ or a first mover for 3D printing-convergent media platforms and in-game manufacture.

MakieLab executive team consisted of game and media industry folks including:

- **Alice Taylor**
  Previously a commissioner at BBC and Channel Alice was the idea originator, drawing inspiration from the book titled Makers – by Cory Doctorow (2009) (her husband). She brought together the founding MakieLab team that included CTO Luke Petre, CDO Sulka Haro and COO Jo Roach.

- **Luke Petre (CTO)**
  Previously a tool developer at Media Molecule Luke worked on award winning games including Little Big Planet 1 & 2. Luke brought console gaming development experience and an understanding of user-generated content from his earlier MMO development background (Lord of the Rings Online, Dungeons & Dragons Online).

- **Jo Roach (COO)**
  A cross-media production director and talent scout had directed and managed multiple award-winning playful media experiences including Somethin’ Else and Channel 4 (Routes, SuperMe, Linkem, Skins & Misfits).

- **Sulka Haro (CDO)**
  Previously 10 years Lead Designer at Sulake, the creators of Habbo Hotel, a game for children with upwards of 250 million registered players. Sulka brought extensive knowledge of virtual goods, virtual economics and metrics as well as design experience in creating products for massive online audiences (Habbo Hotel, Virtual Magic Kingdom).

### 3.7.3. Recruitment & Access

Through a series of meetings with Alice Taylor and Jo Roach access to MakieLab was negotiated in the form of a research partnership that allowed for full time access to the start-up and an opportunity to research and participate in relevant product development and testing. Negotiating access to conduct a longitudinal field study of a start-up needed careful consideration as did working to gain deep access to a start-up during an early boot strapped, fundraising period. In the case of London where desk space is expensive asking to join a start-up as a researcher requires that the founders to give time and resources to a potentially non-productive agent. Moreover, the researcher is often perceived to have an agenda outside of the goals of the business and so gaining acceptance on the part of the start-up is understandably challenging. It is also important to recognise that permission is not the same as acceptance (Crabtree et al. 2012). A balance must be struck between a desire for access on the part of a researcher and a respectful and productive means of engaging with the context and firm under study and I sought to strike this balance by adopting a contributory, active form of participation.

### 3.7.4. Ethics and Research Agreement

The research agreement drawn up in conjunction with MakieLab stipulated that they had the right to review and/or block publication of anything that they deem commercially sensitive and that any consumer information be treated inline with their company policy of data protection and privacy. The terms of use and conditions of sale that MakieLab consumers encountered in their engagement with MakieLab products, services and games outlined on-going research. Any research conducted with consumers in a face-to-face context was conducted with the informed consent of the persons involved and they were issued with MakieLab consent forms and ethics guides.

### 3.7.5. Research Timeline

A research timeline is presented in image 3.3. I joined the company in advance of its open-alpha in 2011 and continued to observe the company development periodically until it’s eventual sale in late 2016/early 2017 to Disney. As such, I joined MakieLab just as they were prototyping and building games and toolsets that allowed user design and customisation of digital avatars and subsequent manufacturing of these doll/avatars. I considered this to be an optimal research time where the company was making critical early stage decisions in preparation for their limited batch open-alpha launch. Within the first two years of operation, MakieLab created what it claimed as the world’s first customisable (via an app) 3D printed toy (*Makies*), which was demoed in a private alpha in summer 2012 before wider public release. By November 2012, the company consisted of 13 people making up art, engineering, communications, retail, front-end, back-end and games developer teams. By 2015, this had expanded and reconfigured as the business required to 17. In 2016, the London team was discontinued and the company and relevant intellectual property was sold to Disney in an “undisclosed and confidential” deal (Benedict, 2017; O’Hear, 2017). MakieLab was a venture-backed start-up and an investment profile for it is listed at (https://angel.co/makielab). This field study spans this time period.

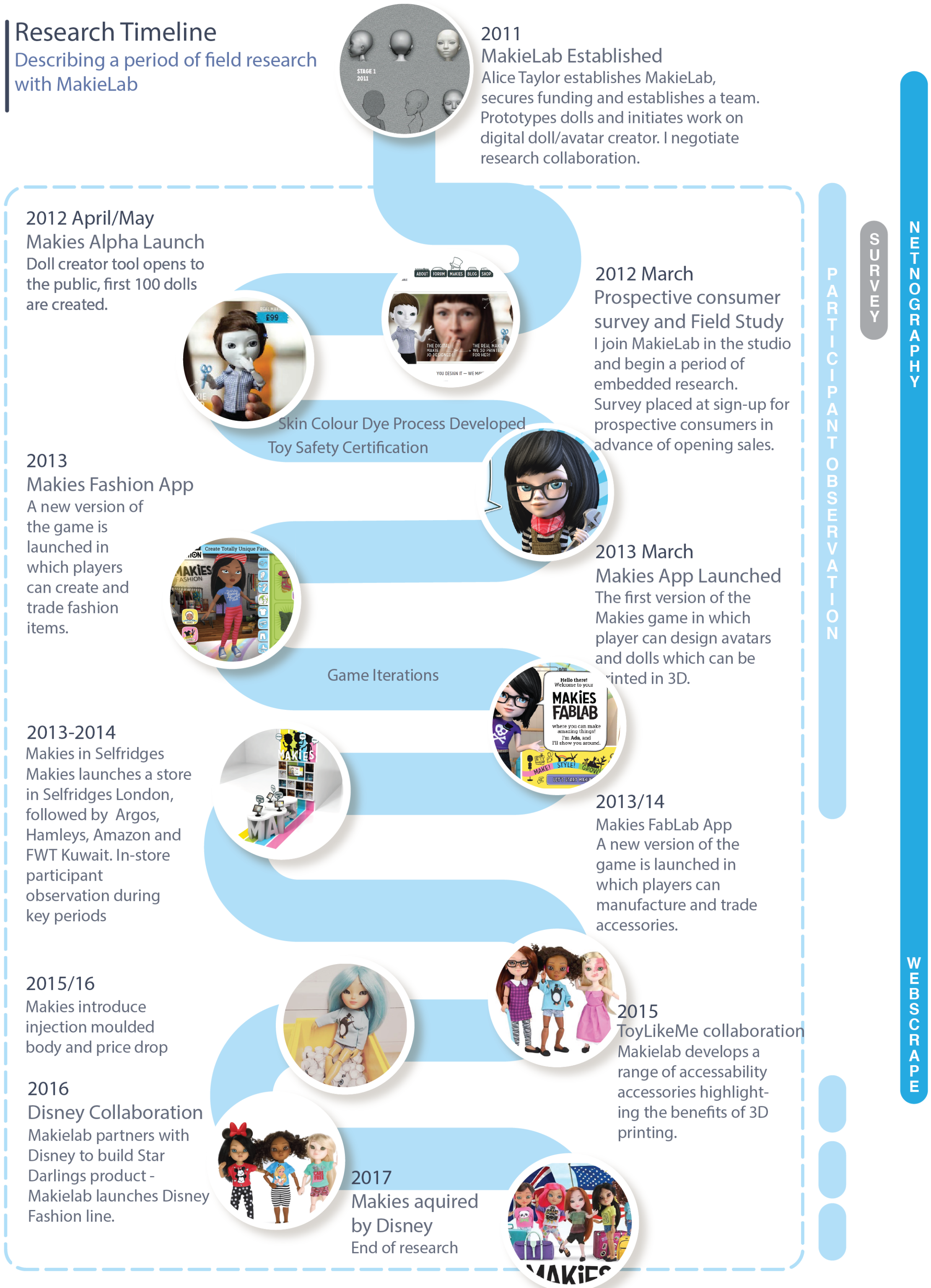



Image 3.3 Research Timeline

## *3.8 PARTICIPANT OBSERVATION*

Within the field study participant observation was the primary method of interacting with the organisation, observing and documenting activity under study and capturing insights. As a research approach, fieldwork and participant observation emerge from, and are associated with social sciences such as anthropology and sociology and they are sometimes described as ethnographic methods (DeWalt and DeWalt, 2002). Such approaches to research typically involve researchers entering into the field to research people, societies and cultures in context, sometimes for prolonged periods of time. Participant observation is a research process then that enables researchers to gather rich, qualitative insights into their research subject, in its natural setting or context (Kawulich, 2005). Researchers gain insights by observing and participating (to varying degrees) in those activities.

Participant observation is described as a process involving '*active looking, improving memory, informal interviewing, writing detailed field notes, and perhaps most importantly, patience."* (DeWalt and DeWalt, 2002).

Where this research set out to consider how convergence of 3D printing with digital game products presents opportunities for development in production of toys and merchandise a research partnership with a firm moving to adopt 3D printing in the production of game related toys was considered a key opportunity. Participant observation was selected in this research as a means by which the researcher could gain access to, observe and participate within a firm moving to use 3D printing with a digital game platform. The start-up selected was exploring possibilities associated with a 3D printing in a particular configuration with the digital games industry. The research involved a process of active participant observation working with and observing a group of people who collectively anticipated and worked towards the creation of a media platform in which 3D printing would be used to manufacture goods from digital games. The field study also considered the wider context in which MakieLab operated and as such was supported by a survey and netnography.

In doing so it took an approach to participant observation that might be aligned with or situated in design ethnography and overlaps with action research. As Murphy & Marcus (2013) note, over the past several decades anthropologists and designers have formed partnerships of different sorts on collaborative projects and have worked with and for designers in various configurations and in various partnerships and within these partnerships the usefulness of ethnography for design practitioners has been central to these partnerships. This overlap between design and anthropology has inspired the emergence of anthropology with increasingly interactive and actionable outcomes and future looking perspectives. With this evolution comes the emergence and development of what some researchers refer to as design anthropology (Gunn, Otto and Smith, 2013; Miller, 2015).

In contrast to more traditional anthropological approaches, Otto & Smith (2013) in (Gunn, Otto and Smith, 2013) argue that *"design anthropology is coming of age as a separate (sub)discipline with its own concepts, methods, research practices, and practitioners, in short its own distinct style and practice of knowledge production".* Design anthropologists are generally concerned with how people *"perceive, create, and transform their environments through their everyday activities* (Gunn, Otto and Smith, 2013)" and design anthropology is a move to shift the focus from anthropological description to action (Otto & Smith 2013 in Gunn et al. 2013). This somewhat interventionist and collaborative approach opens possibilities for designers and researchers alike and within it the key mode of research is that of design ethnography.

Importantly it must be noted that I stop short of calling the research presented within this research ethnography. The presentation of ethnographic research is a complex process, and though ethnographic methods were employed and a form of ethnographic record produced in the course of this research this research document does not take the form of ethnography. Instead, it is within the shift in focus from anthropological description to *action* that the research aimed to capture with an interest in generating industry relevant research exploratory outputs with actionable outcomes and future looking perspectives. Where research was captured and analysed within the context and timing of the field study it was made available to MakieLab and in some cases influenced or contributed to the design and development of a platform development in production of toys and merchandise related to digital games.

### 3.8.1. Methodological Justification

A field study involving a mixed methods approach including participant observation was consequently considered appropriate for a range of reasons.

Firstly participant observation was employed in part in response to critiques that suggest that academics and practitioners have different frames of reference with respect to the types of information believed to constitute valid bases for action (Rynes, Bartunek and Daft, 2001). It is also noted in varying disciplines that there are differences between what academics and practitioners consider relevant or appropriate as goals, time frames, resource allocation and research output (Rogers, 1995). Operating as an embedded researcher, who had some prior domain specific knowledge lessened this colonial or outsider gap and forced the researcher to consider how the research output would be most valuable to all relevant parties.

*"You have to go to the setting, get down on the shop floor, immerse yourself in the work and learn through first-hand experience what doing it consists of."* (Crabtree, Rouncefield and Tolmie, 2012b)

The motivations behind employing participant observation in this wider field research lay firstly in the assertion that researchers should work to see things from the point of views of their research subjects or directly from the field rather than imposing their own cultural and political viewpoints. In a similar vein to colonial critiques aimed at early anthropological studies this research and methodology was selected and designed to avoid similar criticism sometimes aimed at academic researchers working on industry topics such as manufacturing and management.

Secondly the important questions may not be entirely obvious from outside of the research field or industry domain. Participant observation approaches allow the researcher to approach research fields, and developments with an open mind and to explore and develop research questions and focus in an on-going basis. It also allows the academic researcher to build relationships and partnerships that facilitate contextual understandings from the perspectives of professionals and consumers acting within that industry. Where the literature review found that some studies in mass customisation, toolkits for user design/customisation were limited by access to functional commercial models and consumer data in a live context this field study approach provides an opportunity for such access and participant observation allowed for consideration of this research from both the perspective of the consumer and the firm.

Moreover the research wished to consider opportunities associated with 3D printing for the games industry and this research partnership with MakieLab not only allowed insider access to a firm moving to do just this but it provided participatory access and an ability to work in conjunction with a team and organisations interested in the insights generated by this research. In addition where this embedded participatory approach was active and aimed to produce actionable and useable insights it theoretically allows the researcher and the industry based team to draw upon insights captured and to potentially cyclically develop the technology, processes and services they are creating to better fit their goals.

This research may be noted for its deep access to MakieLab in which it gained access to conduct deep research as well as partnerships with the development teams and therefore the means to design and conduct research with live consumers and partner companies including Selfridges London. I argue that this approach to research allowed me, as a researcher access to aspects of the company and business that would not typically have been accessible to a researcher working in a more detached way.

### 3.8.2. *Relational Stance*

I worked to create a relationship with MakieLab and the founders and I entered into the field as a doctoral researcher, making clear the objectives of the research, initiating the research with a shorter-term on-boarding aim related to research with ways to revisiting the research partnership on an on-going basis. I communicated my intent for the research to be relevant to the organisation and to the doctoral research. In doing so I brought skills and experience to the project from the retail industry, research and a product design background. I proposed to contribute to and participate in tasks and the running of the start-up in pursuit of gaining first hand participatory experience of a firm emerging in the industry segment I wished to study.

This approach may be understood as a form of active participation observation and is not unusual amongst ethnographers and design anthropologists, some of which become skilled at activities they are seeking to understand (Lynch, 1985; Wacquant, 2002). Some argue, as I do that participatory approaches to research allows for a fuller insight and understanding into groups, organisations and their activities (Tedlock, 2005). I consequently became an active participant observer researcher visibly embedded within the firm, observing the establishment of the start-up, the launch of the open alpha and observing, participating in subsequent periods of development and conducting and providing research findings where relevant to inform and support development.

### 3.8.3. *Data Collection*

A key challenge of participant observation is that of recording, data collection and interpretation. Here the researcher must consider how they record notes and how they process and communicate outcomes. With ethnographic methods like participant observation the researcher typically creates an accumulated written record of their observations and experiences (Emerson, Fretz and Shaw, 1995). Data according to Crabtree and Rouncefield (2012) has no value until we make it into something that illuminates a setting's work and its organisation. They describe the ethnographic record which may contain field notes, photographs, audio and video recordings, diagrams, documents, etc. as an "aide memoir".

Working in a start-up provides a wealth of perspectives and interactions both internal to the organisation and between the organisation and other businesses or between the business and consumers. As a participant I attended daily ‘stand-ups’ in which members of the team described what they worked on the day previous and what they would work on that day. On a weekly basis, I participated in `sprint planning’ in which the team reviewed the previous week and planned the work for the following week. Additionally there were frequent developer, design, art, business and marketing teams reviews and launch points. Quarterly, there were ‘post-mortems’ in which the team reviewed their previous work sprints and its efficacy as aligned with their anticipated targets. Each of these touch points provided insight into the team perspectives, differences, decision making processes and motivations and provided the researcher with insights on what would happen next and what the team was finding, prioritizing and aiming for. It is impossible as an individual researcher (adopting a participatory stance) to collate all of these in any manageable way alone. However with the increasing digitisation of all of the backend and communications platforms that assist in the running of a start-up there was an on-going, live record of the entire start-up process and internal/external communications produced by the entire team during the course of each work day. In this way the individual members of the start-up contributed as field researchers documenting and debating activities on the various platforms used to facilitate the start-up processes, these included Google Docs, Slack and Trello as well as email and Zendesk. The website, forums and digital products created by the start-up also form part of this record. This collective live record formed a key data resource of this research and was consulted on an on-going basis. Alongside this as a researcher I made frequent analysis notes about assumptions, points that seemed significant, questions that arose, perspectives and insights gained.

### 3.8.4. Analysis and Accountability

Participant observation as an method is a process of on-going observation and analysis and as Crabtree et al. (2012) suggest if you have been *“immersing yourself in the work of a setting, developing vulgar competence in it, doing so by mapping the sequential order of work and the activities that produce and animate it – then you have already been doing analysis.”*

In the process of conducting participant observation the researcher tends to create an on-going field study record of insights or notes against a pre-determined point upon which they wished to focus, these can be difficult for outsiders to interpret. Field study records that that have not been subject to a degree of processing and analysis are complicated and are may be confusing and limited in usefulness in the first instance to those uninvolved with the study.

It is the role of the researcher to move beyond a fragmentary collection of exhibits and to generate an analytic account accessible to their intended audience (Fink, 2000). Designing how to frame and present an analysis is complex, and researchers, depending on background and motivations have different perspectives on how analysis should be framed and carried out. In many cases, this depends on consideration of the intended audience and whom the researcher intends the research should to accountable to.

Drawing upon Ryle's (1968) call to accountability Crabtree and Rouncefield (2012) argue that accountability, *'... does not mean philosophically accountable or anthropologically accountable, etc. It means, locally accountable, accountable to these people here and now, to the parties to whatever it is that is being done in a setting.'* Academics are likely to feel accountable to the academic community working in and alongside their disciplines while those working in industry are likely to feel accountable to those relying on their fieldwork be this the start-up or business, technology developers or the wider policy and industry bodies and landscape.

This doctoral research, situated in a design perspective aimed to remain accountable both to the start-up, and to the industries and disciplines in which the work is most relevant. In an academic setting, it is to be positioned as an exploratory study within disciplines that work with and for industry including design, management and manufacturing.

## 3.9 SURVEY - PROSPECTIVE CONSUMERS

Within the Makies field study a web-based questionnaire was deployed as a probing research approach to survey early prospective users of the MakieLab service. This section briefly introduces the survey, justification for its use and practical issues.

### 3.9.1. METHODOLOGICAL JUSTIFICATION

As a research approach questionnaires are a research method consisting of a series of questions that may be open or closed ended or a mix of both. They are used as a tool for gathering information from people and are widely used in the industry and academic disciplines relevant to this research.

Questionnaires are commonly used in market research and are a good way of capturing information from distributed respondents. The design of the questionnaire is generally informed by the requirements of the research questions motivating it's selection as a research method and is often informed by the background of the researcher. It is important that the questionnaire is designed in such a way so as to make it possible and reasonably low effort for the respondent to participate and complete it. Low response rates and respondent drop off rates are high on longer surveys. The number of questions asked should be considered carefully and the questions selected for inclusion should be tested for answerability, bias, loading and other leading factors. The language used should be accessible and clear and the response type facilitated by the questionnaire appropriate for the question asked (Trobia, 2008).

Questionnaires do have some important use notes and limitations to be aware of as a researcher. Surveys and questionnaires are noted for with limitations relating to reach, bias and validity given that the researcher rarely as opportunity to interrogate or follow up on the answers given. In the first instance response rates are often low, and responding at all directly relies on the motivation of the respondent who may not feel motivated and under supply information or may be motivated for unknown or biased reasons and self elect to respond in an unrepresentative way. It is also difficult, especially in the case of questionnaires completed by remote respondents from different cultural backgrounds to establish if they fully understood the question being asked, and if they submitted what they intended to without mistakes. The design of the questionnaire may also impose researcher biases and limitations in a way that may guide or influence the respondents in unintended ways. Deployed in this research as an exploratory approach these limitations were considered reasonable and sufficiently low risk.

### 3.9.2. Questionnaire Design

This was then a survey of prospective users of the MakieLab service, a service in which consumers could create digital game characters and subsequently have these manufactured on-demand as toys via 3D printing. It was anticipated that the first people to elect to use this service, and would therefore be found in the survey responses were people who might be described as early adopters, in this event I wished to understand their backgrounds and their prior behaviour relating to toys and media.

A questionnaire with a range of open and closed ended questions was designed to elicit insights into early Makies prospective consumers. This was positioned as a Google form in the sign-up flow for the MakieLab doll creator tool and was open for responses for 6 weeks prior to the official Makies launch in April 2011. It was opened just as MakieLab was beginning to talk about it's products and services to the public and was a way in which prospective consumers could sign-up to be given access to purchase dolls from the 'open alpha' – the first batch of Makies dolls to be produced for consumers. A total of 131 responses were collected and analysed. Data from this is available in Appendix 2.

This research was designed in conjunction with the MakieLab communications team as to match their tone and public image. This early collaborative research effort also assisted in integrating the researcher into the wider team. Questions were co-selected to target a range of questions that both the researcher and the MakieLab team were interested in. Importantly the questions were designed to be friendly. The questions asked in the course of this questionnaire are documented below.

1. You are? Male, Female, not telling
2. How old are you?
3. Where do you live?
4. Which of the following do you like doing?
5. Do you post photos or videos online?
6. Which of the following services do you share content to or post to?
7. As a teenager, did you do or do you buy any of the following?
8. Which of the following have you bought within the last 12 months?
9. If you have bought toys, who did you purchase them for?
10. Do you have any favourite memories of an action figure or a doll?
11. How do you feel about action figures/dolls that you can design yourself?
12. What is the coolest feature you'd like in a customisable action figure/doll?
13. How much would you be willing to pay for a high quality/highly customisable action doll of your own design?
14. What kind of customisable toy, other than an action doll would you also like to see? Dinosaurs, Vehicles e.g. Car, Remote Control Vehicle, Fairies, D&D Character Set, Robots, Aliens, Animals, Other:
15. Anything else you want to tell us?

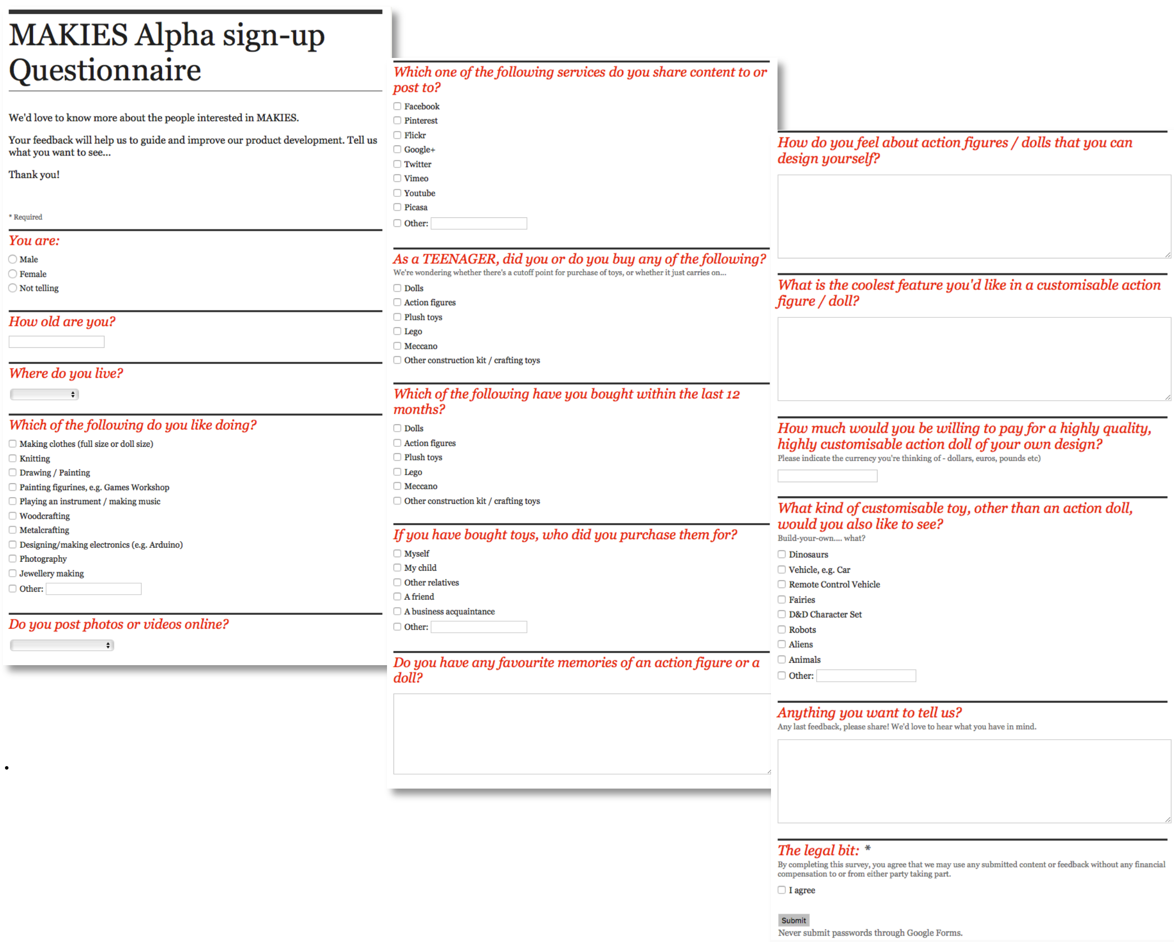
The survey was developed to both provide initial insights of user activity relating to toys and motivations surrounding a start-up employing 3D printing in the production custom toys. Survey questions were designed to capture a mix of quantitative and qualitative data and questions asked participants to respond in various ways, including open-ended long form responses or selection of pre-determined options provided in the survey.

The survey captured age, gender and location of respondents as well as social media use, purchasing behaviour, gifting activity, interest in designing their own toy, feature requests, price sensitivity and willingness to pay and desired toy types. It also aimed to elicit information relating to historic play behaviour, toy ownership and user interactions with such objects.

### 3.9.3 Reach, Recruitment and Sample

The survey targeted prospective users of Makies, who could be understood as self-selecting and motivated early customers. The survey was digitally distributed to optimise for response rate and was strategically placed as part of the sign-up process for interested users of the service.

To reach an appropriate sample the survey was promoted by the founder and staff members of MakieLab via social media and at industry events for start-ups as well as by the researcher. MakieLab investors also shared the link on social media platforms. The link for the survey was shared on twitter. It was also widely shared by start-up and industry folk interested in observing the development of the company. Further detail on analysis and sample size is considered in the findings chapters that follow.



MAKIES Alpha sign-up Questionnaire

We'd love to know more about the people interested in MAKIES.

Your feedback will help us to guide and improve our product development. Tell us what you want to see...

Thank you!

* Required

*You are:*
- Male
- Female
- Not telling

*How old are you?*

*Where do you live?*

*Which of the following do you like doing?*
- Making clothes (full size or doll size)
- Knitting
- Drawing / Painting
- Painting figurines, e.g. Games Workshop
- Playing an instrument / making music
- Woodcrafting
- Metalcrafting
- Designing/making electronics (e.g. Arduino)
- Photography
- Jewellery making
- Other:

*Do you post photos or videos online?*

*Which one of the following services do you share content to or post to?*
- Facebook
- Pinterest
- Flickr
- Google+
- Twitter
- Vimeo
- Youtube
- Picasa
- Other:

*As a TEENAGER, did you or do you buy any of the following?*

We're wondering whether there's a cutoff point for purchase of toys, or whether it just carries on...
- Dolls
- Action figures
- Plush toys
- Lego
- Meccano
- Other construction kit / crafting toys

*Which of the following have you bought within the last 12 months?*
- Dolls
- Action figures
- Plush toys
- Lego
- Meccano
- Other construction kit / crafting toys

*If you have bought toys, who did you purchase them for?*
- Myself
- My child
- Other relatives
- A friend
- A business acquaintance
- Other:

*Do you have any favourite memories of an action figure or a doll?*

*How do you feel about action figures / dolls that you can design yourself?*

*What is the coolest feature you'd like in a customisable action figure / doll?*

*How much would you be willing to pay for a highly quality, highly customisable action doll of your own design?*

Please indicate the currency you're thinking of - dollars, euros, pounds etc)

*What kind of customisable toy, other than an action doll, would you also like to see?*

Build-your-own..... what?
- Dinosaurs
- Vehicle, e.g. Car
- Remote Control Vehicle
- Fairies
- D&D Character Set
- Robots
- Aliens
- Animals
- Other:

*Anything you want to tell us?*

Any last feedback, please share! We'd love to hear what you have in mind.

*The legal bit:* *

By completing this survey, you agree that we may use any submitted content or feedback without any financial compensation to or from either party taking part.
- I agree

Submit

Never submit passwords through Google Forms.

Image 3.4 Survey screenshots

## 3.10 NETNOGRAPHY

Within the larger field study a netnography[3] of *3D printing repositories*, *Makies fan forums* and industry reporting related to 3D printing and the toy-media industry was conducted. This research approach is outlined in this section.

This netnography was deployed as a supporting research method to supplement the field research with Makies. It was designed to consider firstly *consumer interactions with media content made possible by access to 3D printing*. It did this by identifying communities using 3D printing and observing activity in these spaces as well as and interactions with content and content production within these communities.

As a research approach netnography may be understood to have developed from ethnographic practices and is sometimes considered as *"network ethnography"* or an online ethnography (Kozinets, 1998). As a research approach it is intended to study interactions and experiences on the web (Kozinets, 1998; Weijo, Hietanen and Mattila, 2014) and is considered to be an interpretive research method that employs participant observation techniques similar to approaches used in the context of online environments.

A netnography generally aims to capture insights and generate understandings that are rich in depth and meaning and it is as a method considered naturalistic, adaptable and unobtrusive as it does not require research participants to be aware of or actively engage with the research (Kozinets 2002). As a research approach it is immersive, involving the researcher as a key actor in data collection and generation of descriptions and understandings. The findings generated though this type of research generally involve rich contextual descriptions and insights. As a method it allows for inclusion of multi-methods and a variety of approaches to analysis of the data captured are possible including content analysis and data science.

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[3] The spelling netnography and nethnography are both accepted in research and are used interchangeable in related research. This document prioritises netnography.

It is a particularly useful method for researchers working with emerging research areas or geographically distributed populations because operationally it allows for an agile and lean inquiry without travel, transcription or access overheads. It may be deployed rapidly, across a distributed context without requirements to establish access agreements and assuming that the areas under study are not private or under non-disclose agreements consent issues and administration are negated (Kozinets, 1997, 1998, 1999; Langer and Beckman, 2005; Beaven and Laws, 2007; Mkono, 2011). It is also a research method of relevance of a researcher with accessibility issues allowing for remote research and offset to real-time analysis.

Like other research methods, netnography presents challenges and limitations that are relevant to note. Within this research netnography was employed as an on-going support to the larger field study research rather than a primary method of data collection and analysis. In capturing samples as this research needed to do a range of technical tools were required. The technical skills and digital tools for conducting a web scrape and netnography research are not widely distributed or easily accessible to all researchers. Furthermore, without careful sampling, identification or accurate cross-referencing with evidence that supports identification or categorization generalising the results outside of the sample is difficult (Kozinets 1998, 2002).

The netnography was deployed in the first instance in consideration of consumer interactions with media content made possible with access to 3D printing but was also employed in pursuit of insights relevant to the other research questions, including how such consumer activity and interactions might present as opportunities for developments in production of toys and merchandise related to media products and implications for stakeholders. This diversity of focus was enabled though selection of a number of research sites, these are considered after the section considering justification.

### *3.10.1. Methodological Justification*

3D printing was a technology that had reasonably recently become available to users outside of industry and its adoption by consumers and by producers of consumer goods was at a relatively early stage as noted by MakieLab COO Jo Roach.

*"Jo Roach, recalls asking 3D printing companies if they'd consider printing dolls. "They'd been making bits of aeroplanes or whatever," she says, "and we walked in with a consumer product and they laughed us out of the room.""* (Marsden, 2014)

As such identifying and reaching users of 3D printing and stakeholders of relevance was a challenge. Web based research was considered an effective way to initiate research as users of 3D printers could be found communicating and documenting activity in online web forums, sharing and hosting content online repositories. These sources also provided access to the types of objects generated, insights into the state of the technology and problems and challenges associated with the state of technological development.

Moreover researchers considering 3D printing have not had much opportunity to examine user generated 3D printable content because the printing technology was relatively new and expensive only just emerging for the consumer market. The years in which this research was conducted marked the first years in which this research was possible. Adoption and diffusion of 3D printing grew significantly over the course of this research with growth in sales of domestic machines, growth of fab labs and other user spaces, development of community and high street print centres and online services such as Ponoko and Shapeways. Concurrently consumer facing design tools were also released and content hosted on online repositories such as Thingiverse and Shapeways showed growth.

A netnography of Thingiverse and Shapeways as a means of examining activity by users of 3D printing was deemed appropriate therefore because it would allow for examination of activity and interactions by consumers and creators online communities and because these sites provided access to a dense grouping of community members and user

generated, submitted and documented content.
With this came the possibility to gain insight into the state of 3D printable content and 3D printing of a large number of creators. This provided me, an individual researcher, with access to a vast quantity of 3D printable content, renders, images of prints, as well as; usage, download and remix counts and user narratives around what they did and why. These sources allowed me to gain an overview of a large community and to examine large volumes of content and related detail in a lean and agile way. Importantly, few studies had been able to consider 3D printable content in any organised way prior to this, given the early stage of 3D printing adoption.

Where the survey with prospective consumers of Makies revealed a range of user reported activity relating to customisation, personalisation, story telling and other interactions with toy and merchandise relating to media content it was anticipated that the netnography of 3D printing repositories might reveal similar activity on Thingiverse and Shapeways so examining user activity here was considered to be of relevance to this study, anticipating that it may provide insights into what people might do with 3D printing and media related content.

Relatedly where MakieLab were building a game and printing platform that would allow people to print their game characters and in-game assets it was considered useful to identify what people were already doing with game and media related content with access to design tooling and 3D printers. Thingiverse and Shapeways also both collaborate with developers and businesses building tools and services that use 3D printing as a means of producing objects for their customer bases and in doing so are a key location for considering the emergence of early state 3D printing services and related businesses.  The wider industry examination also provided insights in this respect.

Secondly a netnography focused on industry reporting related to stakeholders would allow for consideration of general adoption of 3D printing across the industries relevant to this research and allow for consideration of general trends and developments. This part of the research involved tracking various forms of reporting related to 3D printing, in particular reporting that overlapped with toy, game and media industries. This provided an overview of how industries and markets were responding to developments in and adoption of 3D printing and what they anticipated or perceived as valuable development industries and trends.

Finally where activity by Makies consumers and fans on Makies web forums social media sites might allow for insights as to how Makies consumers or prospective consumers were interacting with Makies content and the subsequent printed toys the netnography was considered an unobtrusive way of doing this and functioned as a way to document and describe user activity relating to convergent media platforms.

### 3.10.2. Field Study Sites and Focus

The netnography examined online 3D printing repositories then as a means of *identifying and categorising types of content* and *user interactions with media content made possible by 3D printing*. Examined reporting to establish *industry adoption of 3D printing in the production of media related goods* and findings of relevance to these stakeholders. Finally, it was also used in consideration of activity by Makies customers and fans and did so by focusing on Makies forums and related web sites.

The netnography was designed to focus on:

1. Individual users or consumers of 3D printing and 3D printed products
2. Industry/stakeholder adoption of 3D printing

The research aimed to identify and examine:

1. Categories of content found on 3D printing repositories
2. Examples of media content/products referenced by users
3. Types or categories of user interactions with media content
4. Industry/Stakeholder developments related to 3D printing

Shapeways and Thingiverse were identified as being particularly useful research sites given their dominance as consumer orientated 3D printing repositories. As a location for examining activity related to 3D printing online repositories these would provide a dense grouping of 3D printing users, clusters of 3D printable content and access to CAD files, renders and photographs of prints as well as user discussion and comments on the content captured. Web based research on these platforms was anticipate to be an effective way to initiate research as users of 3D printers could be found communicating and documenting activity in online web forums, sharing and hosting content on online repositories such as Thingiverse forums and Shapeways. These sites form the primary focus of the netnography. Further detail on each of these sites and the type of data collated during the research is documented in the findings chapter addressing Netnography findings.

On a secondary level an industry focused study that involved tracking industry reports, patents and publications was anticipated to be useful in understanding general adoption of 3D printing across stakeholder industries relevant to this research. Here reporting related to 3D printing, in particular reporting that overlapped with toy, game and media industries was indicated as relevant sources.

Finally activity by Makies consumers and fans found in Makies forums and across various social media sites were indicated as valuable sources of considering what how people interact with media content and how they respond to 3D printable-media content.

### 3.10.3. *Ethics*

Netnography departs from methods that gain informed consent prior to engagement and data collection and collates information that is not explicitly given to the researcher. Additionally difficulties related to identification of the people behind online comments or content should be noted and on-going ethics questions remain over securing informed consent with online methods that have not expressly asked for permission. In the case of this doctoral research all information was collated from public forums or web spaces where the creators have an expectation of the objects being downloaded, printed or edited so consent issues are to a degree mitigated and overall this research was consider to be early exploratory research at a particular point in time in an emerging field so generalisability is of secondary importance.

### 3.10.4. Data Capture and Analysis

In a netnography data is typically collected directly, copied or captured from web communications including blog posts, pictures comments or other written form interactions. Operationally this approach allowed me as an individual researcher to conduct an agile and lean inquiry on thousands of examples without a need to travel or individually communicate with the research subjects.

This vastly reduced access overheads and provided a macro-level snapshot user activity relating to 3D printing at a time when adoption was early and distributed. Additionally given the public settings and user agreements on these online repositories it could be deployed rapidly as an approach without requirements to establish access agreements (Kozinets, 1997, 1998, 1999; Langer and Beckman, 2005; Beaven and Laws, 2007; Mkono, 2011).

This netnography primarily captured samples of 3D printable content and associated data hosted on online repositories. It did so using a scripted process to automatically download content hosted on online 3D printing repositories. The particular implementation of the web-scrape and the targeting and selection process are outlined in detail in the Netnography chapter, so too are the analysis criteria.

Where the netnography focused on Makies consumers and users it was a more involved process of browsing and documenting activity manually. Similarly where it considered industry developments and stakeholder relevant reporting alerts and other reporting options were used to notify the research of articles of relevance as well as patents, press releases and shareholder reports.

Related to this a twitter account for the research was curated under the handle @DigitalFabricat. This twitter account curated digital content about 3D printing and in doing so gathered a considerable number of followers interested in and working with 3D printing. This account presented as a tool through which the researcher could issue surveys, ask questions and test concepts. It also served to legitimise the researcher as being knowledgeable about 3D printing and provided a means of gaining access to and verifying identities of commenters in forums who in many cases used the same digital identity for their twitter handle. Hash tags allowing filtering of themes used to monitor 3D printing issues and themes of relevance at any given point and were used to engage directly with the community and user groups of relevance to the research topic. This also facilitated gathering of industry relevant reporting.

## 3.11 PARTICULARS OF WORKING WITH A START-UP

Start-ups have limited futures and runways during their incorporation and early stage development. As they progress through each funding stage they typically do not have a runway (survival time) more than 12-18 months. Start-ups pivot, refocus and reorganise rapidly as they attempt to adjust to survive and grow.

Conducting research therefore requires adaptability, responsiveness and rapid deploy and collection. Researchers must be able to rapidly identify opportunities to conduct research and also to implement and execute research quickly without a drop in quality or rigor. This also means that planned research sometimes needs to be abandoned as the company pivots and refocuses.

MakieLab pivoted frequently within the time of this research, this meant that the research behind this doctoral work was also required to pivot and refocus. Working with a live start-up during such a fast paced and precarious stage of development is risky, and requires flexibility on the part of the researcher. In order to work in such a way preparation is key and the researcher must keep in mind ethics, data security and recording strategies. Importantly while a deep access research approach means that the opportunities for research are vast, an ability to recognise research opportunities and filter incoming information, data and findings are of great importance.

## 3.12 RESEARCHER NOTES

With any research it is useful to acknowledge the perspective of the researcher and the possible impacts and influence of the researcher on the research subjects and analysis. This is particularly true of participant observation and field methods where the researcher participates in a deep and longitudinal way. Research that involves working directly with participants, commercial platforms, start-ups or technology companies must consider how the presence of the researcher will influence the data generated through response bias or researcher presence (Poggenpoel and Myburgh, 2003). Poggenpoel at al. (2003)

suggest the potential reasons for this bias can include researcher discomfort; insufficient preparation, inappropriate interviews, an over or under degree of affinity between researcher and population under study, including researchers being a member of the group themselves.

This section therefore introduces me as a researcher. I, Natasha Carolan am a researcher and designer with an early academic grounding in sociology, anthropology and psychology from Queens University, Belfast. I subsequently re-trained in Industrial Design at University of Ulster, Belfast and have worked with and researched 3D printing since 2007. I have prior experience of working in retail management and market research and bring with me knowledge of retail of FMCG and Toys. During the early stages of this research I worked to develop an interdisciplinary perspective and immersed myself in cross-disciplinary research approaches and innovation theory. I therefore have grounding in the backgrounds studied in the course of this research and have a mix of academic and industry research experience that suit the topic under investigation.

Fieldwork requires the researcher to have a solid grasp of the language of the local culture she is working in, the language of the domain (in this case 3D printing but also games) and the language of the organisation (Chipchase, 2017). In this case the language of a technology based start-up in Silicon Roundabout London and with it the language of agile delivery and related production and organisational processes my background allowed me to integrate with ease into this culture.

With technology start ups and manufacturing companies it should be noted that I am a woman and women are typically under represented in technology companies. As such one cannot exclude the possibility that gender assumptions and interactions have not influenced the interactions and data generated. However MakieLab had a 50% gender balance and as such it may be assumed gender played less of a role here.

As a researcher I subscribe to principles of research openness and democratising access to knowledge. I engage with the research and 3D printing community in various ways, attending conferences, meet-ups and speaking at conferences. During the course of this research I curated a twitter handle @DigitalFabricat as a means of accessing industry opinion and reaching a community of people using or interested in 3D printing. My background as researcher assisted in providing access to relevant 3D printing communities of practice.

It is important to note that with participant observation and industry based field studies such as this, there is a risk of becoming so deeply involved in the study that the researcher might go “native” (this term is now considered problematic and derogatory) and in doing so undermine the value of the research (Geertz, 1973; Otto and Smith, 2013). These risks are associated with an ability to maintain a researcher viewpoint as well as managing the huge amount of information generated in the day to day of the organisation and the requirement to carefully mediate the relationships emerging as part of the research.

Intentionally maintaining my open identity as researcher within the organisation, and a directed and intentional process of document findings, archiving artefacts and maintain report logs (similar to an ethnographic record) and making analysis notes relating to my assumptions assisted in allowing me to maintain a degree of separation from the organisation and processes and assisted in avoiding going deeply native but as Crabtree et al. (2012) suggest *“You have to go to the setting, get down on the shop floor, immerse yourself in the work and learn through first-hand experience what doing it consists of”* then the researcher develops a form of *“…vulgar competence”*.

As such there is a note to be made relating to my background and immersion in the practical elements of 3D printing and the possible existence or development of taken for granted insights and understandings, but where I might be understood as an active participant or a complete member of the research group/context under study (Spradley, 1980), I brought with me insights and a proficiency in the wider domain that it would have taken a less active or complete member more time to acquire. In this way I may be understood to be an immersed member of the community under study conducing research intended to be communicated to the community under study and to academia.

Finally, it should be noted that health issues altered the timeline of my research with MakieLab. In some cases planned research could not be completed on schedule because I was unable to conduct the research, in some cases I was absent for periods of the research, though I remained connected remotely. Collectively periods of illness forced revisiting and adaption of some parts of the research strategies and subsequent analysis period as necessary.

## 3.13 SUMMARY

This chapter describes the philosophical positioning, research design and methodological selection employed in this doctoral research. It introduced the field study with MakieLab and individually addressed the selection of methods making up the field study research with justification for their selection and reference to practical matters including access. The following section of the thesis presents the field study research and findings sorted according to research method.

# SECTION 2 – MAKIES

# FIELD RESEARCH

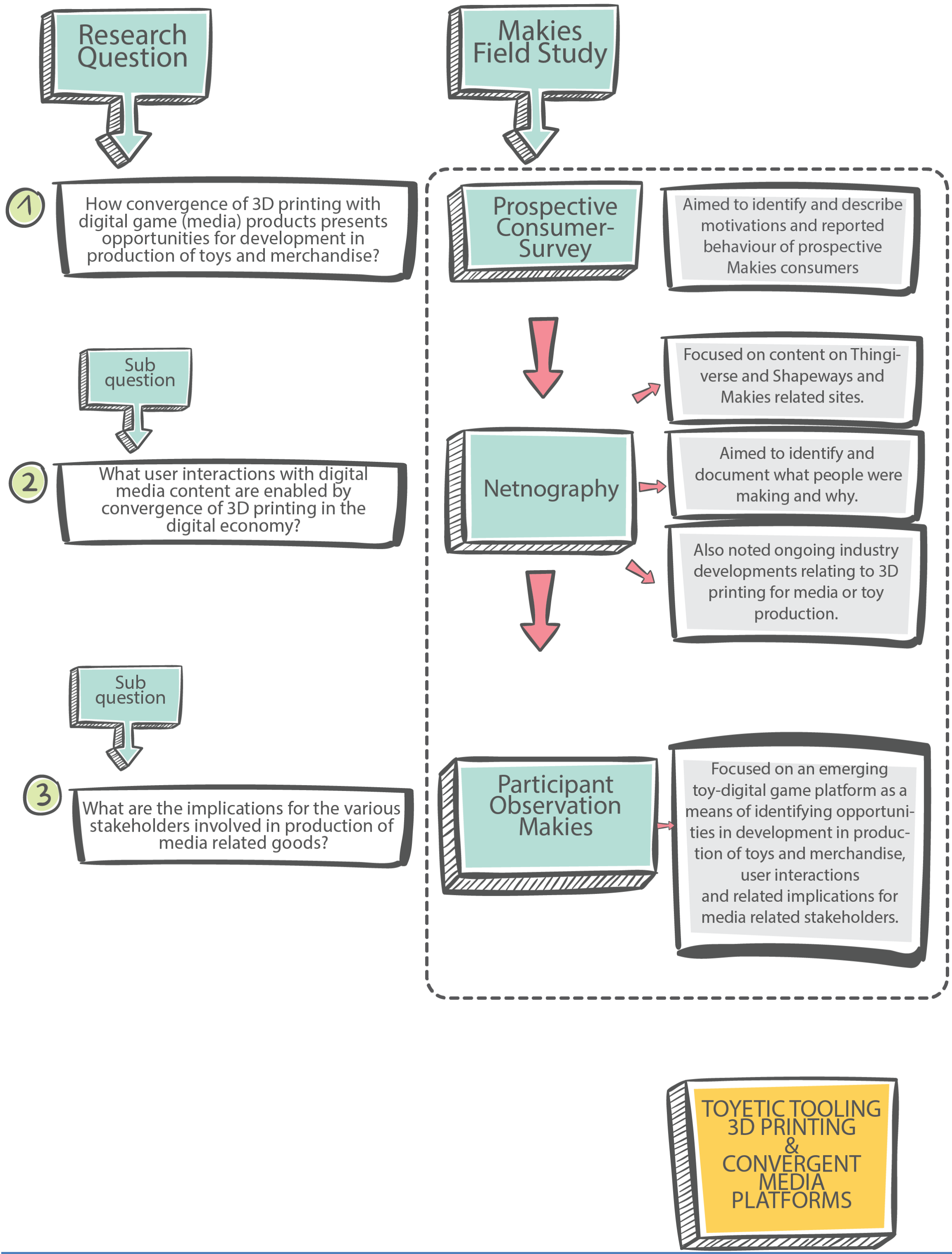


Image 4.1 Field Research Guide

# 4. Survey

# 4.0 SURVEY: FINDINGS & DISCUSSION

## *4.1 PROSPECTIVE CONSUMER SURVEY*

This chapter describes a survey of prospective Makies consumers conducted as part of the wider field study and presents initial findings from this survey. Where this research asked what user interactions with media content are facilitated by 3D printing this survey was developed to both provide initial insights *into prospective consumers of a 3D printing-digital game platform and their historic activity relating to toys* and secondly to *provide insights into associated opportunities and implications for stakeholders related to 3D printing in the games industry.* A total of 131 responses were collected and analysed in the course of this survey. This section describes the research implementation and the subsequent analysis of data. The chapter ends with a brief discussion of the findings.

### *4.1.1. Survey Research*

As the methodology chapter outlined the survey was launched in advance of the official launch of the Makies web platform. Here MakieLab stationed a Google survey placeholder at their website www.makie.me presenting it as a sign up form for the alpha launch invite. Prospective customers signing up were incentivised to participate in the survey with early access to the service and products when it went live and a promise of being able to assist in shaping the product as early adopters or alpha users as MakieLab termed it. The products offered by MakieLab were considered to be in an early release 'alpha' stage (akin to beta testing in software) and were therefore understood to not necessarily contain all of the planned features, or be of final product finish and quality, a test product of sorts.

### *4.1.2. Recruitment and Targeting*

In order to distribute the survey it was promoted by the founder and staff members of MakieLab via social media and at industry events for start-ups as well as by the researcher. The link for the survey was also seeded into doll collecting forums and shared on twitter with hash tags for collectable dolls and kids toys. It was widely shared by start-up and industry folk interested in observing the development of the company. MakieLab investors also shared the link on social media platforms.

84.7% respondents were from Europe and the rest from North America, Asia and Australia. A majority - 51.5% indicated that they were male. The average age was around 35 years old, youngest at 18 and oldest at 64.

The alpha call captured a grouping typical of an early adopter group/technology focused group, active on social media sites such as Twitter and aware of gaming and technology trends such as 3D printing. These people are also likely to have been exposed to MakieLab at this early stage through Alice Taylor's event schedule and social media presence. MakieLab at this point was pitching at a 14+ or adult market as it had not yet received toy safety certification and could not support sales to children younger than 14.

#### *4.1.4. Limitations*

Limitations relating to self-selection of respondents and the relatively small sample size of respondents must be noted. This limits the generalisability and validity of the data across wider toy consumer populations. Given the method of survey distribution this survey is also likely to have captured those already familiar with MakieLab, the technology start-up scene, doll collectors and the founder members. Relatedly the survey needed to be sufficiently short and friendly so as to not negatively impact sign up to the Makies alpha also so the range and phrasing of questions was limited. The survey was sufficient in capturing initial insights into a consumer base, useful as a means of building a research relationship with the host organisation and establishing insights into the types of information relating to their target market and consumer group they were interested in capturing.

## 4.2 FINDINGS

The survey allowed the researcher to elicit accounts of historic toy ownership and play as well as related behaviour around purchasing, spend, gifting and collecting. The findings presented below provide insight into this group and were used in shaping the targeting strategy for this research and also served as useful data for Makies.

Where the survey generated quantitative data the data is presented here in the form of charts. For open-ended responses in the survey a coding process was employed to assist in the processing and categorization of these responses. The coding categories are listed in 4.2.1.

### 4.2.1. CODING

For open-ended responses a coding process was employed to assist in the processing and categorisation of responses. Here the research aim was not to quantify such responses but instead to develop a simple categorisation of user intent and activity related to play and media or brand interactions. In the process of coding the responses the researcher labelled and then categorised responses according to stated user activity, interaction or inferred or stated motivation. In doing so the researcher was careful to avoid category schemes that called for value judgments or too much interpretation on the part of the coder. Statements submitted by respondents were therefore categorised into a number of related activity areas and modes and genres of play and creative activity ranging from gentle customisation to destruction were noted.

| | | | |
|---|---|---|---|
| a. | Collecting | b. | Building |
| c. | Creating | d. | Personalisation |
| e. | Curating | f. | Customisation |
| g. | Destruction | h. | Posing |
| i. | Story Telling | | |
| | **Relatedly the survey also coded** | a. | Gender |
| b. | Social activity | c. | Fashion |

Figure 4.1 Survey Findings: Coding Survey

### *4.2.2. History of ownership*

Figure 4.2 shows toy purchasing history or ownership and revealed gendered distribution of toys where female identified persons were more likely to report ownership or play with dolls and plush toys than males. Males were more likely to report ownership of action figures, Lego and Meccano than females. Crafting (construction materials) and Lego were reported frequently by women while males were more likely to report action figures and Lego. It should be noted that ownership is not directly mapped to individual preference as gifting by adults and gendered marketing strategies are likely to have influenced ownership. Here a general insight is provided which corresponds to wider research on gendered play, selection and gifting of toys (Chase, 1997; Blackwell, Rode and Toye, 2009; Auster and Mansbach, 2012).

### *4.2.3. Purchasing behaviour in the past 12 months*

In more recent times the respondents of the survey displayed a degree of gendered purchasing behaviour in so far as women were more likely to have gifted plush toys and dolls than males and were more likely over all to have gifted toys. See figure 4.3

### *4.2.4. Gifting and purchasing behaviour*

52.9% of respondents reported purchasing toys for children, 49.6% for themselves and 35.3 for other relatives and 31.1% for a friend.

### *4.2.5. Feature requests*

Respondents had the opportunity to respond in with their desired features for customisable figurines and dolls. Responses could generally be categorised into - *features*, *accessories*, *interaction* and *responsiveness*, *personality* and "like me" *representativeness*. These responses highlighted existing gaps in the offerings of toy products, pointed to consumer discontent and un-served desires relating to dolls and custom toys.

#### a. Doll features

*'I am interested in wigs (for example, Odeco) as this can change the personality of the doll so quickly. Also an easy way to change the eye colour is a great*

*feature (Odeco again and Blythe). Poseable dolls have also started to attract my interest as they have more possibilities when it comes to taking pictures or setting up dioramas.'*

Face, clothes and hair were cited as key features that users would like to be able to change, select or customise. Mass manufactured dolls don't typically allow this. Makies unlike many mass-produced doll were able to respond to these requests and to allow users to change the eyes and wigs easily. The skullcap on the doll was removable so customers could change it and they had the option to swap eyes. The doll was also designed to be pose-able with ball-jointed limbs that put the doll in the collectable part of the doll market.

*Skin colour, eye colour, body shape, battle damage* and *scars* were also listed as features with discontent at the limitations imposed by the current offerings of dolls and toys. Customisation that makes it possible to create dolls that look like someone they know was also cited as a desirable feature.

### b. Accessories

*'Lots of accessories. The best bit of Playmobil is all the cool little accessories. I really like that stuff. The kids also like setting that stuff up.'*

Fashion and accessories were listed with a wide range of requests that aren't typically offered as accessories for toys. These requests included; goggles, eye patches, hats, inhalers 'asthma puffers', 'Laser death ray eyes', tracking eyes, beards, secret compartments and extra arms.

### c. Interactivity

*"I saw one of your dolls with a lilypad [arduino] inside it's head, that was an exciting moment!" A number of respondents wanted a toy that is able to 'recognise, and interact with, its environment in some way...'.* As such open hardware facilitation of sound and visual interactions enabling playback of user generated sounds, recording and FX and visual were cited as interesting to consumers.

**d. Persona/Personality**

Respondents indicated that they valued building identity, persona and relationships and one of the respondents suggested *'ADIDs (active digital identity) so my figure can be connected to others'*. The possibilities for developing identity, persona and relationships through game play and cross platform exploitation of digital assets are vast.

**e. Physiology and representativeness**

*'Any female figure who doesn't have huge tits and a tiny waist, for one. Any figures with glasses and minor accessories like asthma puffers but who are in themselves, totally cool. Female figures with bob haircuts rather than always long hair. I'm not saying non-feminine. I'm just saying vary it from the doll 'norm'. African dark black, lighter black / olive / pacific rim skin colouring action figures please.'*

Some respondents outlined that they would find value in being able to make dolls that look like them. '*I think it's important for kids to be able to see things that look just like themselves out there in the world to know that they're not alone.'*

Similar themes emerged in responses around gender and lack of representation but with interaction with the company responsible through letter submissions.

*'I collected all of the Thundercats action figures when I was about 10 - completely obsessed with the series, and also had two of my letters published in Thundercats magazine (both complaining about lack of female representation...)*'

### *4.2.6. Reaction to proposed Makies platform*

**How do you feel about action figures / dolls that you can design yourself?**

Sentiment expressed in relation to this question was generally positive with respondents expressing interest and support for something that would aid them in designing toys and dolls for themselves.

*'I currently collect Blythe dolls which I sometimes customise myself. I find this very enjoyable although it can be very time consuming and get expensive. I also enjoy making clothes for my dolls and I spend many hours prototyping and making the final designs. I'm not entirely sure how I would feel about someone else making a doll to my specifications as I enjoy the feeling of bringing my doll to life and seeing a character develop over weeks or months. There is also a feeling of accomplishment from creating your own character with your own hands.'*

Some of the respondents were doll collectors and already participated in doll collecting and customisation. They sought out and collected interesting custom dolls created by others or carried out their own work on dolls. The doll collector market has a rich scene of trade and customisation around "face-ups," custom wigs and fashion production.

*'Customisable face, clothes and hair that you could have designed to your requirements, in general, would be quite cool.'*

Some respondents reported what may be considered accidental or passive customisation or co-created toys through game play and imaginative crafting.

*'As a kid, my friend and I shopped more at the local hardware store than the toy store, for GI Joe accessories. We had pulley driven tree-houses, ziplines, rail cars.... all of which were built buy hand. After my friend's older brother mutilated GI Joe with a bunsen burner, we crafted our own cyborg prostheses from stuff found at the hardware store!'*

An appreciation for toys that “could do stuff” versus figures with “zero moving parts” is reported and surface customisation adding to game play and imagination is reported.

*“… Even, better, Luke had been "modded" with red nail polish, so he'd clearly seen some battles. After that, all my imaginary scenes were epic.’*

Other respondents were interested in a basic degree of designing and customisation making decisions on wigs and clothes and face. While others anticipated wanting to take part in customisation process through face-ups and activity outside of the proposed MakieLab offering.

*‘I would like to be able to paint the face (sell me a kit of exclusive colours!) and change the pose... such as gas heating, air brushing specialists do it in Japan. i never did it myself though...maybe I was always satisfied with what the "proper" designers sold me ;)*

***4.2.7. User interaction with content/toys***

There remains a question over consumer motivations around customisation activity. Customisation to create an aesthetic effect, to create a fit or alter a function where no satisfactory alternatives exist is well understood but less so are those who choose not to participate due to their fears of being able to do it well or their preference for goods designed by a designer.

*‘Mixed. I love it in theory, and I love the idea of those 'kit-mash' customisations, but I don't have faith in my ability to design something cool. Part of me feels more inclined to buy dolls/figures designed entirely by the experts. Maybe a tool belt/bag for the doll where I could pick 'n' mix the accessory contents.’*

This is an underexplored theme in mass customisation research, while post-customisation effects such as the Ikea effect are considered and designing tooling to make customisation easy and achievable in pursuit of competence is examined (Norton *et al.*, 2011; Mochon, Norton and Ariely, 2012) less focus is placed on the on-boarding process and communication of value.

### *4.2.8. Community and social media*

Collecting, curating, posing are also play styles reported and in some cases this lead to the perception of 'belonging' in groups, clubs or communities. It might be suggested that early Internet postings in forums now translates to posting pictures to social media.

### *4.2.9. User generated content creation and transmedia storytelling*

*"In college, I remember the very first Hellboy figure being really cool. I posed it and took pictures. Those were the first pics posted to the Hellboy forum at the time. Made me feel like part of the community in a way I hadn't before."*

*'Making star wars movies with my cousin every summer for years. Lego films shot on a cheap point and shoot with my nephew. Tauntaun races on white bed sheets o sleepovers. Christmas morning the Christmas after empire- my brother and I got Hoth Luke and Han.'*

### *4.2.10 Creation and co-creation as a social experience*

Some respondents highlighted social value in being able to co-create with their children, treating the process of customising as a social experience.

*'Yay! Really want to let my daughter have a hand at it. Looking forward to it as a father/daughter activity.'*

## *4.3 DISCUSSION*

Where the research asked "*what user interactions with media content are enabled by convergence of 3D printing*" a range of insights were surfaced in response to this survey.

While none of the respondents reported historic use of customisation platforms some reported *engaging in various forms of modding and creative/playful activity that might be understood as a form of customisation as part of playing*. Sometimes this was a creative pursuit involving painting at others it was destructive at the expense of the finish of the toy. Customisation activity also ranged from extending capabilities of the toy through building prosthetics and enriching play experience through modding with nail varnish to create battle wounds as well as aesthetic agendas relating to appearance. The integration of customisation as an activity within play appeared to extend and perhaps enhance play, adding to the richness of imagination and context.

This *modding* or *customisation* behaviour overlaps with *curating, posing and story telling,* as well as *building*, *creating* or *making* each of which emerge as key themes. Building, creating and making activity relating to spaces was reported with respondents reporting building environments including shoebox houses, tree-houses, zip lines and rail cars featured.

Some users reported finding that creative activities functioned as a way of *community building*. Others recall a feeling of belonging when joining the social network, forum or user group of a particular toy - *'Made me feel like part of the community in a way I hadn't before.'* and '*Getting my own codename when I joined the Action Man club in the late 1980s.'* Networking and social sharing spaces may be understood as value co-creation platforms and it is suggested that they add value to the toy and play experience facilitating a sense of community, belonging and relationships.

*Cross platform play* and early forms of what might be described as *user generated content creation* was also reported. Many of the toys recalled by respondents were toys relating to media products and were reused by the respondents in imaginative play ranging from hosting fashion shows and war games with 'epic imaginary scenes". This scene and world building, curating and in some cases filming, photographing and posting this new, user created content to the internet, across various social media and web platforms may be understood as a form of user generated content creation and in some cases also relates to themes of transmedia story telling.

Where respondents requested a wide range of niche accessories the ability for 3D printing to be used in flexible and responsive, small scale production runs makes possible the opportunity for firms to exploit a wider range of their content as consumable, printable assets. Be this facilitating collecting of new game assets, niche content or props which may be printed by the user to add to the physical toy or printing new versions of faces or toys items that have sustained damage or been upgraded though game play.

While none of these themes are new they have been underexplored in relation to the democratising and participatory, co-creative potential of 3D printing. Where the research asked *what are the implications for the various stakeholders involved in production of media related goods?* 3D printing in the context of Makies provides an opportunity to integrate or facilitate these play behaviours in both the digital and physical space. It also makes possible the facilitation of user interactions with toys and content including co-design or customisation. Where this research with consumers revealed that *people participate in or perform customisation as a part of play activity* there are obvious ways in which 3D printing might allow for in-play activity to manifest in the real world through printing.

The reported range of user interactions with toys and media related objects were of direct relevance to the research questions of *what user interactions with media content are facilitated by 3D printing*. While grounded in play activity pre-dating 3D printing the relevance and applicability of this activity to 3D printing and convergent media platforms was obvious. Relatedly a range of un-served user needs and requirements were uncovered in this survey. Consideration of these reveals that such skin colour, feature and niche accessory requests have not been widely served by companies using mass production processes because the initial tooling set-up is considered too costly and the content or accessories too niche to make economic sense in the context of mass production economics. 3D printing and it's flexible, responsive democratising potential both facilitates these new responsive and small batch scales of manufacture but also facilitates user interaction with content prior to manufacture thus *opportunities for firms in co-opting and otherwise facilitating this range of user activity may be observed.*

## *4.4 SUMMARY*

This survey initiated the main phase of field research by surveying prospective consumers of the Makies platform. In doing so this research built on the literature review by contributing to understanding of what user interactions with media products might be facilitated by 3D printing in the digital economy. It did this by providing insight into the types of content people request from a firm that they understand to be providing custom toys from digital games. It also provides insights into historic user interactions and play with toys and media related products. Collectively these findings contribute to the top-level research question considering how convergence of 3D printing with digital game products presents opportunities for development in production of toys and merchandise, furthermore they inform the remainder of the field study and netnography. Findings from this research are considered further in the conclusion chapter.

# 5. Netnography

# 5.0 NETNOGRAPHY: FINDINGS & DISCUSSION

This chapter presents findings gathered during the course of a netnography of activity related to 3D printing in media, game and toy and toy producing industries and 3D printing repositories Thingiverse and Shapeways. This research was conducted as part of the larger field study, and was designed to target the research questions and support research aims. This chapter considers in the first instance practical matters then presents and outlines the findings.

## *5.1 RESEARCH IMPLEMENTATION AND EXECUTION*

The methodology chapter introduced netnography as a method and considered the reasons behind selecting this research approach. This section briefly re-states this and elaborates on site-specific detail and implementation notes.

This netnography examined 3D printing repositories as a means of *identifying and categorising types of content* and *user interactions with media content made possible by 3D printing* and examined reporting to establish *industry adoption of 3D printing in the production of media related goods* and findings of relevance to these stakeholders.

The netnography was designed to focus on:

1. Individual users or consumers of 3D printing and 3D printed products
2. Industry/stakeholder adoption of 3D printing

The research aimed to identify and examine:

1. Examples of media content/products referenced by users
2. Categories of content found on 3D printing repositories
3. Types or categories of user interactions with media content
4. Industry/Stakeholder developments related to 3D printing

A variety of capture methods and selection criteria were selected and these are discussed in each section of findings.

### 5.5.1. FIELD STUDY SITES

This netnography examined user activity relating to 3D printing and did so primarily by capturing samples of 3D printable content and associated data hosted on two sites - Shapeways and Thingiverse. Web based research on these platforms was considered an effective way to initiate research as users of 3D printers could be found communicating and documenting activity in online web forums, sharing and hosting content on online repositories such as Thingiverse forums and Shapeways. As a location for examining activity related to 3D printing online repositories provided a dense grouping of 3D printing users, clusters of 3D printable content and provided access to CAD files, renders and photographs of prints as well as user discussion and comments on the content captured.

***Site 1: Thingiverse***

**Thingiverse** is a web-platform upon which users create, host, download and/or remix 3D printable content. Though its mission has evolved over the years it's roots are in open source and open hardware communities of practice. These origins are reflected in its mostly non-commercial structure and it's support of creative commons licenses. Thingiverse was established in 2008 by Zach Smith as a companion to MakerBot Industries, MakerBot is best known as a desktop 3D printer company aimed at home users. During development of MakerBot the founders recognized the benefit of making available printable content to drive adoption of their 3D printing technology (West and Kuk, 2014) and established Thingiverse as a repository hosting printable content. This web-based platform allows sharing of user-created digital design files that may be manufactured using a range of on-demand manufacturing tools including 3D printing. Thingiverse users do not pay a fee to access, use, remix or consume content. Thingiverse was selected as a site for this doctoral research because it provided access to a large section of user generated content and provided access to a large sample size of users and content.

Thingiverse is considered to be the largest and 'most important of the 3D printing repositories…' (Moilanen *et al.*, 2013) and is widely used by DIY and Maker communities including the RepRap Project and MakerBot operators where designs (mostly open source) are hosted under GNU General Public Licenses or Creative Commons licenses. The type of license is chosen by the person who uploads the design file and providing that they permit other users to, the design file may be downloaded for print or remix (Rideout, 2011; Kyriakou and Nickerson, 2014; Rayna and Striukova, 2016).

As the graph following this paragraph shows Thingiverse was considered a representative sample of what people were 3D printing during this time and was a useful resource in considering volume and growth in the industry. A persistent archive of Thingiverse content and changes can be searched at the Web Archive[4].

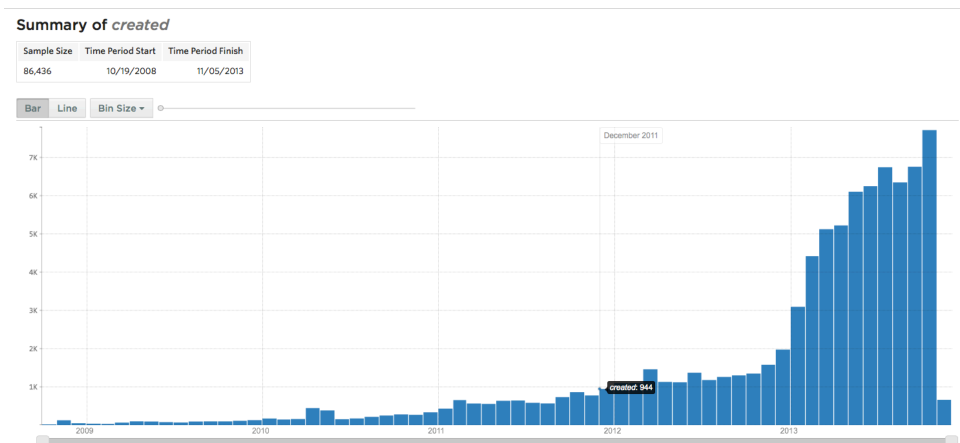


Figure 5.1 – Thingiverse content volume over time

***Site 2: Shapeways***

**Shapeways.com** is a similar web platform to Thingiverse but with a more commercial pitch and it acts as a retailer of content. Users are able to submit 3D printable content to Shapeways and Shapeways then manages retail, production and distribution of the printed items that are made available for sale to general consumers.

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[4] Internet Archive capture of Thingiverse
https://web.archive.org/web/20081023031932/http://www.thingiverse.com/

Shapeways styled itself at the time of writing as a commercial platform, a shop of sorts, where user generated products are manufactured on-demand. Products made available on Shapeways are listed with prices as they are intended for sale thus underlining the commercial intent of users and the company.

***Site 3: Industry and Media Reporting***

Here a range of sources were considered including shareholder and stock market reports, press releases and other forms of industry based reporting.

### 5.1.2. Data Capture

As a researcher I participated in these platforms, creating user accounts on both, creating content and observing, re-using and or consuming content created by others. In doing so I established that there was value in considering the content categories and types of user interactions with content. Here I noted overlap with user submitted requests and desires captured in the prospective consumer survey. Therefore I worked to select and capture samples of data from these sites.

As the methodology chapter indicated a web scrape was used to automatically capture and download a selection of content hosted on online 3D printing repositories. This was a script-based process that automatically crawled the websites and captured desired information. An effort was made to avoid collecting the CAD files themselves given that these could be considered commercially sensitive and in some cases were protected under creative commons licences restricting their use, sharing and reuse. This had an additional benefit of reducing the overhead of data management and storage given the usually large size of CAD data.

Web crawling or scraping to extract data from web sources is a common web activity and is used by marketers and researchers to conduct market research, competitor analysis and to map networks and sites (Srivastava and Cooley, 2003). Web scraping was selected as a method to examine Thingiverse as the research called for an examination of user generated content, content that is hosted on a web repository and collates a range of useful user data including titling, tags, view, print, download and collection counts as well as descriptions of the content and images.

A web scrape was considered useful in so far as it expedited collection of large amounts of data through parallelized data acquisition and in the case of this research it provided a rich insight into a range of relevant content including qualitative elements including descriptions and comments, as well as download, print, remix, like and collection counts per thing. Each of these data nodes were collated in a database that allows for statistical and content analysis of content.

After initial scrapes to understand the structure of the website a web based software as a service (SaaS) platform called Import.io was used to extract data from Thingiverse. Import.io is a web based tool that can be configured to automatically extract data and can be trained using a point and click interface. The service runs in the cloud and data may be downloaded in CSV or JSON formats for subsequent processing. Scrapes or extractors can be designed by the user, trained on an initial URL and scaled across unlimited URLs.

This research ran multiple instances of scrapes (updated on March 2017) capped at 10 pages per instance/keyword or the equivalent of 300-500 Thingiverse 'things' per run. The page count was used as a cap because the subsequent processing and coding processes were manual and required individual visual processing by the researcher so 300-500 images per run was sufficient. Should more automated coding processes emerge via machine learning this analysis should be re-run on a larger data set. For now, as an initial, inductive research project seeking to establish early patterns in user generated 3D printable content it was considered sufficient.

### 5.1.3. Targeting

Before scraping the sites an initial testing probe of the sites using simple keyword searches to provide general counts of content according to the criteria outlined below was conducted to assist in understanding of the general content categories.

Keyword searches considered the following by:

1. Initial *category* and *keyword* scrapes to generate a general understanding of the website the categories available and the types of content people were making.
2. *Keyword* searches associated with *media products* and *brands* to understand what content people were creating using 3D printing and media content.
3. Keyword searches related to *user intent*, user interactions with content and an associated analysis and categorization of content.

### 5.1.4. Scrape Design & Data Selection

The next stage of research involved web scrapes or web crawls of these online repositories to extract a richer set of data. These crawls were informed by the keyword searches and were designed with a focus on the types of content available with the aim of understanding what people were doing with 3D printing and what types of content they were creating.

Web scrapes were trained to extract content at two levels:

1. Keyword search level – a search that scraped **pages** containing multiple things according to keywords fed to the crawler.
2. Thing level in which individual item or **thing** pages are scraped. Things should be understood as individual 3D printable objects and related information.

The sections that follow describe each approach to research, including targeting and capture as appropriate.

## *5.2 MEDIA REFERENCED ON 3D PRINTING REPOSITORIES*

Where the research asks firstly *how convergence of 3D printing with digital game (media) products presents opportunities for development in production of toys and merchandise* and *what user interactions with media content are enabled by convergence of 3D printing in the digital economy* this section of research considers;

1. Media content referenced by creators on these repositories
2. Categories or types or 3D printable media related content created by users of 3D printing repositories.

It does this to consider the range of media referenced by creators on these sites, and to consider in the second instance what types of 3D printable objects they create. This research was conducted in multiple phases.

Firstly to consider media referenced in 3D printing repositories searches were conducted against popular media titles relating to:

A. Motion pictures (Films or Movies)
B. Digital Games
C. Toy and Game brand tags

This provided initial content counts against each title, as a means of establishing a general indication of a *count* or *volume* of content relating to these product types.

Secondly through a visually orientated analysis of the user generated media content captured in these searches a categorisation of media related 3D printable content created by users of these repositories was conducted. Here an exploratory list of types or categories of media related 3D printable content was drawn up.

The web-scrape captured then 3D printable content relating to media related products. Here a wide availability of toy like objects related to media products including digital games and movies could be identified. The following sections consider content relating to motion pictures, digital game and toy and game brands. Here volumes associated with search terms and key words are noted. A general snapshot of volume of content associated with these keywords is presented as a means of gaining a brief snapshot understanding of the level of activity related to a subset of media content. This isn't exhaustive and is intended to be indicative only.

### 5.2.1. Motion Pictures

In the first instance keyword searches were conducted manually to establish the volume of content available that is tagged, named or otherwise described using particular terms relating to named motion picture series. A manual search was conducted using the publically available search tool and motion picture titles as keywords. A simple count associated with each media product was then generated and recorded. Keywords were selected to maximise accuracy of return for example meaning that in the case of Jurassic World, the term Jurassic was used without any following term and Ice Age was used in place of dawn of the dinosaurs. In the case of Madagascar and The Fast and Furious search was hindered by the wider usage of these terms and so these are not included in the count.

These movie series were drawn from a table provided by Wikipedia. For the purposes of this research the accuracy of the Hollywood accounting (already understood to be problematic) was not necessary but was rather noted as a consideration of market size.
This table is considered useful as a sample of motion pictures likely to be known to users of Thingiverse. Excluded from these searches are brands that have built relationships with Thingiverse or Shapeways though which to sell content. This search revealed 25 keywords relating to motion picture films and found 5107 related things. See Table 5.1 on the following page.

*Table 5.1: Thing Count for Motion Pictures*

| Rank | Series | Total worldwide box office | No. of films | Average of films | Highest-grossing film | Thing Count |
|---|---|---|---|---|---|---|
| 1 | Marvel Cinematic Universe film currently playing | $10,913,782,656 | 14 | $779,555,904 | The Avengers ($1,518,812,988) | 159 |
| 2 | ]J. K. Rowling's Wizarding World film currently playing | $8,537,585,070 | 9 | $948,620,563 | Deathly Hallows – Part 2 ($1,341,511,219) | 183 |
| 3 | Star Wars film currently playing | $7,514,660,967 | 9 | $834,962,330 | The Force Awakens ($2,068,223,624) | 1476 |
| 4 | James Bond | $7,040,275,645 | 26 | $270,779,833 | Skyfall ($1,108,561,013) | 22 |
| 5 | J. R. R. Tolkien's Middle-earth | $5,884,488,087 | 7 | $840,641,155 | The Lord of the Rings: The Return of the King ($1,120,237,002) | 57 |
| 6 | Batman film currently playing | $4,971,246,453 | 14 | $355,089,032 | The Dark Knight Rises ($1,084,939,099) | 939 |
| 7 | X-Men film currently playing | $4,903,900,778 | 10 | $490,390,078 | Deadpool ($783,112,979) | 107 |
| 8 | Spider-Man | $3,963,259,504 | 5 | $792,651,901 | Spider-Man 3 ($890,871,626) | 81 |
| 9 | The Fast and the Furious | $3,896,130,579 | 7 | $556,590,083 | Furious 7 ($1,516,045,911) | |
| 10 | Transformers | $3,779,711,271 | 5 | $755,942,254 | Dark of the Moon ($1,123,794,079) | 260 |
| 11 | Pirates of the Caribbean | $3,729,577,967 | 4 | $932,394,492 | Dead Man's Chest ($1,066,179,725) | 15 |
| 12 | Jurassic Park | $3,687,760,348 | 4 | $921,940,087 | Jurassic World ($1,670,400,637) | 77 |
| 13 | Shrek | $3,510,794,482 | 5 | $702,158,896 | Shrek 2 ($919,838,758) | 38 |
| 14 | The Twilight Saga | $3,346,157,056 | 5 | $669,231,411 | Breaking Dawn – Part 2 ($829,746,820) | 0 |
| 15 | Ice Age | $3,217,251,681 | 5 | $643,450,336 | Dawn of the Dinosaurs ($886,686,817) | 26 |
| 16 | The Hunger Games | $2,968,191,442 | 4 | $742,047,861 | Catching Fire ($865,011,746) | 24 |
| 17 | Avengers | $2,924,216,682 | 2 | $1,462,108,341 | The Avengers ($1,518,812,988) | 159 |
| 18 | Mission: Impossible | $2,778,977,995 | 5 | $555,795,599 | Ghost Protocol ($694,713,380) | 5 |
| 19 | Despicable Me | $2,673,274,267 | 3 | $891,091,422 | Minions ($1,159,398,397) | 122 |
| 20 | Superman | $2,554,201,360 | 8 | $319,275,170 | Batman v Superman: Dawn of Justice ($873,260,194) | 268 |
| 21 | Iron Man | $2,423,918,805 | 3 | $807,972,935 | Iron Man 3 ($1,214,811,252) | 271 |
| 22 | DC Extended Universe | $2,286,905,766 | 3 | $762,301,922 | Batman v Superman: Dawn of Justice ($873,260,194) | 32 |
| 23 | Star Trek | $2,266,723,196 | 13 | $174,363,323 | Into Darkness ($467,381,584) | 686 |
| 24 | Madagascar | $2,256,517,920 | 4 | $564,129,480 | Europe's Most Wanted ($746,921,274) | |
| 25 | Captain America | $2,238,138,536 | 3 | $746,046,179 | Civil War ($1,153,304,495) | 100 |

### 5.2.2. DIGITAL GAMES

A related keyword search was conducted with content tagged with digital game titles and brands – see Table 5.2. This also revealed volumes of content related to game brands and game products. 17 keywords relating to games were crawled and this surfaced 4767 things.

***Table 5.2: Keyword Search – Game Brands and Tagged Content Thingiverse***

| **Name** | **Search Term** | **Tagged content** |
|---|---|---|
| Minecraft | Minecraft | 1182 |
| Wii | Wii | 251 |
| Grand Theft Auto | Grand Theft Auto | 14 |
| Super Mario Bros. | Super Mario | 214 |
| Mario Kart Wii | Mario Kart (sic cart) | 31 |
| Tetris | Tetris | 89 |
| The Elder Scrolls V: Skyrim | Skyrim | 216 |
| Diablo III | Diablo | 51 |
| Overwatch | Overwatch | 206 |
| Terraria | Terraria | 19 |
| Call of Duty: World at War | Call of Duty | 54 |
| Pokémon | Pokémon | 1542 |
| Sonic the Hedgehog | Sonic | 230 |
| Space Invaders | Space invaders | 74 |
| E.T. the Extra-Terrestrial | E.T. | 9 |
| Halo | Halo | 491 |
| Pac-man | Pac Man | 94 |

These tables indicate that people are creating content that can be recognized as relating to a media product or brand and that they sometimes tag with terms that suggest it relates to, is associated with or otherwise inspired by motion pictures and other known brand entities. While these tagged content counts represent a small number of the 756,820 things on Thingiverse as of March 2017 they make up 1.3% of Thingiverse content and as later sections will reveal these both correspond to media holdings with large market values associated with their merchandise.

### 5.2.3. Popular Toy/Game Brand

A manual search of Shapeways website (dated to March 7th 2017) provided insight into the number of items tagged with toy and game brand names or titles. In order to do this a list of popular brands relating to film, game and toy titles was drawn up and these were used to query the Shapeways database using a desktop browser.

Note: Originally this research was conducted using a script that crawled relevant categories, tags, descriptors and other metadata and images creating an offline database. However it must be noted that Shapeways forbids crawling or otherwise employing scripts or spiders to trawl their content and in doing so a cross reference indicates that they may suppress sensitive brand tags so this data has been discounted for now and instead only data from publically available searches are presented.

***Table 5.3: Keyword search related to popular toy/game brands comparing thing count on Thingiverse and Shapeways.***

| Brand (search term) | Number of products 2017 March Thingiverse | Number of products 2017 March Shapeways |
|---|---|---|
| Pokémon | 1533 | 886 |
| Barbie | 88 | 43 |
| Lego | 2649 | 2360 |
| Adventure Time | 123 | 9072 |
| Star Wars | 638 | 13000 |
| Star Trek | 670 | 6175 |
| Zelda | 513 | 563 |
| Batman | 929 | 545 |
| Minecraft | 1174 | 830 |
| Mario | 636 | 555 |
| World of WarCraft | 89 | 8647 |
| Portal | 401 | 372 |
| Ironman | 197 | 18000 |
| Angry Birds | 39 | 1266 |

## *5.3 MEDIA RELATED 3D PRINTABLE OBJECTS*

A range of media related content created by users of Thingiverse and Shapeways was identified during the course of the netnography. Examples of 3D printable objects referencing media content are documented and described in this section of the chapter. The research finds that a range of 3D printable objects that reference media products are created. These may be provisionally sorted into initial categories including:

1. Figurines and busts
2. Vehicles and ships
3. Weapons and tools
4. Costume and props
5. Landscape and environment
6. Currency, Tokens, passes and insignias
7. Toy and toy system compatible objects (items compatible with existing toys that extend, enhance or otherwise customise existing toys)
8. Memes, political statements
9. Maps, guides, decoders and items with in world or in game function
10. Media branded utilitarian goods
11. Merchandise and branded goods

There are also some recognisable groupings related to interactions with content that may be noted.

12. Features, expressions, poses and injuries
13. Styling (pixelated, cartoon, adult theme)
14. Remix, mash-up and cross media interactions

Examples of these categories are explored in later sections of this chapter (Table 5.4 collates and discusses categories of content found on 3D printing repositories.) While the categories considered here are not considered to be exhaustive they provide insight into what people make when they have access to 3D printers and how they reference media content. Referencing media content is not new of course as the literature review found with exploration of fan studies but 3D printers and the ability to distribute and sell such content may have implications for a range of stakeholders.

Before considering these categories it is useful to consider the firstly the users of Thingiverse and Shapeways and who they are. Some insights into who these people are and how they position their work are available from their profiles and other information may be gleaned from media reporting. A wide range of types of users may be found. Some are specialists, designers, prop makers, animators and other people with experience of model making and 3D printing. Others are hobbyists and individuals experimenting with the technology, perhaps repairing items or printing things to see how the technology functions, some are people with niche interests creating content that they can't find in the traditional routes, these include people who might be described as fans and fan artists. Collectively, they create a range of content that the following section describes and begins to categorise.

It is not unusual to find media related toys such as *cars*, *dolls and figurines*, space *ships* and *replica weapon*s in toys stores, comic book stores and in related market places. Some of the objects found on Thingiverse and Shapeways are similar to what would be expected from a mass produced toy. Others are similar to figurines produced for fans and collectors, comparable to DIY or vinyl toys and others are similar to and at times compatible with figures produced by tabletop war-gaming producers such as Games Workshop. Objects like this have also been produced though fan art activity. Where these objects in Thingiverse and Shapeways are created by a range of users, some of which might be described as fans and hobbyists and others that might be described as designers or prop makers it might be suggested that this activity by Thingiverse users marks a form of 3D printing enabled fan art and may also be considered under user activity related to DIY toy production (Atılgan, 2014), designer toys (Steinberg, 2010) or user created toys. As the literature review suggests there is little research activity relating to 3D printing in production of toys or in fan art.

Where the research found examples of costume and prop-like objects it notes that in these cases 3D printing is being used by the creators to produce items that assist them in dressing up as certain characters. Costume and prop objects are sometimes offered for sale in specialist stores, media specialist stores like Disney or general market stores like

Wal-Mart to allow consumers to dress-up like those characters they wish to role play as. In fan studies research there is a widely explored practice of cosplay, an activity that generally refers to costume play or *"taking on the role of a character"* (Winge, 2006; Lotecki, 2012; Rahman *et al.*, 2012; Lamerichs, 2013), examining this practice shows that specialist stores and designers work to create costumes and wigs for cosplayers while others participate in creating costumes for themselves. This research suggests that people are using 3D printing in the production of cosplay items.

Some other objects found in the course of this research here are less usually found as mass produced toys or merchandise. *In-world currency, tokens* and *passes* are not usually produced as toys or merchandise, these props are in themselves often insignificant in the narrative or media content in which they exist but some creators have used 3D printing to create these very items. As an example the wall tiles from the apartment of Deckard in Blade Runner are not found as merchandise or toys, yet 3D printable versions of these tiles are available on Shapeways.

Some objects found in this research may be described as *system compatible toys and objects*, objects that interface with or connect to existing toys. Some are construction style objects, with system compatible connectors; others are objects that connect to more generic toys and figures. In some cases it might be a backpack for a mass produced figurine, in other cases it might be a weapon that hasn't been released as a mass-produced toy but has been created by a Thingiverse user so as to be compatible with their pre-existing collector figurines. In some cases Lego compatible with anime style hairstyles have been created allowing people to create anime Lego figures. Generally speaking these items extend, enhance or otherwise customise existing toys.

*Maps, guides, decoders* and *items* with in world or in game function are sometimes found within these repositories. On Zelda player created a 3D printed map of Hyrule, "*The seller, according to McFarland, had spent six months building the map in Minecraft, then converted it to an STL file, 3D printed it, and painted it. The result is stunning, a bird's-eye view of the entire world of Hyrule. If you're a Zelda fan, you're probably well* *familiar with the forests, rivers, and, of course, the huge graveyard, but you've likely never seen them like this before."* (Scott, 2016) The user activity here was noticed by a wider community of Zelda players who in turn requested copies and the originator of the map began selling them for $300 creating a small business. This map functioned a bit like a feelie, providing gamers with a 3D overview or map to refer to during game play.

Related to digital games, it should ne noted that there is a considerable presence of tabletop game related objects on these repositories.

There are also some recognisable groupings related to other interactions with content that may be noted. The extent to which people have interacted with or altered the content from the original varies, some simply copying or replicating content, others interacting more actively. In some cases people edit or adjust the items from their original forms creating caricatures, interpretations, mash-ups or features not found with the original.

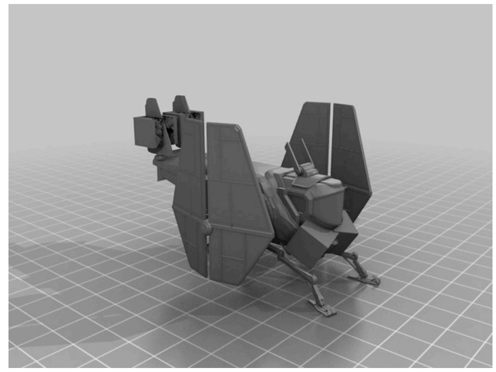
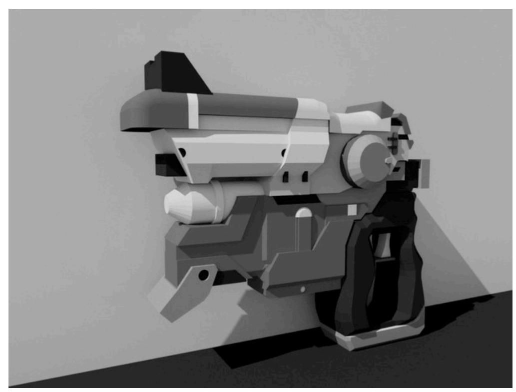
One grouping of objects noted in the netnography may be described as *memes* and *political statements*, these cross Internet based memes with media content or characters. These are not usually created as commercial toys and merchandise but various creators specialise in creating objects with political underpinnings or responding to Internet memes with 3D printable content.

Table 5.4 collates and discusses categories of content found on 3D printing repositories.

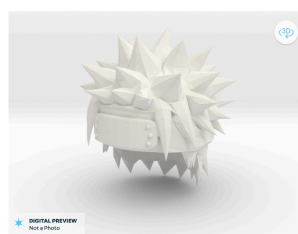
*Table 5.4 Categories of content found on 3D printing repositories*

| | |
|---|---|
| ***1. Figurines***<br>3D printable figurines relating to media products like digital games, films and comics are common on Thingiverse and Shapeways. Batman has been modelled by a number of creators. Some reference rather closely the originating material, making figurines that could be mistaken for licenced merchandise[5] while others are more creative with their interpretations [6] (Johnathan Miller.) | <br><br><br> |
| ***2. Busts***<br>Commercial services providing 3D scanning services busts are a feature on 3D printing repositories such as Shapeways. In some cases people add their own face to that of a popular media character or simply create character busts of known characters.<br>Examples include Batman, Darth Vader and Sheldon Cooper. [7] [8] | <br> |

[5] Batman Figure https://www.shapeways.com/product/VJ5TELMNT/batman?optionId=79383968&li=marketplace
[6] Batman https://www.shapeways.com/product/47H4CPJER/batman?optionId=64564608&li=marketplace
[7] Zissou Bust https://www.shapeways.com/product/7LQHNPC5M/steve-zissou-7-inches?optionId=6090215
[8] Sherlock Bust https://www.shapeways.com/product/99DPC5UYJ/sherlock-s?optionId=59419147&li=marketplace

| | |
|---|---|
| ***3. Miniature Vehicles***<br>Vehicles and ships are common on 3D printing repositories even from games and films that are relatively new or obscure and do not yet have a toy and figurine merchandise line yet. As an example No Man's Sky is a PS4 game that was released in August 2016 it had not of the time of the research made available any official toys or figures in the form of ships. The pictured model ship was made available on Thingiverse by October 2016, just two months after the game was released. [9] |  |
| ***4. Weapons and tools***<br>Similarly weapons (toy and prop) are also common on online repositories. Here is a printable plasma blaster from No Man's Sky[10]. A weapon that was not available as merchandise at the time of finding this item on Thingiverse. Some of these are intended to be used as props or as part of costumes and others are smaller and seemingly intended for figurines. |  |

[9] A space ship from No Mans Sky http://www.thingiverse.com/thing:1810550
[10] No Mans Sky Weapon https://www.thingiverse.com/thing:1707085

| | |
|---|---|
| ***5. Accessories for existing toys***<br>Some makers on Shapeways make accessories that are compatible with commercially available figures. Here is an example of a printable backpack for a Star Wars trooper figure. [11]<br>Creating accessories that are compatible with exiting figurines or toys is a relatively common practice. Examples include this prosthetic arm for Action man style figures. [12] | <br> |
| ***6. Construction compatible objects***<br>A range of objects that are compatible with existing toys may be found on 3D printing repositories. An example is that of Lego compatible figures EGO [13] and a range of Lego compatible anime style hairstyles. [14] | <br> |

[11]Starwars Trooper Backpack https://www.shapeways.com/product/H46BQZRWS/prhi-star-wars-shocktrooper-backpack-6-quot?optionId=58975130
[12] Action Man compatible arm https://www.shapeways.com/product/3T6LCG8SE/prhi-solid-arm-complete-kit-right-with-open-hand?optionId=90335612
[13] Ego, Lego compatable figures https://www.shapeways.com/product/K5BQPAT38/ego-miniature-figure?optionId=43525645&li=marketplace
[14] Naruto hair style https://www.shapeways.com/product/7FHBSQQKQ/custom-naruto-inspired-lego?optionId=39988703&li=marketplace

***7. Props***

A Thingiverse user created a Prison of Azkaban prisoner identification sign (this was a prop in Harry Potter) so that they could dress up as Bellatrix Lestrange. This may be considered as a form of costume play - cosplay.

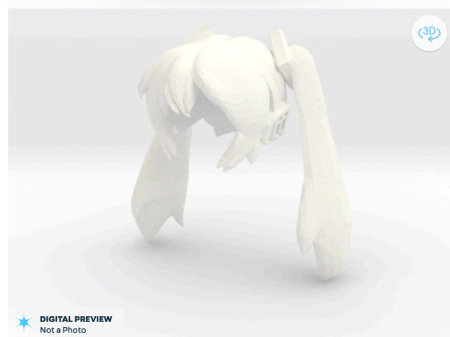
This item references a relatively unimportant prop in the Prisoner of Azkaban film in which Bellatrix Lestrange holds this up as a prisoner ID.[15] At the time of creating this item the sign had not been licensed or manufactured as a toy or merchandise by license holders or the media producer.



[15]Harry Potter prop https://www.shapeways.com/product/HMZFP5229/azkaban-prison-sign?optionId=59715577

***8. Costume Items***

Relatedly items that can be printed to complete costumes including Star Trek visors[16], Harry Potter Spectacles and Iron Man masks are also common. Some of these items are toy sized and intended to dress up existing toys or figures while and others are designed as full size, intended for costume play. The Hatsune hairstyle here is a Lego compatible hairstyle that may be used with existing Lego figures allowing players to create Hatsune Miku in Lego.




[16]Star Trek visor https://www.shapeways.com/product/Z9R7AED8X/star-trek-visor-lens?optionId=60630324

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***9. Jewellery***

All sorts of content gets turned into jewellery or accessory type objects such as cufflinks and necklaces. Some directly copy jewellery from films such as the Holtzmann Screw You Pendant. [17]

While others take various forms and sources of content and fashion them into jewellery such as this Totoro cufflinks set.[18]

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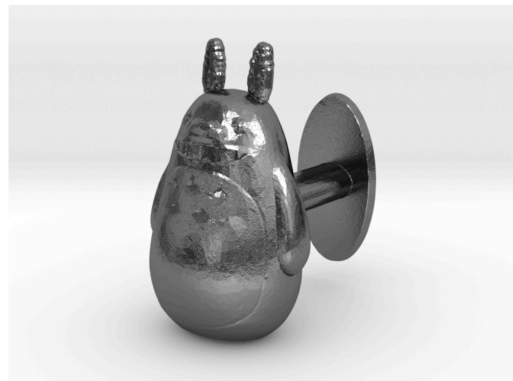

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***10. In-game and in-world currencies***

There are a number of fictional denominations available on Shapeways including quatloos. [19] Quatloos are a monetary unit on the planet Triskelion in Star Trek and was used to bet on competitions in which some of the Star Trek central characters had been forced to participate.

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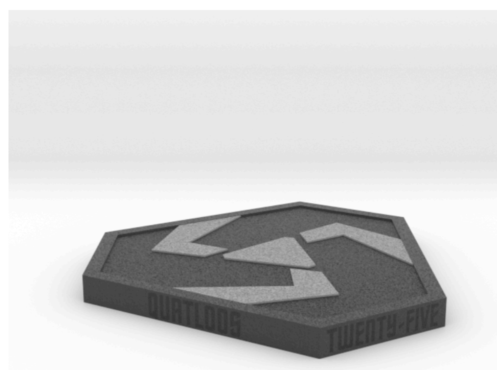


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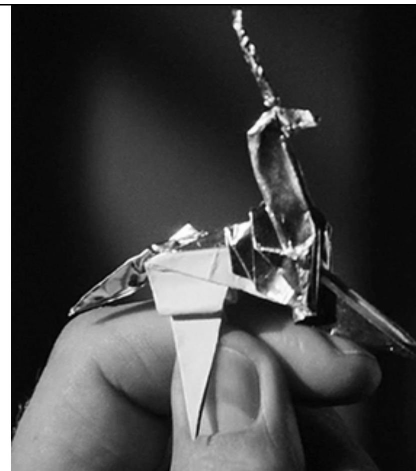
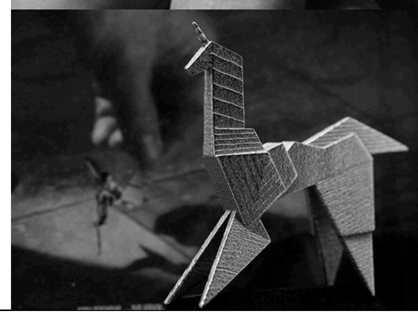
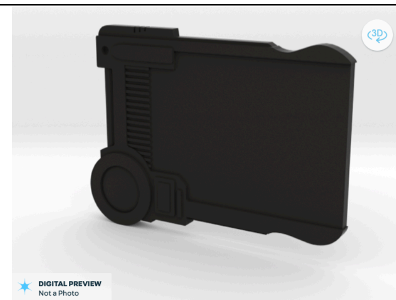
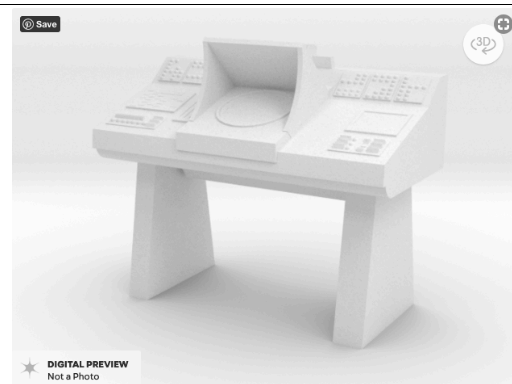
[17] Holtzmann screw you pendant https://www.shapeways.com/product/QHAXEGNEJ/ghostbusters-mini-holtzmann-screw-u-pendant?optionId=60734351

[18] Totoro cufflink set https://www.shapeways.com/product/GJ8YMS22Y/totoro-cufflink?optionId=60365676

[19] Quatloo currency token https://www.shapeways.com/product/ZVCP6SHEP/twenty-five-25-quatloos?optionId=59376716

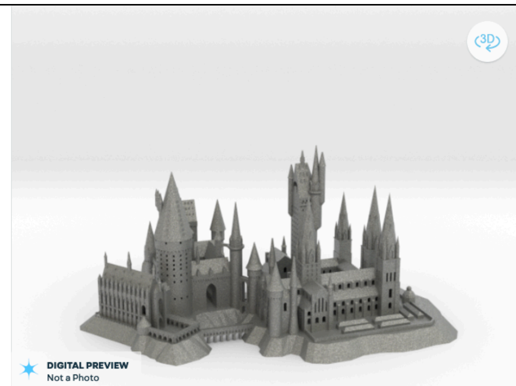
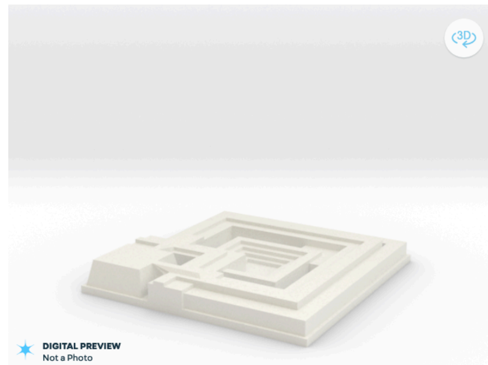
| | |
|---|---|
| ***11. Cult References – tokens or totems*** <br> Relatively obscure film references and props are reproduced as printable things, as an example Gaff's Unicorn from Blade Runner is available on Shapeways. This origami unicorn is considered to be a signal that Deckard is a replicant. [20] <br><br> This signifier was a clue of sorts and overlaps with feelies or game objects that assist in narrative building or game play might be observed here. |   |
| ***12. Badges, Stamps, Passes & Insignia*** <br> Items that signify tribal membership, community, fictional corporation and other media related organisations and in game associations or affiliations. One example being a stamp with the insignia of a playable group in Tom Clancy the Division. [21] |   |

[20]Gaffs origami unicorn https://www.shapewayscom/product/LG8H4EVND/gaff-s-unicorn-blade-runner-origami?optionId=59012968
[21] The Division – Tom Clancey Arm patch stamp. https://www.shapeways.com/product/DDH2YEAEL/the-division-shd-clothing-stamp?optionId=59080032&li=marketplace

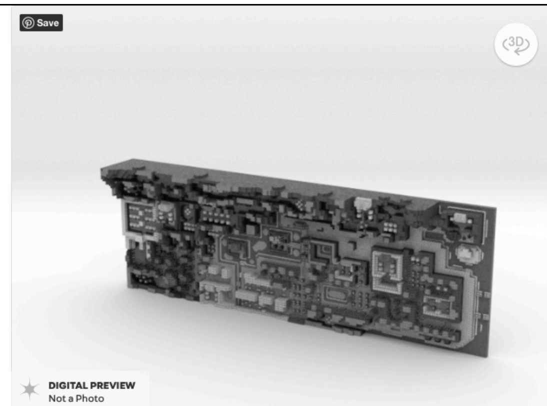
| | |
|---|---|
| LeeLoo, a central character in the Fifth Element uses a multi-pass holder during a key scene. A multi-pass is not a typical merchandise object but is available on Shapeways.[22] |  |
| ***13. Consoles, control pads and technology***<br>The Star Trek control panel and a Frankenstein power switch are available for printing.[23] The use case of these is not often described but these items tend to be included under the descriptor miniatures so it might assumed that these are used in conjunction with figurines allowing people to recreate scenes and environments. |  |

[22] Multipass from the Fifth Element https://www.shapeways.com/product/5K77N593K/multipass-from-fifth-element-props?optionId=5607004

[23]Console Star Trek https://www.shapeways.com/product/R8FHZXTEG/transporter-console-star-trek-classic/

| | |
|---|---|
| ***14. Buildings, landscape and Environment***<br>Scale models of fictional buildings are found on 3d printing repositories. The example presented here is that of Hogwarts school buildings.[24] This creator created miniature models buildings from Hogwarts, Harry Potter. Relatedly this wall tile,[25] featured in the apartment of Deckard in Blade Runner. Not a common item to find as a toy or as merchandise, but scale and full size models of this item are available for printing on Shapeways. |  <br>  |
| ***15. Narrative enhancing customisation - story telling***<br>Some objects created by Thingiverse and Shapeways users incorporated features like scars and injuries.<br>Here people were augmenting characters with additional features. Where the prospective customer survey revealed historic play behaviour relating to melting, painting and otherwise customisation toys to display injuries |  |

[24]Hogwarts https://www.shapeways.com/product/3RNUB2C23/1-1800-hogwarts?optionId=61757556
[25]Blade runner Wall Tile https://www.shapeways.com/product/3UTERFCQS/blade-runner-tile-1-2-scale-hollow?optionId=4833372&li=marketplace

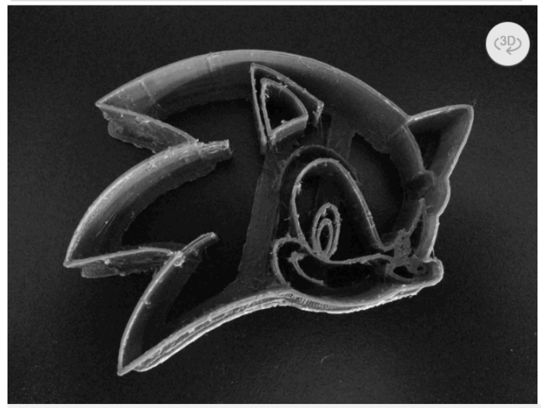
| | |
|---|---|
| sustained during play it is suggested that this behaviour assists in story telling or play. This facial scar on an Ogre provides an example. [26] This activity can be found various in subtle ways on Shapeways with scars incorporated into models. | |
| ***16. Maps and guides*** Various objects relating to in world environments are available. This being a map of Hyrule, an in game space in Zelda Breath of the wild. [27] Physical objects like this can assist in game play presenting as a physical representation of the in game environment allowing player navigation processes. |   |

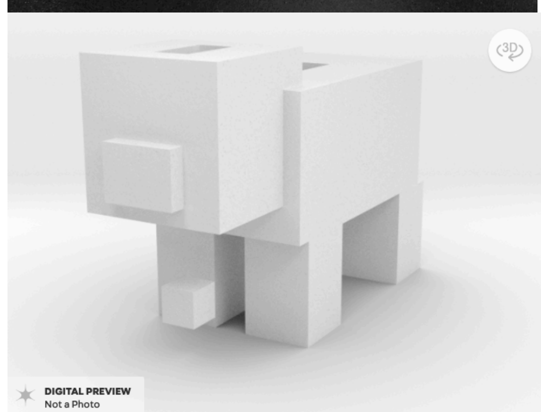
[26]Scarred Ogre https://www.shapeways.com/product/YVJ4ZGVNZ/scarred-ogre-bead-6mm-hole?optionId=56211168

[27] Zelda Hyrule Map https://www.shapeways.com/product/HPGCB3B62/loz-8bit-hyrule-map?optionId=85078087&li=marketplace

***17. Utilitarian objects that reference media content***

Items that might also be described as media branded tools or utilitarian objects are found. This may be considered as the literature review indicated, a form of media merchandise or character merchandising on commodity goods. This research suggests that this activity may be considered as a form of user generated media commodity. Similar to that activity of stickering rulers or backpacks, as considered by (Steinberg, 2012) creators here create media branded objects for use and display. Two examples are presented here, firstly a Sonic the Hedgehog Cookie cutter [28] and secondly a Minecraft inspired piggy bank[29]




[28] Sonic Cookie Cutter https://www.shapeways.com/product/P8KSJLY23/sonic-the-hedgehog-cookie-cutter?optionId=60272527&li=related-items
[29] Minecraft piggy bank https://www.shapeways.com/product/RG2FB65NK/minecraft-piggy-bank?optionId=59687082&li=marketplace

| | |
|---|---|
| ***18. Merchandise and media branded objects***<br>Familiar merchandise objects are also found by Thingiverse and Shapeways. Here user generated phone cases branded with game and media brands including Pokemon are found. [30] |  |
| ***19. Political artefacts***<br>Some people create politically orientated mash-ups, here Trump and Jabba are mashed together into Jabba the Trump[31]. The creator behind this Fernando Sosa creates political sculptures targeting current political leaders and politically relevant issues. Jabba the Hutt is considered as a character to be one of the galaxy's most powerful gangsters, *"with far reaching influence in both politics and the criminal underworld."* (Star Wars) |  |

[30] Pokemon phone case https://www.shapeways.com/product/DPNLTDJVW/pokemon-case-for-iphone-5-squirtle-evo-ver?optionId=17601857&li=marketplace
[31] Jabba the Trump https://www.shapeways.com/product/FWKV8WYGH/jabba-the-trump-small?optionId=58690331

***20. Memes***

A wide range of memes have been turned into 3D printable content, these include grumpy cat,[32] sad Keanu and Szechuan Sauce from Rick and Morty. [33]

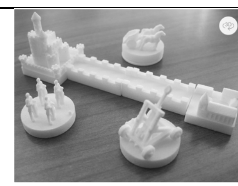
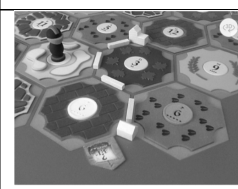
Physical memes are a relatively new type of product and while some companies have produced t-shirts or items featuring meme images it has been rare to find manufactured 3D toy like objects inspired by memes. In some cases memes are remixed with other media content.

[32]Grumpy Cat meme print https://www.shapeways.com/product/H4454KUDD/grumpy-cat?optionId=43200491

[33] Rick and Morty Szechuan Sauce https://www.shapeways.com/product/6JCDZFM7C/szechuan-sauce-from-rick-and-morty?optionId=63133297&li=featured

***Table 5.5 Table Top and Gaming***

The table top and role play gaming communities appear to have embraced 3D printing as a means of making gaming related items including dice, figurines and game pieces as well as props, game tiles and accessories. ***Table 5.5 Table Top and Gaming artefacts***

| | |
|---|---|
| ***Dice***<br>A vast range of intricate and unusual gaming dice are created by and for people interested in tabletop and role-play gaming. [34] |  |
| ***Figurines and game pieces***<br>Gaming figurines are found in repositories. Figures are often modular and painted by hand. [35] |  |
| ***Accessories for figurines***<br>Accessories that personalize, customise or add to existing figures from War Hammer and Dungeons and Dragons series are also available.[36] |  |
| ***Table top props***<br>Game pieces and props to be used with their table top sets are common [37] |  |
| **Terrain and game tiles**<br>[38] Gamers also create game tiles and connectors. |  |

[34] Gaming dice https://www.shapeways.com/product/T3ZY4LFDB/thorn-dice-set-with-decader?optionId=40708059&li=marketplace
[35] Dungeon and dragons figure - https://www.shapeways.com/product/UCR6WXKS4/dragonborn-paladin?optionId=65439905&li=marketplace
[36] Games Workshop compatible accessories https://www.shapeways.com/product/8WE7KZMSZ/mini-knight-wolf-feet-shin-guards?optionId=65204946&li=marketplace
[37] Table top props https://www.shapeways.com/product/HRFD7DBJF/catan-pieces-knights-white?optionId=41349125&li=marketplace
[38] Game tiles https://www.shapeways.com/product/KYJ9V5V7Q/catan-hex-tile-wheat-79mm?optionId=58514335&li=marketplace

## 5.4 USER INTERACTIONS WITH MEDIA CONTENT

Where the research asks what user interactions with media content are enabled by convergence of 3D printing in the digital economy?  This section considers interactions with content facilitated by 3D printing it does so by considering user described tags and terms and also by considering patterns in content production.

This research was conducted in two phases. In the first instance the research drew upon a web scrape process and subsequent analysis of user assigned tags to allow for identification of user assigned descriptors and terms relating to interactions, intent, motivation or function. Secondly through a continued manual (visually orientated) search it identified some other interactions of note with a focus on media related content.

### 5.4.1. USER ASSIGNED TAGS AND TERMS RELATING TO INTERACTION OR FUNCTION

Here I sorted the findings from the web scrape by assigning or identifying intent behind interactions through a process of interpreting tags and content descriptions provided by the creators themselves. The findings here are intended to be indicative not exhaustive, providing insights into types of interactions and intent behind the content hosted on these platforms and to provide a more general overview of what people create using 3D printing and why.

To provide a general insight into user interactions a keyword search was conducted using the search tool, a selection of words were used including repair, remix, clone etc. Where overlaps in meaning occurred the most frequently used term was employed in the search. As an example remix and mash-up are used interchangeably and Thingiverse users often tag items with both terms creating overlap in count so the most popular search term was selected and the count associated with that term.

Alongside this a sub selection of this content was examined, categorized and it’s function noted with thoughts as to the use-case and intent behind the item. In some cases this was

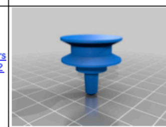
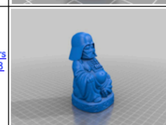
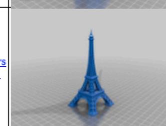
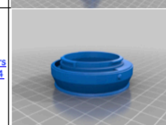
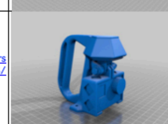
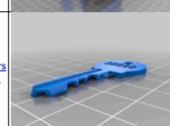
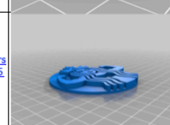
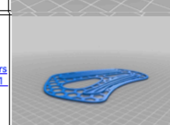
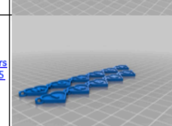
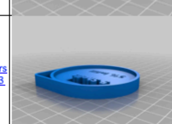
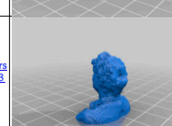
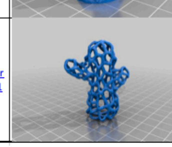
stated explicitly in the listing and in others it was simply inferred or assumed as a function of the product type or design. As an example a dishwasher wheel is assumed to be an artefact of repair and user intent inferred in this case is considered to be repair.
Here users appeared to create, or adapt content to:

1. Repair, mend or fix
2. Remix, mash or mash-up
3. Model
4. Adapt, extend or connect,
5. Weaponise
6. Prototype
7. Replicate
8. Parody
9. Adapt or assist
10. Personalise
11. Represent or depict
12. Clone
13. Experiment

It might also be assumed that some content created has been created as test prints to verify that printers are correctly calibrated or as content to print so that they can observe the printing process.

Some of these interactions may be drive by utilitarian or pragmatic reasons or intent, repairing or adapting existing products. Some is related to editing, creating or re-scaling items while others are examples of user innovation creating items that they cannot find elsewhere or adjusting and adapting existing items to serve new functions or perform differently. Some appear motivated by decorative reasons, customising or personalising items while others appear motivated by hedonic, political or satire, invoking humour or parody or other political statements. Inferred or stated intent user interactions with this content also shows parallels with user reported behaviour in the prospective consumer survey for Makies and includes creating accessories for existing toys, narrative enhancements relating to surface finish (scars) while tools, accessories, vehicles, spaceships are also common. Table 5.6 on the following page documents user assigned tags and terms relating to intent or function and presents a number of examples of related content to demonstrate.

## *Table 5.6 User assigned tags and terms relating to intent or function*

| - | Keywords included (most popular term represented in count) | Description/Intent inferred | Count (End March 2017) | Item name | Example | STL image | With makes/ranked popular | Number |
|---|---|---|---|---|---|---|---|---|
| Fix | Repair, mend and fix | ...to repair or fix an existing thing. In some cases because a repair would be expensive, in other cases because the spare part or component cannot be found or is no longer manufactured. | 6926 | Dishwasher drawer wheel by RapApaR | http://www.thingiverse.com/thing:1164821/#files |  | http://www.thingiverse.com/search?sort=popular&q=fix&type=makes | 362 |
| Remix/mash-up | Remix, mash, mash-up | Appropriate, edit, reference and/or combine from other sources to create a new 'thing'. | 7269 | Darth Vader Buddha by tamraz – combines Starwars Darthvader with cultural/religious icon Buddha | http://www.thingiverse.com/thing:1092181 |  | http://www.thingiverse.com/search?sort=popular&q=REMIX&type=makes | 934 |
| Model | Model | To represent and capture detail as a copy or representation of an object. | 10000 | Eiffel Tower by B9Creations | http://www.thingiverse.com/thing:22051 |  | http://www.thingiverse.com/search?sort=popular&q=Model&type=makes | 10000 |
| Adapt | Adapt, extend, connect | To adapt, bridge or connect. | 1280 | Macro lens adapters for Nikon F-mount | http://www.thingiverse.com/thing:621794 |  | http://www.thingiverse.com/search?sort=popular&q=Adapt&type=makes | 79 |
| Weapon | Weapon | Weapon/replica | 954 | MP40 - Functional Assembly | MP40 - Functional Assembly http://www.thingiverse.com/thing:1038339 |  | http://www.thingiverse.com/search?sort=popular&q=WEAPON&type=makes | 72 |
| Prototype | Prototype (model excluded) | To create a first or preliminary version of a design, to test and refine | 2694 | GoPro Hero 3 Steady Cam Concepy by Gyrobot | http://www.thingiverse.com/thing:152276/#comments |  | http://www.thingiverse.com/search?sort=popular&q=PROTOTYPE&type=makes | 252 |
| Replicate | replica (copy is excluded as this is used by Thingiverse versoning and does not always refer to an intent to copy) | To imitate, duplicate or reproduce | 1276 | UK Key Duplicator by smellymoo | http://www.thingiverse.com/thing:79407 |  | http://www.thingiverse.com/search?sort=popular&q=REPLICATE&type=makes | 235 |
| Parody | Parody | To produce a humorously exaggerated imitation of | 31 | Buff Starbuck Logo by Jskier99 | http://www.thingiverse.com/thing:1430559 |  | http://www.thingiverse.com/search?q=PARODY&sa= | 2 |
| Assist | Assist, Assistive | Make, alter or modify (something) to suit a particular individual or task or to personal specifications | 515 | Wrist brace by piuLAB | http://www.thingiverse.com/thing:403001 |  | http://www.thingiverse.com/search?sort=relevant&q=ASSIST&type=things | 40 |
| Personalise | Personalise | design or produce (something) to meet someone's individual requirements. | 163 | Heart chain with text by JustinSDK | http://www.thingiverse.com/thing:1504859 |  | http://www.thingiverse.com/search?sort=relevant&q=ASSIST&type=things | 11 |
| Represent | Represent/Depict | To provide example, represent or depict an otherwise difficult to visualize concept, structure or phenomenon | 464 | Infill Tiles by MakerbotLearning | http://www.thingiverse.com/thing:858863 |  | http://www.thingiverse.com/search?sort=relevant&q=REPRESENT&type=things | 24 |
| Clone | Clone | Generated as a result of scanning either by user-selected tools or as a result of scanning services. | 1425 | Cegielski's Head by bkrawciw | http://www.thingiverse.com/thing:1952630 |  | http://www.thingiverse.com/search?sort=relevant&q=CLONE&type=things | 540 |
| Experiment/play | Experimenting | "just experimenting/playing around" | 1700 | Experimenting with Vornoi patterns by rocketboy | http://www.thingiverse.com/thing:752431 |  | http://www.thingiverse.com/search?sort=relevant&q=EXPERIMENT&type=things | 159 |

### 5.4.2. Other Interactions of Note

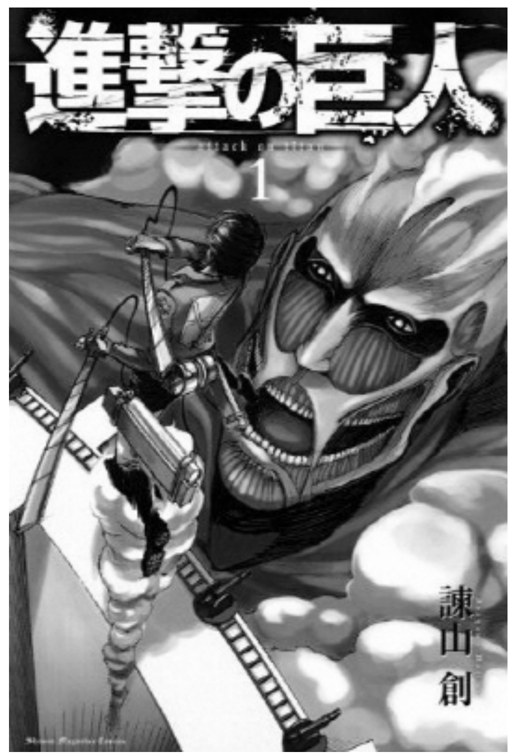
The previous section identified user assigned descriptors relating to interactions with content and intent. Over the following pages this section provides examples of interactions with media related content that represent what this research suggests are of relevance to consider as media producers. These were identified though a manual search of Shapeways.

The first three examples here are considered as remix or mash-ups in which people take one or more forms of media content and mix or mash them with other content creating, in effect a hybrid object referencing multiple content sources. In many of the examples of mash-ups or remix found on Thingiverse and Shapeways *Cross media porting or interactions* with content may also be noted in which people re-create content in the style of a different media product, a key example being that of media content being re-created in the style of Minecraft characters, in some cases this activity could be described as *remix,* some as *mash-ups.*

Some creators *re-create media content in particular styles* or *themes*, with pixelated, cartoon or adult themes amongst those observable on 3D printing repositories. Some descriptors relating to Japanese culture may also be noted in relation to styles, including chibi (small/petit) and kawaii (cute). 3DK Toys for example create what they describe as; *"… a new collection of 15 parody skulls inspired by the creatures and characters of Star Wars!"* Other creators create objects that might be understood as capturing *injuries, expressions, poses and other activity specific moments.*

Similar kinds of activity have also been noted in wider fan art and designer toy contexts though little research directly references such activity. Here the research finds that 3D printing enables fan art and a wide range of user interactions with media content.

*Table 5.7 Other user interactions of note*

| | |
|---|---|
| ***1. Mash up - My Little Titan***<br>This print, titled My Little Titan[39] is a user described mash-up of My Little Pony and Attack on Titan. Offered on Shapeways by Think Forward Designs it mashes the original figure of My Little Pony as owned by Hasbro with Attack on Titan a Japanese Manga series written and illustrated by Hajime Isayama.<br><br>These two media properties are unlikely to collaborate commercially so user generated mash-ups are perhaps the only way that these media products will cross.<br><br>It is not clear if the creator has received permission to create this print. This mash-up is niche and is unlikely to be widely understood or recognized because fans of one of these enterprises are unlikely to be fans of the other. The model is available for sale on Shapeways for £38.49 | <br>My Little Titan – MLP & Titan Mash-up<br><br><br>Attack on Titan, Vol 1, Kodansha |

[39]My Little Titan https://www.shapeways.com/product/PMD64652D/my-little-titan?optionId=58131695&li=marketplace

***2. Mash up - Tonari no Chtulhu***

Described by the creator as a mash-up of Hayao Miyazaki's Totoro with H.P. Lovecraft's Chtulhu this is a sandstone print available for sale on Shapeways.com for £146.86 as of March 6th 2017.[40] My Neighbour Totoro is a 1988 Japanese animated film first produced by Studio Ghibli and has been re-released in various formats and translations since with a range of supporting spin-off products including books, cartoons and toys. Totoro the character is widely recognized with a wide range of legally recognized merchandise. This mash-up also references The Call of Cthulhu a short story that was originally published in Weird Tales in 1928. Lovecraft sketched Cthulhu and described it as…

*"A monster of vaguely anthropoid outline, but with an octopus-like head whose face was a mass of feelers, a scaly, rubbery-looking body, prodigious claws on hind and fore feet, and long, narrow wings behind."* (The Call of Cthulhu by H.P. Lovecraft)

Tonari no Chtulhu mash-up


[40] Totoro no chtulhu https://www.shapeways.com/product/B3FQ4XU22/tonari-no-chtulhu?optionId=41293559

***3. Mash-up Pop Buddha***

Here Budau or Pu-Tai [41] (Laughing Buddha) is used as the origin for line of 3D printable sculptures whose heads have been replaced with the heads of well known media icons such as Darth Vader, Yoda and a Storm trooper. This mashes a cultural and religious icon with popular intellectual property of a well-known media franchise.

While the first two examples considered here combined relatively inoffensive media products in one printable object a Darth Vader Buddha might be considered insensitive.

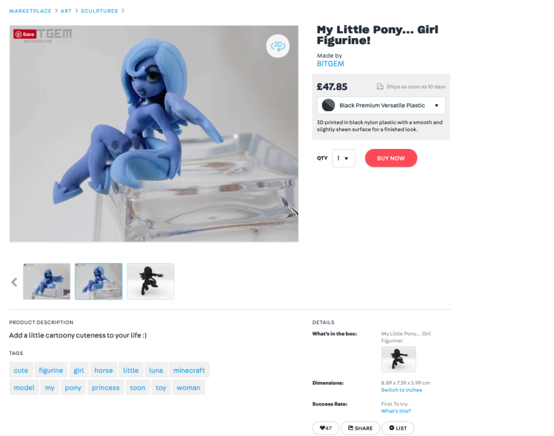
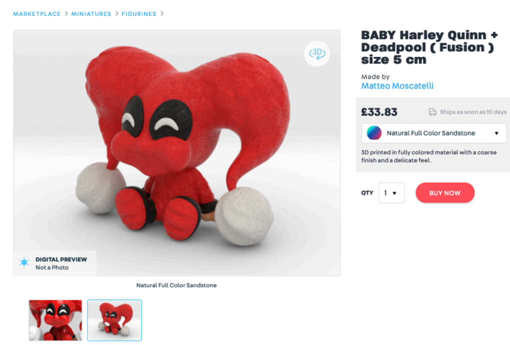
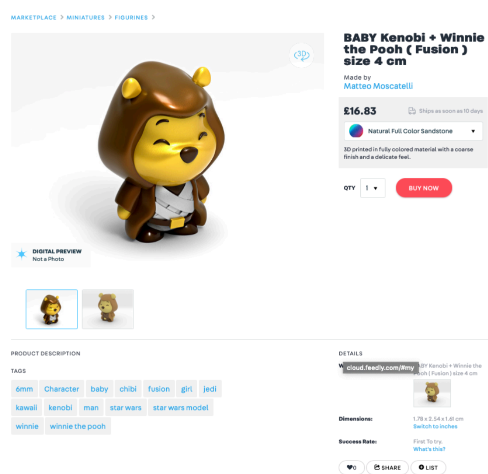

***4. Recreate in a particular style***

Some creators produce objects with particular styles or themes, 3DK Toys for example create what they describe as; *"SKULL WARS is a new collection of 15 parody skulls inspired by the creatures and characters of Star Wars!"* [42]


---

[41] Pop Buddha http://www.thingiverse.com/thing:1092181

[42] Parody Star Wars Skulls https://www.shapeways.com/product/CJEBS32JG/skull-wars-accident-prone-skull?optionId=60831517&li=marketplace

| | |
|---|---|
| ***5. Recreate in a particular style - My Little Pony reworked as adult content***<br>This My Little Pony figure has been remixed as a sexualized cross between a pony and girl, perhaps intended for the Brony market. [43] Questions may be raised as to the implications over brand and image control. |  |
| ***6. Recreate in a particular style - Chibi style***<br>Chibi stylised remix of Harley Quinn and Deadpool [44] |  |
| ***7. Recreate in a particular style -* Chibi style**<br>Chibi mash-up of Kenobi and Winnie the Pooh [45] |  |

[43]My Little Pony – as a girl figurine in adult pose. https://www.shapeways.com/product/3UZZ3Z2X6/my-little-pony-girl-figurine?optionId=63956535

[44] Chibi Harley Quinn = Deadpool remixhttps://www.shapeways.com/product/G8RC84J8C/baby-harley-quinn-deadpool-nbsp-fusion-size-5-cm?optionId=65569436&li=marketplace

[45] Pooh Kenobi Chibi = https://www.shapeways.com/product/KRTGKTK6B/baby-kenobi-winnie-the-pooh-fusion-size-4-cm?optionId=65693351

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***8. Cross Media Interactions***

MineToys create Minecraft Style characters, some of which incorporate content from other media producers' such as Nintendo. [46]

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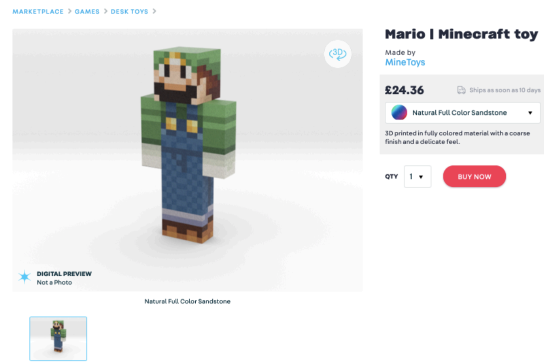
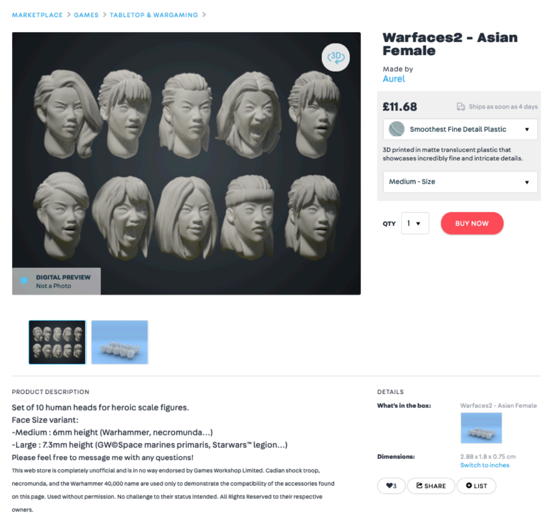



</td>
</tr>
<tr>
<td>

***9. Features, expressions, poses and injuries***

War faces with variant hairstyles and expressions. [47]

</td>
<td>




</td>
</tr>
</table>

[46]Cross media interactions https://www.shapeways.com/product/887SJU4KA/mario-minecraft-toy?optionId=73187359&li=marketplace

[47]War faces https://www.shapeways.com/product/SZTWBB8KR/warfaces2-asian-female?optionId=82097847&li=marketplace

## 5.5 INDUSTRY/STAKEHOLDER ADOPTION OF 3D PRINTING

The netnography also tracked industry and stakeholder adoption of 3D printing in the production of toys and merchandise. This section considers findings from this line of enquiry. Where the research considered the implications for the various stakeholders involved in production of media related goods this section identifies industry and stakeholder adoption of 3D printing and provides some initial insights into the indicative sizing and download counts as a means of providing insight into indicating industry value and in consideration volume of download.

This part of the netnography involved tracking various sources of industry and media reporting including 3D printing focused reporting, shareholder and stock market reports, press releases and game, toy and media industry reporting as well as general media.

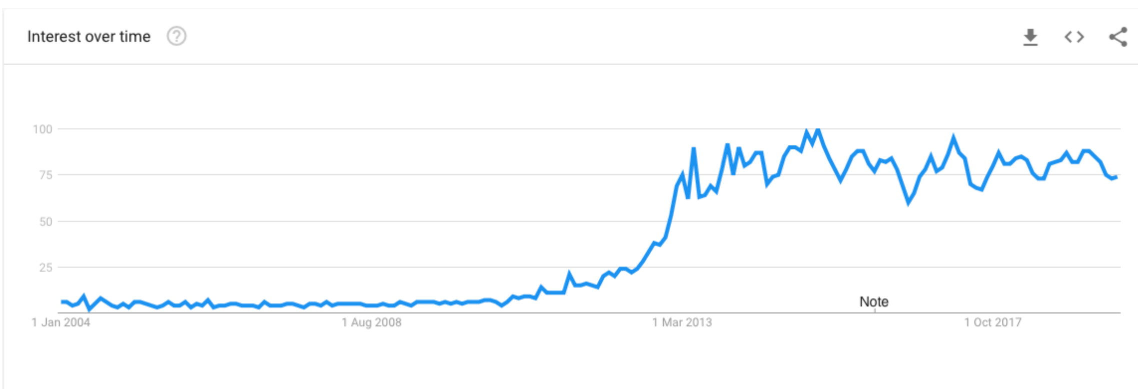



Figure 5.2– "3D printing" search term use over time. Scale – 100 relates to Google determined percentage peak

As trends charts from Google indicated general awareness and hype of 3D printing grew between 2010 and 2015 as popular news, television and blogging sites began to write about 3D printing for mainstream audiences. Examples of 3D printed products were being made available to the general public and were generally very optimistic about the possibilities of the technology. Implying, perhaps unintentionally and with a futures perspective not always communicated adequately, the ability to fabricate anything. Other discussions that were popular in general media were perceived risks to intellectual property owners with citation of the copying potential afforded by 3D printing and also the 3D printed gun debate in which people worried about unregulated weapon manufacture or the ability to download a gun. So, during the years of this research 3D printing went from a relatively unknown, science fiction type process in the awareness of the general public to a technology that was spoken about in the news and popular media and with this widened awareness a wide range of business ventures moved concurrently to exploit the technology.

This was also a time in which largest producers of 3D printing equipment were working to drive adoption of their equipment working with various industries to establish manufacturing needs, develop colour and multiple stage processing and volume production. 3D printing had been adopted by various firms and stakeholders involved in industries ranging from aerospace to dental but remained during the early stages of this research an early stage of adoption in the manufacture of consumer goods by or for media companies. At the time of initiating this research 3D printing was not a widely used technique in relation to media products, in particular media related consumer goods. However as the research progressed increasingly visible activity was noted alongside MakieLab as considered here.

The netnography finds that Shapeways and partners provide a range of services and tools that allow people to create and customise. Examples include a Mineways service[48] allows Minecraft Players to port their game content for 3D printing via Shapeways; Crayon Creatures[49] that allows people to made 3D models from drawings created by their children. Pup Workshop[50] that allows people to create small sandstone pups. People can also submit photographs and have their pet 3D modelled and printed[51]. While Monstermatic[52] and We are Huemans[53] allows people to create monsters and characters.

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[48] Mineways http://realtimerendering.com/erich/minecraft/public/mineways
[49] Crayon Creatures https://www.crayoncreatures.com
[50] Pup Workshop http://pupworkshop.com
[51] Arty Lobster Pet printing service https://artylobster.com
[52] Monster Matic https://www.kickstarter.com/projects/claytonmitchell/monstermatic-the-first-3d-printing-game
[53] http://wearehuemans.com/make-a-hueman/

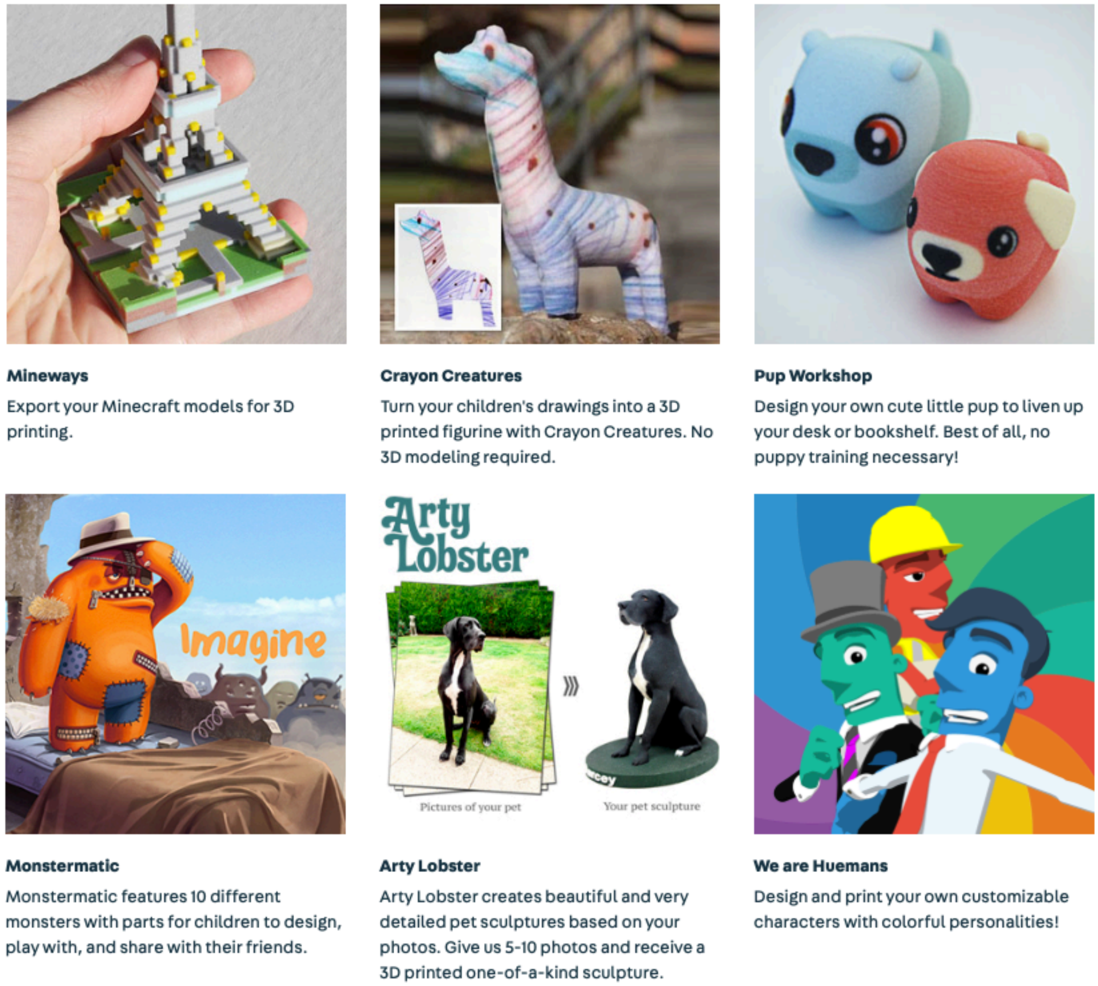


Image 5.1 – Shapeways toy creator tools and services

These examples from Shapeways mirror wider industry adoption trends and activity. This section of the research highlights emergent industry developments associated with 3D printing in relation to toys and media.

### 5.5.1. Toy Industry Adoption of 3D Printing

A series of industry partnerships between toy companies Mattel and Hasbro with manufacturing companies including Shapeways and tool designers Autodesk were noted during the mid stages of this research, both validating the line of enquiry and assisting in providing industry based insight into perceived opportunities for 3D printing and industry types.

*"We are thrilled to collaborate with Hasbro, a premier, global, branded play company, to jointly define, shape and lead the entire digital play space, powered by 3D printing,"* said Avi Reichental, President and CEO, 3DS. (in 3DSystems 2014)

In 2014 and 2015 a series of co-ventures and collaborations between 3D printing industry bodies such as Shapeways, 3D Systems and toy industry bodies such as Mattel, Disney and Hasbro began to emerge. These co-ventures signalled interest in 3D printing as a manufacturing process, a prototyping process but also as a co-creation or customisation process on the part of the toy industry. Autodesk and Mattel signed an agreement to collaborate on the Mattel toy line with 3D design and printing technology. Suggesting the development of cross platform media in which consumers would be able to design and customise products through apps and make them real using 3D printing.

*"The joint initiative will provide a new immersive experience by combining beloved physical toys with digital adventures. An upcoming series of apps will empower consumers to imagine, design and customize their own toys, and help to make the toys real through 3D printing."* [54]

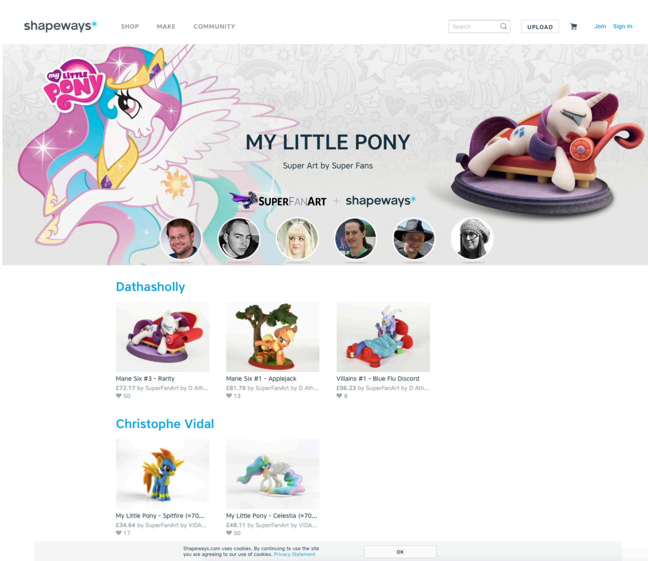


Image 5.2 – My Little Pony – fan produced artifacts.

Mattel and Autodesk were not alone in such ventures, following an earlier move in 2014 where 3D Systems and Hasbro announced a co-venture to *'co-develop, co-venture and deliver new immersive, creative play experiences powered by 3D printing for children and their families later this year.'*[55] Additionally Hasbro who own My

[54] Autodesk and Mattel signed an agreement to collaborate on the Mattel toy line with 3D design and printing technology http://investors.autodesk.com/phoenix.zhtml?c=117861&p=RssLanding&cat=news&id=2037611
[55] 3D Systems and Hasbro announce a co-venture. http://investor.hasbro.com/releasedetail.cfm?releaseid=825857

Little Pony and Transformers opened their intellectual property to selected fan artists on Shapeways. Artist-created My Little Pony products were made available for sale marking the development of a fan artist platform upon which a media producer facilitated fab artist created content and supported subsequent sale and manufacture of said content.

This was in part because in 2011 Shapeways user Brandon Lee Johnson created printable My Little Pony figures on Shapeways.com in breach of intellectual property protections. Hasbro, instead of pursuing legal routes, removing the content entirely or blocking further production worked instead to collaborate with Shapeways. Hasbro and Shapeways then later collaborated on SuperFanArt[56] a site where selected fan artists can market and sell their 3D creations. My Little Pony products by a range of fan artists were made available for sale with each party profiting from this collaboration. According to Hutchins (2014) SuperFanArt is now looking for potential artists to create 3D-printable designs for Transformers, G.I. Joe, Monopoly, Dragonvale, Scrabble and Dungeons &Dragons (Hutchins, 2014).

Hasbro and Mattel were investigating 3D printing just as the technology was reaching a point of maturation appropriate to allow research and development of custom toys and in theory to launch custom on-demand products for general sale. While 3D printing was not new it was still limited in capability with issues of colour, finish and cost hindering general uptake for complex products but given the often simple form of toys 3D printing was initially considered appropriate for the production of simple products such as toys.

*"3D printing is getting cheaper, allowing the manufacturing of action figures. We're already seeing the growth of companies like Sandboxr, which make it easier for game makers to create and distribute models based on their titles, while Amazon has launched a 3D printing store for customers."* (Stuart and Webber, 2015)

Collectively this looked like an interesting time for 3D printing associated with popular

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[56] Shapeways – Super FanArt www.shapeways.com/superfanart/mylittlepony

media products and toys. These announcements signalled intention to explore 3D printing as a manufacturing process but also as a means by which digital content could be "made real" and consumers could be involved in the creation process.

### 5.5.2. Media Industry Adoption of 3D Printing

Some of the larger producers experimented with services that allowed customers to customise products elated to their media lines. Super Awesome Me as an example, was a trial partnership between Wal-Mart, Disney Consumer Products and 3D Plus Me combined 3D scanning and 3D printing to allow users to scan their face and have it added to printable superhero figurines. A 3D print of a customer's face and head was then attached to a mass-produced plastic body of a superhero toy like Iron Man. The trial ran for a number of weeks in a number of stores and items sold for approximately $59.[57]

*"I just got the result, and to my pleasant surprise, the figure looks pretty cool! My likeness definitely rings true in this 3D sculpt, and the paint work matches my hair and eye color, and even facial hair much more accurately than I would have predicted. The head is made out of a resin-like material, which has a sort of grainy, chalky texture that doesn't really mesh with the plastic Titan Heroes body, but the overall effect is still very cool and remarkably spot-on, even for someone as typically non-photogenic as me."*

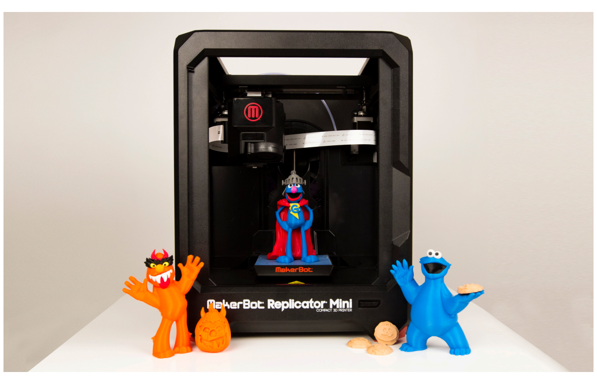



Image 5.3 – MakerBot & Sesame Street collaboration.

In a similar move some media owners also licensed their media content to 3D printing providers or machine manufacturers. Sesame Street for example moved to explore 3D printing in a partnership with MakerBot. In 2014 MakerBot announced that it would bring its first licensed brand - Sesame Street,

[57] Super Awesome Me http://superawesomeme.com

a television product to the MakerBot Digital Store and to MakerBot retail stores, choosing to make Mr. Snuffleupagus available for consumer download and as a printed product in their retail stores (Howard, 2014). This perhaps marked a move by MakerBot to secure desirable content from which user uptake of their printers could be driven and marked a move by Sesame Street that could be considered as a way to explore a new content delivery platform and a new manufacturing process.

Behind the scenes people working in media related fields such as stop motion, animation and motion picture production were already experimenting with the technology and in some cases beginning to introduce it to their workflows and processes. Uptake of 3D printing, around this time, was significant in animation industries, which has been one of the most advanced adopters of the technology to date. Here production of models and prototypes in processes related to stop motion has become commonplace. In this media producing space 3D printing has had significant impact on work-flow processes with disruption particularly evident in the production of stop motion animation (Jaremko-Greenwold, 2015; Clarke, 2016).

*"3D printing helped Laika Studios development more efficient workflow as instead of manipulating clay in between shots, as in the traditional process, the studio had an array of detailed parts which could be interchanged accordingly."* (Jaremko-Greenwold, 2015)

### 5.5.3. Game Industry Adoption of 3D Printing

Importantly designers and artists working in 3D for games used digital tools in the creation of game art that could be adjusted to output 3D printable content, as such experimentation on the fringes of the games industry could be noted.

*"One of the fun things about traveling to a distant land is bringing back a souvenir to remember the journey. That's easy enough when visiting France or China, but what about trips to the World of WarCraft? Or time spent creating your own land in Minecraft? Those digital provinces were once resigned to verbal description, or at*

*best, screenshots emailed to friends. But now, FigurePrints has figured out how to use 3-D printers to create a gift shop for electronic explorers."*(Flaherty, 2012a)

3D printing was employed by some as a way to allow players to map their game environments and export printable models of in-game landscapes, buildings or features. Mineways and FigurePrints are services that allow Minecraft players to map and export their Minecraft worlds into a 3D printable format and have it printed.

*"Anyone who already plays Minecraft and is an experienced builder should be able to just download Mineways, export a model, and get it printed. For everyone else, it's just another good excuse to start playing the game and getting to grips with the world of blocks."* (Haines, 2012)

A subset of software developers and games developers worked to codify or automate some of these media product to printable format processes and in doing so spawned services that, in some cases, grew into businesses. Companies like Shapeways provided APIs allowing developers and media producers to use their manufacturing services.

Others used 3D printing to facilitate production of open source, downloadable and printable board games that could be customised and printed by players. *"The team at Ill Gotten Games is doing just that by creating Pocket Tactic, the first open source miniatures game designed to be manufactured on a 3D printer."* (Flaherty, 2012b)

Some games producers moved to use 3D printing in the production of their own merchandise. A key early example of this is the Kerbal Space Program 'a multi-genre game where the players create their own space program'. Developed and published by Squad (Monkey Squad, S.A. de C.V.) for various gaming platforms and originating with Felipe Falanghe the Kerbal Space Program was launched in June 2011 (Russin, 2013; Villapaz, 2017). The Kerbal Space Program use 3D printing as a means of creating merchandise and have an online store available on Shapeways.com at where it is possible to purchase and print Kerbals as well as associated planets and props. Products in their store range from £14.43 to £163.54 (Prices correct as of 2017)

Outside of industry, this research found that there was some use of 3D printing evident in relation to games. On online repositories it seemed that referencing game and media content was a way in which people found inspiration for what to print. A number of players and hobbyists could be observed modelling game related characters and accessories simultaneously making these available for download on Thingiverse, or sale on Shapeways. Relatedly hobbyist and game player focused editorials provided insight into how you as a game player could use 3D printing to make your own print of game characters (Jenny, 2013b, 2013a). Players and hobbyists could also access consumer accessible 3D printers that existed in hobbyist and maker spaces and were adopting at home printing with small, low-resolution desktop printers.

As the ethnographic partnership was finishing up in 2016/2017 a series of new game industry focused start-ups and business ventures had emerged that sought to harness the possibilities of 3D printing for the games industry.
These included:

- ***Eucl3D*** a company that claimed to 'bring games to life' offering 3D printing of game merchandise was founded by Jesse Manek, Brian Graf and Brian Bordley hoping to occupy this domain. Their plan was inspired by what they perceived as a lack of 'quality collectables' for lifelong games and established partnerships with game companies including Kerbal Space Program, Elite Dangerous and Star trek online (Butler Millsaps, 2016). They have since ceased operation.
- **Whispering Gibbon** a start-up based in Newcastle, UK who describe themselves as specializing in bringing virtual content to reality through the power of 3D printing (Molitch-hou, 2016a, 2016b). Whispering Gibbon anticipates offering printing of customised characters and game generated content as well as in game captures. Their key technology is "RenderFab, a technology for converting objects optimized for visual display to models optimized for 3D printing. Whispering Gibbon are not content creators themselves but instead intend to

work with game development firms to integrate with their game platforms.

- **FabZat** are building a business model around the idea that they will be able to create 3D printable content from digital assets and make available a 'plug-in' that allows existing content creators to quickly set up a store retailing printable content without the need to develop this themselves. (Sher, 2017)
- **Toyze** described itself as the first 'app store for licensed, customizable, 3D printed models of your favourite game characters. (Sher, 2015)

The more successful of these ventures in many cases went on to be acquired by the largest 3D printing firms in a series of moves that it might be assumed relates to growth requirements to drive adoption of 3D printing. Some of this work has been quietly paused and waits for a time when 3D printing costs and abilities reach more consumer acceptable price and quality points.

### 5.5.4. Indicative Market Sizing

An exploratory examination of the revenue and merchandise potential of media product indicates that the market relating to toys and merchandise from some of these media products is large. Harry Potter as an example is a successful media franchise with a range of merchandise, tie ins, sequels, games and other related products. Harry Potter content is easily found on both Thingiverse and Shapeways. With official merchandise revenue estimated at $7,307,500,000 a significant market exists for Harry Potter merchandise. Table 5.8 provides example revenue breakdown of Harry Potter enterprises.

***Table 5.8 revenue breakdowns of Harry Potter products.***

| Movie (Global Sales) | Sales |
|---|---|
| Harry Potter and the Deathly Hallows Part 2 | $1,326,444,886 |
| Harry Potter and the Deathly Hallows Part 1 | $955,417,476 |
| Harry Potter and the Half-Blood Prince | $934,416,487 |
| Harry Potter and the Order of the Phoenix | $939,885,929 |
| Harry Potter and the Goblet of Fire | $896,911,078 |
| Harry Potter and the Prisoner of Azkaban | $796,688,549 |
| Harry Potter and the Chamber of Secrets | $878,979,634 |
| Harry Potter and the Sorcerer's Stone | $974,755,371 |
| Total Movie Sales | $7,216,000,000 |
| Book Sales | $7,743,000,000 |
| DVD / Digital Sales | $1,978,000,000 |
| Rentals | $607,000,000 |
| Toy Sales (Estimate) | $7,307,500,000 |
| Total Harry Potter Sales | $24,851,000,000 |

It might be assumed then that should 3D printing reach a sufficient state of development so as to complete with mass manufactured toys in terms of cost price and quality that there might be market value associated with building out user customisation and co-creation platforms for such brands or co-opting user generated content.

### 5.5.5. Download Counts Associated with 3D Printable Media Content

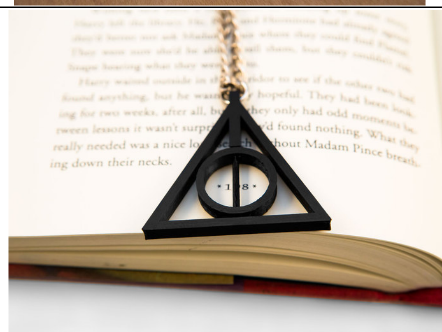
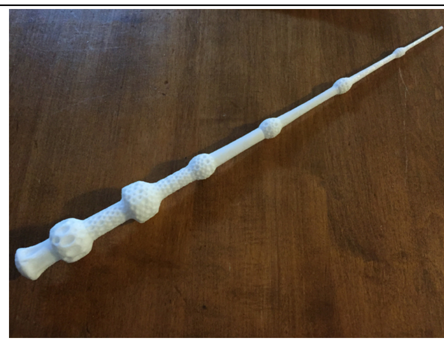
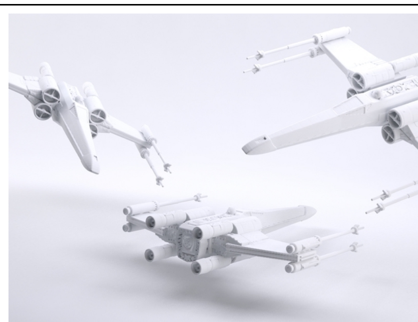
This section considers download counts associated with content as a means of gauging indicative levels of interest in 3D printable media related content. The table provided in the following section provides a snapshot of popular and liked Thingiverse content that relates to motion picture brands and provides insight into the type of product created, the download and make count.

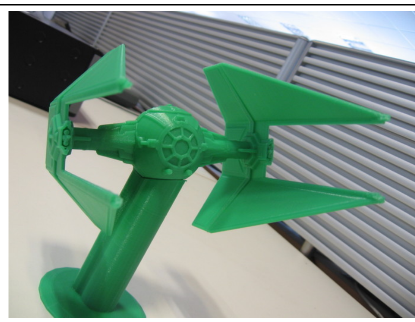
This table presents make, remix and downloads counts relating to popular examples of media related content submitted by users. These figures are up to March 2017.

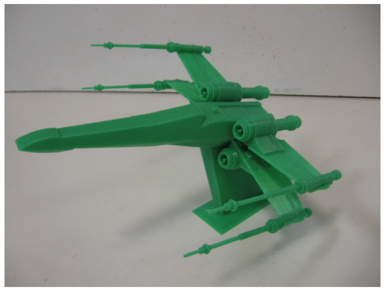
It should be noted that the **make count** requires user verification of a print (in many cases hours or days after downloading the content) cannot be considered to be a useful indicator of how much content has been printed. Additionally download count can also not be assumed to relate to an actual print count as not all people who download will print but the volume of downloads provides an insight into user interest in such content. These items have been selected as they are popular items relating to popular media products, some of these are available as mass manufactured toys or figures but some are not available on the mass market and might be suggested to fulfil an underserved market.

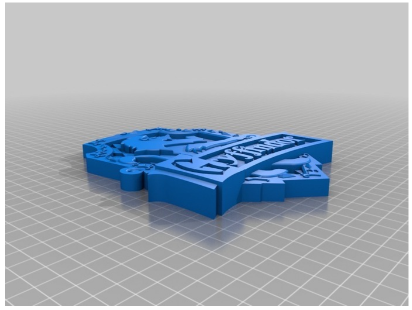
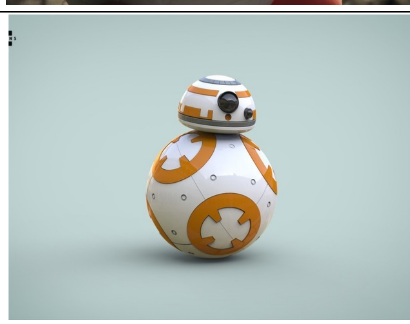
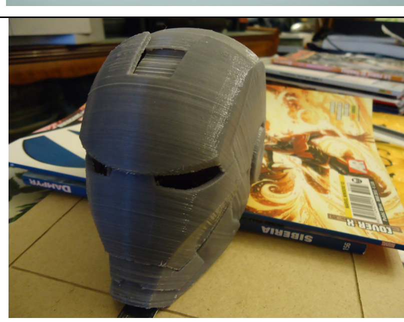
While the volume of content is relatively small compared to Thingiverse total of 758,700 as of March 23rd 2017 40781 downloads of toy merchandise from just 50 pieces of user generated content is not insignificant at a time when 3D printer distribution and capability is at limited stages of diffusion and adoption. Table 5.9 shows download counts of popular media related content on Thingiverse.

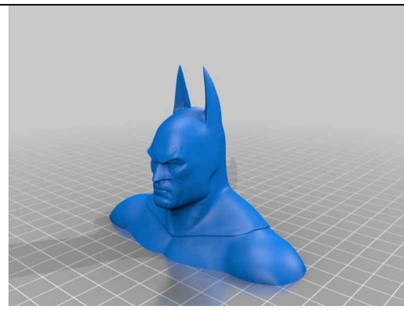
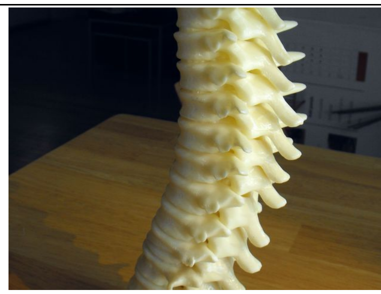
*Table 5.9 Download count of popular media content*

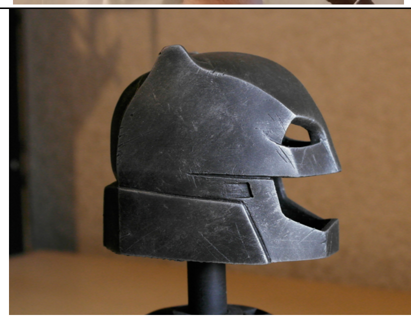
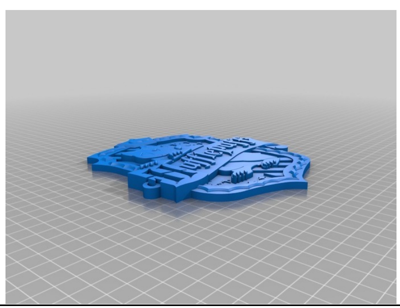
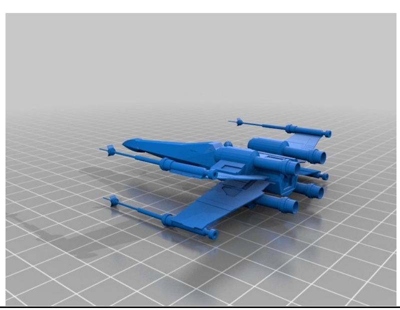
| Name | Image | Author | Remix Count | Download Count |
|---|---|---|---|---|
| Batman Bust |  | MustangDave | 7 | 20573 |
| Harry Potter Deathly Hallows Rotating Pendant |  | ecken | 5 | 18998 |
| The Elder Wand |  | jakereeves | na | 17317 |
| Star Wars X Wing Fighter |  | 660 | 2 | 17136 |

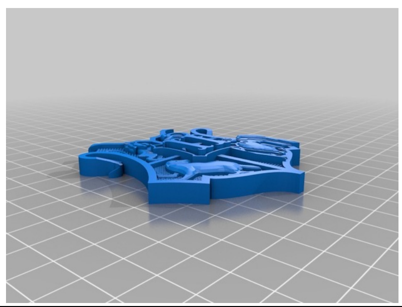
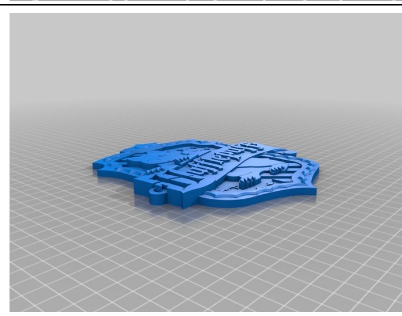
| | | | | |
|---|---|---|---|---|
| Batman Cookie Cutter |  | Buhi | 2 | 16249 |
| Iron Man MK6 MK 6 Suit |  | DaDave | 2 | 15262 |
| Star Wars TIE Interceptor - sliced to print without support, and with stand |  | DavidHanwell | 3 | 13168 |
| Hulk 3D Scan |  | 3DWP | 7 | 13109 |
| Batman |  | mrfab | 3 | 12815 |

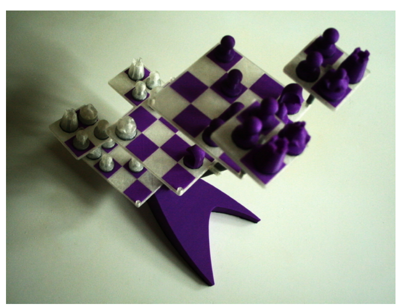
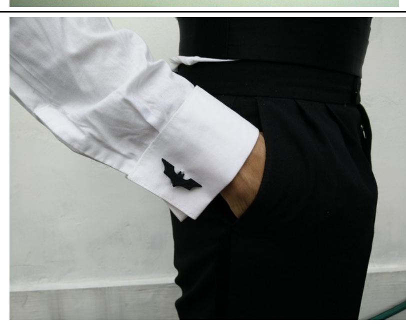
| | | | | |
|---|---|---|---|---|
| Star Wars X-Wing - sliced to print without support, and with stand |  | DavidHanwell | 2 | 12176 |
| Star Wars Ep7 New Storm Trooper Helmet |  | Geoffro | | 11590 |
| Thermal Detonator from Star Wars, Makes great Christmas tree baubles with a bang! |  | AprilStorm | 1 | 10441 |
| Star Wars Star Destroyer with Detailed Stand |  | fflbm4 | 0 | 10348 |
| Motorized Star Wars AT-AT |  | LtDan | 2 | 10058 |

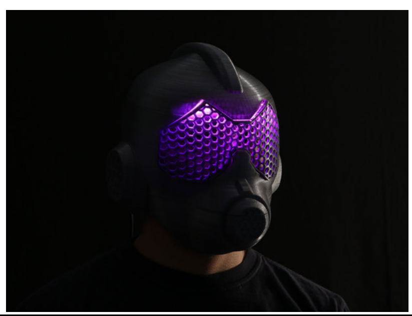
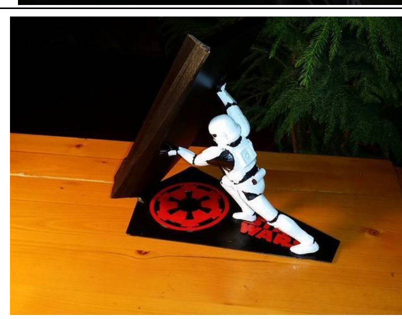
| | | | | |
|---|---|---|---|---|
| Harry Potter Gryffindor Crest |  | Imminentfate | 4 | 9890 |
| Harry Potter Glasses |  | Tunell | 7 | 9558 |
| BB-8 Star Wars Ball Droid remix for Sphero |  | UrbanAtWork | 5 | 9146 |
| BB8 Droid - Star Wars: The Force Awakens |  | MaxterOne | 3 | 8531 |
| Ironman helmet in 3 parts |  | odino | 2 | 8214 |

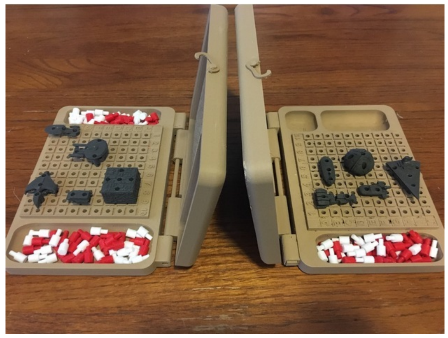
| | | | | |
|---|---|---|---|---|
| Batman Bust - clean re-build Hi-Res. |  | Geoffro | 4 | 8061 |
| Spine Candle Holder |  | cbabbage | 3 | 7831 |
| Sorting Hat (Harry Potter) |   | cerberus333 | 3 | 7461 |
| Star Wars Display Stand |  | muckychris | 1 | 6833 |
| Star Wars R2D2 cookie cutter |  | bluedynno | 2 | 6714 |

| | | | | |
|---|---|---|---|---|
| Life Size Thor's Hammer (Mjolnir) |  | ChaosCoreTech | 5 | 6115 |
| Helmet batman vs Superman |  | Davidd26 | 6 | 6093 |
| Batman |  | LeoDDC | | 5812 |
| Harry Potter Slytherin Crest |  | Imminentfate | 3 | 5440 |
| X-Wing Fighter from Star Wars |  | lagnaf | 1 | 5410 |

| | | | | |
|---|---|---|---|---|
| Star Wars Cufflinks |  | belch | 2 | 5387 |
| Batman Fidget Spinner |  | TenDutch | 1 | 5133 |
| Harry Potter Hogwarts Crest |  | 3dberd | 1 | 4833 |
| Harry Potter Hufflepuff Crest |  | Imminentfate | 2 | 4701 |
| LED Wand inspired by Harry Potter |  | tuxedodiplomat | 1 | 4310 |

| | | | | |
|---|---|---|---|---|
| Cal Spas Jacuzzi Headrest/Pillow Inserts |  | catroberts | 0 | 4242 |
| Captain America Helmet |  | SMARTDAGGER | 0 | 4201 |
| K-2SO STAR WARS ROGUE ONE ROBOT |  | Masterclip | 1 | 3805 |
| Portable Star Trek 3D Chess with Low Profile Pieces |  | alan_one | 1 | 3451 |
| Batman Cufflinks |  | 4x4print | 0 | 2774 |

| | | | | |
|---|---|---|---|---|
| Helmet batman vs Superman (flat bottom) |  | muckychris | 0 | 2497 |
| Star Wars - Dark Holocron |  | MKotsamanes | 0 | 2383 |
| Another Batman Bust (HD) Arkham |  | Geoffro | | 2145 |
| Avengers Wasp Helmet |  | adafruit | 1 | 1836 |
| Star Wars Stormtrooper Universal/Intergalactic Cellphone Charging Stand |  | ray4510 | 0 | 1805 |

| | | | | |
|---|---|---|---|---|
| BattleFleet Star Wars vs. Star Trek |  | chemteacher628 | 0 | 1016 |

| Like Count | Make Count | Remix Count | Download Count |
|---|---|---|---|
| 41973 | 1280 | 111 | 40781 |

## *5.6 DISCUSSION*

The findings outlined in this chapter are from the netnography considering activity related to 3D printing on *3D printing repositories* and from other *industry and media reporting*. This section summarises and discusses these findings highlighting what people make with access to 3D printing, user interactions facilitated by 3D printing and associated opportunities for development in production of media related toys and merchandise with implications for stakeholders involved in media, toy and merchandise industries.

The research provided insight into what people are making with 3D printing, and how they use, reference or otherwise interact with media related content.

The research finds that the extent of interaction or creative participation by users varies. Some content has been edited or altered by the creator or subsequent users in ways that may be described as *remix* where creators reference, combine or otherwise sample existing media content and create new content from this. Some creators also combine a selection of content creating new hybrid remixes or *mash-ups* and in doing so sometimes reference brands or media products that would not ordinarily be combined.

Some creators that may be described as fan artists recreate media related content in their particular *fan art* style, This might be a cartoon style or particular fan art aesthetic. This 3D printing activity may be likened to activity noted in designer or vinyl toy markets. Fan art and designer toy activity prior to accessible 3D printing typically involved had produced artefacts or vinyl toy techniques allowing batch manufacture. With 3D printing fan artists and indie creators may harness the potential of distributed manufacture and scalable production.

In terms of user interactions with media content, in a general context a range of activity may be noted in which people set out to repair, adapt, copy and otherwise create or adjust existing items or content using 3D printing. In some cases overlap with motivations relating to mass customisation could be noted where people engage in customisation as a means of adapting items to their needs, preferences or fit requirements (Dellaert and Stremersch, 2003; Franke, Keinz and Steger, 2009), in some cases motivations related to mastery or 'I designed it myself' may be noted (Franke, Schreier and Kaiser, 2010), personalisation  or user innovation (von Hippel, 2001; von Hippel, 2004) in which case 3D printing provides a user accessible means of manufacture for goods and objects that the user had been unable to find in a configuration that fitted their needs or requirements and therefore engages in a form of innovation. Perhaps less well understood or examined activity relating to parody or political statements may also be found, as well as activity related to experimentation and play.

A range of character-based content referencing characters from media products can be found in the form of figurines, busts and caricatures. Content that allows people to dress up as or cosplay as particular characters or create play-scapes with scale models of vehicles, control panels and other in-game items are also found. In creating content people sometimes reference obscure or niche or cult props and items from films, items that would not likely have been mass manufactured, as they would be considered too niche to justify mass production tooling set-up costs. Examples of such content found on

Thingiverse or Shapeways include currency from Star Trek worlds and the Multi Pass holder from the Fifth Element neither of which has been picked up in licensing deals or produced as merchandise. In other cases people create content that references very specific interactions, perhaps referencing scars or particular poses from individual scenes in a media product. Here they highlight key narrative moments or features and create printable content relating to this.

Where people create content that has not been made available though more traditional routes of licensing and merchandise production there may be an opportunity for stakeholders to create services and systems that allow people to consume niche content. Where 3D printing allows for on-demand manufacture niche content becomes producible in low volumes in reasonably affordable ways. While the indicative volume of media related content is relatively small compared to the content totals on Thingiverse of 758,700 as of March 23rd 2017 a count of 40781 downloads of toy merchandise from just 50 pieces of user generated content was not insignificant at a time when 3D printer distribution and capability was at limited stages of diffusion and adoption. A simple cross-reference with indicative market sizes of some of these media products (e.g. Harry Potter) also indicates that there is potentially significant economic value associated with this content.

Relatedly this research surfaced industry activity relating to 3D printing and highlighted the emergence of a range of start-ups and services using 3D printing in association with media products. It may be suggested that there are a range of opportunities for media related stakeholders to develop innovative service offerings, providing different forms of access to media content, allowing or facilitating interactions with content, harnessing fan activity and providing ways that fans can 3D printing content. The chapter that follows research examines MakieLab as an example of such a media-producing stakeholder moving to co-opt opportunities associated with using 3D printing in the production of toys directly derived from user generated digital content.

## 5.7 SUMMARY

In terms of the core question behind the research that considers how convergence of 3D printing with digital media products presents opportunities for development in production of toys and merchandise the netnography makes contributions to understanding of what *types of content*, in particular content *relating to media products* may be found on 3D printing repositories. Where the literature review revealed little examination of user generated 3D printable content, or user interactions with media content facilitated by 3D printing this research makes some early contributions allowing for consideration of what people create with access to accessible design tooling and 3D printing facilities.

With this it also considered *user interactions facilitated by 3D printing* noting a range of user activity, some well understood and considered in by research from mass customisation and related fields, and some less well understood. In describing a range of types of products hosted on these repositories as well as inferred intent and a range of user interactions with media content media products this research allowed for consideration of the implications for various stakeholders involved in production of media related goods.

In terms of implications for stakeholders while it confirms that some users of 3D printing do interact with media product in ways that might be considered infringing it also identifies fan production, sharing, downloading and consuming activity suggesting a developing peer based or fan economy related to 3D printable user generated content and with this a range of opportunities related to production of toys and merchandise. The findings from this chapter are discussed further in the conclusion chapter of the thesis.

# 6. MakieLab Field Study: Findings & Discussion

# 6. Field Study - MakieLab

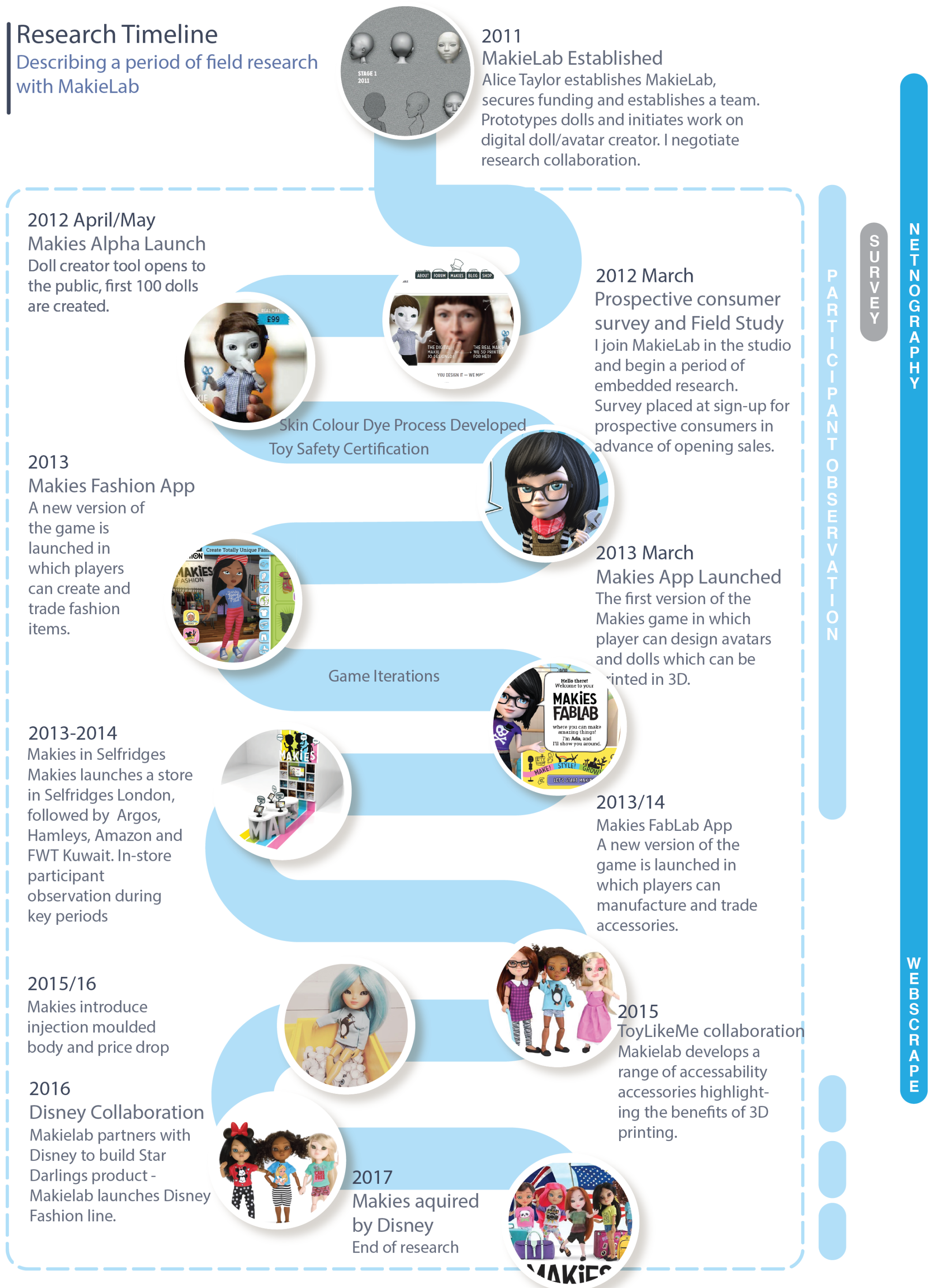



Image 6.1 Field Study Timeline

# 6.0 MAKIELAB FIELD STUDY: FINDINGS & DISCUSSION

This chapter describes and documents field research conducted with MakieLab, presenting findings from a period of embedded participant observation and refers to the supporting netnography and survey research where relevant. This chapter begins with consideration of the field – MakieLab, the context of the field study and outlines findings from this period of embedded participant observation. Here it describes MakieLab platforms, products and services, with insights of relevance relating to the firm and development processes behind these followed by examples of content and products created or customised by users of MakieLab. The chapter concludes with a brief discussion of these findings in relation to the overall research questions.

## *6.1 FIELD STUDY - MAKIELAB*

The methodology chapter introduced MakieLab in full and as the methodology chapter indicates this field study was designed with the top-level aim of understanding how convergence of 3D printing with digital game products might present opportunities for development in production of toys and merchandise. As a research partner MakieLab was considered to be an example of a first mover in this space, adopting 3D printing in the production of toys and goods directly related to in-game content.

To conduct this research I moved to London and joined MakieLab as a researcher. The details of this relationship have been explored in the methodology chapter. As a researcher I joined the company offices and conducted a range of research over a period of years. The timeline for this research is outlined in Image 6.1. During this period I observed the development and testing of the tools and prototype tools, the design and development of the games, retail space and other key moments in the start-up. This involved active participant observation in which I participated in varying ways in each of these key moments while also noting and documeting processes during the course of the research. This chapter surfaces some of the key insights from this period of research and is generally organised around products, systems and or events of significance.

### 6.1.1. MakieLab, Organisation, Team and Partnerships of Note

MakieLab, the firm consisted of a studio, a workshop, online and offline retail spaces, a website, digital games, web forums and a customer support portal. MakieLab manufactured their products with various 3D printing partners including Digits to Widgets and 3D Worknet in London and the Netherlands. They established retail partnerships with Selfridges, Hamleys, Argos in the UK and Fantasy World Toys, Kuwait. They also had distribution partnerships with DHL and FedEx. Digitally MakieLab distributed their games primarily on IOS and some were ported for Android.

MakieLab was founded in London and was central in the Old Street, Shoreditch technology community. The employees and founders were deeply embedded in these communities and made use of their advice, support and capabilities. Makies was made up of a team that evolved and adapted over the years of this study. The founding team hailed from various parts of the game, media and technology sectors and brought with them a range of industry experience and networks that served MakieLab well in securing funding and partnerships. Given their individual sets of expertise and experience they brought much to this study.

The employees also hailed from related sectors and grouped into a number of teams and sub teams that reflected the various business functions of MakieLab. These teams included business development and executive operations, operations and human resources, game design and development, art and fashion, product design and engineering; retail, merchandising, logistics, manufacturing and distribution and marketing and customer service.

The teams overlapped and worked collaboratively. Where a traditional digital game artist would create 3D assets for a game environment Makies required that the 3D asset also be 3D printable and as such product and engineering teams worked collaboratively with the art team to ensure this was possible. Where Makies allowed players to customise the faces of their avatars/dolls the developer teams worked collaboratively with the art and product design teams to create user accessible tools that would allow users to generate 3D printable geometries capable of being printed. In some ways this was frustrating for the individual teams because their traditional disciplinary boundaries and roles and responsibilities had shifted and the complexity of their workflow increased beyond that of a more typical example of their role. Furthermore the workflow processes and art pipeline required to manage all of the assets across the digital and physical management processes was complex.

### 6.1.2. Context of the Field

While MakieLab was the location of the field study and the firm in which the participant observation was primarily concentrated, the field of study is not limited solely to the research subject or site as it cannot be considered in isolation of the wider market, industrial forces and consumer climate in which the research subject exists. This section briefly notes the context in which the study with MakieLab was conducted. Some further detail relating to these findings is found in Chapter 5 addressing the findings from netnography.

During the early development stages of MakieLab general public awareness of 3D printing was growing with popular news, television and blogging sites writing about 3D printing for mainstream audiences, relatedly hype could be observed. Media discussions sometimes over-stated the functionality and viability of 3D printing and surfaced stories relating to 3D printed guns and discussions considering the risks of intellectual property infringement. During the years of this research 3D printing went then from a relatively unknown outside of science fiction process into the awareness of the general public and with this widened awareness a wide range of business ventures moved concurrently to exploit the technology.

MakieLab emerged at a time in which producers of 3D printing equipment were working to drive adoption of their equipment and build partnerships with various industries, efforts that could be noted from their annual reports and press releases. Some media related fields were experimenting with the technology and in some cases beginning to introduce it to their workflows and processes.

Research with Makies was conducted at an early stage of adoption of 3D printing in the manufacture of consumer goods by or for media companies. At the time of initiating this research 3D printing was not a widely used technique in relation to media products beyond stop motion processes, in particular media related consumer goods. However as the research progressed increasingly visible activity was noted alongside MakieLab efforts.

Relatedly online 3D printing repositories responded during this time by provisioning or supporting services and tools that allowed people to create their own printable content. The emergence of a number of start-ups aiming to use 3D printing as a means of manufacture could be noted while toy and media companies moved to test or otherwise adopt 3D printing as services, experiences or tools in providing custom goods.

MakieLab was then an early mover in a small trend which some firms moved to adopt 3D printing as a means of direct manufacture of media related toys and merchandise. MakieLab claimed to be the first at this time to use 3D printing to make toys (Benedict, 2017), and was the first to receive toy safety certification a 3D printed toy (Hermans, 2013; Sacco, 2013). MakieLab received significant media coverage of their exploits during these years and grew a global user base.

### 6.1.3. Research Relationship, Execution and Process

As the methodology chapter outlined, I gained access to the start-up as a researcher embedded within the team participating in various ways to understand the company, product, consumers and market. Bringing with me a number of internally relevant skills and experience in related fields I was able to build locally trusting and mutual relationships with the team members. This was important because as Bruneel et al. (2010) indicate:

*"Like designers and anthropologists, universities and for-profit industries often have different, sometimes competing, goals and purposes. For instance, collaboration between industry and universities can face obstacles because these organizations are driven by different incentive systems and different goals"* (Bruneel, D'Este, and Salter 2010).

In initiating the research partnership with CEO and founder Alice Taylor and COO and co-founder Jo Roach we had collectively established that the research approach was intended to be mutually beneficial. The challenge was to extend this agreement and perception to the wider team and though they knew I was a researcher and what my aims were as I joined they quickly came to understand that I was engaged and proactive within MakieLab and the Makies agenda and brought with me valuable insights and skills.

I found that it was important that my presenting identity was not primarily academic researcher because the pace and drive of the team was incompatible with an academic presentation and style of interaction. The team did not make use of academic resources, did not consult research emerging from universities and occasionally voiced concerns about the value of research findings that came from academic contexts. This appeared to be rooted in difficulties with trust, language, digestibility and a mismatch in perceived usefulness in a business context. The team were however open to findings and research that referenced industry or were gained in the course of research conducted in the context of MakieLab or other businesses.

Instead I worked to internally identify, clarify and surface questions that the team were surfacing internally, applying intent and focus on the explorations and testing of the start-up and contextualising it in the wider industry. I did this while contributing to daily tasks, using my retail background to direct the retail design and fit out in Selfridges, my ecommerce background in the build and functioning of the MakieLab retail store and my product design background in testing, supply chain, production line and assembly of the physical products. Collectively these contributions validated my presence as a team member, established my membership and value to the organisation and made people feel comfortable enough to work naturally and at ease around me.

In daily communication I was a member of all of the online platforms and tools that the team used to plan, manage, track and allocate work. The tools that they used to communicate and the services they used to test, measure and track. I was able to view almost all interactions within and between teams and had access to an on going record of these. In this way the natural communication styles of the team assisted with documentation for the research record.

When research issues of relevance came up I asked questions to clarify and where relevant proposed, planned or initiated research including user testing, focus groups, surveys and experiments. I was able to recruit team members to assist me in this research where necessary. I also participated in the natural day-to-day testing that the typical technology start up conducts, examples include price sensitivity and elasticity and AB testing. In this way I was perceived to be a locally accountable researcher and the research I was conducting, often collaboratively was used internally for the organisation.

Image 6.2 Example of Makies toys

With participant observation it is relevant to consider risks and discussion associated with what researchers have historically problematically termed *"going native"*. In short, a form of becoming integrated into the community under study and effectively becoming an insider which some people indicate results in the researcher losing the ability to remain objective as a researcher. An on-going debate between those employing ethnographic methods as to the value or risk of becoming an insider continues (Gold, 1958; Tedlock, 1991, 2005; Labaree, 2002) with different schools of thought arguing in support or critique of either perspective (Bonner and Tolhurst, 2002).

Where Jan Chipchase (2017) argues that fieldwork requires the researcher to have a solid grasp of the language of the local culture they are working in and language of the domain (in this case 3D printing but also games) and organisation I suggest that I existed within and operated within these communities, cultures and organisations prior to this research and as such this research may be understood to be a form of insider led research.

Nevertheless a researcher defined process of frequent re-engagement with my research area and my individual researcher agenda were considered necessary in order to remain independent and effective as a researcher.

A further significant challenge was that of managing the workload and record of research findings and the subsequent analysis of the findings. Where the length of research engagement and the volume of observations collated during the course of the entire timeline are akin to an ethnographic study data management was important. Observations and data collated was extensive and participatory research involved exposure to a vast volume of information typical of a fast paced early start-up with multiple disciplines operating concurrently. The greater work was then that of being able to process and make sense of the information in the wider context in which the work was happening. The findings and record of data generated through this research is substantially larger than this research document and what this document selects to present.

## 6.2 MAKIELAB PLATFORMS, PRODUCTS AND SERVICES

Where the research sought to consider how convergence of 3D printing with digital media products presents opportunities for development in production of toys and merchandise MakieLab was identified as an appropriate as it was directly operating with this convergence. This section documents MakieLab platforms, products and services because these products, services and platforms may be considered (as they are in this research) as an early example of a convergent media platform in which digital game assets bridge the digital and physical, are playable as characters, useable as in game tools and printable as toys and figures.

### *6.2.1. MakieLab Platform: Online Doll Creator*

MakieLab initiated their work by building a web based doll/avatar platform upon which customers could create digital characters that could be 3D printed as pose-able doll figures. This web tool was designed as a means of firstly, verifying that they could 3D print this user created content and co-opt user activity relating to doll collecting, in which a wide range of doll customisation and trading is observed amongst a doll collecting community, but it also overlapped with avatar creation tools from the games industry. This web tool presented a series of design stages for users, with a defined design space that ensured successful generation of a custom character for all customers.

Image 6.3 Makies web tool – doll creator

Prospective customers were able to create a digital doll from scratch, or choose one from pre-generated models as a starting point. Various hair and eye styles and colours were selectable by clicking on relevant icons and users could adjust the shape of the eyes, nose, cheeks, mouth, cheeks, jaw and eyebrows using slider tools. They could add to the doll a selection of themed accessories including earrings, shoes, boots, bags, instruments, fashion items and accessories. Users could create and save an unlimited number of digital Makies for free. When they completed their character doll they could name and save their creation, and could choose to purchase a physical version.

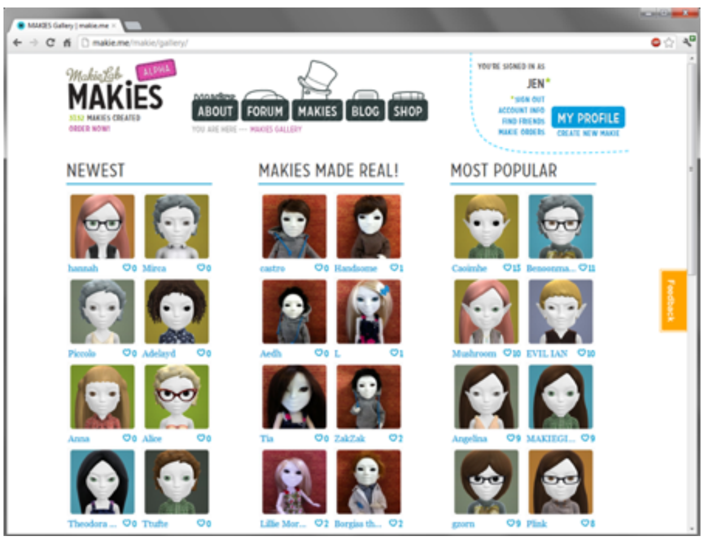


Image 6.4 Example of user created Makies

Upon selecting ‘Buy Me’ the customer could choose from a selection of pre-made outfits to dress their physical Makies doll. On completion of the purchase MakieLab would 3D print and assemble the doll to the customer’s specifications. Each doll shipped to the customer with a signed and numbered certificate. Every Makies doll had a unique identification number that was used to connect the digital character with the physical doll and allow identification of faces in production.

This web tool was developed to provide a simple web process for creating custom avatars that could be 3D printed as dolls. The process by which the digital doll was translated into a printable format was an automated software process and is documented in Appendix 4.

In short the tool could be described as a web based customisation tool that facilitates user production of playable digital avatars and concurrently 3D printable toys. Importantly MakieLab created a web flow and a web back-end that automatically processed these user-created digital characters for use in digital games as playable characters but also as 3D printable figures for purchase. This bringing together of 3D printing with what could

- up to this point be considered as avatar creation tools marked a key moment of convergence, linking game tools to a manufacturing process thereby allowing utilisation of digital game assets across digital and physical spaces. MakieLab were among the first to do this. Importantly they patented the software process that converts these digital assets into a printable format. The functionality of this tool and software process formed the basis of their customisation tools and was carried across into their digital games by MakieLab. (See Appendix 4.)

### *6.2.2. MakieLab Platform: Games and apps*


Image 6.5 Makies games and apps

In addition to a web based doll creation tool MakieLab created a series of apps and games in which users could create dolls, accessories and fashion items that could be manufactured on demand for the consumer. Games and apps were released on iOS and Android at various price points. Versions were released sequentially and in different regions for testing and iteration before development cycles ceased.

These apps and games were developed by a small start-up team that varied in size from 6 to 15 depending on requirements and involved artists, product designers, engineers and software developers. This team configuration was unusual in it’s overlap with professionals with digital and physical orientations. This overlap was necessary to allow for production of viable prints from digital content. The team adopted lean principles and followed agile development practices. Testing was conducted frequently and findings from these sessions were integrated to the development direction.

*“What if children could use their fertile imagination to design their own dolls, just like gamers do with avatars?”* Alice Taylor, Makerfaire 2014
Makies anticipated a future in which game assets would be printable either at home or by services integrated with digital games. Alice Taylor frequently spoke of a future in which in-app items and accessories would be printable by the end user either at home on their own printer or delivered as part of a game subscription model or simply purchasable on-demand.

*"While Makies means a customer can come and build and create the action doll of their choosing, they also get an avatar version too, which happens to be standing in a 3D space. Stuff that you do digitally will result in physical unlockables, and vice versa."* Alice Taylor in Wired Magazine by Geere, (2012)

MakieLab created a number of games including:

- **Makies Factory** The first app released was an introductory app that provided the same functionality as the online doll creation tool. This app was called Makies “Doll Factory” and was a free to play app for iPads and mobile devices. In this app users could create and dress their own doll and have it made into a printed toy. This app launched in early 2013 and formed the basis of the avatar creator in each of the following games.

- **Makies Doll Factory** This app release was similar to the MakieLab online web tool though which people could create dolls. Similar functionality was provided and the tool ran on android and iOS. This app was free and users were pushed into a web flow when they decided to purchase a doll. This app formed the basis of the remaining games.

- **Makies Fab Lab** MakieLab continued game development and in 2014 launched Makies FabLab on AppStore for iOS devices. Makies FabLab was a resource management game in which a user created character/avatar planted animated plants in a garden and fed wool producing livestock to produce materials that could be turned into clothes and accessories. The avatar creation process in these games allowed the user to create characters both playable and non-playable and if they wished they were able to purchase and have their avatar 3D printed and dressed in the items of clothing they selected in the app.


Image 6.6 Makies Fashion game images

- **Makies Fashion** Makies Fashion game players designed and curated fashion items that they were able to trade in game. The were able to dress their doll in game with their newly created fashion pieces and accessories and they could also have these made real for their printed Makies doll. This first version of the game was simple and based on dress-up and pattern building play.

Makies Fashion is described in detail below and notes on research that contributed to this game design are outlined.


Image 6.7 Makies Fashion game app

Though the survey and interactions with Makies fans and customers though workshops and monitoring the MakieLab web forums it was established (by myself as researcher and the MakieLab team) that a subset of Makies fans participated in production of clothing and accessories for their Makies and an emerging economy of doll accessories and fashion items could be observed.

MakieLab game development team subsequently developed a fashion game in which players created fashion items and collections for sale in an in-game economy. These items were subsequently (intended to be) producible

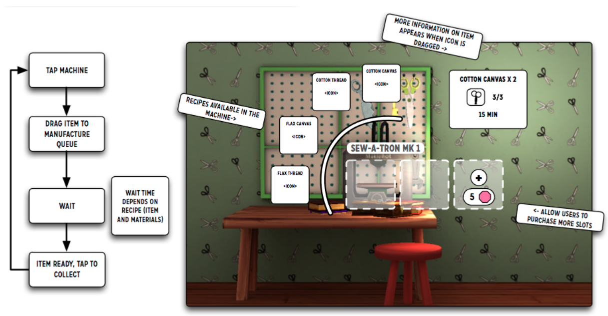



Image 6.8 In-game production tools

as finished fashion items for Makies dolls. Makies game players participated in production of raw materials in their garden and from their animals in order to create finished digital clothing items for Makies.

The game incorporated a range of machines:

- **Knit-Wit**: Turns raw resources like harvested raw cotton into thread and canvas
- **Sew-a-Tron**: Sewing machine, which turns thread, canvas and accessories into clothes
- **MakieBot**: Accessory creation machine, turns resources into non-cloth pieces used for some clothing items (zippers)
- **Texturizer**: Allows texturizing the clothes with user-made patterns. Consumes dye.

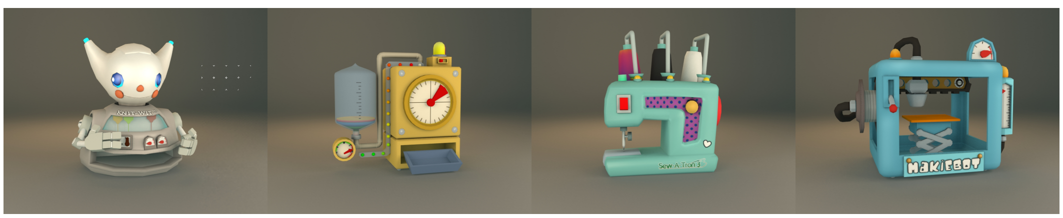


Image 6.9 In-game characterful production tools

The game design allowed players to participate in all stages of fashion production, generating and growing animals and plant materials, harvesting raw materials (wool, cotton…), processing materials into useable formats (thread), running machines, preparing the items for display and sale, marketing and trading. Players experienced bottlenecks in production and other relevant experiences in the fashion industry and could upgrade production to afford themselves more production volume.

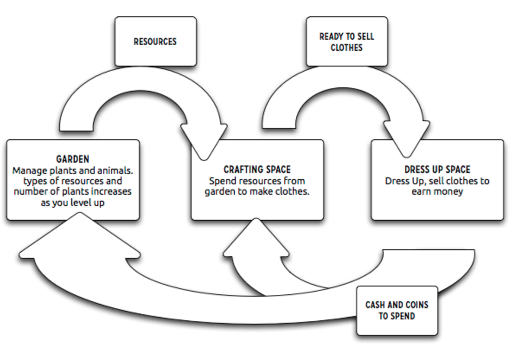



Image 6.10 In-game economy

This game also allowed for an online economy of trading/selling of user generated content that was directly facilitated by the tools and trading platform that MakieLab designed.

Player-created fashion items could be sold, to both non-playable characters/in game core characters and to friends and other players though an in-game newspaper/market service provisionally called Netsy.

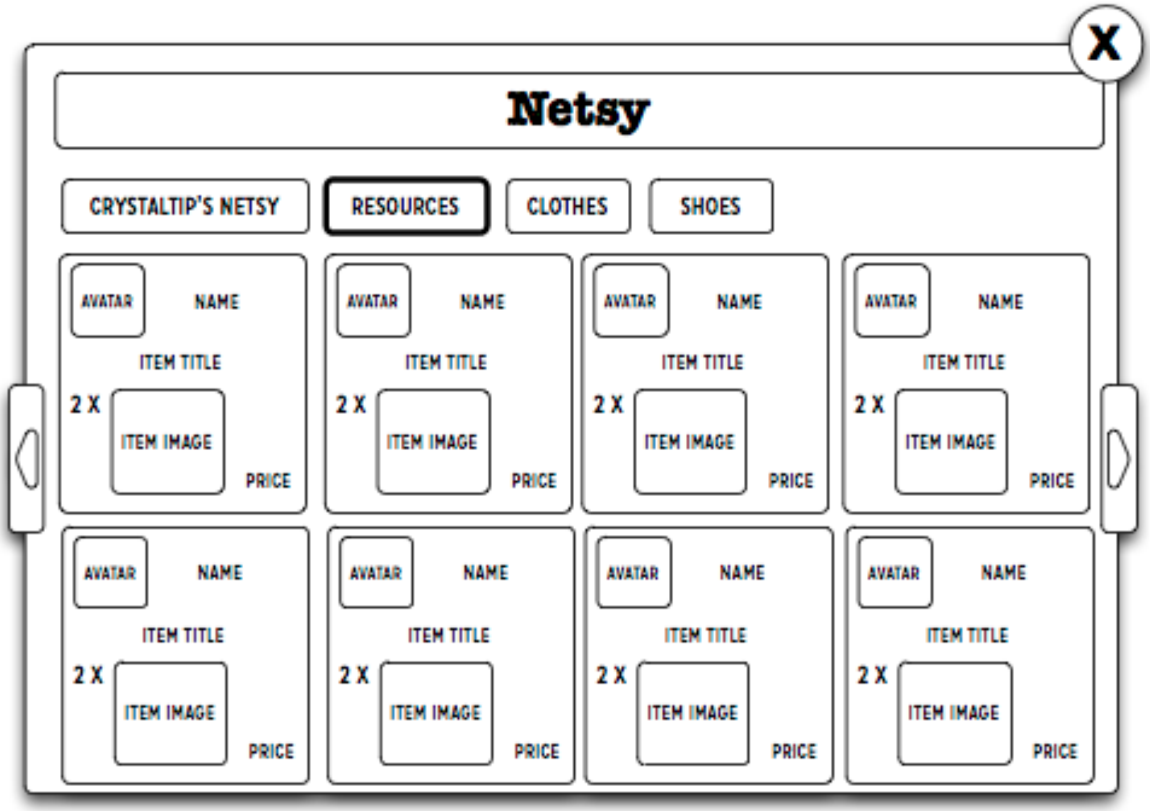



Image 6.11 In-game retail store allowing sale and trading of fan produced items and materials

This was in short a fashion game in which players were able to play as fashion industry folk participating in the economy behind fashion production.

MakieLab would derive income from in-game purchases intended to speed or scale production and through fees associated with choosing to have an item manufactured into a real t-shirt or fashion item for a physical Makies doll. In conjunction with MakieLab fashion team and the COO I worked on building a specification for the back end of this service which allowed players to have the items the designed in game manufactured fashion as fashion items that they could then dress their Makies with. We verified that this was a viable service that would work optimally at a large volume of throughput, and anticipated launching this back end when we achieved a volume of players that would justify this. Though MakieLab did not switch on this fashion production functionality the game presents as an example of how media producing firms might work to create game products/services that facilitate production of user created content and co-opt and commodify this activity. Further discussion of this is available in Chapter 7 and further detail relating to the game design is available in Appendix 3.

### *6.2.3. User customised toys and avatars*


Image 6.12 Makies header comparing digital and physical doll

Makies were described as action dolls that were manufactured from user created digital characters. The dolls were 3D printed on demand for the consumer while the digital version remained playable in game.

Makies dolls are 9 inches tall, and consist of friction fit joints allowing the dolls to be posed. A range of accessories and fashion as well as swappable wigs and eyes were also available. Initially skin colour was restricted to white and over time a range of skin colours were developed.

Makies dolls cost £99.00 originally and were tested at various price points ranging from £29.00 to £125. Originally Makies dolls were entirely 3D printed but MakieLab substituted the printed body with a less expensive injection moulded body allowing MakieLab to drop the price.

### *6.2.4. NPCs and premade characters*

In addition to user created characters MakieLab developed characters that were central to game narratives. These are understood to be NPCs – non-playable characters. These characters were made available as pre-made dolls and batch production of these goods made for process and cost efficiencies.

### *6.2.5. Digital interactivity though 3D printing*

Alice Taylor often spoke of toys to life in which Makies would be playable in game as digital characters and as physical toys but importantly here this also included an element of interactivity that would be facilitated by 3D printing. During my time at MakieLab I participated in early research described as 'data freckles'. These could be understood as individualised forms of QR codes and were intended to function as a way in which custom, user generated 3D printable content could be read by game software using cameras. MakieLab did some early work to generate unique freckle patterns for dolls that could be read as a means of identifying the object for interactive game play similar to that of Skylanders.  This is explored further in the conclusion chapter but is noted here as a development opportunity for production of media related goods made possible by 3D printing.

### *6.2.6. Online retail store*

MakieLab provided consumers with online purchasing options through a retail platform from which they could purchase pre-made dolls and accessories including wigs and fashion.

### *6.2.7. Makies in Selfridges and in-store retail*

As researcher I considered the consumption of Makies products and services at Makies retail space in Selfridges London. This venue was a carefully designed collection of digital creation tools, pre-made dolls and related merchandise. This retail presence was developed in early 2013 with an official launch over Christmas 2013 (Doctorow, 2013).

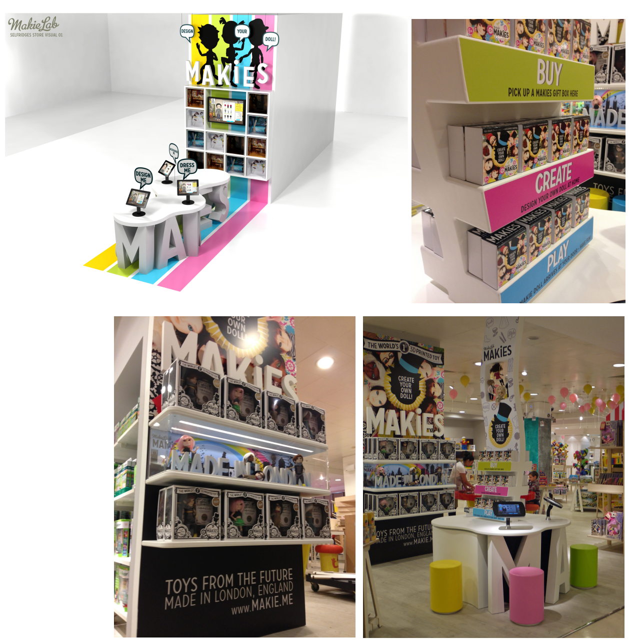



Image 6.13 Makies store in Selfridges London

The Makies store showcased the digital and physical products and functioned as space in which people could create in person with assistance from staff. Here visitors could sit down with their children and co-create Makies dolls with their child, or spend time playing with the tool, some going away resolving to spend more time at home creating it. They were also able to purchase gift boxes that allowed them to continue their doll creation at home or pre-made character dolls.

With my prior retail experience I collaborated on the planning, design and installation of this store collaborating with various team members in MakieLab and in Selfridges on the design and user experience of this space and the service offered within it. Here MakieLab and Selfridges various parties had input into the design and operations, and constraints related to budget, space usage rules and display requirements and a requirement that non-specialist staff would be required to operate in this space at times shaped how this was implemented. (This research doesn't include comments or findings related to the design of the space or the service, but does note that both of these are important in facilitating consumer interactions in these spaces and recommends further research in this respect.)

As a researcher I spent periods of time here participating as a visible Makies representative or a researcher on the shop floor, this provided me with access to prospective Makies consumers. Within this space I conducted a range of short periods of research.

Image 6.14 Printing in store

**1. Printing in-store**

In October 2013 we displayed MakerBot 3D printer in the store (Park, 2013), this printer was printing shoes for Makies and was intended on one level to assist prospective consumers in their understanding of the process by which the dolls were made and secondly to highlight a partnership between Makies and 3D printing material developers Faberdashery. Quickly it became obvious that it functioned as an attention capture or draw for passing consumers, capturing their attention and drawing them into the Makies space. This attention grabbing function of the machine was not anticipated by Makies or myself in advance of this but it resulted in small crowds or audiences who spent time watching the machine working, focusing on the deposition of material on whatever build was in progress. In a way the machine functioned as a form of spectacle or novelty drawing potential consumers into the Makies space and prompting enquiries about what Makies were. Here people excitedly asked what the machine was, what materials it used, what else could we 3D print. They also described it as '*magic*'. As the discussion chapter - Section 7 will consider in greater detail this machine functioned as a kind of spectacle, novelty or performance.

Image 6.15 Contests

**2. Contests**

Within the context of the Makies store in collaboration with Makies we were able to distribute invites to customers to submit pictures of items that a Makies might need on a journey. These elicited insights into the type of items Makies consumers were potentially interested in accessorising their Makies with. This functioned as a probe of sorts eliciting consumer information relating to desired product and accessory types. MakieLab responded to these user submitted requests with a range of accessories.

## 6.3 CONTENT AND PRODUCTS CREATED OR CUSTOMISED BY USERS

A key observation from this period of research was that of *how Makies fans created content and products to accessorise and display their doll characters* and *how MakieLab moved in response to facilitate and co-opt this activity*. Such fan and user activities are relatively common in the doll collecting community and are also observed in collector and toy markets related to media merchandise and toys.

This section firstly documents and describes content and products created by MakieLab users. Examples were gathered as part of the on-going participant observation; examples were collated in person though contact with Makies customers and fans at meet-ups and collector workshops organised by me at MakieLab. Additionally examples were captured through an on-going netnography of content posted on the Internet. I documented examples posted in the MakieLab forums, monitored hash tags and postings on Twitter and Instagram as well as doll collecting forums and YouTube. This section presents representative examples of creation and interactions by Makies users and is not intended to be complete or exhaustive.

Secondly noting requests for features and interactions requested in the prospective consumer survey MakieLab moved to facilitate some of these requests and to platform examples of user activity and interactions with the dolls or content. MakieLab responded to such fan and consumer activity in a range of ways, facilitating co-production of toys and content, remix, hacking and mash-up of Makies content and responding to and co-opting user activity. Some examples of this are considered in this section. It is suggested that these examples provide insights into how firms might move to co-opt fan interactions with media content with consideration of how 3D printing facilitates this.

### *6.3.1. Smart, connected Makies projects*

Image 6.16 Open hardware hacking Makies

In response to the prospective consumer survey in which a number of users asked for connected and interactive functions MakieLab designed the head of Makies dolls to incorporate an Arduino Lilypad, an open hardware product that allowed people to create connected and interactive products Users hacked Makies dolls to include or incorporate accessories or unique functionality such as this Makies with moving cat ears. This user documented their build and shared the prototype on YouTube.

### *6.3.2. Face-ups*

Image 6.17 Face-ups

Where the prospective consumer survey indicated interest in being able to customise the face and desire to participate in make-up and face-up activity MakieLab shipped their first dolls as blank faces with no make-up or colour. This allowed recipients of Makies to create their own face-up. Face-ups in which doll collectors apply make-up, paint or other materials to create characterful, beautiful faces are common amongst doll collectors and the early Makies user base. People tended to write blog posts or document their process on video or photo sharing sites including Instagram. Some people offered face-ups as a service. Accomplished artists were able to charge a premium for this and dolls with particularly beautiful face-ups resold for a significant premium on the original doll cost.

In response to this user activity and request MakieLab eventually began offering basic face-ups on dolls and provided tutorials and kits that allowed their user base to create their own face-ups. MakieLab also hired one of the more accomplished artists to work as staff and then later as a contract face-up artist.

MakieLab designed their customisation tool around this user activity also designing an interface that allowed users to customise their doll character face by adjusting the eye, lip, brow, face and ear shape in a wide range of ways.


Image 6.18 Face customisation tool

Here users of the tool were able to use sliders and buttons to alter the shape of the face. They were able to rotate the render/3D model in the tool to examine their creation in all angles before pressing print. MakieLab was unable to incorporate automated face-up processes so a standard face-up was developed and applied by hand to later dolls. Users were able to request that MakieLab leave the face entirely blank should they wish to apply the face-up themselves.

### *6.3.3. Skin tones*

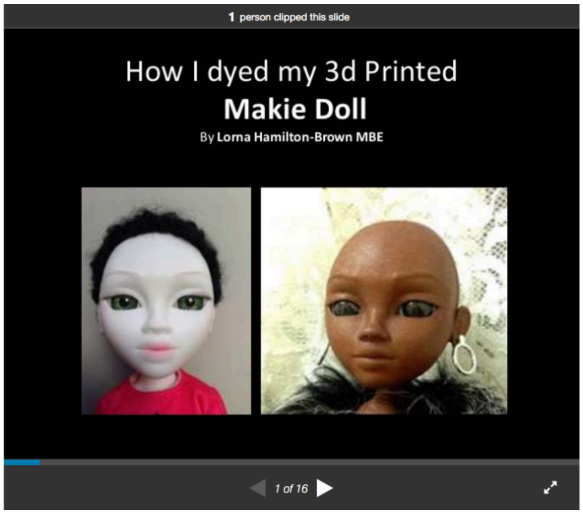


Image 6.19 Dye for skin colour

Recalling that the original dolls were white – because 3D printers typically operated with white powder during the initial years of Makies production, where the prospective survey revealed requests for representative skin tones MakieLab began colour development work in conjunction with a major 3D printing partner. Finding that they were unable to print in colour MakieLab began testing dying processes to facilitate these requests. Some early collectors also dyed and painted their dolls to give them new skin tones, often expressing a desire to match their own. MakieLab eventually refined and introduced a range of skin tones in conjunction with a 3D printing partner.

### *6.3.4. Skin features*

Some Makies owners requested skin features like freckles, moles and birthmarks, some created them themselves and after testing as part of this research MakieLab eventually offered a range of characters with these features and provided custom face-up incorporating these. In a future in which 3D printing deals more effectively with colour these would be trivial to provide on a toy like a Makies doll and the process for creating these could be incorporated into the digital customisation tool or avatar creation flow. During the course of this research the examples were painted or applied by hand.

Image 6.20 Skin features

### *6.3.5. Facial hair*

Beards, stubble and moustaches also featured in user requests to MakieLab. Male dolls were relatively rare at the time of research and users were keen to create characters that featured facial hair. MakieLab experimented with printing beards and hair. This work was not completed during the course of this research.

### *6.3.6. Tattoos*

Image 6.21 Tattoos by Sioux

Tattoos were requested by those wanting to make dolls look like themselves or to align with a character they had in mind. Some Makies customers did this themselves and MakieLab experimented with providing tattoos as a service.

### *6.3.7. Props and accessories*

In line with requests made in the course of the prospective consumer survey in which people requested a range of accessories Makies customers also created or acquired a wide range of props and accessories for Makies dolls. Examples included bags, glasses, shoes, furniture, vehicles and pets. MakieLab monitored user activity in this space, surveyed customers and created a range of corresponding 3D printed accessories.  In some cases MakieLab facilitated user voting for most popular items and engaged Makies customers in product development processes. From this on-going interaction with MakieLab consumers a product library of thousands of printable accessories was generated.

Traditional toy companies typically struggle with such requests as they are bound by the constraints of mass manufacture. With 3D printing MakieLab was able to produce these accessories on-demand and in relatively low numbers. Moreover released digital print files on Thingiverse and Shapeways allowing consumers to remix and print for themselves.

Image 6.22 Makies accessories

### *6.3.8. Hair and wig styles*

MakieLab customers frequently requested wigs and hairstyles to allow them to create dolls that looked like them, or a friend.  Some Makies collectors created or sourced wigs independently while others restyled existing wigs to suit their requirements. Requests were made in the course of the prospective consumer survey for hair or wigs that would facilitate representativeness.  I worked with suppliers in China to develop styles that matched these requests. The MakieLab product team also developed a special wig cap and skull construction that aided Makies customisers in creating wigs and for easy swapping of hair for those that wished to easily change wigs.

Image 6.23 User created wig by Sioux

### *6.3.9. Fashion items*

A swap and sell economy quickly emerged from the early Makies community. Fans posted about fashion items they made or owned that were Makies doll sized and offered it for sale or for swap. They did this on the Makies community forums and on external sites.

Some people set up Etsy stores to sell these items, an example being a core Makies consumer/fan Mamta who in the first instance started producing and distributing fashion items for Makies on forums and platforms like Etsy. Mamta was a popular producer and Makies moved to commission her to create fashion lines for MakieLab. MakieLab rendered these items digitally, making them available in-game and sold her items via its doll creator tools and shop. This co-opting of fan activity might be described as what Noppe, (2011) describes as commodifying fan activity. Some Makies fans bought fashion and accessory items suitable for Makies in bulk from producers in China so as to resell to UK and US based customers and a Facebook group established by Makies fans functioned as a space in which these fans traded and swapped fashion and accessory items.

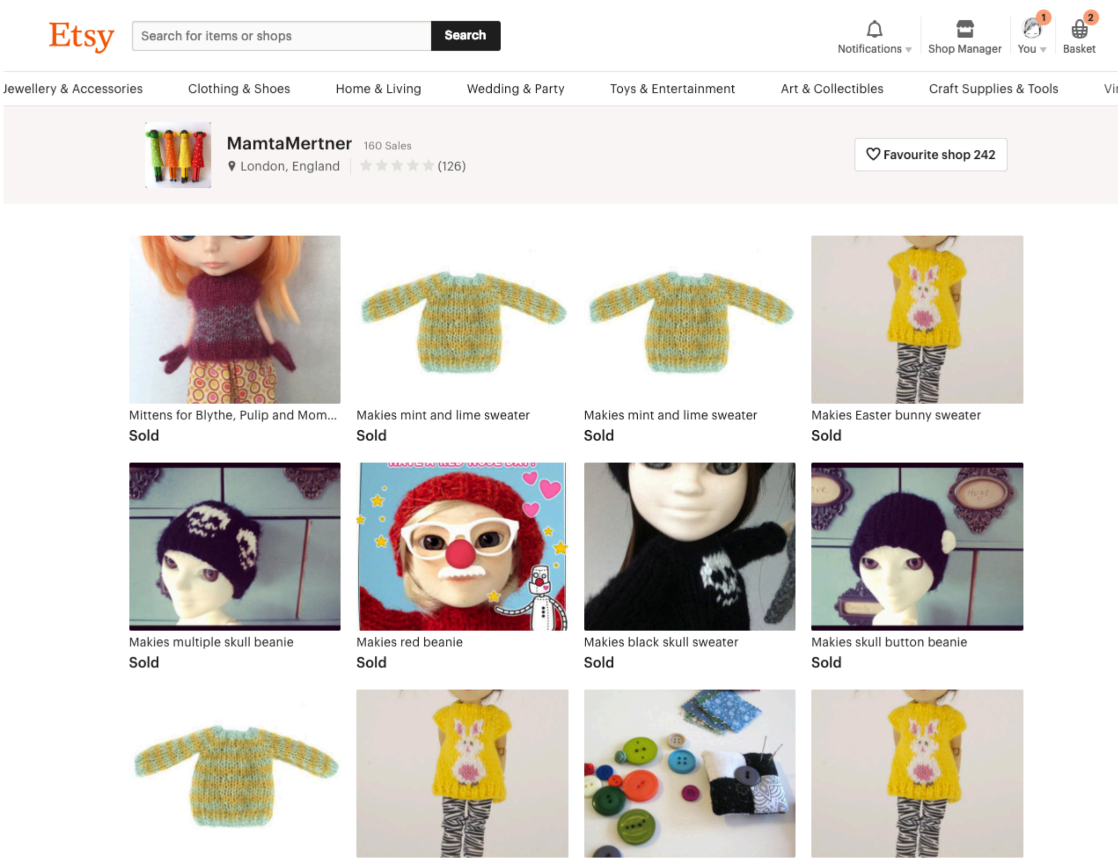



Image 6.24 Fan created Etsy store

This activity is not dissimilar to fan art or user generated content production. As such, noting this behaviour as an opportunity to facilitate and co-opt content creation and related user activity MakieLab designed Makies fashion, a game in response to this observed user activity. This game was described in earlier parts of this chapter.

### *6.3.10. Assistive Devices "Toy Like Me"*

Where Makies fans worked to customise dolls to create representative features and the survey revealed some sentiment relating to representative skin tones and body shapes

MakieLab was able to cater to such requests. Dolls with relatable BMI, skin tone, hair, birth marks, conditions or disabilities have not been developed by many of the large toy companies. Dolls that reference disabilities have not been widely available in the mass market and in line with modification and DIY behaviour associated with assistive technology (Buehler, Branham, *et al.*, 2015) toys are sometimes modified by users, parents or child who create accessories for these dolls as a crafting or DIY activity (Buehler, Easley, *et al.*, 2015). Unlike larger toy companies who face significant production costs to produce mass manufactured products and instead responded with rough hand-fabricated prototypes MakieLab was uniquely positioned to respond quickly to such requests using 3D printing to make consumer ready goods. MakieLab therefore made available assistive devices such as hearing aids, long canes and cochlear implants. In addition to allowing Makies creators to add these accessories to their doll they were also able to choose from three pre-set doll characters that came with a range of accessories or birthmarks, providing representative characters.

Image 6.25 Makies with assistive devices

### *6.3.11. Community Events*

Doll collector meet-ups and swap meets were common for Makies consumers, MakieLab moved to host these meet-ups and provided the meet-ups with access to prototypes and fashion items they were testing. This allowed me as a researcher, and MakieLab as a firm, to gain insight into user responses to products in development. This community activity was very much driven by the community itself and they valued interaction from members of the MakieLab team.

### *6.3.12. Photos*

The primary user activity after acquiring a Makies doll was to photograph it and share photographs on social media and the Makies forum as well as other doll forums across the Internet. MakieLab frequently reposted these user created photos as part of their social media presence.

### *6.3.13. Videos*

MakieLab customers created videos of themselves unboxing Makies, how they played and customised Makies and shared these on social media and video hosting platforms including Flickr. These were also frequently shared within MakieLab forums. A number of toy and doll collector YouTube personalities also video blogged about Makies exposing the company to a wide range of doll collectors and parents, children and other customers of toys. MakieLab responded by sharing this user-generated content across various platforms.

## 6.4 CONVERGENCE OF 3D PRINTING WITH DIGITAL GAME PRODUCTS & OPPORTUNITIES FOR PRODUCTION OF TOYS AND MERCHANDISE

This section of the chapter draws out discussion related to these findings and organises these in two sections. Firstly discussing convergence of 3D printing with digital game products and opportunities for firms in relation to production of toys and merchandise. Secondly it considers user interactions facilitated by convergence of 3D printing and implications for stakeholders. These top-level opportunities and points are outlined here and discussed in further detail in Chapter 7.

### A. AUTOMATED TRANSLATION OF DIGITAL ASSETS TO 3D PRINTABLE CONTENT

A key process revealed in the course of the field study/participant observation were the adjustments MakieLab made to their art production processes. Participant observation revealed an overlap of skillsets and professions in the MakieLab team between digital content designers and product/industrial designers who used the same design tools but in differing ways.

MakieLab extended and optimised game art production processes in the creation of game content (3D characters and environment) by integrating product design/industrial design and engineering skillsets in content creation. In doing so they created at first a process by which all art content had a playable in game component but also a 3D printable counterpart.

This overlap in skillsets made possible direct exploitation of digital media content created for Makies games as 3D printable artefacts. As the art team developed digital assets they were simultaneously creating artefacts that could with minimum adjustments be developed for direct manufacture using on-demand manufacturing processes as in the case of Makies.

This new process did lengthen and complicate game production timelines for MakieLab and involved navigation of skillsets and conventions that were not typical for such teams but as time progressed they built a software process to automate this work meaning that their digital art production processes automatically produced content that could be 3D printed. MakieLab considered this software process key to their central processes and patented this process.

The implications of an art or content production process in which media content is immediately exploitable as 3D printable content is significant for media producing companies. The first reason for this is the potential for in media merchandising and the widened range of content that can be consumed by consumers. These findings are explored in the next section.

### *B. In-media merchandising, expanding the range of exploitable content*

As the previous section revealed MakieLab established a new art and production process that outputted 3D printable content automatically. This might be considered as an automated merchandise pipeline and cuts out a range of intermediaries that would typically be involved in the production of toys and merchandise.

This automation had the effect of vastly expanding the range of game content that could be offered to consumer or players as 3D printed artefacts. Unlike other toy companies MakieLab had a 3D printable range of accessories (hairbrushes, musical instruments, shoes) that numbered in the thousands and when colour choice was made available in the tens of thousands.

The field study revealed that the range of in-game content that they were able to make available to their consumers could be larger than a traditional game company would have been able to through licensing deals or mass manufacture as a result of a combination of their design process, automated software processes and their adoption of 3D printing.

Where tooling costs and turn around time involved with mass manufacture typically push toy and merchandise producers into developing only items that they know they will be able to sell in sufficient volume so as to recoup initial investment the on-demand nature of 3D printing in combination with the automated software processes disrupt this calculation.

When the process of converting an in-game object into a printable format is automated potentially all content in a digital game can be 3D printed, and in the case that 3D printing reached consumer acceptable quality and price points this could mean that all 3D game content could be made available for consumption as toys or merchandise. Automated software translation processes allowing direct conversion of digital content assets into 3D printable formats reduces initial tooling set-up costs that are associated with mass production, allowing MakieLab to exploit niche content in an on-demand context via 3D printing.

This allows games company to reposition all in game or digital media content as potentially consumable as physical artefacts. This means that the digital game or media environment may be considered as a merchandising zone and that the game company can facilitate in media merchandising.

Subsequently the field study revealed that employing 3D printing as a means of manufacture allowed MakieLab to serve digital content as 3D printed toys or accessories, and in combination with their art production processes and automated software processes also allowed them to exploit a much wider range of content, niche content that would not be typically available to consumers if they had used mass production processes. The research found MakieLab then to be an early example of how media producers may leverage their digital content across digital and physical formats, opening a much wider range of their intellectual property to consumers.

This research indicates that it may be useful to consider 3D printing-media set-ups such as MakieLab as *convergent media platforms*. Convergent media platforms are considered in this research as *a means by which media producers may exploit content across digital and physical platforms; allowing for sale and trade of digital content in game as well as the manufacture of the content as objects such as merchandise or toys.*

In this way 3D printing and convergence with media products may allow firms to vertically integrate production of merchandise and derivative products such as toys. With this the media producing firm may increase profit margins by cutting out various intermediaries and costs associated with the administration of such deals. This has disruptive potential for production and distribution of toys and merchandise associated with media content.

## 6.5 USER INTERACTIONS WITH MEDIA CONTENT AND IMPLICATIONS FOR STAKEHOLDERS

Where the research considered user interactions with media content facilitated by 3D printing a point of focus of the field research was that of how MakieLab worked to facilitate or otherwise co-opt user activity and interactions with content.

Just as the prospective consumer survey and the netnography revealed latent consumer intent and activity related to interactions with media content, similar Makies fan activity was evident during the course of the field study. These were considered in the previous section. In response to these findings MakieLab worked to facilitate user interactions with content in a range of ways including via games, the web platform, retail spaces, online forums, social media platforms, 'create your own' DIY packs and on third party online 3D printing and open hardware repositories.

The field study provided insight into how MakieLab worked to facilitate these user interactions and co-opt this activity and content. This section summarises some key examples of how firms like MakieLab may facilitate or otherwise co-opt user interactions with their media content.

A. Provision of customisation tools on web and game platforms
B. Provision of content for user remix/reuse on third party services and tools
C. Provision of "create your own" toolkits and tutorials
D. Development of in-store retail co-creation experience pitched as experiences
E. Commodification of user generated content

### A. Provision of Customisation Tools on Web and Game Platforms

As the earlier section indicated, each of the MakieLab games, apps and web platforms were designed to facilitate user interactions with media content. Games by MakieLab incorporated tools that allowed players to create or customise characters, accessories or fashion items. The design approaches behind these tools by Makies are widely considered in literature considering mass customisation, user accessible design tools and online game avatar development and are not the focus or contribution of this research. Instead the research points to how convergence of 3D printing with these tools in the context of digital games and media products disrupted how we might think about content, making possible user co-production, direct manufacture of toys and merchandise from media content and reconfiguring range of relationships. This contribution is explored further in Chapter 7.

### B. Provision of Content Remix/Reuse on Third Party Services and Tools

MakieLab made 3D printable accessories available for download or purchase on Thingiverse and Shapeways. The accessories released on these platforms included fashion, accessibility and seasonal items.

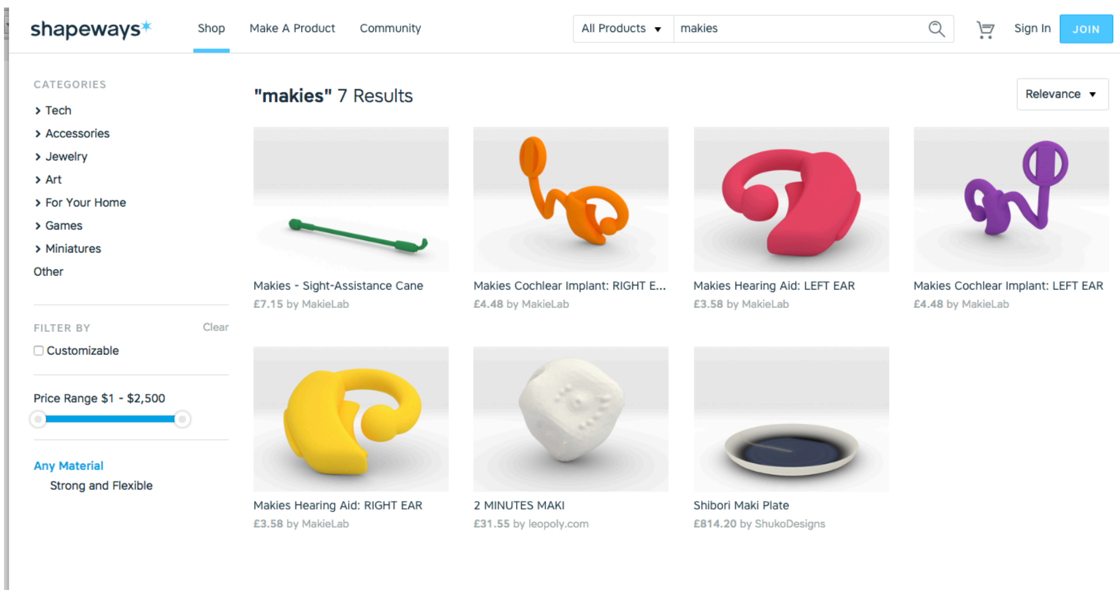



Image 6.26 content made available for user download or remix on Shapeways

On Thingiverse this content was made available by Makies for free with a Creative Commons – Attribution – Non Commercial – Share Alike license allowing users to freely use, print and remix the content with the provision that it was for non-commercial use. In this was MakieLab made available content that fans of Makies could remix and 3D print. This content was downloadable by users and an examination of Thingiverse shows that some users remixed this content into new or edited items. Similarly on

Shapeways this was made available for purchase under similar licensing conditions but in these cases Shapeways would manufacture and ship the printed item to the consumer.

Within mass production systems custom manufacturing, user specified or edited content and remix of content isn't easily offered. Furthermore where some of this content was niche and of interest only to a limited subsection of the Makies fan base mass production processes would have rendered the products un-viable. Had MakieLab needed to use mass production processes the initial tooling cost would have been sufficiently high so as to require that MakieLab establish appropriately high levels of consumer interest in the products to justify initial set-up costs. In the case of 3D printing these costs are limited to the design, prototyping and testing costs and the on-demand, flexible nature of 3D printing as a manufacturing process means that MakieLab did not have to front production costs, instead producing these items on-demand as requested or outsourcing production to Shapeways or by users on at home printers.

### C. Provision of "Create Your Own" Toolkits and Tutorials

In response to user activity noted as part of the field study relating to sharing of tutorials and creation of fashion items MakieLab developed a series of kits that provided users with content and materials that allowed them to create their own accessories and fashion items. Examples of kits included a "create your own fashion" kit, 3D print accessories on a home printer kit and a make-up kit for Makies.

Image 6.27 Makies Create your Own Kit

These allowed Makies consumers to continue creating items outside of the digital environment to support their core product. This approach to facilitating user creation is considered in literature relating to unfinished design and toolkits for user innovation and

DIY (Hippel and von Hippel, 2001; Piller and Walcher, 2006; Franke, Keinz and Schreier, 2008; Lovell and Buechley, 2010; Sinclair, 2012).

### D. IN-STORE RETAIL CO-CREATION EXPERIENCE

In conjunction with MakieLab I established a retail presence in Selfridges London in which an in store co-creation experience was designed for customers in which they could create a Makies doll in store on iPads with or without assistance from Makies staff. I spent a number of days on the shop floor observing, and later facilitating user co-creation in store in a live commercial context. In doing so I identified a number of themes relating to the creation process that have been under explored in research these included making as spectacle, commodification of the creation process, creation process as an experience to be consumed.

In the UK and the US most consumers do not see their goods being manufactured and are not familiar with the tooling or processes behind their manufacture. We brought small 3D printers into Selfridges to create accessories with and for consumers and found a significant level of consumer interest in the printing process itself. This workshop research with customers in store in Selfridges revealed consumer curiosity relating to the customisation and manufacturing process and I found that this was sufficiently valued by consumers that they would pay to participate in the customisation process and would purchase printed goods just to see them manufactured. Here I found that consumers were interested in understanding and seeing how their product was manufactured, how they could participate and the idea that it was made just for them. I also found that at times the desire to engage in the co-creative process and observe manufacture/assembly surpassed the consumer value perception of the subsequent good.

I very much recommend future work exploring whether the process of making might be situated as a form of experiential engagement. Where mass customisation research has uncovered many of the key insights for the research topic at hand, the notion of situating the co-design process as an experience or simply assessing the value of a co-creation process is under explored. While Bosqué (2015) briefly considers printing, “to see the printer work” I find that the experiential aspects to making are under explored in a an consumer experience and commercial context. This was an unexpected finding from the early stage research, and one that warrants further study.

### *E. Co-opting and Commodifying User Created Content*

The field study revealed (as prior sections noted) that doll collectors and Makies users created a wide range of accessories and media content for their Makies including videos, photographs, comics, fashion items, props, houses and pets. They also generated content and objects that may be considered as fan art. In some cases they sold items they created in fan-based communities or on platforms including Etsy and EBay. This research finds that fan production is diversifying as new production technologies including 3D printing become more widely available and as tools democratise user abilities to create and distribute fan produced objects the possibilities related to commodifying fan production are of increasing relevance.

The field study and observation revealed that MakieLab worked to co-opt a subsection of this activity and content and did so in a number of ways. In some cases they shared this digital content on their platforms by re-blogging, interviewing, re-tweeting or reposting user created content. Where users shared tutorials or instructions MakieLab worked to co-create tutorials that they then shared on their platforms. In the case of physical objects MakieLab commercially co-opted some user created work by contracting the original creator to create more for the firm or by creating similar accessories and objects that could be printed.

Importantly MakieLab intentionally built their games as platforms upon which user generated content could be co-opted, creating an economy of digital and physical fashion and accessory trading. A key example of this was found in Makies Fashion Game in which players produced materials and sub assembly items for fashion items as part of gameplay and then were able to created fashion items, customise them and make them available to other players for sale in an in-game store called Netsy. MakieLab intended to derive revenue from this in-game economy by operating as the platform owner, deriving income from purchases and acting as the manufacturer of any goods that people chose to print or have fabricated. I argue that this may be considered as an example of commodification of user created content.

This commodification of user created content is common in digital content such as images and videos but as Noppe argues *"…commodification—is an issue that has received little attention from fans and fan scholars"* (Noppe, 2011).

In particular where users create 3D printable objects (digital design files that can be exploited as saleable digital items and again as saleable physical items) there is little understanding of how firms might successfully co-opt this activity. Historically co-opting content has been seen to be legally, operationally and economically difficult and hindered by issues relating to taxation, intellectual property, toy safety and other regulatory issues (Pearson, 2010; Noppe, 2011a). But as the literature review in an example of Hatsune indicated there can be value in doing so (Leavitt, Knight and Yoshiba, 2016; Sousa, 2016; Jørgensen, Vitting-Seerup and Wallevik, 2017).

3D printing in a convergent media platform configuration changes these operationally difficult dynamics by effectively creating a fan production platform in which all of these terms and conditions and value production may be concentrated and controlled. Where MakieLab operates as a platform and tool developer that controls the means of production it can reasonably manage issues relating to intellectual property, safety standards and can also provide reporting and management of revenue. In doing so MakieLab was able to transcend some key issues associated with commodification of fan art (Noppe, 2011) allowing them to manage the economy, the materials and safety aspects and intellectual property.

### CHALLENGES

Any discussion of 3D printing should also note that there are key challenges associated with the technology that for the time being are relevant to any discussions over the disruptive potential of the technology. The period of ethnographic involvement with MakieLab revealed more than a few challenges associated with using 3D printing in the production of consumer goods such as toys. These are discussed again in the conclusion chapter but cost and colour issues should be noted in relation to 3D printing and it can be seen that these inhibited the work of MakieLab throughout its entire course.

### A. Cost

As the literature review outlined in relation to toyetic potential calculations there is a complicated set of calculations need to understand whether 3D printing is the right move for firms wishing to make merchandise or toys from their content. While MakieLab was technically able to take their products to market for less than they would have had they pursued mass production they encountered issues over time with product cost as a result of the relatively high cost of 3D printing.

MakieLab was able to make dolls at a relatively speaking low cost in the first instance because the initial tooling set up involved in 3D printing can be significantly lower than setting up mass production processes. MakieLab was able to effectively rent production space from existing 3D printing firms and did not need to invest in initial machine or tooling costs so their first items could be said to be comparatively inexpensive.

Producing a first time-one off item using 3D printing is then less expensive than doing the same on a mass production system. This is why 3D printing has become so embedded in prototyping processes and is because mould tooling costs are significant to get started given the labour and material costs involved in making complex moulds. However with sufficient throughput and volume the unit costs per part over time with mass production falls where 3D printing does not.

So 3D printing start-up costs are lower but the process does not afford such significant decreases over time. 3D printing is, at the time of writing still an expensive process and the product cost of items produced in this way is still typically higher than an equivalent produced via mass production processes (Covert, 2014; Sweatman, 2015).

In the case of Makies the product cost to consumers of Makies was much higher than a mass-produced doll of an equivalent size because the print cost to MakieLab was much higher than the unit cost of a doll produced in a mass production system would have been. As an example a MakieLab doll body cost around £67.00 to 3D print when the company started. A similarly sized, albeit not custom, doll could be found for sale to consumers on any retail platform for £15.00. MakieLab realised that this cost was inhibiting their growth so they worked to reduce costs by introducing an injection moulded plastic body and retained 3D printing for the custom doll face.

The initial set up costs for the injection-moulding tool were around £20,000 and MakieLab was able to pay for this by agreeing to produce a pre-determined volume of doll bodies with that supplier at a cost of £5.00 per piece. This initial cost would then drop for subsequent batches depending on the volumes required.

The face part to a Makies doll cost £9.00 to 3D print (before colour, eye, wig…) and when combined with an injection moulded body and the other relevant accessories allowed MakieLab to produce a doll at a cost price of around £20. While this was still above consumer expectations as set by mass production processes it was closer to an acceptable price range. It can be seen then that cost is a significant factor to consider in convergent media platforms such as Makies. Should 3D printing costs continue to drop this would make such approaches much more commercially viable.

### *B. Colour*

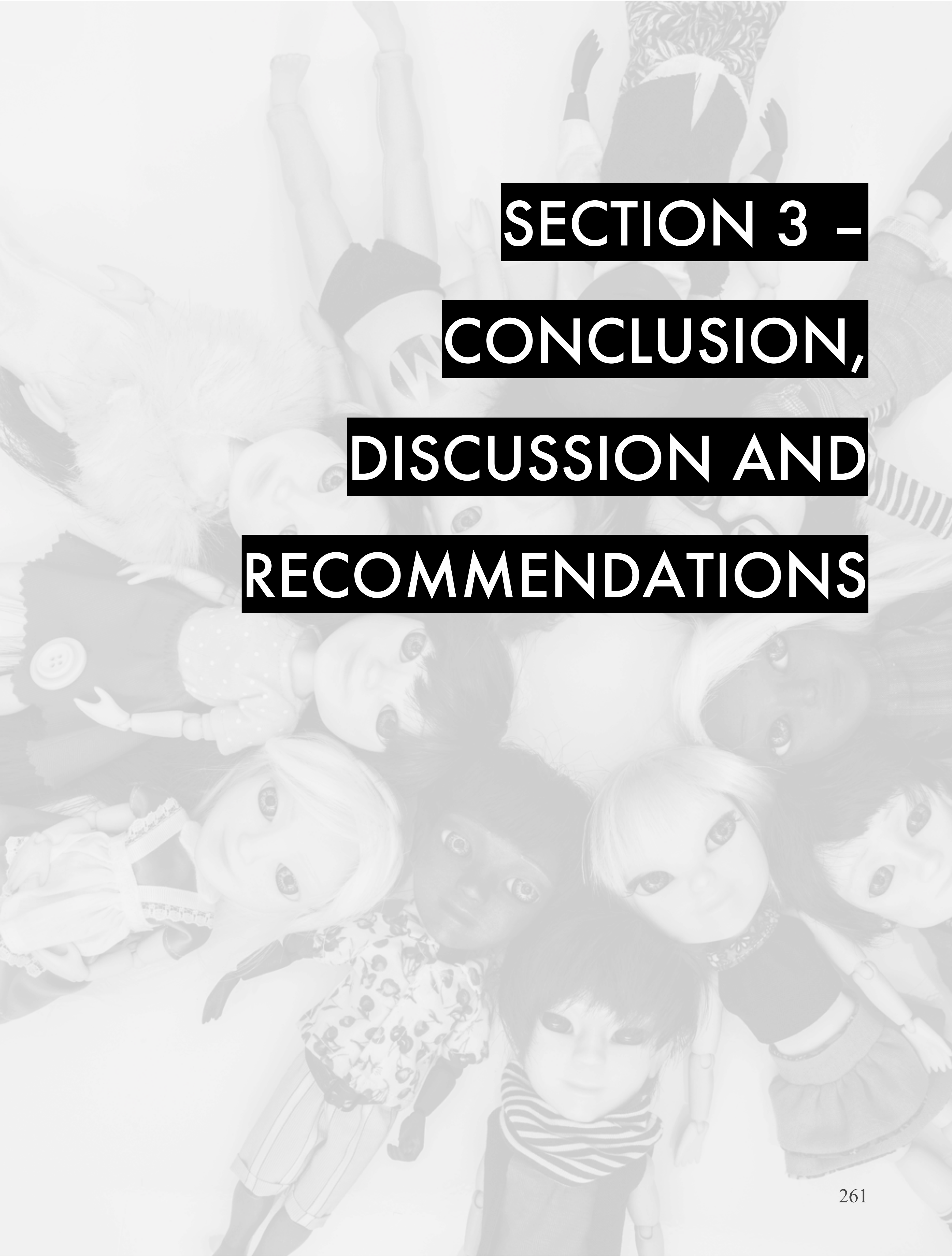
3D printing is still at a relatively young stage of development and where it is used in production of consumer ready products it is at the time of writing limited by finish and colour issues. The first batch of Makies dolls were white/uncoloured because colour processes for the particular type of 3D printing used in their production had not been developed yet. This presented consumers with ghostly white dolls and wasn't always well received.

Image 6.28 Example of a white doll

Over time dye processes were developed that assisted in allowing them to provide humanoid skin colours. Issues with consistency were common, relatedly this dye process is a whole component process meaning that features including freckles and such are not possible. This colour issue remains relevant for figurines and other products relevant to the games industry. While MakieLab got around this by creating assemblies any firm wishing to create complex, multicolour products for consumers using 3D printing will need to consider this issue carefully.

## 6.6 SUMMARY

This chapter described findings from a field study with MakieLab. The field study involved participant observation of MakieLab and was supported by the adjoining survey and netnography. The study involved an examination of products, services and games created by Makies; identification of opportunities afforded by convergence of 3D printing with media products; and examples of content created by Makies consumers and interactions facilitated by this convergence. This provided insights into how convergence of 3D printing with digital game products presents opportunities for development in production of toys and merchandise. Relatedly it provided insights into examples of user interactions with digital game content enabled by this convergence finding relationships with those activities noted on Thingiverse and Shapeways. Just as the netnography found that people created a range of objects related to media content this research with MakieLab finds that user and fan activity related to media products is worth reconsidering in the context of 3D printing and convergence with media products. This research also provides insights into how firms may move to facilitate and co-opt and such activity and considers the implications for the game and toy industry stakeholders involved in production of media related goods. This work and these findings are expanded in the following chapter.



# SECTION 3 – CONCLUSION, DISCUSSION AND RECOMMENDATIONS

# 7. Conclusion

# 7.0 CONCLUSION

This chapter concludes this doctoral research providing an overview of the research and discussion of findings. This chapter collates and discusses findings derived from each research stage and provides insights into development opportunities related to convergence of 3D printing with media products. It outlines implications for a range of related stakeholders. The chapter concludes with contributions to knowledge and recommendations for further work.

## *7.1 THESIS OVERVIEW*

*"The current upswing of interest in 3D printing technologies may, in the near future, affect our ways of thinking about, designing and appropriating playthings. In July 2014 Hasbro announced that it would soon allow players to access its digital tools in order to customize its toys to some degree (Hasbro press release 2014). It is likely that the creative cultures surrounding the MLP:FiM [My Little Pony: Friendship is Magic] phenomenon, such as the sewing of character costumes, the baking of MLP-inspired cakes, and photoplaying with toy characters, will evolve further. Possibilities for co-creation multiply as players become enabled to print accessories and props, and even create completely custom made pony friends of their own, following recently launched, customizable toy concepts such as the Makies doll."*

(Heljakka, 2015)

In the years preceding this research a range of researchers were considering and anticipating the development trajectory and disruptive potential of 3D printing. This is not an unusual practice for researchers or industry practitioners and as the literature review noted a wide range of papers are available considering the disruptive potential of 3D printing. Researchers and practitioners at this time typically anticipated or speculated and pointed to disruption of mass production paradigms and implications of rapid prototyping, rapid tooling or custom manufacture approach. Alternatively they approached the topic from community and democratisation perspectives each of which capture relevant points on 3D printing. Commonly cited possibilities relate to; distributed manufacture, home fabrication, disintermediation, vertical and horizontal integration and have been considered in various, often speculative contexts relating to 3D printing, albeit not specifically in relation to the toy and media industry. This is where this research makes its first significant contribution, situating research with live examples of firms using 3D printing in a media related context.

Secondly though this research does notes disruptive potential relating to automation of production, disintermediation of manufacturing and retail bodies, vertical integration of manufacture and direct control of production as well as direct, on-demand delivery of content from media product to consumer these are not the focus of this research. This research instead aimed to dive a little deeper and in doing so developed a perspective on 3D printing that had received little consideration up to this point. This perspective developed in the context of a live industry case study and provides insight into an early example of 3D printing used as a means of manufacture for a media company and associated development opportunities. The findings here in some cases situate 3D printing in media studies and studies of fandom, both domains that have had little opportunity or reason to consider 3D printing.

This research considered *how convergence of 3D printing with digital game (or media) products presents opportunities for development in production of toys and merchandise*. Within this two sub questions considered *user interactions with media content enabled by convergence of 3D printing* and secondly *implications for various stakeholders involved in production of media related goods.*

**Chapter 1** introduced the research with insights into the context of the research. **Chapter 2** considered literature and research of relevance to the research questions and supported development and refinement of the research questions by providing insight into gaps in research and literature. **Chapter 3** outlined the methodology adopted in this research. **Chapter 4** outlined **a survey of prospective Makies consumers** conducted within this field study that revealed user activity relating to media related toys and merchandise. **Chapter 5** outlines a **netnography of user-generated content on Thingiverse and Shapeways.** Here a range of user interactions with content derived from, or otherwise inspired by media content was identified. **Chapter 6** outlined findings from a period of **participant observation** during the course of a **field study** with MakieLab. This provided perspective from a firm working to build a convergent media platform allowing people to create and 3D print game content. **Chapter 7** concludes the research.

## *7.2 RESEARCH CONTRIBUTIONS AND DISCUSSION*

This research finds that the particular intersection or convergence with media content noted with MakieLab and the software enabled facilitation of flow of content from digital to physical has wide ranging implications for the media and media merchandise industries. I suggest that these 3D printing-media platforms formed as a result of convergence of 3D printing with media products should be considered as *convergent media platforms* and find that this coming together of 3D printing and media content presents possibilities for development in production of media related toys and merchandise, as well as developments facilitating user interactions with media products and associated implications for various stakeholders.

In this section of the thesis document I discuss the findings uncovered during each stage of the research in six contributions. Firstly I find a *role for 3D printing in transmedia storytelling* and transmedia production. Secondly I find that *3D printing disrupts existing calculations of toyetic potential* disrupting traditional assessments of the merchandise value of media products. Thirdly I highlight development opportunities for which this research terms *convergent media platforms* and identify an associated opportunity relating to *in-media merchandising*. Fourthly I note a concept relating to *data freckles or between-media interactivity* facilitated by 3D printing. Fifth, I note opportunity associated with *commodification of user generated 3D printable content and fan art* and finally I note opportunity in positioning *creating as consumable experience* or commodification of consumer creation activity.

It should be noted that these are not considered exhaustive; rather these are contributions that considered of key relevance to the research question directing this research and areas that have been under-explored in existing research related to 3D printing and media products to date. Within each of these discussion points areas of relevance for further research and testing are noted.

### 1. A ROLE FOR 3D PRINTING IN TRANSMEDIA AND TRANSMEDIA STRATEGIES

This research notes that 3D printing may be employed as a delivery mechanism or channel though which audiences or consumers of media products may select or receive content in the form of toys or printed objects. I point then to a role for these *3D printable objects as transmedia content* and also *call for consideration of 3D printing as a transmedia content delivery channel*.

*"Possibilities for co-creation multiply as players become enabled to print accessories and props, and even create completely custom made pony friends of their own, following recently launched, customizable toy concepts such as the Makies doll."*

(Heljakka, 2015)

Where I spent time as an embedded field researcher with MakieLab, I observed, and participated in a firm working alongside convergence of 3D printing technologies and capabilities with the technologies and capabilities of digital game platforms. What this convergence allowed in the first instance was the transmission and translation of digital game content directly into production of toys and objects[58].

*"By design, Pokemon unfolds across games, television programs, films, and books, with no media privileged over any other."* (Jenkins, 2003)

There are various speculative futures and science fiction writings available that may be used to assist in envisioning 3D printing in transmedia strategy. If we look at Makers, a novel by Cory Doctorow (2009) we may imagine how distributed access to 3D printing would allow for such flow of content, or indeed the work of Charles Stross and his writing in Rule 34 about the physical delivery of 3D printed pornographic spam as ransomware in the form of printed dildos embossed with the URL for the antivirus. It is not a leap to imagine consumers of digital games receiving 3D printed puzzles and keys

[58] Appendix 4 presents insight into the software process allowing for translation of digital asset to printable format.

to assist in game play, or objects that in someway enhance, continue or support the core narrative of the media product it is delivered alongside. We might also think of such objects as akin to feelies, delivered on-demand.
As part of the field study I noted that MakieLab explored in-game production of objects including fashion and accessory items. These could be 3D printed or manufactured on-demand for the consumers of that game and in many cases these printed objects were supportive the narrative of the game. MakieLab also explored linking this physical content back to the digital continuation of the game rendering these objects as key to game play. They anticipated a future in which these items would be printable at home by players on home printing machines. MakieLab did not necessarily consider this activity transmedia, nor examine it under those strategies but it may be suggested that this work by MakieLab constitutes a transmedia strategy employing 3D printing as a delivery channel.

To explore the possible role of 3D printing in transmedia story telling and associated opportunities further it is useful to return to definitions. According to Giovagnoli (2011) the term transmedia was coined by Kinder (1991) and has since developed as a key media research theme with various related terms including *"multiple platforms"* (Jeffery-Poulter, 2003), *"intertextual commodity"* (Marshall, 2004), *"transmedial worlds"* (Klastrup and Tosca, 2004), *"transmedial interactions",* (Bardzell *et al.*, 2007) and *"multimodality"* (Kress and van Leeuwen, 2001) forming a rich and evolving research area.

*"At the most basic level, transmedia stories are stories told across multiple media"* (Scolari, 2009). "*It represents a process where integral elements of a fiction get dispersed systematically across multiple delivery channels for the purpose of creating a unified and coordinated entertainment experience"* (Jenkins, 2010) and *"...each medium does what it does best — so that a story might be introduced in a film, expanded through television, novels, and comics, and its world might be explored and experienced through game play."* (Jenkins *et al.*, 2006)

A key example of transmedia strategy is that of Star Wars in 1976 with its pioneering approach to merchandise and supporting products. Raybourn (2014) points to the development of a transmedia strategy and notes that a publishing group produced and promoted a range of products, games, toys, cartoons, books and comics associated with the film with an objective to *"create a fan base that followed the transmedia experience across different media so as to not miss out on any part of the story"*. Though this practice is now relatively commonplace it was at the time considered to be a shift in practice and has been noted since for it's success as a strategy (Jenkins, 2004; Kapell *et al.*, 2006).

Of course, a query is raised as to whether printed toys or merchandise should be considered as content and whether transmission from in-game or in-media content to a physical manifestation should be considered flow of content. This research suggests that it should but even in the absence of agreement, it may be noted that though transmedia theorists do typically cite narrative based examples, books, films, and television in their examples Jenkins reminds us to *"be clear that narrative represents simply one kind of transmedia logic that is shaping the contemporary entertainment realm"* noting that *"...branding, spectacle, performance, games, perhaps others – which can operate either independently or may be combined within any given entertainment experience"* (Jenkins, 2010).

It is in this diversity of channels, processes, experiences and media related artefacts that this research suggests a role for 3D printing in transmedia story telling, finding various ways in which 3D printing may be engaged as a "*process where integral elements of a fiction get dispersed systematically across multiple delivery channels for the purpose of creating a unified and coordinated entertainment experience"* (Jenkins, 2010). The diversity of transmedia logic that Jenkins points to does, I argue, leave space for consideration of 3D printed toys as relevant to transmedia and this tension is further resolved when transmedia play and branding are considered.

On transmedia storytelling, researchers suggest that it functions by *expanding* or *extending* what might be known about a particular fictional, providing a diverse set of sources and channels that support a core narrative (Evans, 2008; Jenkins, 2010; Simons, 2010). Toys and merchandise may therefore be considered as resources that allow players or consumers of media content to expand their understanding of the fictional world. Researchers generally consider such objects as enhancing transmedia, or contributing to expansions of the transmedia story.

Considering the origami unicorn in Blade runner for example, Neil Young considers the concept of *"additive comprehension"* citing the director cut segment showing Deckard discovering an origami unicorn arguing that this invited viewers to question whether Deckard might be a replicant: *"That changes your whole perception of the film, your perception of the ending...* (Neil Young in Jenkins 2006). Where this research found examples of 3D printable copies of the Blade Runner origami possibilities for 3D printing to function as a way to manufacture and distribute such narrative supporting items to consumers of media or game players is noted.

Speaking of toys researchers find that *"Licensed toys afford a material version of transmedia storytelling, and their relationship to the creation of meaning in transmedia franchises cannot be underestimated. In certain explicit instances, such as the case of Boba Fett, they do feed back into the on-going narrative of the transmedia franchise in question"* (Harvey, 2016a). According to Harvey (2016) Boba Fett was first revealed in public at a small town county fair in 1978, an appearance that pre-dated the Star Wars holiday special in which his character would actually be revealed. Harvey argues that this was an inadvertent reveal, that functioned in conjunction with the mail order, token collect pathways to accessing the Boba Fett toy, perhaps accidentally as a means of viral marketing in which curious consumers sought information on this character (in advance of the official reveal). Relatedly Rehak (2013) speaking of *'object practices',* suggests that toys or *'material articulations*' are more than merely marketing and promotional tools, rather that they intrinsic to audience engagement with story worlds.

Jenkins also considers transmedia functions described as textual activators, that is *"setting into motion the production, assessment, and archiving information"* here relationships to fan activity are noted.

*"Transmedia storytelling refers to a new aesthetic that has emerged in response to media convergence— one that places new demands on consumers and depends on the active participation of knowledge communities. Transmedia storytelling is the art of world making. To fully experience any fictional world, consumers must assume the role of hunters and gatherers, chasing down bits of the story across media channels, comparing notes with each other via online discussion groups, and collaborating to ensure that everyone who invests time and effort will come away with a richer entertainment experience"* (Jenkins, 2006, pp. 20-21).

These shifts in consumption practices mean that consumers are driven to track and consume multiple sources and to co-ordinate efforts in finding, acquiring, documenting and processing this distributed information. Transmedia and media products are often supported with wikis and other collaborative platforms and social media sites with consumers participating in various forms of debate and discussion in the process of understanding and consuming stories and the world in which they exist (Guschwan, 2012; Highfield, Harrington and Bruns, 2013; Galuszka, 2014). Here researchers assess this activity under terms including collective intelligence (Lévy, 1997) and fandom (Henry Jenkins, 2007; K.baym, 2007; Milner, 2009; Lamerichs, 2018) and research relating to peer production and communities of practice is also of relevance.

Relatedly fan fiction and other forms of user generated content are often found alongside transmedia products, where fans, perhaps incentivised by gaps in non-liner or multi channel stories create content to bridge, or fill gaps and to serve demand from other community members. This research found evidence of 3D printable user generated fan art and content on websites including Thingiverse and Shapeways and this is further considered in point 5 and 6 of this chapter.

Jenkins also argues that transmedia *"provides a set of roles and goals which readers can assume as they enact aspects of the story through their everyday life* and points to costumes and role playing games that allow for immersion in the narrative as well as performative play with toys and media related figures and costumes (Jenkins, 2007). In the course of examining content on 3D printing repositories a range of user generated 3D printable objects including Star Trek visors, Fifth Element identity cards and Harry Potter wands were found and these may be described as objects allowing for costume-play. This research argues that these objects can allow for playful immersion in and identification with the originating narratives.

Play is an important theme when it comes to toys and media related objects though play as a theme is arguably underexplored in relation to transmedia. Jenkins highlights the importance of play in various digital and participatory contexts, play for its own sake, as a means of experimenting and as a way of learning (Jenkins, 2010). According to Alper & Herr-Stephenson (2013) transmedia play refers to a *"…way to understand how children develop new media literacies through their interactions with contemporary media that links stories and structures across platforms"*. Stephen Dinehart (2008) argues that play is central to transmedia storytelling experiences, Harvey (2016) notes that *"many elements of transmedia franchises or transmedia projects explicitly require playful activity, including games (and videogames), toys, alternate reality games (ARGs) and certain varieties of website."*

Relationships here to feelies may also be noted in which physical objects may be key to participating in, or understanding games. At this point the research notes that digital delivery to home printers and subsequent 3D printing of feelies may be considered as an example of a possible role for 3D printing as a transmedia channel. This research found a range of game media related 3D printable content and in doing so, notes that in-game content could be delivered in physical formats as a means of unlocking or otherwise levelling up in in-game environments, performing narrative or experience functions, expanding or enhancing the central narrative or experience. In a later section addressing data freckles one way in which these objects may be designed to assist in the development of the narrative, may aid in levelling up, and may function as prizes or social indicators. There are few examples of 3D printable items that function as such, and little research that considers these potential developments. This research argues that this would be a relevant line of enquiry for games researchers.

In summary this research notes opportunities relating to the production of media related toys and merchandise in which 3D printing functions as a transmedia channel, providing a means by which the media content my be ported for production as a toy, object or merchandise and points to game related functions inline with those understood in relation to feelies. Where this research explored 3D printing websites and repositories documenting the types of content (in particular media related content) created by early general users of 3D printing it found a wide range of content that could be described as transmedia content. This content may perform various functions relating to transmedia. These objects may enhance or expand the story or story world allowing in the cases of Cosplay, consumers to dress up like characters, tribes or creatures or capture moments, characters and in-world objects of relevance to that particular fan. Where this research notes the closeness of production of digital artefacts and the production of 3D printable toys this research suggests that there is also an opportunity for 3D printing to allow media consumers to interact with media content, co-produce and otherwise generate 3D printable content of relation to media products.

This research suggests that transmedia content made physical may be considered as toys and merchandise and fall into the category of toyetic output and as the next section of this chapter will consider there are also possibilities relating to toyetic potential calculations or assessment of the value of media content.

### 2. 3D PRINTING DISRUPTS CALCULATIONS OF TOYETIC POTENTIAL

A second contribution that this research makes is the finding that 3D printing may *radically alter how the toy and merchandise potential of media products such as games* *and films may be assessed*. Here I argue that 3D printing disrupts traditional media-toy production processes and supply chains changing the costs associated with merchandise and media related goods. In response I suggest that media producers may wish to rethink how they evaluate the toyetic potential of content.

In assessing the potential revenue of any media product executives typically consider various possible revenue opportunities and a key consideration is that of *toyetic potential*. The term originates in discussion relating to 'toyetic' characters, which are considered as those characters with potential to be turned into toys. As a term it is attributed to Bernie Loomis (Fleming, 1996). Consideration of toyetic and licensed media related goods tends to lead to examples including Star Wars, My Little Pony, Toy Story and Care Bears each of which are known for their supporting ranges of toys and merchandise, and some of which became media products due to the popularity of the originating toy.

Toyetic potential as used in this research refers then to the toy and merchandise potential of a media product. Toyetic potential more generally refers to how media related derivative toys and merchandise function in part as a means of supporting the central revenue stream (Jenkins, 2004; Kapell et al., 2006). This is considered in wider research under various terms including *"subsidiary rights"* (Murray 2005), *"media licensing"*, *"brand merchandising"* (Santo, 2012), *"character licensing"* or *"character merchandising"* (Steinberg, 2010). Media products that are considered commercially valuable from a merchandising perspective are referred to as *'toyetic'*. Toyetic potential may then be understood as the prospective value or suitability of a media property such as a film or animation for merchandising and licensing of toys, games and other novelties.

Historically evaluations of the potential for, and value of, subsidiary rights and derivatives in the film industry were conducted early in the production phase and projects that demonstrated 'toyetic potential' were often fast-tracked through commissioning and production processes (Murray 2005).

Dell Furano, president of licensing and merchandising for Sony stated that, *'No program can ever make enough money for the studio if the property doesn't sell through [in retail channels] for 12 to 18 months'* (Matzer, 1996) cited in (Murray, 2005)

Moreover because of the importance of ensuring these alterative revenue streams researchers note that the power dynamics in the production of media are complicated and at times dominated by commerce. Jeanette Steemers (2009) notes *"As much as programme-makers stress the creative integrity, educational value and age-appropriateness of what they have produced, there are frequently suspicions among parents and cultural critics … that these shows are little more than "giant toy ads"* (Hayes, 2008)*, whose function is simply to attract children as consumers for a plethora of branded products ranging from toys and DVDs to pyjamas and lunch boxes."* (Steemers, 2009)

Herman & McChesney (1997) also notes that merchandising potential *"is becoming an important criterion for determining which films get made and which do not".* Just as the importance of licensing for media product revenue has been noted, it is important to note that toyetic potential is often a significant driver in determining which media products will be supported through to market.

Relationships between toy production processes and media production processes also to be noted and this overlap in tools and process has been highlighted in animation industries by Gurevitch (2012) who, speaking of computer generated content suggests that *"the objects and characters that populate CG features are integrally related to contemporary practices of industrial product design engineering…".* It is also important to note the relevance of manufacturing and industrial, cultural, social and economic forces that surround the media and merchandise industries and the influence of these on calculations of toyetic potential. Toyetic potential is closely linked to production processes and manufacturing paradigms of the period in which toys and media products are made and distributed. Developments or shifts in industrial processes as well concurrent cultural, social and economic changes play key roles in shaping developments in toys (Harvey, 2016b).

Where mass production processes have been central to production of consumer goods and toys over recent decades consideration of toyetic potential typically involved identifying content that would be suitable for production at mass scales, that could sell at appropriate volumes so as to justify mass production tooling costs and also cover the subsequent distribution and advertising costs associated with retailing such items (Murray 2005; Gurevitch 2012). Here relationships with retail and advertising were important, where huge volumes of toys were manufactured to justify set-up and tooling costs associated with manufacturing them. Alongside large-scale distribution, retailing and warehousing were required to deal with such volumes and advertising was crucial to push demand for these items to ensure that the licensing and toy production venture would succeed.

As in the case of this research where 3D printing was used in place of mass production techniques alternative economics came into play. As such I argue that with 3D printing the calculations behind considering toyetic media may be adjusted. This research goes some way to begin work in this space. It is in this shift in manufacturing strategy that this research indicates potential for adjustments to toyetic potential estimations and the concurrent development of new toyetic strategies. This research identified and studied a toy and game firm that moved to use 3D printing in the production of game related toys. This firm, MakieLab, brought together toy-manufacturing capabilities with game development capabilities, as observed in the course of participant observation. To do so MakieLab developed a process by which media content from their games could be directly manufactured using 3D printing.
Two factors made this possible:

1. Automated/software conversion of digital media assets into 3D printable formats
2. Overlap of skillsets and professions between digital content designers and product/industrial designers

Research conducted with MakieLab found that the tools and processes that game developers and designers use in production of game content are closely related to the tools that industrial or product designers use. In the case of MakieLab the game art and product design teams both used the same tools and worked together in a collaborative team. Importantly MakieLab worked to develop co-production processes in which the art process for the game development process concurrently produced content that could be 3D printed. In the first instance this involved close co-working practices between game artists and product designers. Over time, with assistance from the software tools development team this process was automated and in doing so art assets were automatically translated into 3D printable formats.

Here MakieLab effectively encoded industrial design knowledge and procedure into a software process that allowed automated translation of digital game assets into formats that allowed for 3D printing. These software-encoded constraints ensured functionality and avoided extreme geometries that might have produced dangerous objects. Knowledge relating to wall thicknesses and 3D build chamber was also encoded in this process also allowing for manufacturing quality and efficiency. (This software process was patented and later acquired by Disney. It is available for consideration in Appendix 4.)

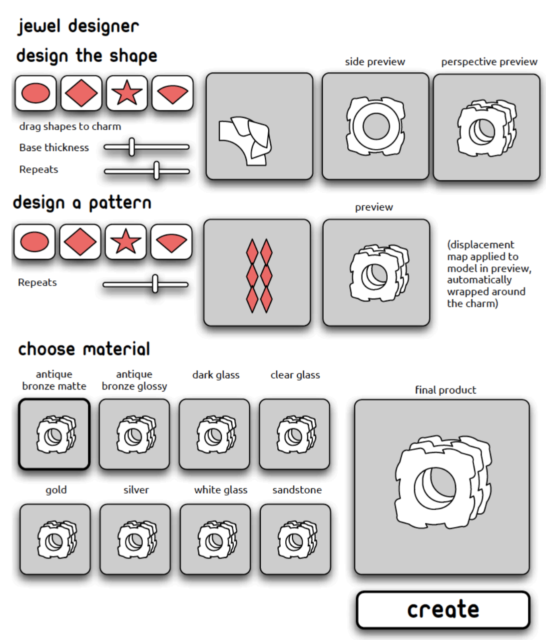



Image 7.1 Makies digital game prototype allowing in-game creation of accessories.

In designing tools to allow people to create their own character doll faces MakieLab created a tool that enabled users to produce faces that would be printable and functional as toys. This process was in the first instance limited to the design of Makies faces – the part that consumers were able to customise but this software process was intended to be useable across the entirety of the game content. In doing this MakieLab was able to make available almost all game content for printing by consumers and players.

Image 7.2 Makies Toy Like Me figures, demonstrating niche accessibility customisation.

MakieLab were as a consequence of this work able to develop a vast product library with thousands of accessories including fashion items such as spectacles and jewellery, vehicles, weapons, lab and electronic equipment, furniture, assistive devices and animals. MakieLab created a large and diverse supporting range of accessories that no other doll or action figure has been able to supply to their consumers as quickly or easily. A case example of this is how MakieLab responded to the 'Toy Like Me' challenge in which a campaign called for toy producers to create toys that were more representative of people with disabilities and features not commonly found in media or toys. This inability on the part of larger toy producers to deliver diverse ranges of supporting accessories and respond to challenges like Toy Like Me may be attributed to the mass production set up cost for manufacturing such goods at scale. Especially in cases of niche content in which toy firms cannot ensure sell though of this content at scale.

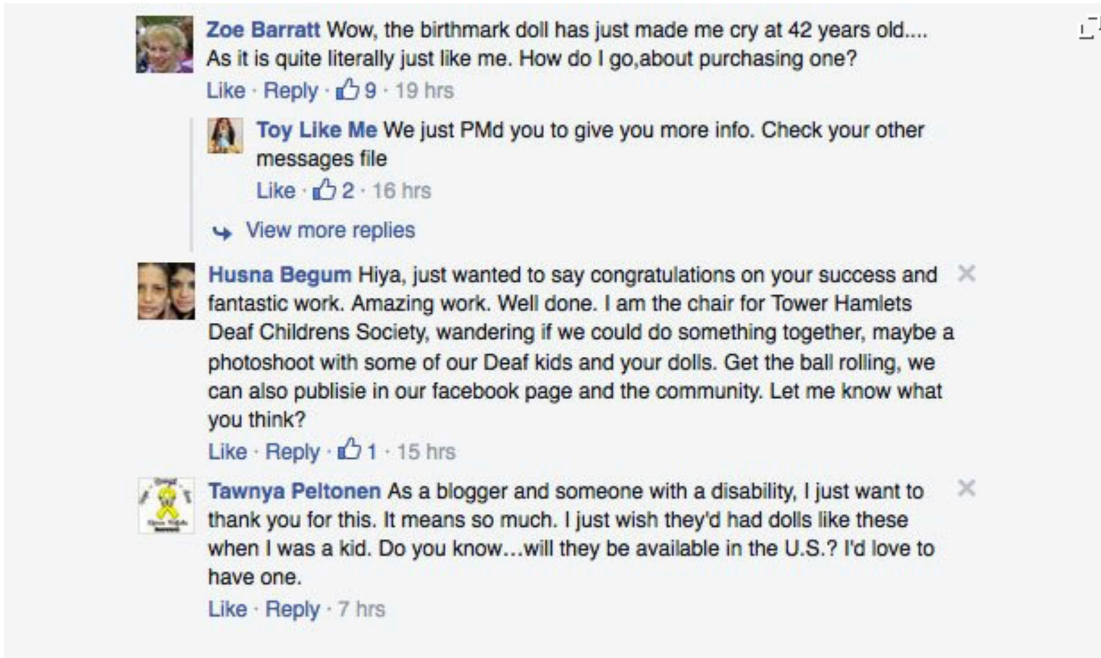



Image 7.3 Consumer responses on Makies Facebook to - Toy Like Me figures.

Where MakieLab made available a large library of 3D printable content to consumers, through automated software processes the typical costs associated with design, production, warehousing were altered substantially. On-demand manufacture and the automation described above made it possible to make a large range of content available to consumers in a relatively easy way. Furthermore though the individual unit cost to consumer is higher than mass produced equivalents, 3D printing allows for niche content to reach the market uninhibited by the requirement to sell at volume and low cost. Importantly as the research with MakieLab indicated in a comparison of the costing for producing a single Makies body via 3D printing versus injection moulding provisionally confirmed the economy behind this (see Chapter - MakieLab Field Study). Here the initial tooling and set-up costs associated with getting a toy to market were technically lower using 3D printing processes (when tooling cost is considered) but as sell though expanded and volume was reached the mass produced items were less expensive per unit cost overall.

Where consumers lack choice in accessories they appear willing to pay a premium as demonstrated by the popularity of Makies accessories though further cost reductions are considered necessary to bring these costs inline with general consumer expectations. Though 3D printing may not in the near future be able to match the low cost of goods manufactured at scale on mass production systems 3D printing allows for small batch production runs, market testing and cheaper to market initial products. This allows firms to provide access to niche content, and to provide small production runs of goods without needing to ensure the mass sell though needed to justify manufacturing of moulds and the overheads associated with large scale manufacturing supply chain, warehousing and retail.

Furthermore this research also indicates that 3D printing and the associated possibilities for vertical integration, small batch production and digital distribution may undermine traditional calculations based on relationships between mass production, advertising and retail models. Where MakieLab acted as media producer and toy producer and retailed directly to consumers it was able (where it chose) to bypass most traditional producers, retailers and other intermediaries. This makes possible an adjustment in the wider range of factors traditionally considered in assessing toyetic potential.

MakieLab were not entirely alone in exploring these developments and while 3D printing is still relatively new in the production of toys and merchandise the netnography also identified the emergence of a number of firms aiming to exploit digital content from games using 3D printing to unlock content (Flaherty, 2012a, 2012b; Geere, 2012; Balinski, 2014; Bengtson, 2014; Harris, 2014; Hutchins, 2014; Palladino, 2016; Robertson, 2016; Huilgol, 2016; Kell, 2016; Molitch-hou, 2016b; Sher, 2017). This activity may be noted as evidence that industry and investment bodies perceive potential value in the digital to physical pipeline surrounding media products[59].

In summary then 3D printing deployed in the way noted with MakieLab presents

[59] Evidenced by partnerships between large 3D printing machine manufacturers and toy and media industries.

stakeholder relevant opportunities relating to disruption of toyetic calculations of the merchandise value of media products. 3D printing in combination with automated translation from digital asset to printable model disrupts such calculations and allows media producers to make available a wide range of content as merchandise. In this way firms may seek to provide access to ever more niche forms of content. In doing so they are able to either outsource the production though platforms and collaborations like those noted with Hasbro and Shapeways. Alternatively they may provide API like access to their media products allowing direct manufacture of goods at home by consumers or manufacture and ship type operations like MakieLab. No longer are media producing firms solely limited to producing toys relating to only the most popular but rather this shift could allow in some cases exploitation of a long tail of assets from any digital media products as the next section will consider.

### 3. Media products as convergent media platforms and in-media merchandising

In line with the previous section this research finds that where convergence of 3D printing with digital media products facilitates direct manufacture from digital assets it also optionally *repositions digital media products as merchandise platforms and digital media content as printable merchandise*. That is to say that media producers may make the digital assets used in the development of a media product available to consumers as directly 3D printable merchandise. With this arises the possibility to reposition that media product (film or game) as a merchandise platform and place of consumption.

MakieLab is, I argue, an important early example of a *convergent media platform* and that this platform may be considered as an example of in-media merchandising in which game players can consume, customise and 3D print a variety of content from the in-game environment. (I expand on my reasons for using the term ‘convergent media platform’ in the Glossary and terms section at the end of this thesis.) Makies players were able to create a character in-game, adorn the character with accessories and have the character and accessories 3D printed and shipped to their home while the digital version of this character remained playable in an iOS game.

This section of the research, builds upon the two prior statements:

1. That 3D printing makes possible transmedia strategies relating to toys and merchandise from media products
2. That 3D printing fundamentally alters how firms might go about assessing the merchandising or toyetic potential of media product

It goes on to suggest that:

3. 3D printing reconfigures how we might think about the content contained within media products

The netnography found that MakieLab developed a process flow by which players could manufacture avatars or in-game figures and in developing the game “Makies Fashion” they developed processes by which players could design and manufacture fashion items that would be produced and shipped to them the range of content that could be considered as consumable merchandise grew.

This contribution builds upon a paper considering computer-generated animation as product design by Gurevich (2012). He suggested that there were *"... considerable implications for contemporary understandings of 'product placement'* suggesting that every object on a screen is essentially *"an industrially manufactured, carefully placed product..."* Of course it isn't entirely novel to suggest that media products are used as merchandising vehicles. As the previous section noted and as various researchers and industry folks suggest *'Toy-led programming ... has become part of mainstream marketing'* (Clark, 2007). There are various ways in which media producers (in particular motion pictures) generate revenue with *merchandise* (Johnson, 2001; Kapell *et al.*, 2006; Jenkins, 2010), *character merchandising* (Steinberg, 2009, 2010, 2012; Santo, 2012), *product placem*ent (Williams and Petrosky, 2011; Gurevitch, 2012) and *promotional tie-ins* (Adams, 2004; Peters, 2014) amongst other known strategies. Collectively these strategies use media products as vehicles to advertise or sell goods, and related strategies have been part of media production for decades at this point.

While this research does acknowledge that media products are used as merchandising vehicles it calls for a reconsideration of media products in particular digital games and animated content *as co-production platforms or convergent media platforms in which all content may be consumable, potentially editable by players and subsequently 3D printable* as objects such as toys and figurines.

When speaking of merchandise in relation to media the historical emphasis in research has usually been on toys and merchandise objects produced to be sold in support of the media product. The market value of such supporting merchandise is often significant. As (Soter, 1992) noted that while the Batman movie earned Warner Brothers $251.1 million in its initial release, *"Warner was able to double that–earning an additional $500 million–from the sale of licensed t-shirts, coffee mugs, soundtrack albums, cereal and* *other gimmicks tied into the movie."* A more recent example is that of Harry Potter and according to advertising writer Jardine (2001) industry estimates are that Potter merchandising may be worth $1 billion, including a $95 million deal with Coca-Cola. Many of the objects described as toys and merchandise in these cases are not manufactured by the media producers, nor directly commissioned by them, rather they are licensed to merchandise and toy producers who take on the risk associated with their production. Licensees worry that they *" . . . put up extremely high guarantees and fees for a phenomenon that may not in fact be such a huge hit, thus leaving them in the red"* (Dolbow, 2001)*"if you don't succeed on the silver screen, it's very hard to have merchandise jump off the shelves"* (Friedman, 1999).

In organising merchandising and licensing in this way the media producer outsources risk, deriving income from licenses, and in doing so gives up some degree of control over merchandise and giving up some profit. Here the costs, responsibility and risks associated with warehousing, over-stock, poor product performance and retail distribution are passed to third parties who seek these collaborations as a means of tapping into the advertising and marketing potential of large motion pictures and media products.

The direction this research indicates as relevant therefore is that of considering all media content as potentially directly 3D printable. As Gurevitch (2012) notes *"When every object on screen is literally an industrially manufactured, carefully placed product, traditional theories of film, advertising and consumer culture need to be retriangulated."* Gurevitch suggested that the very construction of media content *"constitutes them as products from the outset. When engineers construct an object on their computer for mass industrial production, the visual object they work with is not simply an image of a product, it is a product."* When the product has been designed as an in-game asset and is bridged to production processes though automated software processes the game content becomes downloadable in manufacturable formats and all products within the game become potentially consumable as toys and merchandise without requirements to involve additional stakeholders and manufacturers.

This research indicates then that there is opportunity in retaining control over, and profits from toys and merchandise where 3D printing and the automated translation of digital assets to 3D printable formats make possible direct manufacture of toys and merchandise in on-demand production. This means that the media producer may retain control over production of some of its toys and merchandise, retaining profits in these spaces and where 3D printing allows for on-demand manufacture, direct delivery to consumers and viable small batch production they take on less risks relating to poor product performance, lack of sales, warehousing, distribution and retail pipelines. However they do then take on risks associated with toy safety, distribution pipelines, and supply chain issues relating to scaling of manufacture. It is not proposed that convergent media platforms replace entirely traditional merchandise platforms, rather convergent media platforms are proposed as an additional pipeline for content delivery, a means of engaging consumers, a strategy that the media product may itself establish or may outsource or collaborate with manufacturing firms.

In summary, 3D printing and automated translation into printable formats mean that potentially all media content may be consumable as toys or merchandise objects. That media products such as games may be positioned as a convergent media platform in which consumers or players may both create and consume digital content and physical toys and merchandise objects derived from this content.

Image 7.4 Makies QR code test prints in which QR codes are generated to allow individual identification of custom parts and linking to digital games.

Disney secured various patents related to "*3D printed objects with embedded ID elements"* and in doing so they are patenting the 3D printable future of user-generated, customisable and 3D printable interactive figurines like Skylanders.

Skylanders (Activision) toys may be understood as 'toys to life' action video game in which *"the characters are actually RFID/ NFC-enabled physical game pieces that are used within actual game play. A player is provided with a 'portal' (a RFID/NFC reader which connects to the console via USB or Bluetooth) and the RFID- enabled game pieces. The game pieces are either the character that can be swapped on the portal to change the player's current in-game avatar (in-game avatar movement is through the standard console controller) and spells, potions and adventure pieces that provide enhanced character performance or unlock a special zone within the game"* (Coulton, 2012).

This toys to life or bits to atoms cycle was one that MakieLab hoped to capture and facilitate with their work exploring RFID, conductive ink and *'data freckles'* (akin to QR codes) amongst other strategies as ways in which custom, user generated 3D printable content could be read by game software or otherwise interact with games. MakieLab generated print codes that populated the inside of the head and back of each Makies doll and a unique QR code tag (Image 7.4) and these unique identifiers connected the physical Makies doll with its digital counterpart.

MakieLab also did some early work to generate physical freckle patterns for dolls that could be read as a means of identifying the object for interactive game play. Though this work was paused by MakieLab they verified that there are opportunities to use 3D printing as a means of developing unique and readable patterns such as fingerprints and freckle patterns that can be readable by cameras and other readers as a means of identifying individual objects. Limited at the time by the technical infrastructure needed to implement this in any consumer accessible way MakieLab anticipated that this would become viable as technology incorporated in consumer accessible hardware improved.

Image 7.5 – Makies QR code test Disney.

Research that continued this line of enquiry and situated it under the research themes of game design in the internet of things is that of Coulton et al. (2014). These researchers investigated the design of physical game pieces and were concerned *"with the factors that game designers must consider in relation to the interaction modalities available in the design of these objects for their inclusion within virtual games"*

Coulton (2012) notes that
*"The focus on physical/digital (phygitall) things produces a number of very interesting effects such as: blurring the boundary between toys and games, expanding existing*

*modes of game play to the physical world, providing the opportunity for physical play outside the game, creation of innovative phygital interfaces, and a novel business model around the figures*"

They, like MakieLab identify and highlight possibilities associated with 3D printing and game play or media interactions are obvious and overlaps with research relating to feelies may also be noted here. At the point in which MakieLab and Disney established a partnership in 2015/6 MakieLab began a series of research and development sprints funded by Innovate UK and in collaboration with Disney. During this project we created and tested some examples of figures that incorporated a QR code (Image 7.5), this was intended to be readable by game software.

We also created figures with embedded RFIDs (Image 7.6) intended to be readable by game hardware. We also explored how figures could be broken down into individual pieces allowing us to get around issues of colour, in doing so we established jointing procedures (Image 7.6).


Image 7.6 – QR code test, RFID and sub assembly approaches to colour – Makies & Disney.

This material is presented as an insight into the potential 3D printing brings to the design and manufacture of game related objects and in particular to interactivity facilitated via custom manufacture of readable and unique codes. This also reflects a series of patent applications by Disney (Grunewald, 2016) including *"Three Dimensional (3D) Printed Objects with Embedded Identification (ID) Elements"* and *"Partitioning Models into 3d-Printable Components"* that highlight Disney activity in this space. It should be noted however that data freckles and related research has been superseded by augmented reality and a range of other technological implementations and for this and other reasons this capability and line of enquiry is presented as a reference only.

## 5. Co-opting user generated 3D printable content and commodification of fan art

*"He had an idea that they could push designs out to the printers that were like the Disney designs, but weird and kinky and subversive and a little disturbing."*

*(Doctorow, 2009)*

In his book Makers Cory Doctorow anticipates 3D printing enabling a range of remix and intellectual property risky activity and this research finds that Cory was correct in his anticipation finding examples of fan art, remix and various forms of user interactions with media content enabled by 3D printing and also the emergence of an economy of fan rated 3D printable art. In this research I asked *what user interactions with media content are enabled by convergence of 3D printing in the digital economy* and *what are the implications for the various stakeholders involved in production of media related goods*. This section brings the user, player and/or consumer back into discussion and highlights opportunities for firms to co-opt user generated 3D printable content.

The prospective consumer survey research uncovered a range of user reported activity relating to historic play activity, some of which could be considered as customisation, user generated content creation and cross platform and transmedia storytelling or play on the part of respondents. A range of what this research describes as under-served user requirements or needs were also documented revealing opportunities for firms who might be able to serve these request via flexible manufacturing. Requests could be categorized into *accessory requests*, *interactivity* and *responsiveness*, *personality or continued persona development* and "like me" *representativeness in terms of customizability of hair, features* and *skin colour.*

The survey findings were somewhat mirrored by the netnography of content and activity found on 3D printing repositories. Here research uncovered examples of independent content creators on online repositories, who facilitated by 3D printing and associated design tools and platforms are creating, remixing, sharing and selling 3D printable content (referencing media content) that may be described as fan art or user generated content.

Additionally the field study revealed that Makies fans created a wide range of accessories and media content for their Makies including videos, photographs, comics, fashion items, and props. Some of these content and objects may be considered as a form of fan art. A subset of fans sold items they created in fan-based communities or on ecommerce platforms such as Etsy and EBay.

*"The current upswing of interest in 3D printing technologies may, in the near future, affect our ways of thinking about, designing and appropriating playthings. In July 2014 Hasbro announced that it will soon allow players to access its digital tools in order to customize its toys to some degree. It is likely that the creative cultures surrounding the MLP [My Little Pony]: FiM [Friendship is Magic] phenomenon, such as the sewing of character costumes, the baking of MLP-inspired cakes, and photoplaying with toy characters, will evolve further. Possibilities for co-creation multiply as players become enabled to print accessories and props, and even create completely custom-made pony friends of their own, following recently launched, customizable toy concepts such as the Makies doll."* (Heljakka, 2015)

3D printing it seemed was allowing people to engage with media content to create and remix toys and merchandise and some firms were moving to take advantage of or respond to this activity. MakieLab was a key early example of a firm moving to exploit this activity. MakieLab moved to develop games and apps that co-opted or facilitated fan activity. Alongside the development of MakieLab their growing fan base and player group similar revealed similar user generated content creation, remix customisation and other interactions with media content (in this case Makies game content). These individuals shared digital and physical fan created content on social networks and in forums on Makies websites. In some cases they traded or sold such item, attending toy fairs including Blythcon to do so.

Makies fans and consumers:

- Created and traded accessories for Makies
- Designed, created and traded fashion items for Makies
- Created and traded wigs and hairstyles
- Created elaborate face-ups
- Recorded unboxing and videos and posted Makies related blog posts
- Created and shared tutorials and how-to instructions

As the field study chapter notes MakieLab worked to co-opt this content and activity in various ways, in some cases using it to promote Makies, co-opting fashion creators in the development of fashion products, hiring select creators to work in-house and reposting digital content on their social media sites or on the website. In some cases MakieLab was inspired by this user-generated content or requests by consumers and responded with their own accessories and content or how to guides (Image 7.7)

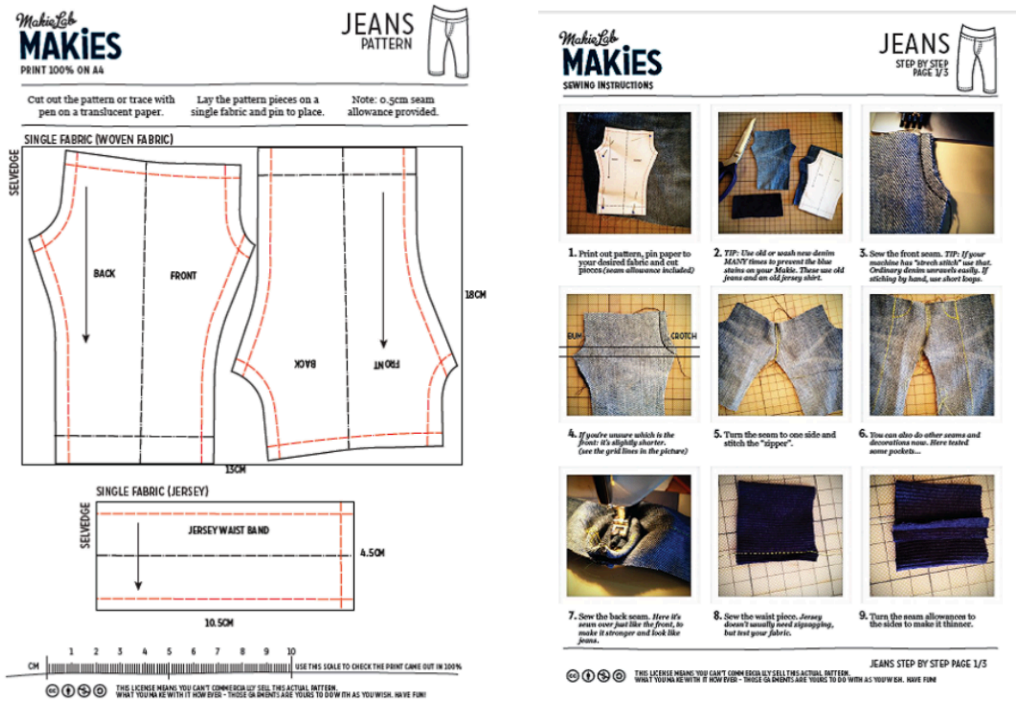



Image 7.7 – Makies Create your own – tutorial or pattern guide.

More centrally MakieLab designed their games to reflect or co-opt this activity, embedding this activity into game play and building tools to facilitate this activity. In the first instance the Makies avatar creator was a digital tool that allowed people to create a customisable doll like figure that was 3D printable as a toy. MakieLab also designed games where game play involved designing and producing fashion and players were also able to sell this content in game and for production as printed fashion pieces for dolls. As such the game allowed players to behave as fashion designers and participate in in-game economies behind such activity. MakieLab therefore created a digital game platform upon which players could co-create characters and content to be played in-game that could also be 3D printed and played with as toys, moving play between screens and into different games. In doing so MakieLab created a mechanism by which they were able to facilitate and co-opt user generated content as part of the game play associated with their games.

There is a wide range of research that considers firm-consumer relations like this, including fan studies, open and user innovation, democratising innovation and mass customisation. The literature review went some way to explore firm-consumer relationships and value creation in such configurations but I highlight fan relationships as key here. In speaking about fan art researchers have historically tended to focus on 2D images, videos, music and other forms of media content and this research extends or contributes to this work by highlighting the relevance of fan created content on 3D printing platforms. Here I suggest that content on Thingiverse and Shapeways are examples of user generated 3D printable fan art.

I argue that there is a subsequent opportunity for media producing firms to co-opt this activity. Commodification of fan art is an issue that has received relatively little attention in academic research (Noppe, 2011). Noppe argues that this lack of attention is due to a range of social, legal, and economic factors that *"kept commercial economies and sharing economies (such as the fannish gift economy) firmly apart"*. Historically co-opting content has been seen to be legally, operationally and economically difficult and hindered by issues relating to taxation, intellectual property, toy safety and other regulatory issues (Pearson, 2010; Noppe, 2011) and there is as a consequence little understanding of how firms might successfully co-opt such activity. However as the literature review in an example of Hatsune indicated there is value in doing so (Leavitt, Knight and Yoshiba, 2016; Sousa, 2016; Jørgensen, Vitting-Seerup and Wallevik, 2017). As Noppe argues *"now that new technologies allow individuals to create media of a quality that makes them economically viable, one of the main reasons for any sharp separation between sharing and commercial economies is steadily losing its significance."*

In concurrence with Noppe this research finds that the technological and commercial context in which user-creators using 3D printing are able to create, host, share/sell and distribute online is increasingly primed for a co-creative and collaborative economy between fan-artists and media producers. In particular, MakieLab intentionally designed their games as platforms upon which user generated content and fan production could be co-opted, creating an in-platform economy of digital and physical fashion and accessory trading. MakieLab intended to derive revenue from this in-game economy by operating as the platform owner, profiting from in game purchases and acting as the manufacturer of any goods that people chose to print or have fabricated. I propose that this may be considered *an example of commodification of user created content made possible by convergence of 3D printing and fabrication tools with digital games.*

3D printing in a convergent media platform configuration changes those aforementioned 'operationally difficult dynamics' by creating a fan production platform in which all terms and conditions and value production may be concentrated and controlled. Where MakieLab operates as a platform and tool developer that controls the means of production it can reasonably manage issues relating to intellectual property, safety standards and can also provide reporting and management of revenue. In doing so MakieLab was able to transcend some key complications associated with commodification of fan art (Noppe, 2011) allowing them to manage the economy, materials and safety aspects and intellectual property issues.

In summary then this research argues that fan production is diversifying as new production technologies including 3D printing become more widely available. As such tools democratise user abilities to create and distribute fan-produced objects possibilities related to commodifying fan production are of increasing relevance. This research suggests that MakieLab is an example of a firm moving to co-opt fan activity made possible by 3D printing. MakieLab and their web tools and games responded to observed user activity in media toy and fan art communities. MakieLab facilitated, co-opted and commodified user-generated content in a variety of ways. Importantly they built games in which game play democratises manufacture of fashion items for dolls, facilitates user generation of content and also enables participation in an in-platform economy of trading and selling fan created items. In short Makies fashion may be considered as an example of commodification of fan production by a media producing industry and more generally as a market based response to the emergence of tools that enable copying, remix and 3D printable an art. This is considered further in the section titled Market response below.

## 6. Creating as consumable experience and commodification of creation activity

Where the previous sections explored opportunities for firms in co-opting or commodifying user generated content this section further develops these arguments by suggesting that media producers may consider developing services that facilitate user content creation and other forms of interaction with media content *with the experience of creation designed as an experience to consume.*

Here I build upon my previous argument and suggest that consumers will participate in user flows or services that allow them to create or make objects for a range of reasons one of which is experiential. People participate in making and co-creation for a range of reasons, one of which is hedonic - *'for the experience'.* This contribution is inspired by exploratory work conducted in the HomeSense project (Voss and Carolan, 2012) in which participants in a user led smart home trial across Europe reported experiential motivations during the course of their co-creation. It is further informed by findings from Makies workshop sessions in Selfridges London in which a selection of consumers indicated that they were interested in consuming workshop sessions as a form of experience.

*"I would like to bring my daughter here to make a doll for her birthday."*

*"This would be a fun experience for my granddaughter and I would like to share that time with her and know that the doll she makes is a thing we made together".*

In participating in the in-store service some customers documented their creative process, sharing it on social media while others wanted to participate in Makies-making sessions with the Makies team to enjoy as a collaborative, creative process with their child comparable to that of the American Girl or Build a Bear process in which the retail experience is centred around curating or making a toy and the space and experience carefully curated (Borghini *et al.*, 2009; Ritzer, 2009; Ilhan, Otnes and Kozinets, 2013).

This form of retail experience is not new, doll company American Girl creates experiences that draw interest from parenting-adult and child grouping in which they sign up to participate in experiential days in which they select, customise (in some cases) American Girl dolls and participate in tea parties and other activities. As Clark (2007) notes *"these are not just shops, they are destinations"*. Here the emphasis is not solely on the consumption of the doll but rather the consumption of the experience.

I argue that brands or media producers may wish to consider implementing experiential services that allow consumers to create content or toys and merchandise in experiential ways and I suggest that 3D printing enables this. Pointing to an industry example of Super Awesome Me, a trial partnership between Wal-Mart, Disney Consumer Products and 3D Plus Me combined 3D scanning and 3D printing to allow users to scan their face and have it added to printable superhero figurines, some early trials using 3D printing in this context have been noted. A 3D print of a customer's face and head was then attached to a mass-produced plastic body of a superhero toy like Iron Man. The trial ran for a number of weeks in a number of stores and items sold for approximately \$59.[60] Though the experience design of this service was simple opportunities for immersive and experiential processes may be noted.

A related and studied example is that of Build A Bear in which *"Customers choose an animal (it's not just bears) without stuffing, take it to a station where it is stuffed 'to the right amount of huggability' and (crucial touch) a heart placed inside. A bar code that is inserted registers it as a one-off owned by a named person. Soundchips can be chosen to giggle, bark and speak messages such as 'I love you'. The buyer can then choose from a variety of outfits, shoes, and accessories, including sunglasses and jewellery. To complete the personalization, a birth certificate records the name and birth date."*.

MakieLab incorporated similar elements, a personalised code in which each doll was linked to it's creator and playable in game but identifiable externally, a body cavity in

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[60] Super Awesome Me http://superawesomeme.com

which a heart of other special accessories could be contained, a head space in which an Arduino Lilypad could be inserted so as to allow for user added functionality. Each doll also came with a 'creation certificate'. These elements enhanced the notion of custom made, and made for you and were generally appreciated by Makies consumers as reflected in feedback delivered to the company.

Furthermore where some consumers reported that the deposition process of fused deposition modelling was "*interesting, mesmerising, fascinating or magical"* an opportunity related spectacle is noted. This note is in line with Bosqué (2015) who found that 3D printing users find the process fascinating *"…observing the printing process is a satisfying experience in itself; obtaining the final product almost feels like a bonus…"* (Bosqué, 2015). Here the research suggests possibilities around situating the making process as an experience to be consumed but also a spectacle to be observed. Spectacle isn't unusual in retail, and was a feature of early retailers who used elaborate window displays of art and other novelties to pull passers by into the store (Pendaloza, 1998) and is considered by (Ritzer, 2009)in his work examining cathedrals of consumption.

Research domains that consider why people customise or participate in co-creation tend to include mass customisation and user innovation and though they sometimes touch upon hedonic and experiential motivations citing motivations and mastery effects including *"I designed it myself"* (Franke, Schreier and Kaiser, 2009) and the *'ikea effect'* (Norton, Mochon and Ariely, 2011). Less explored in this research is the idea that users of these services may participate in and consume the creative process as an experience or for the experience. As such I make a contribution, suggesting that there is value in positioning the making process (content creation and 3D printing) as an experience, comparable to that of the American Girl or Build a Bear process in which people consume the experience or process of making. In addition to repositioning media products as merchandise platforms there is opportunity for media producers to support their media products with platforms upon which consumers may engage with content to remix, customise and otherwise create user generated content and that the design of these may be experiential or playful.

I suggest that stakeholder opportunities relating to this reflect comments by Pine and Gilmore (1999) who suggest experiential value as a mechanism of competition and differentiation for businesses. This line of enquiry is supported by a range of research who citing consumer desire for play and fun defined as *"an experience enjoyed by oneself and actively pursued for its own sake"* (Holbrook *et al.*, 2006; Etgar, 2008). Etgar (2008) also suggests that consumers may want to participate in various production activities simply because they offer deviation from their daily routines. Relatedly research by Holbrook notes *a search for aesthetics, a drive for ethics*, *a drive for spirituality or excitement* and *variety seeking* (McAlister and Pessemier 1982; Kahn 1995; Ratner et al. 1999). He also suggests that participation and performance of the relevant tasks can yield experiences that provide psychological benefits independently of the nature of the goods or services created in the process (Etgar, 2008) and where Fiore (2008) describes consumers as *digital experience seekers* who expect *'engaging, enjoyable experiences'* Holt (1995) points to *consuming as experience* or *consuming as play and* research in consumer studies highlights experiential links with consumption by (Holbrook and Hirschman, 1982; Holt, 1995; Addis and Holbrook, 2001 and Norton *et al.*, 2011)

In summary this research highlights an opportunity to *consider participation in production or co-production of goods as an experience that consumer will consume,* finding an opportunity for producers of 'toyetic' media products to develop playful, experiential co-creative processes that consumers may consume as an experience or during the course of game play or media consumption.

## *7.3 IMPLICATIONS FOR STAKEHOLDERS*

The final question of the research is that of *what are the implications for the various stakeholders involved in production of media related goods?* This section of the research makes notes as to stakeholders of relevance and outlines implications of relevance. These are not intended to be exhaustive but rather reflect the state of play at the time of conducting this research and should serve as indicators and prompts for future work by researchers and industry partners. Stakeholders relevant to this research come from a variety of backgrounds but relevant stakeholders should be considered to include media producers, toy and merchandise producers, game developers and related retail and distribution parties as well as 3D printing developers and services and consumers, players and audiences.

### *7.3.1. For Businesses*

For media producers there is an opportunity, as this research finds to;

1. Directly manufacture goods from digital media content making use of emerging automated translation processes and the cross over in skillsets and tools between digital media artists and product designers.
2. Develop convergent media platforms that allow for new ways of retailing content, a key of example being that of in-media merchandising, in which media producers of digital media products may reposition digital media content as merchandise
3. Reconsider how toyetic potential is calculated and leverage the 'long tail' of merchandise, using 3D printing and related scalable, flexible manufacturing strategies to manufacture content that wouldn't typically have been viable under mass manufacture processing.
4. Consider between-media interactivity facilitated by 3D printing, in the example of data freckles possibilities related to at home manufacture, on-demand manufacture of feelies and other readable objects are possible.
5. Engage consumers in creation of content and leverage associated value by co-

opting said content, capture value associated with fan art and other economies of user content creation

6. Commodify the creation process, providing tools and services that engage users in creating and co-creating content and are positioned as experiences.

In short, the democratising and flexible nature of 3D printing presents opportunities to firms relating to the production and co-production of goods. Here firms have opportunities to involve users and consumer in co-production and the associated benefits of value co-production arising from this (Reeves, 2008b; Rayna, Striukova and Darlington, 2015; Bogers, Hadar and Bilberg, 2016a; Rehnberg and Ponte, 2016). Furthermore they have opportunities related to localised and distributed production (Sachs *et al.*, 1998; Amin, 2010; Petersen, Kidd and Pearce, 2017).

Involving users in design and production of content brings with it advantages relating to sticky information allowing them to gain knowledge and insight from their consumers and co-create value (von Hippel, 1998). There may also be an additional means of generating value beyond by creating and selling products, noting *"value might rather be in the experience of creating and making, in learning and teaching"* (Tavares Smith, 2014).

It is however more specifically opportunities relating to fan production, which is common in relation to media products that this research wishes to highlight as a contribution. Future research and consideration of 3D printing from fan studies perspectives are warranted. Here fan economies and commodification of user produced content and goods are to be considered. Where firms open content to fan artists seed production of fan art which may benefit the originators by exposing the work to new audiences, supporting continued user engagement with the original work and creating content that the firm may co-opt (Noppe 2011; Lee 2011; Manifold 2013). There are various ways in which fan art or user co-production of content or good benefits the originators of the content (Lessig, 2008b; Zwick, Bonsu and Darmody, 2008; Scott, 2009; Seneviratne and Monroy-Hernandez, 2010; Noppe, 2011a; Arai and Kinukawa,

2013) and the example of Hatsune as cited in the literature review highlights this.

Of course media producers and associated businesses do need to consider risks associated with brand equity, possible risks profit and other revenue losses should a fan artist successfully fork the media content in a way that detracts from the original content. Issues of safety arising from third party production of their printable assets, quality control in distributed manufacturing are also likely to be of relevance this is considered further in the section titled Legal Implications below.

### *7.3.2. For Media and Toy Producing Professionals*

Convergence of 3D printing with digital media products also presents new opportunities for related professionals bringing new ways of working, development in job roles and responsibilities. Content creators for media products have an opportunity to create content that may be exploited in both the digital sphere but also as a printable object. There is a growing need to readdress the role of content creator to include design of cross platform content and co-creative processes that include users and content consumers in new ways (Atkinson, 2010; Carolan and Cruickshank, 2010; Cruckshank and Carolan, 2010; Sinclair, 2012). An understanding digital manufacture, tools for co-creation and digital economy issues are also likely to be of relevance to these professions.

There is also an opportunity to develop roles to aid support of users and non-professionals in content creation, whether this is through service and toolkit design allowing user interactions with media content or through the design of experiences and services through which consumers can participate in and consume commodified creation processes. Roles might then shift from design and production of digital products to design and production of cross platform content as well as design of tools, interfaces, services and experiences for consumers to participate in or collaborate with.

### 7.3.3. For Consumers

In the first instance how and where and what people might consume media related goods is evolving, as the study with MakieLab revealed 3D printing and convergence with digital media products allows for direct consumption from the media product itself, or from user targeted co-creation platforms and from fan art and other platforms. This upends the relationship between consumer and media producer and mirrors existing trends in fandom associated with Internet and social media technologies. Convergent media platforms allow consumers new avenues that allow fans and consumers to participate in the co-creation of media related goods and merchandise as well as customising or otherwise co-creating content with the media producers.

Convergence also allows firms to offer a wider range of content to users that may be printed on-demand, allowing them to open a wider range of content to production, exploring the long tail now that toyetic calculations are less reliant on the mass production scales necessary to justify investment. This means that consumers might be able to consume a much wider range of content from media products regardless of the toyetic potential of the content, character or item. This provides a rich content stream for consumer activities around fan art, costume play and collecting. Relatedly where firms open content to fan artists this seeds the development of related fan art economies (Noppe 2011; Lee 2011; Manifold 2013) which may result in a rich secondary economy of related content and social, economic and cultural opportunity for fan artists.

Where 3D printing and associated factors democratise participation in fan production it may also empower a wider range individuals to “tell their stories”, to produce culturally diverse and representative goods such as toys and to transform the media content environment surrounding them. Involving consumers in creation of media products invites new voices, sometimes under-represented or excluded from media products and may diversify media content creating a rich, representative and diverse media landscape. MakieLab as an example was able to respond to and co-opt fan development activity to produce a range of skin tones, representative hairstyles, skin features and assistive devices allowing people to create characters that represented them.

This shift in relations between fan and media producer has been considered from various perspectives by researchers considering fan production (Scott, 2009; Yang, 2009; Pearson, 2010; Rehak, 2014), fan translation and fan subbing (Lee, 2011), dōjinshi (Pearson, 2010; Arai and Kinukawa, 2013; Lamerichs, 2013). It should be acknowledged that where fans participate in fan production and fandom and create value for media owners there remain questions relating to labour value and fan exploitation (Zwick, Bonsu and Darmody, 2008; Milner, 2009; Lee, 2011; Guschwan, 2012; Galuszka, 2014). Further research is considered relevant in this space.

### 7.3.4. For Government and Academia

During the course of this research in the UK various government reports and investigations were conducted to support development of high value manufacturing and 3D printing within the UK, additionally UKIE and other bodies worked to understand the role of 3D printing for the game industry. This body of research was conducted with MakieLab with the support of the EPSRC and Lancaster University and has been requested by Innovate UK in the form of a report on the current state of 3D printing in the UK. This work is expected to be included in future reports regarding UK manufacturing strategy and Digital Economy strategy.

This research suggests that the investment strategy of the government will be key in overcoming issues of price; quality, speed and availability challenges associated with 3D printing and general limitations. So too is support for the institutions that assist in training and developing the creators behind such platforms including maker spaces, code clubs, 3D printing hubs, research and development labs as well as universities. The potential value in expanding merchandise capabilities of media products as well as re-shoring manufacturing and facilitating global sales is not only significant for media producers but also for the economy.

Work to update intellectual property, toy safety, and quality and liability legislation is also likely to be of relevance. While much work has already been conducted considering the gaps and loopholes in UK legislation relating to 3D printing and intellectual property issues much of the focus has tended to be placed on prohibitive measures, aimed at locking down user remix or reuse of content (Bradshaw, Bowyer and Haufe, 2010). There is a role for government and academia in evaluating and shaping future legislation.

# 7.4 LEGAL IMPLICATIONS

## 7.4.1.3D PRINTING AND LEGAL IMPLICATIONS

The research finds that with access to 3D printing and tools like 3D scanners people reference, reuse or remix media or brand related content, producing in the course of this activity, figurines, toys and other items that may be sold or otherwise distributed. Where so much of this content references media content and is in most cases made available for sale or reuse without permission of the actual owners of the intellectual property questions are raised regarding content reuse, in particular where it is used for commercial gain as per Shapeways users. As the netnography revealed content hosted on these sites is generally editable by other users, free to download in the case of Thingiverse, free to share and 3D printable. In the case of Shapeways the content is generally purchased by a consumer and manufactured by Shapeways. It is unclear whether any of these content creators have permission or licenses to use this media content or brand assets, yet a range of creative commons licenses including attribution, commercial, share – share alike have been selected by users and applied to the items the created. Selling or profiting from some of these items is therefore likely to be in breach of typical intellectual property regulations as is sharing or openly distributing the models in other cases (Bradshaw, Bowyer and Haufe, 2010).

There is evidence that some users are aware of the disconnect between their activity and the rights of the intellectual property holders where they attempt to distance themselves from authorship and ownership indicating that they are not owners of the brand. They also state in some cases that the item is inspired by (rather than copied) and in a number of cases the person stated they would make a donation if someone decided to use their content. This suggests that there is some general awareness over the legal status of these items.

As an example RyantheMast made a product titled Kingdom Hearts Goofy – a Goofy figurine from Disney [61].

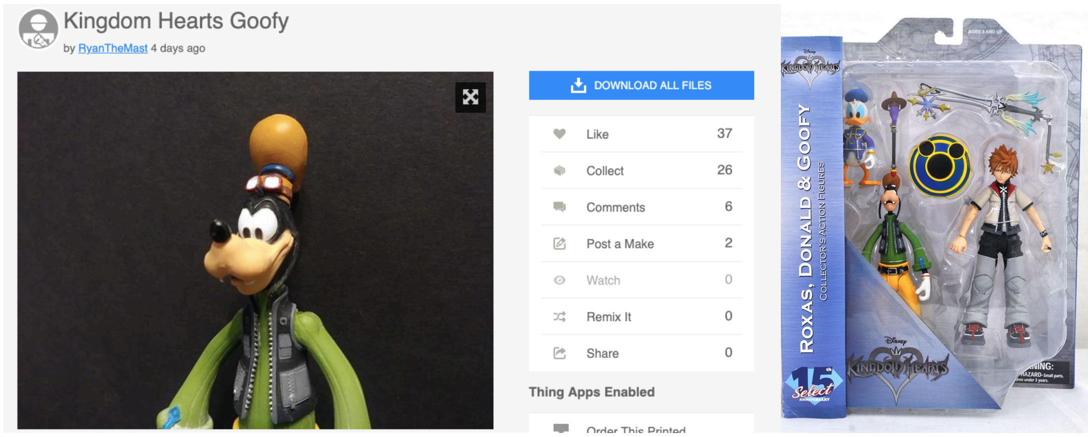
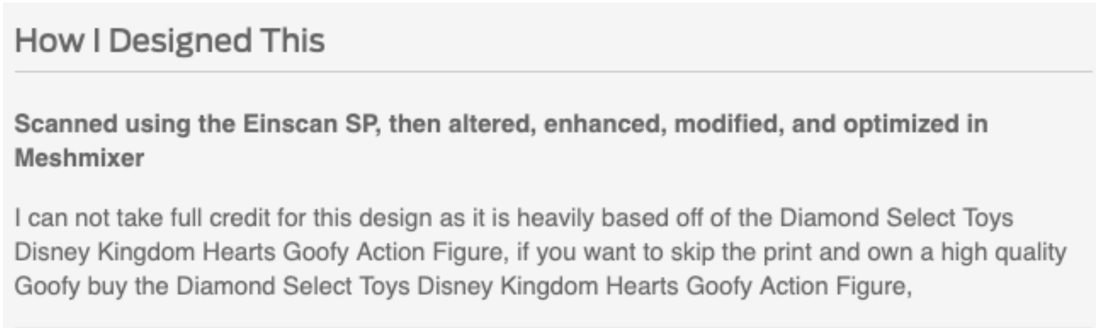



Image 7.8 Scanned Goofy on Thingiverse and commercial model

In a content selection titled "How I designed this" Ryan describes the process by which he created the print. This process involved directly 3D scanning the mass manufactured object and Ryan then converted the scan into a 3D printable model. He indicates that his design was 'heavily based off of the Diamond Select Toys" by Disney and suggests that if you might prefer to own a high quality version you should skip the print and purchase the actual Disney merchandise (available here[62]).

[61] Goofy print on Thingiverse https://www.thingiverse.com/thing:3396676
[62] Disney Goofy Figure https://shop.diamondselecttoys.com/kingdom-hearts-select-series-2-roxas-donald-goofy-action-figures


How I Designed This

**Scanned using the Einscan SP, then altered, enhanced, modified, and optimized in Meshmixer**

I can not take full credit for this design as it is heavily based off of the Diamond Select Toys Disney Kingdom Hearts Goofy Action Figure, if you want to skip the print and own a high quality Goofy buy the Diamond Select Toys Disney Kingdom Hearts Goofy Action Figure,

Image 7.9 Example of a disclaimer

As an example of reuse of media content SkullForge Studios on Shapeways create and sell figurines from Star Wars motion pictures but do so without a licensing deal. They state on their site that *"This web store and its contents are completely unofficial, and its contents are in no way endorsed, or affiliated with Disney or Lucasarts."*[63]

There is evidence that both of these sites attempt to distance or protect themselves from infringing activity mostly though their terms of service, reminding content creators to only use content they have permission to use and though their moves to find ways to build collaborations with media content and secure licenses to use media content.

Both Shapeways and Thingiverse do state in their terms of service that users should avoid infringing intellectual property rights. Shapeways in it's terms of service and conditions of use for users of it's site asks that users of their service;

- *"ensure that any models you upload are your own by uploading only 3D models and designs that consist entirely of content you created yourself or you have the permission and rights to use…"*
- *"only upload your own original work or work that is freely available through a Creative Commons License."*
- *"Please do not infringe other people's intellectual property rights - these may include copyright, patent, registered design, design right, trade mark or trade secret."*

[63] Skull Studio Shapeways https://www.shapeways.com/shops/sun-and-skull-studios

Shapeways also outline that their own liability is protected by the Digital Millennium Copyright Act under the Safe Harbor provision and as such *"…while Shapeways is protected by the DMCA, individual users, like yourself, are not protected and are thus liable for any penalties resulting from copyright infringement."*

### 7.4.2. Legal Response

In speaking about the intellectual property implications of 3D printing there is a significant *"if"* cited in writing and this typically relates to the capabilities of the technology and its implications for intellectual property holders. I also note in various places the limitations of the technology and how this undermines the current value and risk to media producers relating to economies of infringing content or fan art.

This lack of perceived immediate risk at the time of conducting this research 3D printing was due to limitations relating to quality, cost and colour (Covert, 2014; Holman, 2014; Sweatman, 2015) and general issues of access and distribution. These limiting factors served as an inhibiting function for anyone using 3D printing in an infringing way in relation to intellectual property in particular in a commercial context. However some 3D printable content has been subject to early legal interventions as in the case of the first DMCA takedown notice for a 3D printable object in 2011.

*"Because 3D printing relies on computer-based blueprints in order to create physical objects, digital copyright infringement can now impact the physical world. The first example of this happening occurred on February 17, 2011, when Dr. Ulrich Schwanitz sent the world's first Digital Millennium Copyright Act ("DMCA") takedown notice for an object created by a fellow member of the 3D printing community."* (Rideout, 2011)

It is generally accepted that intellectual property laws were not at the time of writing sufficiently robust to deal with fabrication technologies (Bradshaw et al., 2010; Carolan, 2010; Depoorter, 2014; Desai & Magliocca, 2013; Doherty, 2012; Harris Brean, 2015; Holbrook & Osborn, 2014; Kinsley, Owens, & Washington, 2014).

*"... rights holders are likely to be concerned if personal 3D printers become widespread and effective enough to impinge on commercial exploitation of their IP rights."* (Bradshaw, Bowyer and Haufe, 2010)

Furthermore it is anticipated that the technology will develop and should it develop sufficiently to overcome these quality cost and colour issues potential risks and value to intellectual property owners will arise. It is also assumed that rights holders will move in response to limit the risk to their property holdings.

*"As incumbent companies begin to see small scale 3D printing as a threat, they will inevitably attempt to restrict it by expanding intellectual property protections. In doing so they will point to easily understood injuries to existing business models (caused by 3D printing or not) such as lost sales, lower profits, and reduced employment...* (Weinberg, 2010)

Calls for updates to legislation so as to afford better protections for intellectual property holders have already begun and such work is noted in a range of papers (Bradshaw, Bowyer and Haufe, 2010; Weinberg, 2014; Depoorter, 2014; Dolinsky, 2014; Holbrook and Osborn, 2014; Kinsley, Owens and Washington, 2014; Li *et al.*, 2014; Lewis, 2015; Mendis, Secchi and Reeves, 2015; Reeves and Mendis, 2015; Daly, 2016b; Wilkof, 2016).

Legislation affording protection in the case of 3D printable objects is particularly complex and legal approaches and application of legislation varies according to region. As Weinberg (2010) notes, disputes over copies of physical objects are often fought using patent law which is less strict than copyright.

The debate on legislative approaches is complicated further when consideration of which part of the product or process should be targeted, the physical objects produced from the 3D printing or the file that enabled that print. As Brian Rideout (2011) notes 3D printing *"complicates the inquiry into what should be considered copyrightable intellectual* *property: the electronic blueprints and/or the resulting physical object."*

Furthermore intellectual property laws in certain regions, typically written prior to the development of 3D printing, are at times insufficient to afford property holders protection from 3D printed copies in certain use cases. Work by Bradshaw, Bowyer and Haufe (2010) highlights that *"... within the UK at least – personal use of 3D printing technology does not infringe the majority of IP rights."*

There is work to be done in understanding the technology and it's affordances and subsequent required development of legislation as well as a means of applying this globally. The particulars of this legislative work are sadly outside of the scope of this research. However I call for caution in legislative approaches; as Weinberg (2010) notes, *"... Policymakers and judges will be asked to weigh concrete losses today against future benefits that will be hard to quantify and imagine."* (Weinberg, 2010)

Intellectual property holders and regulators therefore have choices to make, though approaches to protecting property typically involve legal structures it may be noted that intellectual property laws are not always regarded as positive, and may inhibit market growth and innovation.

### 7.4.3. Market Response

It is important that the intellectual property response to 3D printing is also careful and open minded about the possibilities afforded by manufacturing technologies like 3D printing. I point to convergent media platforms as market responses that capture value from what might be otherwise considered intellectual property infringement. As Weinberg (2010, 2014) argues in relation to 3D printing and the implications for intellectual property law *"it will be awesome if they don't screw it up"*. He calls for companies to *"avoid the music industries IP mistakes"*. He suggests that companies that deal in 3D printing have the benefit of learning from recent history and cites the actions of the music industry of the late 1990s and early 2000s as a cautionary tale. Where their initial response was to sue those deemed to be infringing on their copyright he argues that this was ineffective, expensive and alienating to fans. Instead the music industry has embraced digital distribution of content and finds revenue models in streaming.

Various researchers note opportunities and value associated with a culture of fan art and remix (Kyriakou, Englehardt and Nickerson, 2012; Rindfleisch and O'Hern, 2015) as well as customisation and creative commerce (Kessler, 2015) and a key example of this can be seen in how Shapeways has tested and established collaborations between content owners and creators on Shapeways towards mutual benefit as in the case of Super Fan Art .[64] SuperFanArt and Makies may both be considered as valuable early market responses.

*"Instead of trying to prohibit it, they're enabling it, and I think that's awesome," said Peter Weijmarshausen, chief executive of Shapeways. "By embracing this new technology, it's good for everybody. The end-user is happy because he or she gets what they want, and we don't get into a fight."* Peter Weijmarshausen in the New York Times (Harris, 2014)


Image 7.10 Shapeways Superfan Art

[64] SuperFanArt on Shapewayshttps://www.shapeways.com/engage/superfanart

### 7.4.4. Wider Legal Issues

More widely implications relating to control of brand or enterprise image are relevant in cases where people remix with illicit content or create objects that are politically sensitive, widely offensive or unsuitable for general consumption. Copying physical goods and producing replicas that have not been subject to the relevant quality and safety controls also raises questions of control.

Political objects are found on sites like Shapeways [65] with creator Amznfx specialising in what he describes as political sculptures. He creates objects related to current political figures such as Donald Trump or Theresa May and in many cases these are intentionally provocative or designed in such a way as to show his disdain at the figures he chooses to represent. While using images of political figures or creating political merchandise might generally considered permissible under parody or satire rulings he also creates objects depicting meme content and in doing so created a figure of Ken Bone, [66] a man who became the subject of a meme after asking a question during the 2016 presidential election. This person is a member of the general public and likely hasn't given permission for his image to be used meaning this object is a potentially unlawful use of a persons name and likeness and against various legal protections afforded to private individuals.

The objects sold by Amznfx are also potentially dangerous to use as in the case of sandstone 3D print of Donald Trump described as a butt plug. [67] Sandstone is porous and fragile so this object is dangerous if used as the object title describes. While the owner of Amznfx does take care to state that the object should not be used as such a wide range of content on both Thingiverse and Shapeways can be described as dangerous.

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[65] Political sculpts by Amznfx https://www.shapeways.com/shops/amznfx

[66] Ken Bone https://www.shapeways.com/product/BYUFJ5PGH/ken-bone-r-inaction-figure?optionId=60986200

[67] Donald Trump Butt Plug on Shapeways. https://www.shapeways.com/product/SCD3B2NJD/donald-trump-plug?optionId=57331330

Any discussion of 3D printing and dangerous items necessarily leads to 3D printed guns. Various online sites have been subject to take down notices specific to 3D printable guns (Greenberg, 2013). This category of item includes objects described as, and demonstrated as functional guns. 3D printing, it is argued, may facilitate production of unregulated weapons and allow circumvention of gun control laws where they exist (Economist, 2014, 2018; Little, 2014; Daly, 2016b). Perhaps of more relevance to the toy and merchandise market is that of the ability to certify toys and merchandise produced via 3D printing as safe. Certifying custom goods carries some additional complexity (Posthuma & Jansen, 2007) but is possible as the research with Makies noted (Hermans, 2013; Sacco, 2013).

## 7.5 RESEARCH LIMITATIONS

The timing of the research is a factor to be considered, this research focused on an early stage of 3D printing adoption and documented first movers using 3D printing to manufacture toys and figures derived from media products. The pace of change was fast and some technological developments outpaced the writing up process. It is also relevant to note that the printed quality of the 3D printed output of most of the content hosted on Thingiverse is still questionable in relation to mass produced equivalents and as such intellectual property holders are unlikely to feel threatened by this activity at the moment. Where 3D printing (during the course of this research) was limited in production terms for complex products it was used successfully to make toys (Howard, 2014) which raised immediate questions for industries related to the toy industry including games, films and other media producers.

In addition this research project ended at a point where the manufacturing industry made some key changes in their investment and development direction, this could be noted in their investment profiles and through press releases. Some withdrew from consumer 3D printing to re-focus on engineering and medical applications including dentistry, military hardware and medial devices as well as aerospace, automotive and infrastructure items. Alongside this came the end of a number of the cited industry explorations and tests documented in this research, some of which may be considered failures and others as strategic shut downs in which founders decide to wait for more favourable conditions. This research was unable to probe further into these decisions.

Testing any platform supported by 3D printing in the years in which this research was written posed challenges of relevance to the research topic. Colour, cost and production quality impact the production quality of the product and therefore consumer perceptions of the product and it's value. 3D printing continues to struggle with these issues (Bradshaw, Bowyer and Haufe, 2010; Carson, 2010; Stemp-Morlock, 2010; Desai and Magliocca, 2013; Weller, Kleer and Piller, 2015) it is assumed that print cost will drop over time so it might be assumed that MakieLab offerings would be more accessible in future iterations. Further research is also required to understand colour processing and operational issues related to on-demand production as well a post processing of custom manufactured goods.

Technological issues with 3D printing presented a range of issues observable during the course of embedded research with MakieLab including difficulty in testing consumer interest due to the limited state of development of 3D printing, an inability to meet consumer expectations in terms of price and finish subsequently limited testing of consumer perceptions and desire relating to printed content. This is true also of the content analysis of Thingiverse and Shapeways where the printed content is of relatively low quality and that the digital model exists and has been printed does not speak to the size of the surrounding economy or level of interest in the content.

MakieLab was just one company attempting custom manufacture of toys and digital to physical convergent media platforms and so it's representativeness is limited. MakieLab developed a very particular aesthetic and product type and this design will necessarily have influenced consumer perceptions and acceptance of the product and associated digital platforms. Further to this dolls provoke a very particular response in some people known as pediophobia, the fear of dolls (Welch, 2012) and while pediophobia is not the subject of this research the influence of this phobia on some research participants cannot be entirely excluded.

## 7.6 RECOMMENDATIONS FOR FUTURE WORK

Recommendations for future research have been indicated throughout this chapter but above all future research should consider the development trajectory of consumer 3D printing and reconsider the timeline upon which 3D printing as a manufacturing process for merchandise products might become truly viable and appropriately economical.

On toyetic or merchandise potential, comparative studies of the costs associated with leveraging media content through mass production processes versus 3D printing processes are recommended. This would provide deeper insights into how on-demand manufacture might adjust calculations of toyetic merchandise potential.

Where the research points to commodification of user creation processes and activity more work is required to develop language, process and business models around such developments. Here research should test the hypothesis that the co-creative process is something that people will consume as an experience and secondly to understand how the experience may be designed in both digital and non-digital contexts.

This research also proposes an extension of definitions of user-generated content to include content found on 3D printing repositories under definitions of user generated content as well as the inclusion of 3D printing repositories as user generated content platforms. Finally it calls for more consideration of convergent media platforms and points to the emergence of a range of co-ventures and collaborations that emerged during the course of this research as being indicative of wider industry interest in these opportunities and therefore a research area of relevance to industry and academia.

As this research draws to a close the value of 3D printing for toy and media-producing industries seems, perhaps obvious but at the outset of this research it was less clear. At the time of initiating this research MakieLab were a first mover, and amongst the first to offer 3D printing of in-game content in a formalised way with other examples around this time including Mineways and printing of Minecraft content (Flaherty 2012;

Humphries 2012) and Kerbal Space Program (Good, 2015; Simon, 2015; Whitbrook, 2015).

Meanwhile during the years of this doctoral research industry papers, patent applications and media coverage of Disney indicated that they have on-going research relating to 3D printing and toys. With patent applications *including "partitioning models into 3D-printable components", "object recognition for 3D printing",* 3D printed objects with embedded ID elements and *'3D printing with custom surface reflection".* Disney Research appear to be building a portfolio of patents that might be interpreted as interest in securing futures in 3D printing for toys.

Noting collaborations between Hasbro, Mattel and other media producers with 3D printing firms (3DSystems, 2014; Balinski, 2014; Hutchins, 2014) and early experimental testing of fan-art contests (Harris, 2014), the research indicates industry interest in similarly co-opting or otherwise understanding 3D printing related user activity.

It should be however noted, that many of these companies and collaborations have not survived or progressed beyond a trial phase, being quietly shuttered or shelved perhaps in the hope that the technology improves on key issues of cost, quality and speed (Covert, 2014; Sweatman, 2015), but 3D printable game content and activity relating to game and media content may still be seen on online repositories and industry activity relating to patents and technology developments continues to further enable the conditions in which these convergent media platforms become fully viable so a future that incorporates convergent media platforms is not impossible. This research is submitted as an early exploration of developments in this space.

## *7.7 SUMMARY*

This chapter concludes the doctoral study. It collated and discussed findings from the research, outlining a series of contributions, highlighting opportunities for development in production of media related goods, opportunities for related stakeholders and recommendations for further research.

The main contribution to knowledge developed within this research is an understanding of the implications of 3D printing for production of media related goods and the possibilities it affords to media producers and fans. Here the research found that convergence of 3D printing with game, film or animation has potential to *alter relationships between media firm and fan*, allows for *adjustments in toyetic potential calculations* and *facilitates exploitation of a long tail of assets from digital media products.* The research also suggests that there is a role for 3D printing as *a channel for transmedia content* and for facilitating *between-media interactivity* and that these collectively present development opportunities for how people interact with, produce and consume media content.

Perhaps most importantly this research makes contributions to understanding of fan participation in production of media content and associated fan produced toys and merchandise enabled by this convergence. The research also provides early insights into the types of products created by fans with access to 3D printing and research notes emerging forms of fan based economies of 3D printable content. Finally it contributes understanding of how digital fabrication and tools for co-creation may provide revenue streams for intellectual property holders and opportunity for engagement between firm and consumer. Here it points to *commodification of user generated content and fan art* and *commodification of consumer creation activity* and provides insights into an early case study of a convergent media platform, MakieLab.

# BIBLIOGRAPHY


3DSystems (2014) '3D Systems and Hasbro Agree To Co-Venture and Mainstream 3D Printing Play Experiences For Children'. 3D Systems, pp. 1–3. Available at: http://www.3dsystems.com/sites/www.3dsystems.com/files/2_14_2014_3d_systems_and_hasbro_agree_to_co-ventureand_mainstream_3d_printing_play_experence_for_children.pdf.

Adams, W. J. (2004) 'Merchandising in the Major Motion Picture Industry: Creating Brand Synergy and Revenue Streams', *Journal of Promotion Management*, 10(1), pp. 55–63.

Addis, M. and Holbrook, M. B. (2001) 'On the conceptual link between mass customisation and experiential consumption: an explosion of subjectivity', *Journal of Consumer Behaviour*, 1(1), pp. 50–66. doi: 10.1002/cb.53.

Allen, N. (2013) *Why 3D Printing is overhyped (I should know, I do it for a living*, *Gizmodo.Com*. Available at: http://gizmodo.com/why-3d-printing-is-overhyped-i-should-know-i-do-it-fo-508176750.

Alper, M. and Herr-Stephenson, R. (2013) 'Transmedia Play: Literacy Across Media', *Journal of Media Literacy Education*, 5(2), pp. 366–369. Available at: www.jmle.org.

Altonen, A. (2011) 'Success Factors of Mass Customization Cases : Chocri and Shoes of Prey'.

Amin, H. (2010) *An inquiry into 3D printing as a potential technology to localized production and understanding emergent business models around personalization for users*, *Design*.

Anderson, C. (2000) *'Disneyland' in Television, The Critical View*. 4th ed. Oxford: Oxford University Press.

Anderson, C. (2012) *Makers: The New Industrial Revolution*.

Arai, Y. and Kinukawa, S. (2013) 'Copyright infringement as user innovation: An Economic Analysis of Dojinshi', *Journal of Cultural Economics*, 38, pp. 131–144. doi: 10.1007/s10824-013-9200-3.

Artzi, D. and Kroll, E. (2011) 'Enhancing aerospace engineering students' learning with 3D printing wind-tunnel models', *Rapid Prototyping Journal*. Emerald, 17(5), pp. 393–402. doi: 10.1108/13552541111156522.

Arvidsson, a. (2008) 'The Ethical Economy of Customer Coproduction', *Journal of Macromarketing*, 28(4), pp. 326–338. doi: 10.1177/0276146708326077.

Arvidsson, A. (2005) 'Brands: A critical perspective', *Journal of Consumer Culture*, 5(2), pp. 235–258. doi: 10.1177/1469540505053093.

Arvidsson, A. (2006) *Brands: Meaning and Value in Media Culture*. Taylor & Francis. Available at: https://books.google.co.uk/books?id=4ml_AgAAQBAJ.

Atılgan, N. Ş. (2014) 'Designer Activity through Open Source Knowledge: Designer Toys Movement', *Procedia - Social and Behavioral Sciences*, 122, pp. 35–39. doi: 10.1016/j.sbspro.2014.01.1299.

Atkinson, P. (2004) 'Post industrial manufacturing systems', in *Challenging craft, International Conference 8th-10th September*.

Atkinson, P. *et al.* (2008) ‘Post Industrial Manufacturing Systems: the undisciplined nature of generative design’, in *Design research society biennial conference*, pp. 1–17.
Atkinson, P. (2010) ‘Boundaries? What Boundaries? The Crisis of Design in a post professional Era’, *Design*, 13(2), pp. 137–155.
Atkinson, P., Marshall, J. and Unver, E. (2007) ‘Generative systems, digital manufacture and craft production’, in *Generative Art Conference*.
Atmaram, P. (2011) *Mass customisation*, *Journal of Engineering Research and Studies MASS*.
Auster, C. J. and Mansbach, C. S. (2012) ‘The Gender Marketing of Toys: An Analysis of Color and Type of Toy on the Disney Store Website’, *Sex Roles*, 67(7–8), pp. 375–388.
Badham, R. (1991) ‘Human-centred CIM Informating the design/manufacturing interface’, *Futures*, 23(10), pp. 1047–1060. doi: 10.1016/0016-3287(91)90071-9.
Baldwin, C. Y. (2007) ‘Where do transactions come from? Modularity, transactions, and the boundaries of firms’, *Industrial and Corporate Change*, 17(1), pp. 155–195. doi: 10.1093/icc/dtm036.
Balinski, B. (2014) ‘3D Systems and Hasbro to bring 3D printing to kids’, *Manufacturers’ Monthly*. Melbourne, pp. 3–5. Available at: https://search.proquest.com/docview/1503197711?accountid=11979 Copyright:
Ballantyne, D. and Varey, R. J. (2007) ‘The service-dominant logic and the future of marketing’, *Journal of the Academy of Marketing Science*, 36(1), pp. 11–14. doi: 10.1007/s11747-007-0075-8.
Bardzell, S. *et al.* (2007) ‘Transmedial interactions and digital games’, in *ACE*. Salzburg: ACM, p. 307. doi: 10.1145/1255047.1255141.
Baumers, M. *et al.* (2016) ‘The cost of additive manufacturing: Machine productivity, economies of scale and technology-push’, *Technological Forecasting and Social Change*. Elsevier B.V., 102, pp. 193–201. doi: 10.1016/j.techfore.2015.02.015.
Beaven, Z. and Laws, C. (2007) ‘“Never let me down again”: Loyal customer attitudes towards ticket distribution channels for live music events: A netnographic exploration of the us leg of the depeche mode 2005–2006 world tour’, *Managing Leisure*. doi: 10.1080/13606710701339322.
Belk, R. W. (1988) ‘Possessions and the Extended Self’, *Journal of Consumer Research*, 15, pp. 139–160. Available at: https://academic.oup.com/jcr/article-abstract/15/2/139/1841428 (Accessed: 29 March 2019).
Bell, J. (1973) *The Coming of Post-industrial Society: A Venture in Social Forecasting*. New York: Basic Books.
Bell, L. *et al.* (2010) ‘Educational implications of the digital fabrication revolution’, *TechTrends*. Springer, 54(5), p. 3. Available at: http://www.springerlink.com/index/T64K711465581703.pdf (Accessed: 19 September 2011).
Benedict (2017) *3ders.org - Reports: Disney acquires ‘world’s first 3D printed toy’ company MakieLab*, *3D Printer News & 3D Printing News*. Available at: https://www.3ders.org/articles/20170222-reports-disney-acquires-worlds-first-3d-printed-toy-company-makielab.html (Accessed: 16 March 2019).
Bengtson, T. (2014) ‘Hasbro Shows Off New DohVinci 3D Printer for Kids at 2014 Toy

Fair in NY', *3Dprint.com*, (February). Available at: https://3dprint.com/1194/hasbro-shows-off-new-dohvinci-3d-printer.
Bird, S. E. (2011) 'Are we all produsers now?: Convergence and media audience practices', *Cultural Studies*, 25(4–5), pp. 502–516. doi: 10.1080/09502386.2011.600532.
Blackwell, A. F., Rode, J. a. and Toye, E. F. (2009) 'How do we program the home? Gender, attention investment, and the psychology of programming at home', *International Journal of Human-Computer Studies*, 67(4), pp. 324–341. doi: 10.1016/j.ijhcs.2008.09.011.
Bogers, M., Afuah, A. and Bastian, B. (2010) 'Users as Innovators: A Review, Critique, and Future Research Directions', *Journal of Management*. South Manage Assoc, 36(4), pp. 857–875. doi: 10.1177/0149206309353944.
Bogers, M., Hadar, R. and Bilberg, A. (2016a) 'Additive manufacturing for consumer-centric business models: Implications for supply chains in consumer goods manufacturing', *Technological Forecasting and Social Change*. Elsevier Inc., 102, pp. 225–239. doi: 10.1016/j.techfore.2015.07.024.
Bogers, M., Hadar, R. and Bilberg, A. (2016b) 'Additive manufacturing for consumer-centric business models: Implications for supply chains in consumer goods manufacturing', *Technological Forecasting and Social Change*, 102, pp. 225–239. doi: 10.1016/j.techfore.2015.07.024.
Bogost, I. and Montfort, N. (2009) 'Platform Studies: Frequently Questioned Answers', *Digital Arts and Culture*, 12–15(December), pp. 1–6.
Bolin, G. (2007) 'Media Technologies, transmedia storytelling and commodification', *Ambivalence towards convergence, digitalization and media change. Nordicom. Göteborg, Sweden*, pp. 237–248. Available at: http://technocult.se/files/13 (Accessed: 2 October 2011).
Bonanni, L., Parkes, A. and Ishii, H. (2008) 'Future Craft : How Digital Media is Transforming Product Design', in *CHI 2008*, pp. 1–12.
Bonner, A. and Tolhurst, G. (2002) *Insider-outsider perspectives of participant observation*, *Nurse Researcher*. doi: 10.7748/nr2002.07.9.4.7.c6194.
Bonney, L., Herd, K. B. B. and Moreau, C. P. P. (2010) 'For You or For Me? How the Intended Recipient Influences the Customization Experience and Valuations of Customized Products', *Advances in Consumer Research*, 38, pp. 1–47. Available at: http://web-docs.stern.nyu.edu/old_web/emplibrary/PMoreau Paper.pdf (Accessed: 31 July 2011).
Booth, P. (2015) 'Crowdfunding: A Spimatic application of digital fandom', *New Media and Society*, 17(2), pp. 149–66.
Booth, P. (2016) 'Board, game, and media: Interactive board games as multimedia convergence', *Convergence*, 22(6), pp. 647–660. doi: 10.1177/1354856514561828.
Borghini, S. *et al.* (2009) 'Why Are Themed Brandstores So Powerful? Retail Brand Ideology at American Girl Place', *Journal of Retailing*, 85(3), pp. 363–375. doi: 10.1016/j.jretai.2009.05.003.
Bosqué, C. (2015) 'What are you printing? Ambivalent emancipation by 3D printing', *Rapid Prototyping Journal*, 21(5), pp. 572–581. doi: 10.1108/RPJ-09-2014-0128.
Bradshaw, S., Bowyer, A. and Haufe, P. (2010) 'The Intellectual Property implications of low-cost 3D printing', *ScriptEd*. University of Edinburgh, 7(1), pp. 5–31. doi:

10.2966/scrip.
Bruneel, J., D'Este, P. and Salter, A. (2010) 'Investigating the factors that dimminish the barriers to university-industry collaboration', *Research Policy*.
Brusoni, S., Prencipe, A. and Pavitt, K. (2001) 'Knowledge specialization, organizational coupling, and the boundaries of the firm: Why do firms know more than they make?', *Administrative science quarterly*. JSTOR, 46(4), pp. 597–621. Available at: http://www.jstor.org/stable/3094825 (Accessed: 21 May 2011).
Budnitz, P. (2006) *I Am Plastic: The Designer Toy Explosion.* New York: Abrams.
Buehler, E., Easley, W., *et al.* (2015) 'Inclusion and Education: 3D Printing for Integrated Classrooms', *ACM SIGACCESS Conference on Computers and Accessibility (ASSETS 2015)*, pp. 281–290. doi: 10.1145/2700648.2809844.
Buehler, E., Branham, S., *et al.* (2015) 'Sharing is Caring: Assistive Technology Designs on Thingiverse', *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems - CHI '15*, pp. 525–534. doi: 10.1145/2702123.2702525.
Burkart, P. and McCourt, T. (2006) *Digital Music Wars.* Edited by M. Lanham. Burkett: Rowman & Littlefield.
Burns, M. and Howison, J. (2001) 'Digital manufacturing - Napster fabbing : Internet delivery of physical products', *Rapid Prototyping Journal*, 7(4), pp. 194–196. Available at: http://www.emeraldinsight.com/journals.htm?articleid=1509278&show=abstract (Accessed: 26 September 2011).
Burroughs, B. and Rama, P. (2015) 'The eSports Trojan Horse: Twitch and Streaming Futures', *Journal For Virtual Worlds Research*, 8(2). doi: 10.4101/jvwr.v8i2.7176.
Butler Millsaps, B. (2016) 'Calling all Captains! Star Trek Online & Eucl3D Partner, Allowing Gamers to Order 3D Printed , Customized Ships', *3Dprint.com*, September. Available at: https://3dprint.com/148291/star-trek-eucl3d-partner/.
Calleja, G. (2007a) 'Digital game involvement: A conceptual model', *Games and Culture*, 2(3), pp. 236–260. doi: 10.1177/1555412007306206.
Calleja, G. (2007b) 'Digital games as designed experience: Reframing the concept of immersion', *Unpublished Doctoral Thesis, Victoria University of …*, p. 256. doi: citeulike-article-id:6042420.
Carolan, N. (2010) *Product Pirates – Intellectual property implications of post industrial manufacture (Digital Fabrication and file-shared product design)*, *FISCAR Proceedings of the Nordic Conference on Activity Theory and the Fourth Finnish Conference on Cultural and Activity Research.* Helsinki: Aalto University.
Carolan, N. and Cruickshank, L. (2010a) *Cutting out the middle wo(man) - the implications of co-design and digital fabrication for the design profession*, *FISCAR Proceedings Helsinki*. Helsink: Aalto University.
Carolan, N. and Cruickshank, L. (2010b) 'Understanding Design Interventions in Democratic Innovation: a Toolkit Approach', *Design Research Journal*, 2(10), pp. 33–38. Available at: http://eprints.lancs.ac.uk/id/eprint/52523.
Carson, K. (2010) *The Homebrew Industrial Revolution: A Low Overhead manifesto*. 1st edn. Available at: http://dl.dropbox.com/u/4116166/NewHomeBrew.pdf.
Chapple, S. and Garofalo, R. (1978) *Rock 'n' Roll Is Here to Pay: The History and Politics ofthe Music Industry*. Chicago: Nelson-Hall.

Charmy, C. (2012) 'The Next Wave of E-Commerce Innovation', *Forbes*, 11 June, pp. 1–23. Available at: http://www.forbes.com/sites/techonomy/2012/06/11/the-next-wave-of-e-commerce-innovation/#49e1bb815abb (Accessed: 11 June 2011).

Chase, R. W. (1997) *CAD for Fashion Design*, *Design*. New Jersey: Prentice Hall. Available at: https://books.google.co.uk/books/about/CAD_for_Fashion_Design.html?id=ujN8QgAACAAJ.

Chipchase, J. (2017) *The Field Study Handbook*. 1st edn. San Francisco Tokyo: Field Institute.

Clark, E. (2007) *The Real Toy Story : Inside the Ruthless Battle for America's Youngest Consumers.* Free Press. Available at: https://books.google.co.uk/books/about/The_Real_Toy_Story.html?id=uVTuTiPnQHQC&redir_esc=y (Accessed: 12 March 2019).

Clarke, C. (2016) *3D Printing provides millions of stop-motion possibilities*, *3D Printing Industry*. Available at: https://3dprintingindustry.com/news/3d-printing-provides-millions-stop-motion-possibilities-101338/.

Clough, P. and Nutbrown, C. (2012) 'Research Design: shaping the study', *A student's Guide to Methodology: justifying inquiry*, pp. 133–154.

Collins, S. (2010) 'Digital Fair: Prosumption and the fair use defence', *Journal of consumer culture*. Sage, 10(1), pp. 37–55. doi: 10.1177/1469540509354014.

Conner, B. P. *et al.* (2014) 'Making sense of 3-D printing: Creating a map of additive manufacturing products and services', *Additive Manufacturing*. Elsevier B.V., 1, pp. 64–76. doi: 10.1016/j.addma.2014.08.005.

Conway, S. (2010) 'A circular wall? Reformulating the fourth wall for videogames', *Journal of Gaming & Virtual Worlds*, 2(2), pp. 145–155. doi: 10.1386/jgvw.2.2.145_1.

Cormier, D., Harrysson, O. and Mahale, T. (2003a) 'RAPID MANUFACTURING IN THE 21 ST CENTURY', 20(3), pp. 193–202.

Cormier, D., Harrysson, O. and Mahale, T. (2003b) 'Rapid Manufacturing in the 21st century', *Journal of the Chinese Institute of Industrial Engineers*, 20(3), pp. 193–202.

Corser, R. (2010) *Fabricating Architecture*. New York: Princeton Architectural Press.

Coulton, P. (2012) 'SKYLANDERs: Near Field in Your Living Room Now.', *The Journal of Pervasive Media*, pp. 136–138.

Coulton, P. *et al.* (2014) 'Game Design in an Internet of Things', *Transactions of the Digital Games Research Association*, 1(3), p. 11. doi: 10.26503/todigra.v1i3.19.

Covert, A. (2014) *3-D printing 'ink' is way too expensive*, *CNN Money Web*. Available at: http://money.cnn.com/2014/02/20/technology/innovation/3d-printer-filament/ (Accessed: 10 February 2016).

Crabtree, A. *et al.* (2012) 'Doing Fieldwork', in *Doing Design Ethnography Part of the series Human–Computer Interaction Series*. London: Springer. doi: 10.1007/978-1-4471-2726-0.

Crabtree, A., Rouncefield, M. and Tolmie, P. (2012a) 'Analysing the Ethnographic Record', in *Doing Design Ethnography*, pp. 111–133.

Crabtree, A., Rouncefield, M. and Tolmie, P. (2012b) *Doing Design Ethnography*, *Doing design ethnography*. London: Springer. doi: https://doi.org/10.1007/978-1-4471-

2726-0.
Cruckshank, L. and Carolan, N. (2010) 'New User-Led Design Processes for Digital Fabrication', in *FISCAR Proceedings of the Nordic Conference on Activity Theory and the Fourth Finnish Conference on Cultural and Activity Research.* Helsinki.
Dahan, E. and Hauser, J. R. (2002) 'The virtual customer', *Journal of Product Innovation Management*. Elsevier, 19(5), pp. 332–353. Available at: http://www.sciencedirect.com/science/article/pii/S0737678202001510 (Accessed: 23 September 2011).
Daly, A. (2016a) '"Don't Believe the Hype? Recent 3D Printing Developments for Law and Society"', in *Socio-Legal Aspects of the 3D Printing Revolution*. Palgrave Macmillan.
Daly, A. (2016b) *Socio-Legal Aspects of the 3D Printing Revolution*. doi: 10.1057/978-1-137-51556-8.
Davis, S. M. (1987) *Future perfect.* Reading, Mass.: Addison-Wesley Publ. Co.
Davis, Z. (1966) 'The Reviews.', *HiFi/Sterio Review*, pp. 17:146-147.
Dean, L. T. (2008) 'Industrial Manufacturing Systems 5.1', *Paper Industry*, pp. 1–17.
Dean, L. T. T., Atkinson, P. and Unver, E. (2005) 'FutureFactories: inverting the mass-production paradigm', in *Symposium on the use of digital technology in designing and making three-dimensional forms, Falmouth, Cornwall, UK*. Available at: http://eprints.hud.ac.uk/3752 (Accessed: 23 September 2011).
Dellaert, B. and Stremersch, S. (2003) 'Modeling the consumer decision to mass customize', *... World Congress on Mass Customization ...*. Available at: http://scg.mit.edu/images/MCPC 2003/site/5-Customer Interaction Behavior/8-Dellaert.pdf.
Depoorter, B. (2014) 'Intellectual Property Infringements & 3D Printing: Decentralized Piracy', *Hastings Law Journal*, 65:1483, pp. 1483–1504.
Desai, D. R. and Magliocca, G. N. (2013) 'Patents, Meet Napster: 3D Printing and the Digitization of Things', *Georgetown Law Journal, Forthcoming.*, p. 57.
Deuze, M. (2007) 'Convergence culture in the creative industries', *International Journal of Cultural Studies*, 10(2), pp. 243–263. doi: 10.1177/1367877907076793.
DeWalt, K. M. and DeWalt, B. R. (2002) *Participant observation : a guide for fieldworkers*. AltaMira Press. Available at: https://books.google.co.uk/books/about/Participant_Observation.html?id=p1wcO3UNXQ4C (Accessed: 20 March 2019).
Diakopoulos, N. *et al.* (2007) 'The Evolution of Authorship in a Remix Society', *Proceedings of the 18th conference on Hypertext and hypermedia HT 07*, (September), p. 133. doi: 10.1145/1286240.1286272.
Dinehart, S. (2008) *Transmedial play: Cognitive and cross-platform narrative*, *NarrativeDesign.org*. Available at: tivedesign.org/2008/05/transmedial-play-cognitive-and- cross-platform-narrative/ Disney.
Doctorow, C. (2009) *Makers*. HarperColins.
Doctorow, C. (2013) *Makies hit shelves at Selfridges*, *BoingBoing*. Available at: https://boingboing.net/2013/08/13/makies-hit-shelves-at-selfridg.html (Accessed: 16 March 2019).
Doherty, D. (2012) 'Downloading Infringment: Patent Law as a Roadblock to the 3D Printing Revolution', *Harvard Journal of Law & Technology*, 26(1), pp. 353–373.

Dolbow, S. (2001) 'Wary over Harry.', *Brandweek*, p. 42(24).
Dolinsky, K. (2014) 'CAD's Cradle: Untangling Copyrightability , Derivative Works , and Fair Use in 3D Printing', pp. 591–682.
Duray, R. (2002) 'Mass customization origins: mass or custom manufacturing?', *International Journal of Operations & Production Management*, 22(3), pp. 314–328. doi: 10.1108/01443570210417614.
Economist, T. (2014) 'Ready, print, fire; Making guns at home', *The Economist*, pp. 14–17. doi: http://dx.doi.org/10.1108/17506200710779521.
Economist, T. (2018) 'Why it is difficult to regulate 3D-printed guns', *The Economist*, 26 July. Available at: https://www.economist.com/the-economist-explains/2018/07/26/why-it-is-difficult-to-regulate-3d-printed-guns.
Eiji, Ō. and Steinberg, M. (2010) 'World and Variation: The Reproduction and Consumption of Narrative', *Mechademia*, 5(1), pp. 99–116. doi: 10.1353/mec.2010.0008.
Emerson, R., Fretz, R. and Shaw, L. (1995) *Writing Ethnographic Fieldnotes*. Second. University of Chicago Press.
Etgar, M. (2008) 'A descriptive model of the consumer co-production process', *Journal of the Academy of Marketing Science*, 36, pp. 97–108. doi: 10.1007/s11747-007-0061-1.
Evans, E. J. (2008) 'Character, audience agency and transmedia drama', *Media, Culture and Society*, 30(2), pp. 197–213. doi: 10.1177/0163443707086861.
Fagerjord, A. (2010) 'After Convergence: YouTube and Remix Culture', in Hunsinger, J., Klastrup, L., and Allen, M. (eds) *International Handbook of Internet Research*. Springer Netherlands, pp. 187–200. Available at: http://www.springerlink.com/index/10.1007/978-1-4020-9789-8.
Fanea-Ivanovici, M. (2019) 'Filmmaking and crowdfunding: A right match?', *Sustainability (Switzerland)*, 11(3). doi: 10.3390/su11030799.
Ferguson, K. (2010) *Everythign is a Remix part 1*.
Ferrara, M. (2011) 'Design and self-production . The advanced dimension of handcraft Design e produção própria . A dimensão avançada do artesanato', 4(April), pp. 5–13. doi: 10.4013/sdrj.2011.41.02.
Fink, A. S. (2000) 'The role of the Researcher in the Qualitative Process. A Potential Barrier to Archiving Qualitative Data.', *Forum Qualitative Sozialforschung / Forum: Qualitative Social Research*. Deutsche Forschungsgemeinschaft, 1(3). Available at: http://www.qualitative-research.net/index.php/fqs/article/view/1021/2201 (Accessed: 22 March 2019).
Finn, H., Søren, J. and Stoyan, T. (2014) 'Disruptive Innovation vs Disruptive Technology: The Disruptive Potential of the Value Propositions of 3D Printing Technology Startups', *Technology Innovation Management Review*, (December), pp. 27–36. Available at: http://timreview.ca/article/855.
Fiore, A. M. (2008) 'The Digital Consumer: Valuable Partner for Product Development and Production', *Clothing and Textiles Research Journal*, 26(2), pp. 177–190. doi: 10.1177/0887302X07306848.
Flaherty, J. (2012a) *Figureprints makes minecraft real with 3-D Printers*, *Wired*. Available at: https://www.wired.com/2012/11/3-d-printed-minecraft/.
Flaherty, J. (2012b) *Watch your back, Hasbro, 3D printed games have arrived*, *Wired*.

Available at: https://www.wired.com/2012/08/watch-your-back-hasbro-3d-printed-games-have-arrived/.

Fleming, D. (1996) *Powerplay : toys as popular culture*. Manchester University Press. Available at: https://books.google.co.uk/books/about/Powerplay.html?id=U3u7AAAAIAAJ&redir_esc=y (Accessed: 12 March 2019).

Fletcher, A. (2006) ‘Do consumers want to design unique products on the Internet? A study of the online virtual community of Threadless. com and their attitudes to mass customisation, mass production and collaborative design’, *Information Systems*. Available at: http://www.clickadvisor.com/downloads/Fletcher_Dissertation_Threadless.pdf (Accessed: 8 October 2011).

Fletcher, G. *et al.* (2016) ‘The social supply chain and the future high street’, *Supply Chain Management: An International Journal*, 21(1), pp. 78–91. doi: 10.1108/SCM-05-2014-0154.

Flick, U. (2011) *Introducing Research Methodology: A Beginner’s Guide to Doing a Research Project*. Los Angeles: SAGE.

Florida, R. (2002) *The Rise of the Creative Class*, *Washington Monthly*. Basic Books.

Fox, S. (2009) ‘Manufacturing goes online [advanced manufacturing technology]’, *Engineering & Technology*, 4(15), p. 62. doi: 10.1049/et.2009.1512.

Franke, N., Keinz, P. and Schreier, M. (2008) ‘Complementing mass customization toolkits with user communities : How peer input improves customer self-design’, *Journal of Product Innovation Management*. Wiley Online Library, 25(6), pp. 546–559. Available at: http://onlinelibrary.wiley.com/doi/10.1111/j.1540-5885.2008.00321.x/full (Accessed: 22 September 2011).

Franke, N., Keinz, P. and Steger, C. J. (2009) ‘Testing the Value of Customization: When Do Customers Really Prefer Products Tailored to Their Preferences?’, *Journal of Marketing*, 73(5), pp. 103–121. doi: 10.1509/jmkg.73.5.103.

Franke, N. and Piller, F. (2004) ‘Value Creation by Toolkits for User Innovation and Design: The Case of the Watch Market’, *Journal of Product Innovation Management*, 21(6), pp. 401–415. doi: 10.1111/j.0737-6782.2004.00094.x.

Franke, N. and Piller, F. T. T. (2003) ‘Key Research Issues in User Interaction with Configuration Toolkits in a Mass Customization System’, *International Journal of Technology Management*. Inderscience, 26(5), pp. 578–599. Available at: http://inderscience.metapress.com/index/UTR3EU85WNDEDXED.pdf (Accessed: 21 September 2011).

Franke, N., Schreier, M. and Kaiser, U. (2009) ‘The “I Designed It Myself” Effect in Mass Customization’, *Management Science*, 56(1), pp. 125–140. doi: 10.1287/mnsc.1090.1077.

Franke, N., Schreier, M. and Kaiser, U. (2010) ‘The “ I Designed It Myself ” Effect in Mass Customization’, 56(1), pp. 125–140. doi: 10.1287/mnsc.1090.1077.

Franke, N. and Shah, S. (2003) ‘How communities support innovative activities: an exploration of assistance and sharing among end-users’, *Research Policy*. Edited by Yolum et al. Elsevier (#4164), 32(1), pp. 157–178. doi: 10.1016/S0048-7333(02)00006-9.

Frazer, J. (1995) ‘An Evolutionary Architecture.’, *Architectural Association*.

Friedman, W. (1999) ‘Saying goodbye to Hollywood’, *Advertising Age*, p. 70 (2) 12.
Füller, J. *et al.* (2004) ‘Community Based Innovation A Method to Utilize the Innovative Potential of Online Communities’, *Access*, 00(C), pp. 1–10.
Fuller, J., Jawecki, G. and Muhlbacher, H. (2007) ‘Innovation creation by online basketball communities’, *Journal of Business Research*, 60(1), pp. 60–71. doi: 10.1016/j.jbusres.2006.09.019.
Galbraith, P. W. and Karlin, J. G. (2016) ‘Media Convergence in Japan’. doi: 10.1017/CBO9781107415324.004.
Galuszka, P. (2014) ‘New Economy of Fandom’, *Popular Music and Society*, 38(1), pp. 25–43. doi: 10.1080/03007766.2014.974325.
Galvagno, M. and Dalli, D. (2014) ‘Theory of value co-creation: a systematic literature review’, *Managing Service Quality*, 24(6), pp. 643–683. doi: 10.1108/MSQ-09-2013-0187.
Gawer, A. (2014) ‘Bridging differing perspectives on technological platforms: Toward an integrative framework’, *Research Policy*. Elsevier B.V., 43(7), pp. 1239–1249. doi: 10.1016/j.respol.2014.03.006.
Geelhoed, A. (2014) ‘The 3D Printing Revolution’, *CCR magazine / Business Information Industry Association*, pp. 1–13. Available at: http://www.biia.com/wp-content/uploads/2013/11/3D-printing-and-credit-risk-management-.pdf.
Geere, B. D. (2012) ‘Get your own custom 3D-printed doll in Makielab’s public alpha’, *Wired UK*, May. Available at: http://www.wired.co.uk/article/makies.
Geertz, C. (1973) ‘Thick description: Toward an interpretive theory of culture 1973’, *The Interpretation of Cultures*. doi: 10.4135/9781412984591.n6.
Gershenfeld, N. (2007) *FAB: The coming revolution on your desktop - from personal computers to personal fabrication*.
Gershuny, J. (1978) *After Industrial Society?: The Emerging Self-service Economy*. Macmillan. Available at: https://books.google.co.uk/books?id=u14fAQAAIAAJ.
Giovagnoli, M. (2011) *Transmedia Storytelling: Imagery, Shapes and Techniques*. Pittsburgh: ETC Press.
Gloor, P. and Cooper, S. (2007) ‘The New Principles of a Swarm Business’, *MIT Sloan management review*, 48(3), pp. 81–84.
Gold, R. (1958) ‘Roles in Sociological Observations’, *Social Forces*, 36(3), pp. 217–223.
Goldhar, J. D. and Lei, D. (1995) ‘Variety is free : Manufacturing in the twenty-first century’, *Management*, 9(4), pp. 73–87.
Good, O. (2015) ‘Kerbal Space Program now offering 3D printed models of your ships’, *Polygon.com*, February. Available at: https://www.polygon.com/2015/2/28/8125803/kerbal-space-program-now-offering-3d-printed-models-of-your-ships.
Grace, J. (2014) ‘The End of Post-Sale Confusion: How consumer 3D printing will dimish the function of trademarks’, *Harvard Journal of Law & Technology*, 28(1), pp. 1823–1834. doi: 10.1080/01947640390160208.
Green, L. (2012) ‘Going Cardboard: A Boardgame Documentary’, *Nashua, NH: T-Cat Productions.*
Greenberg, A. (2013) *State Department Demands Takedown Of 3D-Printable Gun Files For Possible Export Control Violations*, *Forbes/Security*. Available at: http://www.forbes.com/sites/andygreenberg/2013/05/09/state-department-dem?n-

of-3d-printable-gun-for-possible-export-control-violation/#2fa355bc3fb7 (Accessed: 28 January 2016).
Greene, J. ., Caracelli, V. . and Graham, W. . (1989) ‘Toward a conceptual framework for mixed-method evaluation designs’, *Educational Evaluation and Policy Analysis*, 11, pp. 255–274.
Grunewald, S. (2014) ‘CAN YOU TELL ME HOW TO PRINT, HOW TO 3D PRINT SESAME STREET … IF YOU DON’T HAVE A MAKERBOT’, *3D Printing Industry*, May. Available at: https://3dprintingindustry.com/news/3d-printing-sesame-street-makerbot-27459/.
Grunewald, S. (2016) ‘Is Disney Getting into the 3D Printing Business? They Just Filed for Three New Related Patents’, *3Dprint.com*, March.
Gulden, T. (2015) ‘A System Analysis of Transmedia Storytelling Toys in Relation to Desire and Pleasure’, *Procedia Manufacturing*. Elsevier B.V., 3(2351), pp. 2071–2078. doi: 10.1016/j.promfg.2015.07.256.
Gunn, W., Otto, T. and Smith, R. C. (2013) *Design Anthropology Theory and Practice*. Kindle, *Design Anthropology Theory and Practice*. Kindle. London: Bloomsbury Publishing.
Gurevitch, L. (2012) ‘Computer Generated Animation as Product Design Engineered Culture, or Buzz Lightyear to the Sales Floor, to the Checkout and Beyond!’, *Animation*, 7(2), pp. 131–149. doi: 10.1177/1746847712438133.
Guschwan, M. (2012) ‘Fandom, brandom and the limits of participatory culture’, *Journal of Consumer Culture*, 12(1), pp. 19–40. doi: 10.1177/1469540512438154.
Guth, R. (2007) ‘How 3-D Printing Figures To Turn Web Worlds Real’, *The Wall Street Journal Online*.
Hamilton, W. A., Garretson, O. and Kerne, A. (2014) ‘Streaming on twitch: Fostering participatory communities of play within live mixed media’, *Conference on Human Factors in Computing Systems - Proceedings*, pp. 1315–1324. doi: 10.1145/2556288.2557048.
Hanna, P. (2011) ‘The next Napster ? Copyright questions as 3D printing comes of age’, *Ars Technica*, June. doi: 10.1148/radiol.2372041509.
Harris Brean, D. (2015) ‘Asserting Patents To Combat Infringement Via 3D Printing: Is No “Use”’, ... *Intellectual Property, Media & Entertainment Law* ..., Vol. 23(No.3), pp. 771–814. Available at: http://works.bepress.com/context/daniel_brean/article/1000/type/native/viewcontent.
Harris, E. A. (2014) ‘Hasbro to Collaborate with 3D Printing Company to Sell Artwork’, *The New York Times*, 20 July. Available at: https://www.nytimes.com/2014/07/21/business/hasbro-selling-my-little-pony-fan-art.html?_r=0.
Harvey, C. B. (2016a) ‘Fantastic Transmedia’, in *Fantastic Transmedia*. doi: 10.1057/9781137306043_2.
Harvey, C. B. (2016b) ‘Transmedia Memory’, in *Fantastic Transmedia*. doi: 10.1057/9781137306043_9.
Hayes, D. (2008) *Anytime playdate : inside the preschool entertainment boom, or, how television became my baby’s best friend*. Free Press. Available at: https://www.simonandschuster.com/books/Anytime-Playdate/Dade-

Hayes/9781416546849 (Accessed: 12 March 2019).
Heljakka, K. (2015) 'From toys to television and back: My Little Pony appropriated in adult toy play', *Journal of Popular Television*, 3(1), pp. 99–109. doi: 10.1386/jptv.3.1.99.
Hemetsberger, A. and Pieters, R. (2001) 'When Consumers Produce on the Internet: An Inquiry into Motivational Sources of Contribution to Joint-Innovation', *Proceedings of the Fourth International Research Seminar on Marketing Communications and Consumer Behavior*. Edited by D. et al. Christian, pp. 274–291. Available at: https://pdfs.semanticscholar.org/0862/35321b88aa3970430164c60de09f0651954f.pdf (Accessed: 29 March 2019).
Hemmann, K. (2015) 'Queering the media mix: The female gaze in Japanese fan comics', *Transformative Works and Cultures*, 20(0), pp. 1–25. doi: 10.3983/twc.v20i0.628.
Herd, K. (2012) *The development of conceptual models and frameworks to inform design for co‐design in mass customisation*.
Herman, E. S. and McChesney, R. W. (1997) *The global media : the new missionaries of corporate capitalism*. Cassell. Available at: https://books.google.co.uk/books/about/The_Global_Media.html?id=j70kAQAAMAAJ&redir_esc=y (Accessed: 12 March 2017).
Hermans, P. (2013) *Makies make history as the world's first CE-certified EN71-compliant 3D printed toy*, *3D Printing Materials Conference*. Available at: https://www.3dprintingmaterialsconference.com/uncategorized/makies-make-history-as-the-worlds-first-ce-certified-en71-compliant-3d-printed-toy/ (Accessed: 16 March 2019).
Hetcher, S. A. (2009) 'Using Social Norms to Regulate Fan Fiction and Remix Culture', *University of Pennsylvania Law Review*, 157(6), pp. 1869–1935.
Highfield, T., Harrington, S. and Bruns, A. (2013) 'Twitter As a Technology for Audiencing and Fandom', *Information, Communication & Society*, 16(3), pp. 315–339. doi: 10.1080/1369118x.2012.756053.
Hill, B. M. and Monroy-Hernandez,  a. (2012) 'The Remixing Dilemma: The Trade-Off Between Generativity and Originality', *American Behavioral Scientist*, 57(5), pp. 643–663. doi: 10.1177/0002764212469359.
Hippel, E. and von Hippel, Eric (2001) 'User toolkits for innovation', *Journal of Product Innovation Management*. Wiley Online Library, 18(4), pp. 247–257. Available at: http://www2.sa.unibo.it/summer/testi/16_muffatto/von-Hippel-User-Tooktit.pdf (Accessed: 14 September 2011).
von Hippel, E. (1998) 'Economics of Product Development by Users: The Impact of "Sticky" Local Information', *Management Science*, pp. 629–644.
von Hippel, E. (2001) 'User toolkits for innovation', *Journal of Product Innovation Management*. Wiley Online Library, 18(4), pp. 247–257. Available at: http://www2.sa.unibo.it/summer/testi/16_muffatto/von-Hippel-User-Tooktit.pdf (Accessed: 14 September 2011).
von Hippel, E. (2004) 'Democratizing Innovation: The evolving phenomenon of user innovation', pp. 1–26.

von Hippel, E. (2005) *Democratizing Innovation*.
Hippel, Eric Von (2007) 'Horizontal innovation networks-by and or users', *Industrial and corporate change*, pp. 1–26. Available at: http://icc.oxfordjournals.org/content/16/2/293.short (Accessed: 8 October 2011).
Hippel, E Von (2007) 'New Directions for Mass Customization', *Industrial and corporate change*. Available at: http://icc.oxfordjournals.org/content/16/2/293.short (Accessed: 8 October 2011).
von Hippel, E. and Katz, R. (2002) 'Shifting Innovation to Users via Toolkits', *Management science*. JSTOR, 48(7), pp. 821–833. Available at: http://www.jstor.org/stable/822693 (Accessed: 21 September 2011).
van Hoek, R. (2001) 'The rediscovery of postponement a literature review and directions for research', *Journal of Operations Management*, 19(2), pp. 161–184. doi: 10.1016/S0272-6963(00)00057-7.
Holbrook, M. B. *et al.* (2006) 'Consumption experience, customer value, and subjective personal introspection: An illustrative photographic essay', *Journal of Business Research*, 59(6), pp. 714–725. doi: 10.1016/j.jbusres.2006.01.008.
Holbrook, M. B. M. B. and Hirschman, E. C. E. C. (1982) 'The experiential aspects of consumption: Consumer fantasies, feelings, and fun', *Journal of consumer research*, 9(2), p. 132. doi: 10.1086/208906.
Holbrook, T. R. and Osborn, L. (2014) *Digital Patent Infringement in an Era of 3D Printing*, *SSRN*. doi: 10.2139/ssrn.2483550.
Holman, W. (2014) *Crapjects*, *Object Guerilla Blog*. Available at: http://objectguerilla.com/blog/2014/10/23/crapjects (Accessed: 12 December 2017).
Holt, D. B. (1995) 'How Consumers Consume: A Typology of Consumption Practices', *Journal of Consumer Research*, 22(1), p. 1. doi: 10.1086/209431.
Holt, D. B. B. D. B. (1995) 'How Consumers Consume: A Typology of Consumption Practices', *Journal of Consumer Research*. JSTOR, 22(1), pp. 1–16. doi: 10.1016/0098-7913(84)90029-7.
Howard, J. (2014) 'MakerBot to Bring its First Licensed Brand , Sesame Street , to the MakerBot Digital Store and to MakerBot Retail Stores', pp. 1–2.
Huang, C., Do, E. Y. and Gross, M. D. (no date) 'MouseHaus Table, a Physical Interface for Urban Design', *User Interface Software and Technology, Conference Supplement*, (Figure 2), pp. 41–42.
Huffman, C. and Kahn, B. E. (1998) 'Variety for sale: Mass customization or mass confusion?', *Journal of Retailing*, 74(4), pp. 491–513. doi: 10.1016/S0022-4359(99)80105-5.
Huilgol, M. (2016) *Mattel's $300 3D Printing Toy Studio Might be the Game Changer we Were Looking for*. Available at: http://techpp.com/2016/02/15/mattel-3d-printer-thingmaker.
Humphries, M. (2012) 'Mineways lets you export Minecraft models for 3D printing', *Geek.com*. Available at: https://www.geek.com/games/mineways-lets-you-export-minecraft-models-for-3d-printing-1454333/.
Hunt, J. (2005) 'A Manifesto for Post Industrial Design', *ID magazine*.
Hutchins, A. A. (2014) 'User-generated sales ; From spinning fiction to 3D printing , Hasbro lets fans dabble in product', *KidScreen*, October, p. 64. doi:

http://dx.doi.org/10.1108/17506200710779521.
Igarashi, Y. and Igarashi, T. (2009a) 'Designing plush toys with a computer', *Communications of the ACM*, 52(12), p. 81. doi: 10.1145/1610252.1610275.
Igarashi, Y. and Igarashi, T. (2009b) 'Designing plush toys with a computer', *Communications of the ACM*, 52(12), p. 81. doi: 10.1145/1610252.1610275.
Ilhan, B. E., Otnes, C. and Kozinets, R. (2013) 'Transmedia Consumption Experiences (TCE): Patching as a Narrative Consumption Practice', *Advances in Consumer Research*.
Ito, M. (2001) 'The Media Mix: Multiple Embodiments of Japanimation Characters', (November), pp. 1–10. Available at: papers2://publication/uuid/8B0D9C5D-1693-4048-93E7-19E26C2E6440.
Ito, M. (2007) 'Technologies of the childhood imagination: Yugioh, media mixes, and everyday cultural production', *Structures of Participation in Digital Culture*, (Allison 2004), pp. 88–112. Available at: http://www.ssrc.org/publications/view/6A130B0A-234A-DE11-AFAC-001CC477EC70/.
Ito, M. (2014) 'Mobilizing the Imagination in Everyday Play: The Case of Japanese Media Mixes', *The International Handbook of Children, Media and Culture*, pp. 397–412. doi: 10.4135/9781848608436.n24.
James, J. and Bhalla, A. (1993) 'Flexible Specialization, new technologies and future industrialization in developing countries', *Futures*, (August).
Jardine, A. (2001) 'Marketing magic', *Marketing*, p. 20,20.
Jaremko-Greenwold, A. (2015) *How 3D Printing Has Revolutionized Stop-Motion Animation for LAIKA*, *IndieWire*. Available at: https://www.indiewire.com/2015/04/how-3d-printing-has-revolutionized-stop-motion-animation-for-laika-62623/.
Jarvenpaa, S. L. and Lang., K. R. (2011) 'Boundary Management in Online Communities: Case Studies ofthe Nine Inch Nails and ccMixter Music Remix Sites.', *Long Range Planning*, 44, pp. 5–6. doi: https://doi.org/10.1016/j.lrp.2011.09.002.
Jeffery-Poulter, S. (2003) 'Creating and producing digital content across multiple platforms', *Journal of Media Practice*. Routledge, 3(3), pp. 155–164. doi: 10.1386/jmpr.3.3.155.
Jenkins, H. (2003) 'Transmedia Storytelling: Moving characters from books to films to video games can make them stronger and more compelling.', *MIT Technology Review*, p. 28. Available at: https://www.technologyreview.com/s/401760/transmedia-storytelling/.
Jenkins, H. (2004) '"Quentin Tarantino's Star Wars? Digital Cinema, Media Convergence and Participatory Culture "', *http://web.mit.edu/cms/People/henry3/publications.html*, pp. 1–23. Available at: http://web.mit.edu/21fms/www/faculty/henry3/starwars.html- 10/29/2004 - 1.
Jenkins, H. *et al.* (2006) 'Confronting the Challenges of Participatory Culture: Media Education for the 21st Century', *The John D. and Catherine McArthur Foundation*, pp. 147–168. doi: 10.1016/b978-0-12-801867-5.00008-2.
Jenkins, H. (2006) *Convergence Culture: Where Old and New Media Collide*. New York: NYU Press.

Jenkins, Henry (2007) 'The future of fandom', *Fandom: Identities and Communities in a Mediated world*, pp. 357–364. Available at: http://www.binaryspark.com/classes/Fandom/readings/Afterword - The Future of Fandom.pdf.

Jenkins, H. (2007) *Transmedia Storytelling 101*, *Confessions of an Aca-fan:The Official Weblog of Henry Jenkins*. doi: 10.1007/978-3-319-01821-8.

Jenkins, H. (2010) 'Transmedia storytelling and entertainment: An annotated syllabus', *Continuum*, 24(6), pp. 943–958. doi: 10.1080/10304312.2010.510599.

Jenny (2013a) *How-To: 3D Print a Video Game Figurine*, *Make*. Available at: https://makezine.com/2013/06/27/how-to-3d-print-a-video-game-figurine/.

Jenny (2013b) *How to make your own 3D print of a video game character*, *Kotaku*. Available at: https://kotaku.com/how-to-make-your-own-3d-print-of-a-video-game-character-599171712.

Jeppesen, L. B. and Molin, M. J. (2003) 'Consumers as Co-developers: Learning and Innovation Outside the Firm', *Technology Analysis & Strategic Management*, 15(3), pp. 363–383. doi: 10.1080/09537320310001601531org/10.1080/09537320310001601531.

Jeremyville (2004) *Vinyl Will Kill!* Hong Kong: IdN.

Jeremyville (2007) *Jeremyville Sessions*. Hong Kong: IdN.

Jhally, S. and Livant, B. (1986) 'Watching as Working: the Valorization of Audience Consciousness', *Journal of Communication*, 36(3), pp. 124–143. doi: 10.1111/j.1460-2466.1986.tb01442.x.

Jia, F. *et al.* (2016) 'Investigating the feasibility of supply chain-centric business models in 3D chocolate printing: A simulation study', *Technological Forecasting and Social Change*. Elsevier Inc., 102, pp. 202–213. doi: 10.1016/j.techfore.2015.07.026.

Jiao, J. and Tseng, M. M. (2004) 'Customizability analysis in design for mass customization', *Computer-Aided Design*, 36(8), pp. 745–757. doi: 10.1016/j.cad.2003.09.012.

Johnson, M. (2001) 'Learning from toys', *California Management Review*, 43(4), pp. 7–25.

Johnson, R. B. and Onwuegbuzie, A. (2004) 'Mixed Methods Research: A Research Paradigm Whose Time Has Come', *Educational Researcher*, 33(14), pp. 14–26. doi: 10.3102/0013189X033007014.

Jørgensen, S. M. H., Vitting-Seerup, S. and Wallevik, K. (2017) 'Hatsune Miku: an uncertain image', *Digital Creativity*. doi: 10.1080/14626268.2017.1381625.

K.baym, N. (2007) 'The new shape of online community: The example of Swedish independent music random', *First Monday*, 12(8).

Kamali, N. and Loker, S. (2002) *Mass Customization: On-line Consumer Involvement in Product Design*, *J. Computer-Mediated Communication*. John Wiley & Sons, Ltd (10.1111). doi: 10.1111/j.1083-6101.2002.tb00155.x.

Kapell, M. W. *et al.* (2006) *Finding the Force of the Star Wars Franchise : Fans , Merchandise, & Critics*. 1st edn. Edited by M. Kapell and J. S. Lawrence. Peter Lang Publishing Inc.

Karhulahti, V. (2012) 'Feelies : The Lost Art of Immersing the Narrative', *DiGRA Nordic 2012 Conference: Local and Global – Games in Culture and Society*,

(2005), pp. 1–9.
Kawulich, B. B. (2005) *Participant Observation as a Data Collection Method*, *Forum Qualitative Sozialforschung / Forum: Qualitative Social Research*. Available at: http://www.qualitative-research.net/index.php/fqs/rt/printerFriendly/466/996 (Accessed: 20 March 2019).
Kell, J. (2016) *Mattel Is Using 3D Printing to Resurrect An Old Hit*, *Fortune.com*. Available at: http://fortune.com/2016/02/12/mattel-3d-printing-toys/ (Accessed: 16 February 2016).
Kessler, S. (2015) *Shapeways CEO: 3D Printing Will Fuel Creative Commerce*, *Mashable*. Available at: http://mashable.com/2012/05/05/3d-printing-creative-commerce/#.BQaMoRU5uqf (Accessed: 5 May 2012).
Kinder, M. (1991) *Playing with Power in Movies, Television, and Video Games: From Muppet Babies to Teenage Mutant Ninja Turtles*. California: University of California Press.
Kinsley, K., Owens, T. and Washington, F. (2014) 'International Legal and Ethical Challenges Related to the Use and Development of 3D Technology in the US And China', IV(3), pp. 1–22. Available at: http://www.scientificpapers.org/wp-content/files/1462_KinsleyBrooksOwens-International_Legal_and_Ethical_Challenges_Related_to_the_Use_and_Development_of_3D_Technology_in.pdf.
Kitahara, T. (2003) *'Omake' no hakubutsushi (A natural history of 'omake')*. Tokyo: PHP Shinsho.
Klastrup, L. and Tosca, S. (2004) 'Transmedial worlds - Rethinking cyberworld design', *Proceedings - 2004 International Conference on Cyberworlds, CW 2004*, (December 2004), pp. 409–416. doi: 10.1109/CW.2004.67.
Kocurek, C. A. (2013) 'The treachery of pixels: Reconsidering feelies in an era of digital play', *Journal of Gaming & Virtual Worlds*, 5(3), pp. 295–306. doi: 10.1386/jgvw.5.3.295_1.
Kodama, H. (1981) 'Automatic method for fabricating a three-dimensional plastic model with photo-hardening polymer', *Review of Scientific Instruments*, 52(11), pp. 1770–73.
Kohtala, C. and Bosqué, C. (2014) 'The Story of MIT-Fablab Norway: Community Embedding of Peer Production » Journal of Peer Production', *Journal of Peer Production*, (5). Available at: http://peerproduction.net/issues/issue-5-shared-machine-shops/peer-reviewed-articles/the-story-of-mit-fablab-norway-community-embedding-of-peer-production/ (Accessed: 27 September 2015).
De Kosnik, A. (2009) 'Should fan fiction be free?', *Cinema Journal*, 48(4), pp. 118–124.
Kotha, S. (1995) 'Mass customization: Implementing the emerging paradigm for competitive advantage', *Strategic Management Journal*, 16(S1), pp. 21–42. doi: 10.1002/smj.4250160916.
Kotha, S. (1996) 'From mass production to mass customization: The case of the National Industrial Bicycle Company of Japan', *European Management Journal*, 14(5), pp. 442–450. doi: 10.1016/0263-2373(96)00037-0.
Kotha, S. and Pine, B. J. (1994) 'Mass Customization: The New Frontier in Business Competition', in *The Academy of Management Review*. Harvard Business School Press, p. 588. doi: 10.2307/258941.

Kozinets, R. V. (1997) '"I Want To Believe": A Netnography of The X-Philes' Subculture of Consumption', *Advances in Consumer Research*. doi: 10.1038/scientificamerican0709-33.
Kozinets, R. V. (1998) 'On netnography: Initial reflections on consumer research investigations of cyberculture', *Advances in consumer research*, 25, pp. 366–371. Available at: http://www.acrwebsite.org/volumes/display.asp?id=8180 (Accessed: 22 March 2019).
Kozinets, R. V (1999) 'E-tribalized marketing?: The strategic implications of virtual communities of consumption', *European Management Journal*. Elsevier, 17(3), pp. 252–264. doi: 10.1016/S0263-2373(99)00004-3.
Kress, G. and van Leeuwen, T. (2001) *Multimodal Discourse: The Modes and Media of Contemporary Communication*, *College Composition and Communication*. doi: 10.2307/1512155.
Von Krogh, G., Spaeth, S. and Lakhani, K. R. (2003) 'Community, joining, and specialization in open source software innovation: A case study', *Research Policy*, 32(7), pp. 1217–1241. doi: 10.1016/S0048-7333(03)00050-7.
Kusakawa, S. (1981) *Terebi anime 20 nen shi (A tewnty-year history of television anime)*. Tokyo: Rippu Shobō.
Kyriakou, H., Englehardt, S. and Nickerson, J. V. (2012) *Networks of Innovation in 3d Printing*, *SSRN Electronic Journal*. doi: 10.2139/ssrn.2146080.
Kyriakou, H. and Nickerson, J. (2014) 'Collective Innovation in Open Source Hardware', *Collective Intelligence*, (Tuomi 2002), pp. 1–4. doi: 10.2139/ssrn.2421332.
Kyriakou, H., Nickerson, J. W. and Sabnis, G. (2016) 'Knowledge Reuse for Customization: Metamodels in an Open Design Community for 3D Printing', *Management Information Systems Quarterly*, 41((forthcoming)), pp. 315–332.
Labaree, R. V (2002) 'The risk of "going observationalist": negotiating the hidden dilemmas of being an insider participant observer', *Qualitative Research*. SAGE Publications, 2(1), pp. 97–122. doi: 10.1177/1468794102002001641.
Lakhani, K. R. and Wolf, R. G. (2019) 'Why Hackers Do What They Do', *Perspectives on Free and Open Source Software*, pp. 1–27. doi: 10.7551/mitpress/5326.003.0005.
Lam, F.-Y. (2010) 'Comic Market : How the World's Biggest Amateur Comic Fair Shaped Japanese Dōjinshi Culture', *Mechademia*, 5, pp. 232–248. doi: 10.1353/mec.2010.0011.
Lamerichs, N. (2011) 'Theory Stranger than fiction: Fan identity in cosplay', *Transformative Works and Cultures*, 7. doi: 10.3983/twc.2011.0246.
Lamerichs, N. (2013) 'The cultural dynamic of doujinshi and cosplay: Local anime fandom in Japan, USA and Europe', *Participations, Journal of Audience & Reception Studies*, 10, issue(1), pp. 154–176. Available at: http://www.participations.org/Volume 10/Issue 1/10 Lamerichs 10.1.pdf.
Lamerichs, N. (2018) *Productive Fandom*, *Productive Fandom*. doi: 10.2307/j.ctv65svxz.
Landay, J. (2009) 'Design tools for the rest of us', *Communications of the ACM*, 52(12), p. 80. doi: 10.1145/1610252.1610274.
Lang, K. R., Di Shang and Zicklin, R. (2007) *Designing markets for co-production of*

*digital culture goods*, *Proceedings of the ninth international conference on Electronic commerce*. doi: 10.1016/j.dss.2009.05.010.
Langer, R. and Beckman, S. C. (2005) 'Sensitive research topics: Netnography revisited', *Qualitative Market Research*. doi: 10.1108/13522750510592454.
Langlois, R. (2002) 'Modularity in technology and organization', *Journal of Economic Behavior & Organization*. Elsevier, 49(1), pp. 19–37. doi: 10.1016/S0167-2681(02)00056-2.
Lau, M. *et al.* (2011) 'Converting 3D Furniture Models to Fabricatable Parts and Connectors', *ACM Transactions on Graphics (TOG) - Proceedings of ACM SIGGRAPH*, 30(4). doi: 10.1145/1964921.1964980.
Leavitt, A., Knight, T. and Yoshiba, A. (2016) 'Producing Hatsune Miku: Concerts, Commercialisation, and the Politics of Peer Production.', in *Media Convergence in Japan*. Kinema Club, pp. 200–229.
Lee, H.-K. (2011) 'Participatory media fandom: A case study of anime fansubbing', *Media, Culture & Society*, 33(8), pp. 1131–1147. doi: 10.1177/0163443711418271.
Lee, S., Barua, A. and Whinston, A. (2000) 'The Complementarity of Mass Customization and Electronic Commerce.', *Economics of Innovation and New Technology*, 8(2), pp. 81–110.
Lei, David, Hitt, Michael, Goldhar, J. (1996) 'Advanced Manufacturing Technology: Organizational Design and Strategic Flexibility', *Organization Studies*, 3(17), pp. 501–523.
Lessig, L. (2008a) *Remix: Making Art and Commerce Thrive in the Hybrid Economy*. 1st edn. New York: The Penguin Press. Available at: http://scholar.google.com/scholar?hl=en&btnG=Search&q=intitle:Remix:+Making+Art+and+Commerce+Thrive+in+the+Hybrid+Economy#0 (Accessed: 16 October 2014).
Lessig, L. (2008b) *Remix*. Available at: http://www.amazon.com/Remix-byLessig-Lessig/dp/B00683XZZA/ref=sr_1_2?ie=UTF8&qid=1410795163&sr=8-2&keywords=remix+lessig.
Lévy, P. (1997) *Collective Intelligence: Mankind's Emerging World in Cyberspace*, *Challenges*. doi: 10.1109/MCI.2006.1672982.
Lewis, A. (2015) 'The Legality of 3D Printing: How Technology Is Moving Faster than the Law', *Tulane Journal of Technology & Intellectual Property*, 17, pp. 303–319.
Li, P. *et al.* (2014) 'Intellectual property and 3D printing: a case study on 3D chocolate printing', *Journal of Intellectual Property Law & Practice*, 9(4), pp. 322–332. doi: 10.1093/jiplp/jpt217.
Lipson, H. and Kurman, M. (2013) *Fabricated: The New World of 3D Printing*, *John Wiley & Sons, Inc., Indianapolis, Indiana*. John Wiley & Sons, Inc., Indianapolis, Indiana. Available at: http://avaxhm.com/ebooks/1118350634-1395885808.html.
Literat, I. (2012) 'The Work of Art in the Age of Mediated Participation', *Internation Journal of Communication*, 11, pp. 2962–2984. Available at: http://ijoc.org/index.php/ijoc/article/view/1531.
Little, R. K. (2014) 'Guns Don't Kill People, 3D Printing Does? Why the Technology is a Distraction from Effective Gun Controls', *Hastings Law Journal*, 65(6), pp. 1505–1514.

Lochrie, M. and Coulton, P. (2012) 'Sharing the viewing experience through second screens', *EuroiTV'12 - Proceedings of the 10th European Conference on Interactive TV and Video*, pp. 199–202. doi: 10.1145/2325616.2325655.
Lotecki, A. (2012) 'Cosplay Culture : The Development of Interactive and Living Art through Play', p. 106.
Lovell, E. and Buechley, L. (2010) 'An e-sewing tutorial for DIY learning', *Proceedings of the 9th International Conference on Interaction Design and Children - IDC '10*. New York, New York, USA: ACM Press, p. 230. doi: 10.1145/1810543.1810578.
Lury, C. (2004) *Brands: The Logos of the Global Economy*. Routledge. Available at: https://doi.org/10.4324/9780203495025.
Luthje, C. and Lüthje, C. (2004) 'Characteristics of innovating users in a consumer goods field An empirical study of sport-related product consumers', *Technovation*. Elsevier, 24(9), pp. 683–695. doi: 10.1016/S0166-4972(02)00150-5.
Lynch, M. (1985) *Art and Artifact in Laboratory Science*.
Malone, E. and Lipson, H. (2007) 'Fab@Home: the personal desktop fabricator kit', *Rapid Prototyping Journal*, 13(4), pp. 245–255. doi: 10.1108/13552540710776197.
Manifold, M. C. (2013) 'Enchanting Tales and Imagic Stories: The Educational Benefits of Fanart Making', *Art Education*, 66.6(November), pp. 12–20.
Marsden, R. (2014) 'Kicking Barbie's: How the growth of 3D printing enabled me to make an army of custom made figurines.', *The Independent*, 19 November.
Marshall, L. (2003) 'For and Against the Record Industry: An Introduction to Bootleg Collectors and Tape Traders', *Popular Music*, 22(1), pp. 57–72.
Marshall, P. D. (2004) *New media cultures*. London: Arnold.
Matzer, M. (1996) 'Contented kingdoms', *Ad Week*, pp. 30–33.
Mccracken, G. (1986) 'Culture and of Consumption: A Theoretical Account of the Structure and Movement of the Cultural meaning of consumer goods', *Journal of Consumer Research*, 13(1), pp. 71–84.
Mendis, D., Secchi, D. and Reeves, P. (2015) 'A Legal and Empirical Study into the Intellectual Property Implications of 3D Printing - Executive Summary', (March).
Meuter, M. L. *et al.* (2003) 'The influence of technology anxiety on consumer use and experiences with self-service technologies', *Journal of Business Research*, 56, pp. 899–906. doi: 10.1016/S0148-2963(01)00276-4.
Meyer, M. H. and Lehnerd, A. P. (1997) *The Power of Product Platforms: Building Value and Cost Leadership*. New York: Free Press.
Mikhak, B. *et al.* (2002) 'Fab Lab LAB: An alternate model of ICT for Development', in *International Conference on Development by Design. Bangalore, India*. Citeseer. Available at: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.72.315&rep=rep1&type=pdf (Accessed: 26 September 2011).
Miller, C. (2015) 'What's "Anthropological" about Design Anthropology? A Personal Reflection.', *Paper presented at the Design Anthropololgical Futures, Copenhagen, Denmark.*, pp. 1–9. Available at: https://kadk.dk/co-design/research-network-design-anthropology/closing-conference-design-anthropological-futures.
Milner, R. M. (2009) 'Working for the text: Fan labor and the new organization', *International Journal of Cultural Studies*, 12(5), pp. 491–508. doi:

10.1177/1367877909337861.
Mkono, M. (2011) ‘The Othering of Food in Touristic Eatertainment: A Netnography’, *Tourist Studies*, 11(3), pp. 253–270. doi: 10.1177/1468797611431502.
Mochon, D., Norton, M. I. and Ariely, D. (2012) ‘Bolstering and restoring feelings of competence via the IKEA effect’, *International Journal of Research in Marketing*. Elsevier B.V., 29(4), pp. 363–369. doi: 10.1016/j.ijresmar.2012.05.001.
Moilanen, J. *et al.* (2013) ‘Cultures of sharing in 3D printing : what can we learn from the licence choices of Thingiverse users ?’, (Kennedy), pp. 1–9.
Molitch-hou, M. (2016a) *3D Printing and Gaming Merge in G2A 3D+ Project*, *3D Printing Industry*. Available at: http://3dprintingindustry.com/2016/02/03/3d-printing-and-gaming-merge-in-g2a-3d-project/.
Molitch-hou, M. (2016b) ‘Whispering Gibbon the Latest to Launch In Game 3D Printing’, *3D Printing Industry*, (January), pp. 2–5.
Monroy-Hernández, A. (2012) *Designing for remixing: supporting an Online community of amateur creators*. Massachussetts Institute of Technology. Available at: http://dspace.mit.edu/handle/1721.1/78202.
Moor, E. (2003) ‘Branded Spaces: The Scope of New Marketing’, *Journal of Consumer Culture*, 3(1), pp. 39–60.
Mori, Y. (2007) ‘Plushie: an interactive design system for plush toys.’, *ACM Transactions on Graphics*, 26(3).
Morris, J. (2011) ‘Sound in the cloud: Cloud computing and the digital music commodity’, *First Monday*, 16(5), pp. 1–16.
Morrison, P. D. and Roberts, J. H. (2002) ‘The Nature of Lead Users and Measurement of Leading Edge Status’, *Review Literature And Arts Of The Americas*, pp. 1–16.
Moser, K and Piller, F. (2006) ‘Mass customisation case studies: Cases from the international mass customisation case collection’, *Journal of Engineering Research and Studies MASS*, 1(4), pp. 242–246.
Moser, Klaus and Piller, F. T. (2006) ‘The international mass customisation case collection: an opportunity for learning from previous experiences’, *International Journal of Mass Customisation*, 1(4), pp. 1–142. doi: 10.1002/jsfa.2348.
Mota, C. (2011) ‘The Rise of Personal Fabrication’, *Proceedings of the 8th ACM conference on Creativity and cognition*, pp. 279–288. doi: 10.1145/2069618.2069665.
Muffato, M. and Roveda, M. (2002) ‘Product qrchitecture and platforms: a conceptual framework.’, *International Journal of Technology Management*, 24(10), pp. 1–16.
Murphy, K. M. and Marcus, G. E. (2013) ‘Epilogue: Enthnography and Design, Ethnography in Design... Ethnography by Design’, in *Design Anthropology: Theory and Practice*. doi: 10.1007/978-3-8274-2853-0.
Murray, S (2005) ‘Brand loyalties: rethinking content within global corporate media’, *Media, Culture & Society*, 27(3), pp. 415–435. doi: 10.1177/0163443705053973.
Murray, Simone (2005) ‘Brand loyalties: rethinking content within global corporate media’, *Media, Culture & Society*, 27(3), pp. 415–435. doi: 10.1177/0163443705053973.
Muskat, M., Blackman, D. and Muskat, B. (2012) ‘Mixed methods: Combining expert interviews, cross-impact analysis and scenario development’, *Electronic Journal of Business Research Methods*, 10(1), pp. 9–21. doi:

http://dx.doi.org/10.2139/ssrn.2202179.
Nambisan, S. and Baron, R. A. (2009) ‘Virtual Customer Environments: Testing a Model of Voluntary Participation in Value Co-creation Activities’, *Journal of Product Innovation Management*. Blackwell Publishing Inc, 26(4), pp. 388–406. doi: 10.1111/j.1540-5885.2009.00667.x.
Negroponte, N. (1995) *Being Digital*, *Media*. doi: 10.1016/0169-7552(94)90144-9.
Negus, K. (2002) ‘The Work of Cultural Intermediaries and the Enduring Distance Between Production and Consumption’, *Cultural Studies*, 16(4), pp. 501–515. doi: 10.1080/09502380210139089.
‘New Advances in Rapid Prototyping using inkjet-based 3D printing’ (2011) *Technology*, (April).
Nightingale, Virginia. and Dwyer, Tim. (2007) *New Media Worlds: Challenges for Convergence*. Edited by V. Nightingale and T. Dwyer. Melbourne, Australia: Oxford University Press. doi: neue medien; globalisierung.
Noppe, N. (2011a) ‘Why We Should Talk about Commodifying Fan Work’, *Transformative Works and Cultures*, (8). doi: 10.3983/twc.2011.0369.1.
Noppe, N. (2011b) ‘Why we should talk about commodofying fan work’, *Transformative Works and Cultures*, (8). doi: 0.3983/twc.2011.0369.
Norton, M. I. I. *et al.* (2011) *The" IKEA Effect": When Labor Leads to Love*. Harvard Business School. Available at: http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1777100 (Accessed: 26 September 2011).
Norton, M. I., Mochon, D. and Ariely, D. (2011) ‘The IKEA effect: When labor leads to love’, *Journal of Consumer Psychology*. Society for Consumer Psychology, pp. 1–8. doi: 10.1016/j.jcps.2011.08.002.
Nuttavuthisit, K. (2010) ‘If you can’t beat them, let them join: The development of strategies to foster consumers’ co-creative practices’, *Business Horizons*. ‘Kelley School of Business, Indiana University’, 53(3), pp. 315–324. doi: 10.1016/j.bushor.2010.01.005.
O’Hear, S. (2017) *Disney has quietly acquired tech and assets of MakieLab, a startup that 3D printed dolls*, *TechCrunch*. Available at: https://techcrunch.com/2017/02/22/makielab-may-the-force-be-with-you/ (Accessed: 16 March 2019).
Ogles, J. (2007) ‘How to take money from kids: Sell toys both physical and virtual’, *Wired*, August. Available at: http://www.wired.com/gadgets/miscellaneous/news/2007/07/webkinz?currentPage=all.
OH, Y. *et al.* (2006) ‘The designosaur and the furniture factory simple software for fast fabrication’, *DESIGN COMPUTING AND COGNITION ’06*. Springer, 2, pp. 123–140. Available at: http://www.springerlink.com/index/RM42G05417643R19.pdf (Accessed: 14 September 2011).
Olexa, R. (2001) ‘No Title’, *Manufacturing Engineering*, 2(127).
Otto, T. and Smith, R. C. (2013) ‘Design Anthropology: A Distinct Style of Knowing’, *Design Anthropology: Theory and Practice*. doi: 10.1017/CBO9781107415324.004.
Palladino, V. (2016) ‘Kids will soon make their own toys with with Mattel’s $300 ThingMaker 3D printer.’, *Ars Technica*, 15 February, pp. 12–14. Available at:

https://www.gartner.com/doc/3100228/hype-cycle-d-printing-.
Park, R. (2013) *Faberdashery Accessorises the Makies — A Live 3D Printing Event in Selfridges Toy Department*, *3D Printing Industry*. Available at: https://3dprintingindustry.com/news/faberdashery-accessorises-makies-live-3d-printing-event-selfridges-toy-department-19201/ (Accessed: 16 March 2019).
Pavitt, K. (2002) *Systems Integrators as " post-industrial " firms ?*, *Science And Technology*.
Peacock, S. R. (2014) 'Why Manufacturing Matters : 3D Printing , Computer-Aided Designs , and the Rise of End- User Patent Infringement', *William & Mary Law School Scholarship Repository*, 55(5), pp. 1933–1960.
Pearson, R. (2010) 'Fandom in the Digital Era', *Popular Communication*, 8(1), pp. 84–95. doi: 10.1080/15405700903502346.
Pendaloza, L. (1998) 'Just Doing It: A Visual Ethnographic Study of Spectacular Consumption Behavior at Nike Town', *Consumption Markets & Culture*, 2(4), pp. 337–465.
Peters, I. M. (2014) 'Peril-sensitive sunglasses, superheroes in miniature, and pink polka-dot boxers: Artifact and collectible video game feelies, play, and the paratextual gaming experience', *Transformative Works and Cultures*, 16. doi: 10.3983/twc.2014.0509.
Petersen, E., Kidd, R. and Pearce, J. (2017) 'Impact of DIY Home Manufacturing with 3D Printing on the Toy and Game Market', *Technologies*, 5(3), p. 45. doi: 10.3390/technologies5030045.
Phoenix, W. (2006) *Plastic Culture: How Japanese Toys Conquered the World*. Tokyo: Kodansha International.
Piller, F. *et al.* (2005) 'Overcoming Mass Confusion: Collaborative Customer Co-Design in Online Communities', *Journal of Computer-Mediated Communication*. Wiley Online Library, 10(4), pp. 00–00. doi: 10.1111/j.1083-6101.2005.tb00271.x.
Piller, F. T. (2005) 'Mass Customization: Reflections on the State of the Concept', *International Journal of Flexible Manufacturing Systems*, 16(4), pp. 313–334. doi: 10.1007/s10696-005-5170-x.
Piller, F. T. and Walcher, D. (2006) 'Toolkits for idea competitions: a novel method to integrate users in new product development', *R and D Management*, 36(3), pp. 307–318. doi: 10.1111/j.1467-9310.2006.00432.x.
Pine, B. J. and Gilmore, J. H. (1999) *The experience economy: work is theatre & every business a stage*, *Business*. Harvard Business Press. Available at: http://books.google.com/books?hl=en&lr=&id=5hs-tyRrSXMC&pgis=1%5Cnhttp://lcweb.loc.gov/catdir/toc/98-33202.html.
Piore, M. J. and Sabel, C. F. (1984) *The Second Industrial Divide.* New York: Basic books. doi: 10.1177/002234338702400213.
Pîrjan, A. and Petroşanu, D.-M. (2014) 'The impact of 3d printing technology on the society and economy', *Journal of information Systems and Operations Management*, 7(2), pp. 360–370.
Poggenpoel, C. and Myburgh, M. (2003) 'The Researcher As Research Instrument In Educational Research: A Possible Threat To Trustworthiness?', *Education*.
Prahalad, C. K. (2004) *The Future of Competition: Co-Creating Unique Value with Customers*, *Research-Technology Management*.

Prahalad, C. K. K. and Ramaswamy, V. (2000) 'Co-opting customer competence', *Harvard business review*, 78(1), pp. 1–8. Available at: http://www.sld.cu/galerias/pdf/sitios/infodir/coopting_customer_competence.pdf (Accessed: 26 September 2011).
Prahalad, C. K. K. and Ramaswamy, V. (2002) 'The co-creation connection', *Strategy and Business*. BOOZ. ALLEN & HAMILTON, (27), pp. 50–61. Available at: http://www.tantum.com/tantum/pdfs/2009/2_the_co_creation_connection.pdf (Accessed: 26 September 2011).
Prahalad, C. K. K. and Ramaswamy, V. (2004) 'Co-creation experiences: The next practice in value creation', *Journal of Interactive Marketing*, 18(3), pp. 5–14. doi: 10.1002/dir.20015.
Prahalad, C. K. and Ramaswamy, V. (2004) 'Co-creating unique value with customers', *Strategy Leadership*. Emerald Group Publishing Limited, 32(3), pp. 4–9. doi: 10.1108/10878570410699249.
Prahalad, C.K. and Ramaswamy, V. (2004) 'Co-creation experiences: The next practice in value creation', *Journal of Interactive Marketing*, 18(3), pp. 5–14. doi: 10.1002/dir.20015.
Prügl, R. and Schreier, M. (2006) 'Learning from leading-edge customers at The Sims: Opening up the innovation process using toolkits', *R&D Management*, 36(June), pp. 237–250. Available at: www.volkswagen-stiftung.de (Accessed: 29 March 2019).
Qiao, G. and Lu, R. F. (2006) 'Flexible manufacturing systems for mass customisation manufacturing', *Journal of Mass Customisation*. Available at: http://inderscience.metapress.com/index/02lc3ww9vutw1ulg.pdf (Accessed: 8 October 2011).
Qin, S. F. *et al.* (2004) 'Development of a novel 3D simulation modelling system for distributed manufacturing', *International Journal*, 54(1), pp. 69–81.
Rahman, O. *et al.* (2012) '"Cosplay": Imaginative Self and Performing Identity', *Fashion Theory The Journal of Dress, Body and Culture*, 16(3), pp. 317–341. doi: 10.2752/175174112X13340749707204.
Ramaswamy, V. (2011) 'It's about human experiences...and beyond, to co-creation', *Industrial Marketing Management*. Elsevier Inc., 40(2), pp. 195–196. doi: 10.1016/j.indmarman.2010.06.030.
Rank, S. *et al.* (2016) 'Changing Roles in Gaming: Twitch and new gaming audiences', *Proceedings of 1st International Joint Conference of DiGRA and FDG*, (November).
Ratner, R. K., Kahn, B. E. and Kahneman, D. (1999) 'Choosing Less‐Preferred Experiences For the Sake of Variety', *Journal of Consumer Research*. Oxford University Press, 26(1), pp. 1–15. doi: 10.1086/209547.
Rawsthorn, A. (2013) 'Catching Up to 3D Printing', *The New York Times*. Available at: http://www.nytimes.com/2013/07/22/arts/design/Catching-Up-to-3D-Printing.html.
Raybourn, E. M. (2014) 'A new paradigm for serious games: Transmedia learning for more effective training and education', *Journal of Computational Science*. Elsevier B.V., 5(3), pp. 471–481. doi: 10.1016/j.jocs.2013.08.005.
Rayna, T. and Striukova, L. (2016) 'From rapid prototyping to home fabrication: How

3D printing is changing business model innovation', *Technological Forecasting & Social Change*. Elsevier B.V., 102, pp. 214–224. doi: 10.1016/j.techfore.2015.07.023.
Rayna, T., Striukova, L. and Darlington, J. (2015) 'Co-creation and user innovation: The role of online 3D printing platforms', *Journal of Engineering and Technology Management*. Elsevier B.V., 37, pp. 90–102. doi: 10.1016/j.jengtecman.2015.07.002.
Reeves, P. (2007) 'Rapid Manufacturing – A business case for developing reusable multimedia for engeneering education', in *International Symposium for Engineering Education, 2007, Dublin City University, Ireland*, pp. 75–81.
Reeves, P. (2008a) 'Rapid Manufacture for the realisation of "user described" entertainment and recreational content', in *iCAT 2012 | International Conference on Additive Technologies*, pp. 1–6.
Reeves, P. (2008b) 'Rapid Manufacturing for the realisation of "user described" entertainment and recreational content', in *iCAT 2012 | International Conference on Additive Technologies*, pp. 1–6.
Reeves, P. and Mendis, D. (2015) *The Current Status and Impact of 3D Printing Within the Industrial Sector: An Analysis of Six Case Studies*. Available at: http://eprints.bournemouth.ac.uk/21873/1/The_Current_Status_and_Impact_of_3D_Printing_Within_the_Industrial_Sector_-_Study_II.pdf.
Rehak, B. (2013) 'Materializing Monsters: Aurora Models, Garage Kits, and the Object Practices of Horror Media', *Journal of Fandom Studies*, 1(1), pp. 27–45. Available at: https://core.ac.uk/download/pdf/73340097.pdf (Accessed: 12 March 2019).
Rehak, B. (2014) 'Materiality and object-oriented fandom', (16), pp. 1–4.
Rehnberg, M. and Ponte, S. (2016) '3D printing and global value chains: How a new technology may restructure global production', (September), pp. 1–25.
Rideout, B. (2011) 'Printing the impossible triangle: The copyright implications of three-dimensional printing', *Journal of Business Entrepreneurship & Law*, 5, pp. 161–177.
Rindfleisch, A. and O'Hern, M. (2015) 'Brand Remixing: 3D Printing the Nokia Case', *Brand Meaning Management (Review of Marketing Research), Volume 12*, 12, pp. 53–81. doi: 10.1108/S1548-6435201512.
Rischau, J. J. (2011) *Custom Digital Fabrication in Industrial Design*.
Ristov, P. and Ristova, A. T. (2011) *WEB-BASED PRODUCT CONFIGURATION FOR MASS Customization: Towards developing mass customization strategy, Communities*. School of Engineering in Jönköping.
Ritzer, G. (2009) *Enchanting a Disenchanted World: Continuity and Change in the Cathedrals of Consumption*. Thousand Oaks, CA: Sage.
Robertson, A. (2016) 'Hands On With Mattel ' s ' ThingMaker ' 3D Printing For Kids', pp. 3–6.
Robertson, D. and Ulrich, K. (1998) 'Planning for product platforms', *MIT Sloan Management Review*, 39(4), pp. 19–31.
Rogers, E. M. (1995) *Diffusion of Innovations*. 5th edn, *Elements of Diffusion*. 5th edn. New York: Free Press. doi: citeulike-article-id:126680.
Rook, D. W. (1985) 'The ritual dimension of consumer behavior', *Journal of Consumer Research*, 12, pp. 251–269.

Ruffo, M. and Hague, R. (2007) ‘Cost estimation for rapid manufacturing - Simultaneous production of mixed components using laser sintering’, *Proceedings of the Institution of Mechanical Engineers, Part B: Journal of Engineering Manufacture*, 221(11), pp. 1585–1591. doi: 10.1243/09544054JEM894.

Russin, A. (2013) ‘Kerbal Space Program raises metaphysical questions of purpose’, *Spectator Tribune*. Available at: https://spectatortribune.com/kerbal-space-program-raises-metaphysical-questions-of-purpose/.

Ryan, M. (2001) *Narrative as Virtual Reality: Immersion and Interactivity in Literature and Electronic Media*. Baltimore: Johns Hopkins University Press.

Ryle, G. (1968) ‘The thinking of thoughts: What is ’ “Le Penseur”’doing? University Lectures, 18, University of Saskatchewan’, in *University Lectures 18*. Saskatoon: University of Saskatchewwan.

Rynes, S., Bartunek, J. and Daft, R. (2001) ‘Across the Great Divide: Knowledge Creation and Transfer between Practitioners and Academic’, *Academy of Management Journal*, 44(2), pp. 340–355.

Sacco, D. (2013) *Makies become world’s first CE-certified 3D printed toys*, *ToyNews*. Available at: https://www.toynews-online.biz/technology/makies-become-worlds-first-cecertified-3d-printed-toys (Accessed: 16 March 2019).

Sachs, E. *et al.* (1998) ‘The distributed design and fabrication of metal parts and tooling by 3D Printing’, in *Proceedings of the 1998 NSF Design and Manufacturing Grantees Conference, Cintermex Conference Center, Monterrey, Mexico*, pp. 35–36. Available at: http://web.mit.edu/activities/tdp/info-flow/publications/nsf98-conf.pdf (Accessed: 26 September 2011).

Salvador, F., Rungtusanatham, M. and Forza, C. (2004) ‘Supply-chain configurations for mass customization’, *Production Planning and Control*, 15(4), pp. 381–397. doi: 10.1080/0953728042000238818.

Santo, A. (2012) ‘A Teenie Weenie amount of “Goodwill”: Cross-media character brand merchandizing in the 1920s’, *Journal of Consumer Culture*, 12(3), pp. 283–305. doi: 10.1177/1469540512456929.

Sass, L. and Oxman, R. (2006) ‘Materializing design: the implications of rapid prototyping in digital design’, *Design Studies*, 27(3), pp. 325–355. doi: 10.1016/j.destud.2005.11.009.

Saul, G. *et al.* (2011) ‘SketchChair: An All-in-one Chair Design System for End Users’, in *Tei’11*, pp. 73–80.

Saul, G., Xu, C. and Gross, M. D. (2010) ‘Interactive paper devices: end-user design & fabrication’, in *Proceedings of the fourth international conference on Tangible, embedded, and embodied interaction*. ACM, pp. 205–212. Available at: http://portal.acm.org/citation.cfm?id=1709924 (Accessed: 16 September 2011).

Saul, G., Xu, C and Gross, M. D. (2010) ‘Interactive paper devices: end-user design & fabrication’, in *Proceedings of the fourth international conference on Tangible, embedded, and embodied interaction*. ACM, pp. 205–212. Available at: http://portal.acm.org/citation.cfm?id=1709924.

Schnaars, S. P. (1989) *Megamistakes: Forecasting and the myth of rapid technological change*. New York: Pergamon. Available at: https://books.google.co.uk/books/about/Megamistakes.html?id=JFqvAAAAIAAJ&redir_esc=y.

Scolari, C. A. (2009) ‘Transmedia Storytelling: Implicit Consumers, Narrative Worlds, and Branding in Contemporary Media Production’, *Journal of Communication*, 3(3), pp. 586–606. Available at: http://www.allacademic.com/meta/p297424_index.html.

Scott, C. (2016) ‘3D Printed Map of Legend of Zelda’s Hyrule Draws Internet-Wide Attention, Helps Creator Launch Business’, *3Dprint.com*. Available at: https://3dprint.com/159952/3d-printed-legend-of-zelda-map/.

Scott, J. (2010) ‘Get Lamp: A Documentary About Adventures in Text’,. Hopewell Junction, NY: Bovine Ignition Systems.

Scott, S. (2009) ‘Repackaging Fan Culture: The Regifting Economy of Ancillary Content Models’, *Transformative Works and Cultures*, 3. doi: 10.3983/twc.2009.0150.

Scott, S. (2015) ‘The moral economy of crowdfunding and the transformative capacity of fan-ancing’, *New Media and Society*, 17(2), pp. 167–182. doi: 10.1177/1461444814558908.

Sells, E. *et al.* (2010) ‘RepRap: The Replicating Rapid Prototyper: Maximizing Customizability by Breeding the Means of Production’, in *Handbook of research in mass customization and personalisation.* Available at: http://ssrn.com/abstract=1594475.

Sener, B. and Van Rompuy, T. (2005) ‘’In Touch’With Consumers: Freeform as a Co-Design Tool for Real-Time Concept Modification’, *The Design journal*. Berg Publishers, 8(1), pp. 14–27. Available at: http://www.ingentaconnect.com/content/berg/dsgj/2005/00000008/00000001/art00003 (Accessed: 22 September 2011).

Seneviratne, O. and Monroy-Hernandez,  a. (2010) ‘Remix Culture on the Web: A Survey of Content Reuse on Different User-Generated Content Websites’, *Culture*, (March). Available at: http://dig.csail.mit.edu/2010/Papers/WebScience/paper.pdf.

Shah, S. (2000) *Sources and patterns of innovation in a consumer products field: innovations in sporting equipment*. Citeseer. Available at: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.13.5045&rep=rep1&type=pdf (Accessed: 14 September 2011).

Shang, D., Lang, K. R. and Vragov, R. (2007) ‘Designing Markets for Open Source Production of Digital Culture Goods’, pp. 283–292. doi: 10.1145/1282100.1282155.

Shanler, M. (2016) *Hype Cycle for 3D Printing*, *Gartner.com*. Available at: https://www.gartner.com/doc/3100228/hype-cycle-d-printing- (Accessed: 28 February 2016).

Sher, D. (2015) *Toyze Hits One Million 3D Printable Models . The Game Is On.*, *3D Printing Industry*.

Sher, D. (2017) ‘3D Printing Moves Further into Video Games with New Investment in FabZat’, pp. 2015–2018.

Shilane, P. *et al.* (2004) ‘The princeton shape benchmark’, *Proceedings Shape Modeling Applications, 2004.* Ieee, 08540, pp. 167–388. doi: 10.1109/SMI.2004.1314504.

Shneiderman, B. (1983) ‘Direct Manipulation: A step beyond Programming Languages.’, *Computer 16*, 16(8), pp. 57–69.

Da Silveira, G. (2001) ‘Mass customization: Literature review and research directions’, *International Journal of Production Economics*. Elsevier, 72(1), pp. 1–13. doi:

10.1016/S0925-5273(00)00079-7.
Simon (2015) *Kerbal Space Program now offering gamers 3D printed models of their spacecraft*, *www.3Ders.org*. Available at: https://www.3ders.org/articles/20150302-kerbal-space-program-now-offering-gamers-3d-printed-models-of-their-spacecraft.html (Accessed: 23 October 2017).
Simons, N. (2010) 'Studying the reception of transmedia TV fiction', *Proceedings of the 8th international interactive conference on Interactive TV&Video - EuroITV '10*, p. 205. doi: 10.1145/1809777.1809819.
Sinclair, M. (2012) *The specification of a consumer design toolkit to support personalised production via additive manufacturing*.
Sinclair, M. and Campbell, R. I. (2009) 'From Configuration to Design : Capturing the Intent of User-Designers', (May), pp. 1–23.
Solon, O. (2013) 'Digital fabrication is so much more than 3D printing (Wired UK)', *Wired UK*. Available at: http://www.wired.co.uk/news/archive/2013-03/13/digital-fabrication (Accessed: 28 September 2015).
Soter, T. (1992) 'At the Movies : Marketing Lessons from Tinseltown', *Management Review*, 81–11, pp. 10–15.
Sousa, A. M. (2016) 'Beauty is in the eye of the "produser": Virtual idol Hatsune Miku from software, to network, to stage', in *Post-Screen: Intermittence+Interference*. Lisboa: Edições Universitárias Lusófonas e Faculdade de Belas-Artes da Universidade de Lisboa/CIEBA. Available at: https://fbaul.academia.edu/AnaMatildeSousa.
Spradley, J. P. (1980) *Participant observation*. Holt, Rinehart and Winston.
Srivastava, J. and Cooley, R. (2003) 'Web Business Intelligence: Mining the Web for Actionable Knowledge', *INFORMS Journal on Computing*, 15(2), pp. 191–207. doi: 10.1287/ijoc.15.2.191.14447.
Stäblein, T., Holweg, M. and Miemczyk, J. (2011) 'Theoretical versus actual product variety: how much customisation do customers really demand?', *International Journal of Operations & Production Management*, 31(3), pp. 350–370. doi: 10.1108/01443571111111955.
Steemers, J. (2009) 'The thin line between market and quality. Balancing quality and commerce in preschool television', *Televizion*, 22, pp. 53–56.
Steeves, R. (2014) '3D printing will be an intellectual property nightmare', (March), pp. 14–17. doi: http://dx.doi.org/10.1108/17506200710779521.
Steinberg, M. (2009) 'Anytime, anywhere: Tetsuwan Atomu stickers and the emergence of character merchandizing', *Theory, Culture and Society*, 26(2–3), pp. 113–138. doi: 10.1177/0263276409103114.
Steinberg, M. (2010) 'A Vinyl Platform for Dissent: Designer Toys and Character Merchandising', *Journal of Visual Culture*, 9(2), pp. 209–228. doi: 10.1177/1470412910372760.
Steinberg, M. (2012) *Anime's Media Mix: Franchising Toys and Characters in Japan*. Minneapolis London: University of Minnesota Press.
Stemp-Morlock, G. (2010) 'Personal Fabrication: Open source 3D printers could herald the start of a new industrial revolution', *Communications of the ACM*, 53(10), pp. 14–15. doi: 10.1145/1831407.
Stuart, K. and Webber, J. E. (2015) '16 Trends That Will Define the Future of Video

Games’, *The Guardian*, pp. 1–9. Available at: http://www.theguardian.com/technology/2015/jul/23/16-trends-that-will-change-the-games-industry.

Sutherland, I. (2003) *Sketchpad a Man-Machine Graphical Communication System*, *Simulation*. doi: 10.1177/003754976400200514.

Sweatman, W. (2015) *We have a problem: 3D printers are too expensive*, *Hackday Blog*. Available at: http://hackaday.com/2015/06/09/we-have-a-problem-3d-printers-are-too-expensive/ (Accessed: 9 February 2016).

Tapscott, D. and Williams, A. D. (2008) ‘Wikinomics: How Mass Collaboration Changes Everything.’, *Journal of Information Technology & Politics*, 5(2), pp. 259–262. Available at: http://search.ebscohost.com/login.aspx?direct=true&db=lxh&AN=35157924.

Tavares Smith, M. (2014) ‘Digital Clothing Manufacture New Models for the Clothing Industry in the Digital Economy’, (September).

Tedlock, B. (1991) ‘Observation To the From Participant Observation of Participation : the Emergence Narrative Ethnography’, *Journal of anthoropological research*, 47(1), pp. 69–94. Available at: http://www.rnld.org/sites/default/files/Tedlock_Narrative_Ethnography_1991.pdf (Accessed: 20 March 2019).

Tedlock, B. (2005) ‘The Observation of Participation and the emergence of public ethnograhpy.’, in *The Sage Handbook of Qualitative Research*, pp. 151–172.

Terranova, T. (2000) ‘Free Labor: Producing Culture for the Digital Economy’, *Social Text*, 18(2 63), pp. 33–58. doi: 10.1215/01642472-18-2_63-33.

Theberge, P. (2006) ‘Everyday Fandom: Fan Clubs, Blogging, and the Quotidian Rhythms of the Internet’, *Canadian Journal of Communication*, 30(4), pp. 485–502. doi: 10.22230/cjc.2005v30n4a1673.

Thomke, S. and Von Hippel, E. (2002) ‘Customers as innovators: A new way to create value’, *Harvard Business Review*, p. 74.

Toffler, A. (1980) *The Third Wave*, *Blueprint*.

Toivonen, S. (2011) ‘Of discs, boxes and cartridges : the material life of digital games’, *DiGRA 2011 Conference: Think Design Play.*, pp. 1–11.

Toivonen, S. and Sotamaa, O. (2010) ‘Digital distribution of games’, in *Proceedings of the International Academic Conference on the Future of Game Design and Technology - Futureplay ’10*. New York, New York, USA: ACM Press, p. 199. doi: 10.1145/1920778.1920806.

Toma, C. (2017) *How Emerging Bands Find ‘Success ’ in the Contemporary Music Industry*. University of Hudderfield. Available at: http://eprints.hud.ac.uk/id/eprint/32662/.

Trobia, A. (2008) ‘Encyclopedia of survey research methods’, in Lavrakas, P. J. (ed.) *Encyclopedia of Survey Research Methods*. Thousand Oaks California: Sage. doi: 10.5860/choice.46-4199.

Troxler, P. (2014) ‘Fab Labs Forked: A Grassroots Insurgency inside the Next Industrial Revolution’, *Journal of Peer Production*, (5), pp. 1–3.

Troxler, P. and Schweikert, S. (2010) ‘Developing a Business Model for Concurrent Enterprising at the Fab Lab’, in *Proceedings of the 16th International Conference on Concurrent Enterprising, Lugano, Switzerland*, pp. 21–23. Available at:

http://www.ami-communities.eu/pub/bscw.cgi/S4d2e62cb/d573159/Developing a Business Model for  Concurrent Enterprising at the Fab Lab.pdf (Accessed: 2 October 2011).

Turner, K. (2011) ‘How Digital Fabrication is Democratizing Product Design’, in *Rapid 2011*.

Tushnet, R. (2007) ‘Copyright Law, Fan Practices, and the Rights of the Author.’, in Gray, J., Sandvoss, C., and Harrington, C. L. (eds) *Fandom: Identities and Communities in a Mediated World.* 2nd edn. New York: New York: UP, pp. 60–71.

Unver, E., Atkinson, P. and Marshall, J. (2008) ‘Automake Physics: Random Craft Production’, *Computer-AidedDesignandApplications*, 5, pp. 58–65. doi: 10.3722/cadaps.2008.58-65.

Unver, E., Paul, A. and Dave, T. (2006) ‘Applying 3D Scanning and Modeling in Transport Design Education’, *Computer-Aided Design and Applications*, 3(1–4), pp. 41–48. doi: 10.1080/16864360.2006.10738440.

Vargo, S. L. and Lusch, R. F. (2008) ‘Service-dominant logic: continuing the evolution’, *Journal of the Academy of Marketing Science*. Springer, 36(1), pp. 1–10. doi: 10.1007/s11747-007-0069-6.

Vargo, S. L. and Morgan, F. W. (2005) ‘Services in Society and Academic Thought : An Historical Analysis’, *Journal of Macromarketing*, 25(1), pp. 42–53. doi: 10.1177/0276146705275294.

Varney, A. (2006) ‘Feelies: Those trinkets, gimmicks and doodads once included in computer game boxes – what happened to them?’, *The Escapist*, (September). Available at: http://www.escapistmagazine.com/articles/view/issues/ issue_62/365-Feelies.

Verona, G., Prandelli, E. and Sawhney, M. (2006) ‘Innovation and virtual environments: Towards virtual knowledge brokers’, *Organization Studies*, 27(6), pp. 765–788. doi: 10.1177/0170840606061073.

Vilbrandt, T. *et al.* (2008) ‘Universal desktop fabrication’, *Heterogeneous objects modelling and applications: collection of papers on foundations and practice*. Springer-Verlag New York Inc, 4889, pp. 259–284. Available at: http://books.google.com/books?hl=en&lr=&id=4xYel-pm42QC&oi=fnd&pg=PA259&dq=Universal+Desktop+Fabrication&ots=S0KYUCaaD1&sig=B98Hx_RqlTzMminruVRsKL63vpo (Accessed: 15 September 2011).

Villapaz, B. Y. L. (2017) ‘’ Kerbal Space Program ’ Launches NASA ’ Asteroid Redirect Mission ’ Update [ VIDEO ]’, pp. 1–10.

Voss, G. and Carolan, N. (2012) ‘User-Led Design in the Urban / Domestic Environment User-Led Design in the Urban / Domestic Environment’, *Journal of Urban Technology*, 19:2(September 2013), pp. 37–41. doi: 10.1080/10630732.2012.698067.

Wacquant, L. (2002) ‘Scrutinizing the Street: Poverty, Morality, and the Pitfalls of Urban Ethnography Sidewalk’, *American Journal of Sociology*, 107(6), pp. 1468–1532. doi: 10.1086/340461.

Warkentin, M., Bapna, R. and Sugumaran, V. (2000) ‘The role of mass customization in enhancing supply chain relationships in B2C e-commerce markets’, *Journal of*

*Electronic Commerce*, 1(2), pp. 1–17. Available at: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.43.2998&rep=rep1&type=pdf (Accessed: 28 September 2011).
Wasko, J. (1994) *Hollywood in the Information Age: Beyond the Silver Screen.* Cambridge: Polity Press.
Waurzyniak, P. (2010) 'CAD/CAM Software Drives Innovation', *Manufacturing Engineering*, 144(2), pp. 49–55.
Weijo, H., Hietanen, J. and Mattila, P. (2014) 'New insights into online consumption communities and netnography', *Journal of Business Research*. Elsevier Inc., 67(10), pp. 2072–2078. doi: 10.1016/j.jbusres.2014.04.015.
Weinberg, M. (2010) *IT WILL BE AWESOME IF THEY DON'T SCREW IT UP*, *White Paper*.
Weinberg, M. (2014) '3D printing must avoid the music industry's IP mistakes', *Managing Intellectual Property*, 30 September, pp. 14–17. doi: http://dx.doi.org/10.1108/17506200710779521.
Welch, G. (2012) 'Physical-virtual humans: Challenges and opportunities', *Proceedings - 2012 International Symposium on Ubiquitous Virtual Reality, ISUVR 2012*, pp. 10–13. doi: 10.1109/ISUVR.2012.13.
Weller, C., Kleer, R. and Piller, F. T. (2015) 'Economic implications of 3D printing: Market structure models in light of additive manufacturing revisited', *International Journal of Production Economics*. Elsevier, 164, pp. 43–56. doi: 10.1016/j.ijpe.2015.02.020.
West, J. and Kuk, G. (2014) 'Proprietary Benefits from Open Communities: How MakerBot Leveraged Thingiverse in 3D Printing', *SSRN eLibrary*, 2544970, pp. 0–26. doi: 10.2139/ssrn.2544970.
Whitbrook, J. (2015) 'Kerbal Space Program now lets you turn your ships into 3D-printed toys', *Gizmodo*, February. Available at: https://gizmodo.com/kerbal-space-program-now-lets-you-turn-your-ships-into-1688886862.
Wilkof, N. (2016) 'IP and 3D printing: do not ignore the patent aspects', *Virtual and Physical Prototyping*, 11(August), pp. 143–147. doi: 10.1080/17452759.2016.1179584.
Williams, K. and Petrosky, A. (2011) 'Product placement effectiveness: revisited and renewed.', *Journal of Management & Marketing Research*, 6491(May), pp. 1–24. doi: 10.1300/J057v10n01.
Willis, K. . *et al.* (2011) 'Interactive fabrication: new interfaces for digital fabrication', in *Proceedings of the fifth international conference on Tangible, embedded, and embodied interaction*. ACM, pp. 69–72. Available at: http://portal.acm.org/citation.cfm?id=1935716 (Accessed: 16 September 2011).
Willis, K. D. D. K. D. D. *et al.* (2010) 'Spatial sketch: bridging between movement & fabrication', in *Proceedings of the fourth international conference on Tangible, embedded, and embodied interaction*. ACM, pp. 5–12. Available at: http://portal.acm.org/citation.cfm?id=1709890 (Accessed: 25 September 2011).
Wind, J. and Rangaswamy, A. (2001) 'Customrization: The next revolution in mass customization', *Journal of Interactive Marketing*, 15(1), pp. 13–32.
Winge, T. (2006) 'Costuming the Imagination: Origins of Anime and Manga Cosplay', *Mechademia*, 1, pp. 65–76. doi: 10.1353/mec.0.0084.

Wirth, M. and Thiesse, F. (2014) 'Shapeways and the 3D printing revolution', *Ecis*, pp. 1–14.
Wolf, M. (2001) *The Medium of the Video Game,*. Austin: University of Texas Press.
Wolf, P. *et al.* (2014) 'Sharing is Sparing: Open Knowledge Sharing in Fab Labs', *Journal of Peer Production*, (5), pp. 1–11.
Wood, M. M. and Baughman, L. (2012) 'Glee Fandom and Twitter: Something New, or More of the Same Old Thing?', *Communication Studies*, 63(3), pp. 328–344. doi: 10.1080/10510974.2012.674618.
Yang, L. (2009) 'All for love: The corn fandom, prosumers, and the Chinese way of creating a superstar', *International Journal of Cultural Studies*, 12(5), pp. 527–543. doi: 10.1177/1367877909337863.
Zeng, J., Chen, W. and Ding, Q. (2003) 'A Web-based CAD system', *Journal of Materials Processing Technology*, 139(1–3), pp. 229–232. doi: 10.1016/S0924-0136(03)00225-5.
Zwick, D., Bonsu, S. K. and Darmody,  a. (2008) 'Putting Consumers to Work: \`Co-creation\` and new marketing govern-mentality', *Journal of Consumer Culture*, 8(2), pp. 163–196. doi: 10.1177/1469540508090089.

# GLOSSARY AND TERMS

a) *3D Printing* - 3D printing has been used throughout this writing in place of additive manufacture for the purposes of readability. It is also referred to as digital fabrication and the key to understanding it is that it differs from preceding scale or mass production paradigms through scope production capabilities, complex and complete build capabilities, it is suited to bespoke applications as a consequence of the low cost of tooling set up making possible 'on demand manufacturing'. It is important at this stage to differentiate manufacturing strategies which may also be classified as 'on demand' from flexible specialisation and just in time manufacturing strategies which have been found with previous mass manufacturing approaches.

b) *Fan art* is understood as fan generated art relating to intellectual property created and published by the object of their attention, this may be any "artistic product created in homage to, adapted from, inspired by or copied from poplar cultural phenomenon'. (Manifold, 2013) Fan art is strongly evidenced in the comic, manga, anime and music and film industries and with democratised access to digital fabrication we can see that there is evidence of fan artists adopting digital fabrication as a means of creation.

*c)* *Remix or remixing* refers to the act of creating something new based on existing materials (Monroy-Hernández, 2012). Remix is not a new term, nor confined to the internet as remix has been around as a term relating to music "remixing began, historically, as a protective measure," then it became "the final step in making a record" (Davis, 1966). Since this time remix has been applied as activity to film, publishing and now this research will point to remix associated with physical goods as facilitated by digital fabrication.

d) *Digital consumer culture*; drawing comparisons with consumer behaviour associated with web 2.0, research indicates the general suggestion is that a digital consumer culture is characterised by co-creation of value and trends of prosumerism and consumer participation in production.

e) *On-demand* as a term can be understood as '*on request*' or '*when asked for*'. *'On demand design'* as a strategy has been relatively disengaged from the design of products and furniture since the emergence of mass production strategies during the industrial revolution where design activity functioned to serve the standardisation and uniformity needs of mass production. With the emergence and growing proliferation of design tools that interface with digital fabrication technologies and employ generative and computational design, on demand design, user design and customisation is increasingly viable. As a trend this has been observed in a number of fields including fashion, however its proliferation to physical goods (product and furniture) has been slower and restricted to surface treatments or found in service based manufacturing centres such as Ponoko. In recent years design and manufacturing strategies enabling 'customer design' and manufacture of physical goods have emerged from existing commercial design brands e.g. Droog whilst Ponoko is encouraging development of consumer applications enabling user design. This PhD is based on a supposition that this is set to be a growth field and seeks to contribute to discussion and development in this context.

f) *Manufacture* must be considered in three ways; manufacturing *technologies,* manufacturing *processes* and manufacturing *strategies.* The *technologies* considered here will be referred to as digital fabrication technologies and understood as technologies that are driven by digital input. Digital fabrication technologies are diverse and can be understood under a multitude of terms including ‘additive fabrication, solid freeform fabrication, direct digital manufacturing, instant manufacturing, rapid prototyping, 3D printing, additive manufacturing, on-demand manufacturing, rapid technology, rapid prototyping, rapid manufacturing, layered manufacturing, 3D micro-fabrication and desktop manufacturing. Each of these technologies involves a distinct manufacturing process that is often alluded to by the term. Understanding of the complexities of the individual *process* is outside the remit of this research; suffice to understand that these are tools driven by digital input. Digital fabrication technologies are often grouped under an umbrella term ‘post industrial manufacturing systems’. In line with this, manufacturing *strategies* associated with these approaches differ from manufacturing strategies in industrial or mass production systems.

g) ***Commerce*** is understood as the activity of buying or selling goods and services, and *creative commerce* refers to the activity of buying or selling experiences, making processes or co-creative activities.

h) ***Makies*** are 3D printed custom action toys that correspond to a related digital asset that can be played in game and across platforms. Makies is also the brand name for these dolls and the platforms related to company MakieLab.

i) ***Omake*** is a Japanese term that means *extra* or bonus. In the context of anime and animation this might refer to an added extra or give away in the form of a free item such as a sticker, toy or figurine attached to soft drinks or confectionary. It should be noted that sometimes the omake is considered more desirable than the product being sold. A more western context would use this term to describe extras, outtakes or “the making of” features of DVDs or in reference to a small toy contained in a cereal packet as a giveaway item.

j) ***Otaku*** is a Japanese term that refers to people with obsessive interests and is commonly used in regards to fans of anime and manga. It may be understood as a deep or obsessive fandom or interest in a hobby or media product. While used as a pejorative in some cases the term appears to undergoing shifts in meaning and appears to be reclaimed by an increasing number of people now self-identify as otaku.

k) Otaku subculture is has been a central theme of various anime and manga works, documentaries and academic research. Understood as a subculture its origins may be traced to the boom in anime.

l) ***Anime*** is the Japanese term for *animation*, and describes a style of hand-drawn and computer animation. Outside Japan, *anime* is used to refer specifically to animation from Japan or as a Japanese-disseminated animation style. Osamu Tezuka is attributed with giving anime the characteristic art style emerged in the 1960s. Anime is distributed in various ways including television and via the Internet.

m) ***Character merchandizing*** is a term that refers to licensing, production, marketing and consumption of goods and media inspired by the image of a character. A World Intellectual Property Organization definition describes this as the adaptation or secondary exploitation, by the creator of a fictional character or by a real person or by one or several authorized third parties, of the essential personality features (such as the name, image or appearance) of a character in relation to various goods and/or services with a view to creating in prospective customers a desire to acquire those goods and/or to use those services because of the customers' affinity with that character. (1994: 6)

### n) Convergent media platforms

In this research I describe MakieLab as a *convergent media platform* and at various points in this writing I examine and explain the various words and definitions employed. In this section I outline the reasons for selecting the word *platform.*

Platform is widely used in business and computing literature and as a term is used in a multitude of ways. Common examples include social media platforms, messaging platforms, e-commerce platforms, streaming platforms and video gaming platforms. Interpretation or application of the term generally depends on the discipline or background it is approached from. Even within disciplines the meaning of the term platform is fluid. To this point, a blog post by Andreesen (2007) notes that the concept of platform is the focus of a "swirling vortex of confusion".

Understanding the nuances and full range of the use of the term platform is not the aim of this research but some relevant examples are presented here as a means of justifying my particular use of the term platform. On a basic level this research considers adoption of 3D printing in games and media industries, noting adoption by individual practitioners as a tool in existing art, animation or prototyping workflows. However the research indicates that in particular *software enabled convergence of 3D printing with digital media products* and the subsequent opportunities are central to this research.

This convergence of 3D printing with digital media products, as in the case of MakieLab created what I describe as a *platform*. More than a game or manufacturing process, MakieLab built what this research describes as a platform, that supported a series of games and apps from which content could be 3D printed. This platform enabled automated and formalised translation of game art to printable formats and could (had Makies chosen to do so) be opened to other game developers in a white labelling process thus rendering it a form of game/print platform upon which other media producers could provide similar services.

Bogost and Montfort (2009) use platform to refer to "*a computing system of any sort upon which further computing development can be done. It can be implemented entirely in hardware, entirely in software (which runs on any of several hardware platforms), or in some combination of the two"* (Bogost and Montfort, 2009). Meyer and Lehnerd (1997) define a platform as a set of subsystems and interfaces forming a common structure from which a stream of products can be developed and Muffato and Roveda, (2002) describe them as intentionally planned and developed set of subsystems and interfaces from which products can be developed. While Robertson and Ulrich (1998) describe a platform as the assets (components, processes, knowledge, people, or relationships) shared by a set of products. MakieLab created software and supporting processes that allowed for development of apps and games and subsequent translation of game or media content within said media products to 3D printable formats.

The intent behind this specific wording is firstly then to highlight the *particular alignment or convergence of 3D printing with media products such as games in which art to toy production pipelines are automated.* On one level MakieLab could be described as a form of computing platform upon which game developers could build games and apps that would function with Makies software translation process allowing for automated output of 3D printable toys from game art.

Beyond this computing or engineering oriented definition of platform, on a second level the MakieLab platform could also be considered as a content marketplace or platform upon which content is not only hosted but consumed, and traded. As Gawer (2014) notes platforms may be described not only as technological architectures but also as markets. Gawler (2014) goes on to suggest *"Economists view platforms as special kinds of markets that play the role of facilitators of exchange between different types of consumers that could not otherwise transact with each other"*. Similarly Steinberg (2017) suggests that *"platforms function as closed sites where particular commodities meet particular people under very regulated and copyright-protected conditions."* On the Makies platform players were able to create, remix and consume game content both as digital and physical objects and MakieLab anticipated that their games and apps would function as marketplaces or economies of user created content.

Both the economic/marketplace and technology enabling aspects to the processes and organisation configuration that MakieLab established lend weight to my decision to describe it as a convergent media platform.

# APPENDICES

# *APPENDIX 1: INTERVIEW WITH ALICE TAYLOR, FOUNDER OF MAKIELAB*

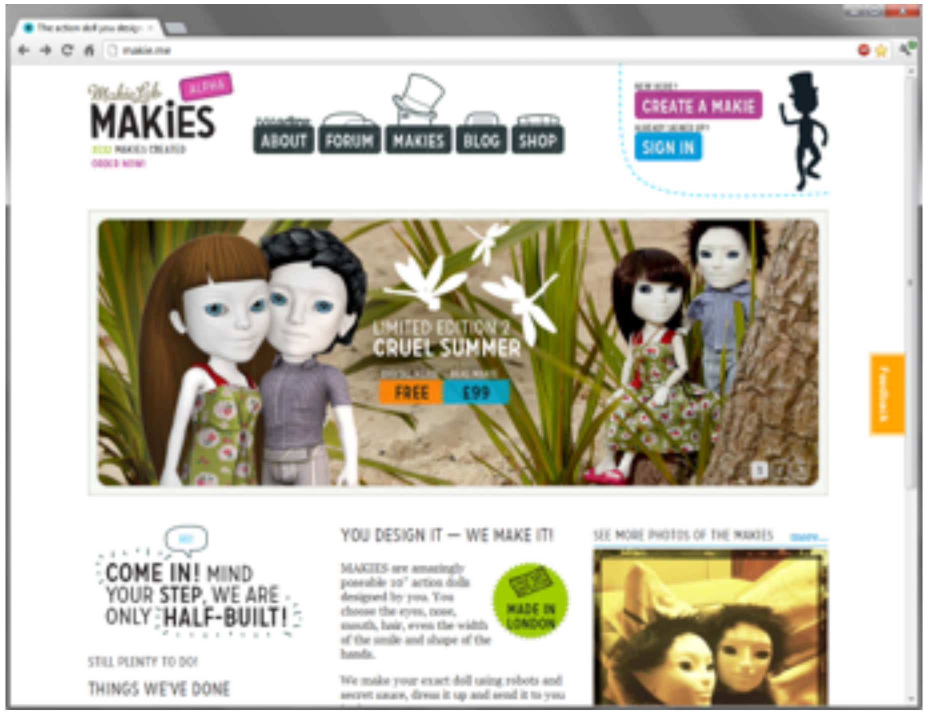
As an introduction to MakieLab an informal interview was conducted with Alice Taylor in mid 2012. This section is provided as an introduction to MakieLab and was designed as an informal way to capture and note Alice's intent for MakieLab early 2012 and what market and consumer desire she anticipated targeting. The questions outlined here were in part generated from the early questions received by interested consumers of Makies. This interview provides an insight into Alice's thinking during the founding stages of MakieLab.

**What is MakieLab?**
Alice: "MakieLab is a Shoreditch-based company making game-connectable 3D printed toys. It was formed in mid-2011 to create a system for producing on-demand individualised toys via a web, smartphone or tablet app. In May 2012 MakieLab alpha-launched customisable, pose able, and super-creative plastic action dolls Makies."

**What does MakieLab offer?**
"The initial offering by MakieLab allows user-customisation of dolls through a web-based design tool available at http://www.Makie.me/ and subsequently SLS prints purchased dolls in nylon and ships assembled dolls to users. Makie.me launched publically in May 2012 with an open alpha batch of 100 dolls selling out in three weeks and two days and subsequently switched to on-going on-demand production in July 2012. MakieLab is now in the process of developing a corresponding game and mechanisms by which the physical doll will interface with the game through embedded electronics or on screen printables."

**What are Makies?**
"Makies are build-your-own, 3D-printed action dolls, with physical features that can be sized and shaped in ever-expanding ways. Manufactured in London, England the body can fit a Lilypad Arduino or similar, and can accommodate LEDs, RFIDs and battery packs, voice chips, Bluetooth and Arduino. On-going expansion of Makies will include plastic colours and more clothes and accessories, plus games and creativity tools. Expansion into a series of toys targeted at the 3+ market is planned for 2013."

**How does Makie.me work?**
"The makie.me website is open alpha, the very beginning of a future plan that includes mobile and younger-user versions.

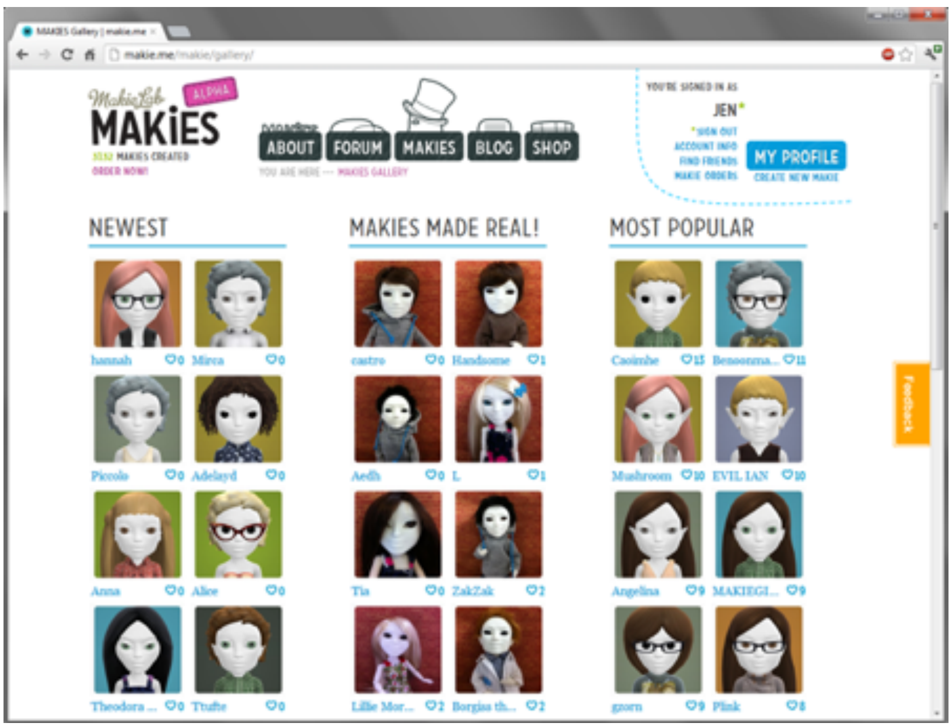



Users can create a digital action doll from scratch, or choose one of our pre-generated models as a starting point.

The user can customise the doll by choosing hair style/colour and eye colour, and using sliders to shape the eyes, nose, cheeks, mouth, cheeks, jaw and eyebrows. Different hand and feet poses are available too. The user names and saves the doll, and then has the option to purchase a physical version. Users can create and save an unlimited number of digital Makies for free.

Upon selecting 'Buy Me', the customer chooses one of a selection of pre-made outfits to dress their physical Makies doll. Once the purchase has been completed, we get on with printing and assembling the doll to the customer's specifications.

Every Makies doll is one-of-a-kind, with a unique identification number, and each one ships to the customer with a signed and numbered certificate."




**What is your relationship with your user group/community?**

"Since alpha launch in May 2012, we've been building a diverse community of creators and early Makies adopters: doll collectors, crafters, hackers and makers of all kinds. Although it's early days, we've already seen a variety of fantastic Makies projects: Arduino ears, photo vignettes with custom-made miniatures, stop-motion videos, and lots more.

This kind of user creativity is what Makies is all about, and we're supporting it by maintaining an open dialogue with our users, spotlighting creative work by our community members, releasing patterns and posting our own experimental results. Coming next: much more to do and make! Clothes, accessories, patterns, textures, competitions, facial features, achievements... and a version for 3+."

**How do you explain 3D printing to your user group?**
"There lots of different types of 3D printing available: imagine it as liquid plastic that sets, or nozzles that extrude plastic like icing a cake, or plastic powder that's melted by lasers into a shape. The last type is what we use: it's called Selective Laser Sintering, to give it its proper Additive Manufacturing (aka 3D Printing) title. The machines we print on are EOS machines, usually a p100 model.

The plastic is a simple white nylon, and is recycled into each print run. There's almost no wastage, and what little there is can be up cycled into nylon clothes. The nylon itself is a bio plastic, meaning it is non-toxic."

**Do you think this is the future of manufacturing, will it replace mass produced products?**
"It's a future for manufacturing, absolutely. 3D printing is an emerging technology, and for now, it's more expensive than many traditional manufacturing techniques. While it's unlikely to replace mass production in the short term, 3D printing really comes into its own for manufacturing unique things, and making rapid changes to in response to customers' wishes.

So we're using 3D printing to manufacture dolls with faces/hair/hands/feet created by their owners, and we'll offer customisations week in, week out, in a very responsive way: if everyone asks for tusks, they can have tusks, in as long as it takes us to model a set of tusks! (Maybe a few hours)."

**Can I have anything I like on my doll?**
"Digitally, yes. We plan to offer all sorts of fun dress-up stuff, and not just pink things, either. In the physical world, for the moment we're limited to "collections" of clothes, which will grow over time. Unfortunately we can't manufacture every single piece of clothing that we (and users) can produce digitally. Not yet, anyway.

Future developments will however include user-generated textures on cloth, and user-generated patterns for download."

**How long to ship?**

“We aim to have the action doll in its tube 10 working days from the moment the customer presses BUY. The process is this: BUY sends the model to the next print batch, which is on-the-fly organised to fit the print space. Our suppliers print the batch pieces, and send them to us for finishing, dressing, hair & eyes, clothes and packaging. Then we wrap, bag and ship, which - depending on the customer’s location - should only take a few days.”

**How much are Makies?**
“Alpha Edition dolls are £99. In the future, we’ll manage to produce dolls at lower and higher price points too, depending on exactly how many customisations, extras and accessories a customer wants. So they’re more expensive than a mass-produced Barbie, or American Girl (just), but less expensive than a collectible Blythe or Pullip.”

**The product is marketed for teens and older? Why?**
“Yes, for now. Because no one has done this before, we have to push 3D printed products through extensive toy safety testing before the products can be labelled for use by babies, toddlers and younger children. Makies are aimed at the 14+ market, but we are working on getting to a 3+ version very soon.”

**How long will a Makies doll last?**
“The dolls should last a lifetime, with a bit of care. They’re pretty robust plastic, but of course it all depends on how you play with them! They are designed to be upgradeable and to be modded; The eyes can be swapped out easily, the hair comes off, and there’s even space in the skull and back for batteries and DIY electronics like a Lilypad Arduino, if you’re that sort of maker.”

**What else can the dolls do?**
“At the moment, each doll exists digitally as well as potentially physically. The digital dolls can do all sorts of things: wander around a 3D environment (technically, a physical doll can do that too, given a bit of help!). But in future, we see a play space where the digital environment unlocks cool things for the physical doll to see or buy, and vice versa...”

**How will the site and apps develop?**
*“Next stop: tablet games. And we’re pushing towards 3+ certification, and colours, and more things to do.”*

**Summary**
This interview very much reflected the pitch Alice made for Makies when she spoke publically. This was the interview that an external researcher was likely to receive had

they approached Alice requesting an opportunity to interview her. With out asking more leaving and insightful questions or working with the company directly it would have been difficult to gain access to the more meaningful areas to consider.

# *APPENDIX 2: PROSPECTIVE CUSTOMER SURVEY*

This section outlines the qualitative and open-ended responses to the survey. The tables in the section that follow point to the raw data with personal identification removed.

COLLECTABLE
‘The first time I saw the first collectible doll I bought was pretty special’

BUILDING CREATING
I liked making shoe box houses for my dolls more than the dolls themselves.’

GENDER CREATING SOCIAL PERSONALISATION
‘I had a cabbage patch kid that my grandmother made clothes for -- to match me. Also the wooden doll I took to school during third grade, with a lunch box full of material to make clothes during recess as a way to make friends. A long line of troll dolls that went everywhere, and likewise playmobile figures -- the latter, I could give the cool ” boy” accessories to fierce, red haired, female figures. A Padme figure was my navigator during college, sat on the dash with Jabba, a troll doll, and a plush snake. Padme and co have been replaced by Chris Ex as the doctor, and a purple dragon I found in the parking lot.’

‘I remember my first doll, Cherry very well. I don't have any specific memories of her other than the time one of her eyes fell out. I also have a teddy bear which I have kept since I was a baby and slept next to him in my bed for many years. When I say many, I mean way too many.’

COLLECTABLE GENDER
‘I collected all of the Thundercats action figures when I was about 10 - completely obsessed with the series, and also had two of my letters published in Thundercats magazine (both complaining about lack of female representation...)’

‘The American 80s brands (Masters of The Universe, My Little Pony, Princess of Power) shaped my sense of design. If there hadn't been Japanese video games I would have been totally fucked up. Loved the universe they built around their brands, still strong today.’

CURATION
‘Having fashion shows with my Barbies when I was about 8 or 9 years old.’

COLLECTABLE
‘Best friend gave me her original Leia Organa when we were 6, and I was diagnosed with juvenile diabetes; began a lifelong collection of female action figures.’

CURATION POSING CUSTOMISATION
‘I got the Princess Leia and C3PO action figures from Empire Strikes Back. C3PO had 0 moving parts, and I always had amazingly boring scenes, where Leia could do stuff, and

C3PO just stood there (in retrospect, much like the movie). Until one day, one of the neighbor kids must have dropped his Luke figure while playing. (I can even picture where I was when I found it, I was so elated.) Even, better, Luke had been "modded" with red nail polish, so he'd clearly seen some battles. After that, all my imaginary scenes were epic.'

BUILDING CREATING
'Playing with a Han Solo action figure in a really hot summer age 6 or 7 in the seventies, making cardboard tube tunnels and half burying them in the garden'

'Pippa was awsome, loved the size, and wish someone would make something a similar size - tricky to make clothes for.'

COLLECTABLE
'I'm a Barbie collector with a preference for vintage. I've memories and memorabilia about my dolls.'

'Not really but id usually only ever get Action Men.'

CREATING
'Loads of fond memories of Thunderbirds toys, and some scratch-built barbie-scale Thunderbirds made with Action Man/Ken dolls that my Gran sewed costumes for.'

CREATING BUILDING CUSTOMISATION
'Making things for them/around them'

DESTRUCTION! POSING CURATION SOCIAL COLLECTABLE

'Playing in the dirt with those bags of small plastic WWII-style soldiers. Preferring the guns, bags, tools and other accessories to the actual action figures. Getting my own codename when I joined the Action Man club in the late 1980s. Away from war; spending hours posing robots (I was an only child). Painting Warhammer but never playing a full game (That's war again). At 31, since toddler-hood I've never had a bedroom or living room without a few action figures and plastic soldiers out.'

CURATION BUILDING SOCIAL
'As a kid I borrowed GI Joes from friends. Wasn't allowed to play with the guns, but enjoyed the figs anyway. Lots of acting out adventure. Later, building environments (outdoors mostly) for them to live in.

POSING SOCIAL
In college, I remember the very first Hellboy figure being really cool. I posed it and took pics. Those were the first pics posted to the Hellboy forum at the time. Made me feel like part of the community in a way I hadn't before.'

CUSTOMISATION

‘i remember having a gi joe/action man figure called zartan when i was nine or 10. It was the first toy i had that had a behaviour that wasn't battery-driven, and for that reason i loved it. The character was basically a mercenary who lived in a swamp, and had some innate ability to disguise himself by changing the colour of his skin based on heat or sunlight. just found him on Wikipedia! here he is: http://en.wikipedia.org/wiki/Zartan’
‘http://www.youtube.com/watch?v=4I4hDoEIMRs (star wars speeder bikes)’

FASHION POSING
‘funny enough my favorite memory is within last 8 years when I purchased the Spinal Tap collectible figures.... what stood out to me was the great articulation. Other then that as a kid the KISS dolls were great because of the costuming/outfit quality. I also recently received some figures from Japan that were given to me... I don't have the fact name here at the moment but the number of options that came along was amazing! almost 3 of every possible gesture!’

DESTRUCTION!
‘My favourite action figure was a toss up between "Battle Armour He-Man" and his colleague "FISTO". Both for the obvious battle damage and elasticated power punch features...’

CURATION STORY TELLING
‘Playing all-day games against friends who had figures from the same collections; inventing mythologies around them.’

DESTRUCTION!
‘I really liked to melt them and check out the damage!’

‘Six Million Dollar Man’

DESTRUCTION! CUSTOMISATION BUILDING CURATION
‘Action man commando - making a zip wire from the bedroom window to the garden using a washing line. It melted his hands, but that just made him look tougher’

CURATION
‘Making star wars movies with my cousin every summer for years. Lego films shot on a cheap point and shoot with my nephew. Tauntaun races on white bed sheets o sleepovers. Christmas morning the Christmas after empire- my brother and I got Hoth Luke and Han.’

‘I was an evel knievel kid. I loved making him fly’

DESTRUCTION
‘Stringing up a naked, bearded Action Man by his left leg and hanging him from the banister rail...’

BUILDING DESTRUCTION CUSTOMISATION MAKING CREATING

‘As a kid, my friend and I shopped more at the local hardware store than the toy store, for GI Joe accessories. We had pulley driven tree-houses, ziplines, rail cars.... all of which were built buy hand. After my friend's older brother mutilated GI Joe with a bunsen burner, we crafted our own cyborg prostheses from stuff found at the hardware store!’

DESTRUCTION
‘Action Man - plenty of memories being in the garden with him buried up to his arm pits :)’
‘Magnetic Batman & Robin were huge favorites. (http://www.megomuseum.com/wgsh/12/batman.html) Subsequent to that, all things Micronauts. Getting Micronauts Rocket Tubes set for x-mas is one of my favorite memories.’

COLLECTABLE
‘Playing with and collecting the very first Action Man products.’

BUILDING
‘I once built a model of the Millennium Falcon, and that was fun.’

**Section 1. Favourite memories of action figures & dolls**
Here users were asked to recall favorite memories of action figures and dolls.

**Table 1: Toys purchase/ownership by gender as teenager**
**Q. As a TEENAGER, did you or do you buy any of the following?**
Ownership of toys can be considered to have been influenced by gender stereotyping typically applied to toy categories with differences observed across male and female categories. Males tended to own meccano, action figures and Lego while females tended to own dolls, plush toys and construction/craft toys.

| TOY | Total | Female | Male |
|---|---|---|---|
| Dolls | 9 | 8 | 1 |
| Plush toys | 13 | 7 | 6 |
| Other construction kit / crafting toys | 31 | 7 | 24 |
| Lego | 40 | 6 | 34 |
| Action figures | 33 | 0 | 33 |
| Meccano | 12 | 0 | 12 |

**Table 2: Toys purchase in past 12 months**
**Which of the following have you bought within the last 12 months?**
Adult purchases of toys, whether for self or other.

| TOY | Total | Female | Male |
|---|---|---|---|
| Dolls | 11 | 7 | 4 |
| Plush toys | 16 | 10 | 6 |
| Other construction kit / crafting toys | 17 | 9 | 8 |
| Lego | 16 | 9 | 7 |
| Action figures | 10 | 1 | 9 |
| Meccano | 1 | 1 | 0 |

**Table 3: Male/female toy gifting behaviour.**
**If you have bought toys, who did you purchase them for?**

| Recipient | Total | Female | Male |
|---|---|---|---|
| Myself | 25 | 12 | 13 |
| A friend | 14 | 6 | 8 |
| Other relatives | 12 | 6 | 6 |
| My child | 13 | 4 | 9 |
| Partner | 1 | 1 | 0 |
| | Est/Tot | 29 | 36 |

**Table 4: What kind of customisable toy, other than an action doll, would you also like to see?**
Robots, everyone wants robots.

| Toy | Total | Female | Male |
|---|---|---|---|
| Vehicle, e.g. Car | 11 | 3 | 8 |
| Fairies | 6 | 5 | 1 |
| Dinosaurs | 15 | 9 | 6 |
| Remote Control Vehicle | 16 | 6 | 10 |
| Robots | 28 | 7 | 21 |
| Aliens | 16 | 8 | 8 |
| Monsters | 1 | 1 | 0 |
| D&D Character Set | 7 | 1 | 6 |
| Space ship | 1 | 1 | 0 |
| Fantastical creatures my kids have drawn | 1 | 1 | 0 |
| Animals | 18 | 13 | 5 |
| ROBOTS OH YES | 1 | 0 | 1 |
| console controller mods | 1 | 1 | 0 |

### Favorite memories of action figures & dolls

Here respondents presented their favorite memories of action figures and dolls which presents as a nostalgic and at times amusing overview of childhoods in the '70s, 80s and 90s. Memories can be categorised into a number of related activity areas and behaviours ranging from gentle customisation to destruction.

While none of the users have reported the existence or use of customisation platforms during their childhood they engaged in customisation activity sometimes at the expense of the finish of the toy and reporting suggests that customisation extended and perhaps enhanced their play activity. Customisation activity ranges from extending capabilities of the toy through building prostheses and enriching play experience through modding with nail varnish to create battle wounds as well as aesthetic agendas relating to appearance. This modding behaviour overlaps with curating, posing and story telling behaviour, as well as building, creating and making each of which emerge as key memory themes from user feedback.

Building, creating and making is reported with building environments around the toy and play activity reported. Shoebox houses, tree-houses, ziplines, rail cars feature suggesting that this extending capability and environment is significant. Curating activity ranges from hosting fashion shows, to war games with 'epic imaginary scenes' and may be captured by creating videos and photographs. Moving parts and the ability to pose figurines is considered important *'C3PO had 0 moving parts, and I always had amazingly boring scenes, where Leia could do stuff'* and appears to facilitate story telling and sharing.

**Personalisation** as understood here as making the toy look like the self or other significant person is reported. In this context dressing in matching clothing is reported, and usually an activity ascribed to an older female adult such as grandmother. Discontent with reinforced **gender** typing is also reported with one respondent submitting letters of complaint to thunderbirds and another swopping for cool boy accessories.

**Destructive** activity appears frequently and appears to inspire a nostalgic historical perspective of the younger self. Melting, painting, burning, burying and *'Stringing up a naked, bearded Action Man by his left leg and hanging him from the banister rail...'* all feature as destructive activities. Examining the damage is a function of curiosity. Destruction activity also serves to extend the story telling capacity of the respective toys through battle wounds and making *'him look tougher.'*

**Social** memories present in a number of different ways. Some users report using making and creating activities as a way of making friends while other recall a feeling of belonging when joining the social network, forum or user group of a particular toy - *'Made me feel like part of the community in a way I hadn't before.'* and '*Getting my own codename when I joined the Action Man club in the late 1980s.'* Networking and social sharing spaces may be understood as value co-creation platforms and it is suggested that they add value to the toy and play experience facilitating a sense of community, belonging and relationships.

### What is the coolest feature you'd like in a customisable action figure / doll?

### Doll parts

Face, clothes and hair are cited as the key features that users consider customising. Hair is suggested because it appears to enable personality switches in dolls as does eye colour and the ability to pose dolls. Skin colour, eye colour, body shape, battle damage and scars are listed as features to be customised with discontent at the limitations imposed by the current offerings of dolls and toys. Finally customisation that allows the user to *personalise* the doll to look like someone they know is also cited as a desirable feature.

### Accessories

Fashion and accessories are listed with imaginative and alternative requests as compared to the more typical array of accessories that are currently offered, including; goggles, eye patches, hats, inhalers 'asthma puffers', 'Laser death ray eyes', tracking eyes, beards, secret compartments and extra arms. Accessories offer expansions in the play space and add value to the toy as a whole.

### Interaction

There is a call to integrate sensor-ware with the doll to facilitate interaction capabilities. Respondents want a toy that is able to *'recognise, and interact with, its environment in some way...'.* Sub levels to this request indicate sound and visual interactions with enabling playback of user generated sounds, recording and FX and visual - through video eyes.

### Persona/Personality

Identity, persona and relationships. One of the respondents suggested 'ADIDs (active digital identity) so my figure can be connected to others'. (Possibly http://evrythng.com/) But possibilities for 'friends' and relations playing on exclusivity and niche are worthwhile considering. Also integration with existing platforms such as Weavrs.

**Results: What is the coolest feature you'd like in a customisable action figure / doll?**

INTERACTION

'I saw one of your dolls with a lilypad inside it's head, that was an exciting moment!'

CUSTOMISATION FASHION

'Customisable face, clothes and hair that you could have designed to your requirements, in general, would be quite cool.'

POSING CUSTOMISATION

'I am interested in wigs (for example, Odeco) as this can change the personality of the doll so quickly. Also an easy way to change the eye colour is a great feature (Odeco again and Blythe). Poseable dolls have also started to attract my interest as they have more possibilities when it comes to taking pictures or setting up dioramas.'

FASHION

'Lots of accessories. The best bit of Playmobil is all the cool little accessories. I really like that stuff. The kids also like setting that stuff up.'

FASHION

'Goggles and eye patches. And hats. Definitely hats.'

PHYSIOLOGY

'Muscle mass/body shape'

PERSONALISATION

'To make it look like someone that I know.'

GENDER PHYSIOLOGY

'Body shape - dolls/action figures seem to all fall into the very slender (if female) or bulked up (if male), not much in between.'

CUSTOMISATION

'I would like to be able to paint the face (sell me a kit of exclusive colours!) and change the pose... such as gas heating, air brushing specialists do it in Japan. i never did it myself though...maybe I was always satisfied with what the "proper" designers sold me ;)

FASHION

'their clothes'

SOUND

'Be cool if she had an audible catch phrase in my voice'

PHYSIOLOGY DIVERSITY

'Custom colored skin. I'd love to be able to create my Glitch in physical form.'

PHYSIOLOGY FASHION DIVERSITY GENDER
'Any female figure who doesn't have huge tits and a tiny waist, for one. Any figures with glasses and minor accessories like asthma puffers but who are in themselves, totally cool. Female figures with bob haircuts rather than always long hair. I'm not saying non-feminine. I'm just saying vary it from the doll 'norm'. African dark black, lighter black / olive / pacific rim skin colouring action figures please.'

POSING
'poseability. Smooth materials. Likeness.'

CUSTOMISATION
'It would be to give it a unique hairstyle, thats usually someones most distinguishable feature imo.'

SOUND POSING
'movement, speech'

'having 4 arms'

SOUND
'Voice recording and playback'

SOUND
'Voice programming / recording'

INTERACTION
'I like the idea of marrying programmable electronics (e.g. Arduino) with action figures.'

CUSTOMISATION
'Custom words embroidered on clothes like what you can get with Nike 6.0 skateboarding shoes. (Boo to Nike/Hooray to customisable trainers).'

STORY TELLING
'Re action figure - battle damage and scars'

POSING
'Great articulation. Being able to position the figure in a wide variety of poses is the best feature.'

INTERACTION
'the ability to recognise, and interact with, its environment in some way...'

INTERACTION
'Wireless sensors like http://www.greengoose.com/'

CUSTOMISATION

‘Having my hand held in the design process, but being able to totally customize the doll if I want. Essentially pressing right up against what's possible, but in a lazy way...

Also, take a photo of something and then sticking it into a magic thing that makes a doll of it...’

SOUND
‘Recordables!’

CUSTOMISATION PERSONALISATION
‘That you can put a photo of somebody on the doll's face’

‘Laser death ray eyes’

POSING
‘expressions/eye lids’
‘Secret arm-compartment like the Bionic Man had.’

INTERACTION
‘Eyes that move of their own accord, tracking you across a room. Bit creepy, eh? :)’

INTERACTION ETHICAL PERSONALISATION STORY TELLING NOSTALGIA
‘Recyclability, reuse or second-life. Can I personalise it for a second 'owner' hand it down through the family, as my oldest child looses interest, but my youngest child gains interest.’

POSING FASHION
‘Articulated shoulder height ( so much mood in there) and good luggage/ rucksacks, webbing etc.’

‘Vechiles. I want motorised Vechiles’

INTERACTION SOCIAL
‘Other than a beard, I would like lights, sounds, and ADIDs (active digital identity) so my figure can be connected to others’

INTERACTION
‘Sentience’

INTERACTION CURATION
Face model from webcam pic(s).
Also, I'd like to put a camera in the doll's eye. THis past weekend I built a Romo (romotive.com) kit with my sons and they LOVED the ability to see out the robot's "eye" via the iPad and snap pics.

FASHION CUSTOMISATION

‘My daughter would be constantly changing the makeup on her dolls’

POSING
‘Depends upon the basics. Great articulation is probably the thing I'd want the most - the ability to do good poses like with Stikfas.’

SOUND INTERACTION
‘Actionable sound and movement.’

INTERACTION
‘Ethernet connectivity’

PERSONALISATION
‘Lookalike’

‘Eyes that light up.’

SOUND PERSONALISATION
‘Ability to add sound fx/noise/playback’

## Results: How do you feel about action figures / dolls that you can design yourself?

CUSTOMISATION
‘Great. I often customise dolls so it's nice to go a step further’

‘Fantastic!’

CUSTOMISATION MAKING FASHION STORY TELLING CREATING
‘I currently collect Blythe dolls which I sometimes customise myself. I find this very enjoyable although it can be very time consuming and get expensive. I also enjoy making clothes for my dolls and I spend many hours prototyping and making the final designs. I'm not entirely sure how I would feel about someone else making a doll to my specifications as I enjoy the feeling of bringing my doll to life and seeing a character develop over weeks or months. There is also a feeling of accomplishment from creating your own character with your own hands.’

‘Amazing. My youngest son (6) will go especially crazy for this.’

CUSTOMISATION
‘Love! I tend to customized anyway.’

CUSTOMISATION
‘I always thought Barbies were boring as a child so would have liked to have designed them myself, especially 'cooler' dolls that did cool things.’

‘Very interesting, as I have no previous experiences, I am eager to see how it feels/makes me feel.’

‘Excited!’

GENDER
‘I do not have to tell you that garage kits (especially female dolls) are extremely widely spread among Japanese males, model kits of vehicles among Western males. Strange that grown-up women of any world seem not to have the same urge, maybe Makie can change this!’

‘That would be cool’

‘Meh’

PERSONALISATION SOCIAL DIVERSITY GENDER
‘I think it's important for kids to be able to see things that look just like themselves out there in the world to know that they're not alone.’

‘It depends. I think I want to show it to my 8 year old daughter, and also my 6 year old son to see what they make of it. Anything where there is a degree of control is cool for kids. It will be useful if they can save multiple designs before choosing, and even save those designs without having them made - having created personalities, they might not want to let them go, but it might not necessarily follow that the parental object will actually be able to afford to get them all.'

'I'm very interested in this opportunity. I'm very interested in the "body of the dolls" subject, and I invite you to search such tag in my dollcultural blog http://dollculture.blogspot.com'

'Awesome.'

'interesting- at the right price might be useful in Key Stage 1 and 2 education - Design and Technology and Science.'

'Seems like a cool idea if you're into that kind of thing.'

'that would be very cool'

'Intrigued, but often put off by price point'

'Excited!'

'100% support'

'I think it's an exciting development and one that I wish was available when I was a child.'

FASHION CUSTOMISATION EXPERT
'Mixed. I love it in theory, and I love the idea of those 'kit-mash' customisations, but I don't have faith in my ability to design something cool. Part of me feels more inclined to buy dolls/figures designed entirely by the experts. Maybe a toolbelt/bag for the doll where I could pick 'n' mix the accessory contents.'

'V cool'

'That's pretty cool!'

PROCESS
'i love the idea, and the potential feels super-exciting.
i guess the things i can see are:
1. the interface has to make you feel really good and accomplished as an amateur toy designer.
2. as a parent now, the idea of having some kind of content controls for younger kids (if relevant) feels important.
how much can you continue to redesign and hack the toy after it's first done?'

‘Bring it on...’

‘Nice. http://www.youtube.com/watch?feature=player_detailpage&v=HAaFUoiOM-Y#t=22s’

PERSONALISATION
‘Just like when you try out a pen, you end up writing your name, my gut feeling is that adults would get these designed based on themselves.’

‘It's great & cool’

‘AWESOME’

PERSONALISATION CUSTOMISATION
‘super excited to incorporate my own ideas/personality to bring it to life’

‘Neat idea - very Japanese in approach.’

CUSTOMISATION PROCESS
‘it is a great concept, that adds ownership and belonging, but also instils a sense of understanding about how a product goes from concept to production.’

‘Intrigued’
‘Excited and intrigued. Will be interesting to see how the kids enjoy it.’
‘Me like!’

SOCIAL
‘Yay! Really want to let my daughter have a hand at it. Looking forward to it as a father/daughter activity.’
‘My daughter loves to design clothes and is constantly making up her dolls so its more of an interest for her’
‘Intrigued, though skeptical.’

SOCIAL
‘I'D LOVE TO DO IT WITH MY KIDS.’
‘Excellent.’

INTERACTION
‘Very interested — interaction + bringing things to life through their interaction with my data (informatics) and data from elsewhere …’

‘I love them.’

‘Great idea - surprised none of the big toy brands haven't done it yet’

## Anything you want to tell us?

'Really enjoying watching your development process. It's very interesting. It's very interesting as you have a very split market (young people/collectors) so I'm interested to see how your pricing/making process reflects this.'

'Good luck!'

EXPERT CUSTOMISATION STORY TELLING
'if you offer designers consulting and experience of how to turn their own visions into plastic matter that would justify very high prize I think. that would interest many of us urban toy,-action figure- i want may own sculpture-maniacs. Complete freedom for designers, and a partner who understands the tech. For end-users just changing minimal bits, it is important how your original character they shall be motivated to customise looks like. If eg. the doll (seen in the pics on your website) is the thing you offer to customize according to people's wishes, then the doll needs to become a brand first i think before there can be a hype around customizing it.

I think the advantage of customisablility means losing the advantage of a coherent universe which helps telling stories (user generated content vs. an author's script) - it's a completely different thing.
customizing helps telling stories about the builders though, you can share designs and compete, and people themselves can start role-playing with their figures... it's just the question of which target group will be the most motivated to do so.

I think markets work very differently in the different markets and you must find the right balance between your original design (your brand) which must be REALLY good to be able to compete against the long tradition of amazing Japanese or Korean custom built dolls and the right focus points of customisation (what exactly is customisable in your doll?).

hope that helps

good luck!!!'

CREATING
'Do as many focus groups with not so geeky kids as you can, I guess. Geeks, and children of geeks are a limited audience. Having said that, my two are fairly 'normal'. Boys like crafts as much as girls if they're approached in the right way - and I don't mean through wheels and engines. James is loving his intricate stained glass colouring in sheets he got for his birthday. Nora, who is 2 years older and female loves less formal restriction in her making.

But my main feedback right now is, let kids create a login and play / save without purchase. It a) gives them room to create and become more attached to one they like the most b) allows parents to gently suggest they take some responsibility c) gives you a bunch of saved customers and saved avatars which could at some point be a great split-it-off-and-do-something-with-it asset. It also encourages them in the imagination stakes - giving them all names, personalities etc.

...and obviously take their feedback and create visible play spaces from the taking of it. Ratings, votes, etc. And and and.... :)'

PHYSIOLOGY POSING
'Proportions are important to me. Anatomic correctness too.'

'Cant wait for the release!'

'Good luck - cool project'

'That was TOTALLY WICKED!'

'Check out www.rockndollstars.com'
'loving it.......'

'Great to meet Alice at DEVELOP3D Live! And I look forward to making a doll once the site is live
Jason Lopes from Legacy Effects.'

'Really really really want you to come to the next Brighton mini maker faire! Sept 8th this year, and even bigger than last years huge success!'

'Keep it up, Makies! Can't wait for next chapter!'

'Price above largely dependant on what I could do with it.'

'I think your Makie dolls are unique and my daughter has already expressed an interest in them. She can't wait to see the finished product and was very disappointed to not have taken part in your beta test last year due to a prior engagement'

'Following Makielab largely due to former coworker Luke Petre. Luke has done great work at several places and I Makielab is a fascinating new venture. Also, 3D Printing is just cool.'

**Part 1 of Prospective Consumer Survey data**

| Which of the following have you bought within the last 12 months? | Do you post photos or videos online? | Which one of the following services do you share content to or post to? | If you have bought toys, who did you purchase them for? |
|---|---|---|---|
| Dolls, Action figures, Plush toys, Lego, Other construction kit / crafting toys | More than once a week | Facebook, Flickr, Google+, Twitter, Youtube, Goodreads, Amazon | Myself, My child |
| | About once a month | Facebook, Twitter, Vimeo, Youtube | |
| | About once a month | Facebook, Flickr, Twitter, Vimeo, Youtube | |
| Action figures, Lego | Rarely | Facebook, Twitter | Myself, A friend |
| Dolls, Action figures, Plush toys, Lego | More than once a week | Facebook, Pinterest, Flickr, Twitter, Vimeo, Youtube, Picasa | My child |
| Lego | Please choose | | Myself, My child, Other relatives |
| Lego, Other construction kit / crafting toys | About once a month | Facebook, Flickr, Google+, Twitter | Myself, Other relatives |
| Action figures, Plush toys, Lego, Meccano, Other construction kit / crafting toys | About once a month | Facebook, Flickr, Twitter | My child |
| Dolls, Lego | Rarely | Facebook, Pinterest, Twitter | My child |
| Action figures, Plush toys, Lego, Other construction kit / crafting toys | More than once a week | Facebook, Twitter, Vimeo | My child |
| Lego | Two-three times a month | Flickr, Twitter, Vimeo, Youtube, Blog | Myself, Other relatives, A friend |
| Action figures, Other | Rarely | Facebook, Pinterest, | My child |

| | | | |
|---|---|---|---|
| construction kit / crafting toys | | Twitter, Vimeo | |
| Other construction kit / crafting toys | About once a month | Facebook, Flickr, Twitter, Youtube | |
| Lego | Two-three times a month | Facebook, Flickr, Twitter, Vimeo, Youtube | My child |
| Other construction kit / crafting toys | More than once a week | Facebook, Flickr, Twitter | Other relatives |
| Dolls, Action figures | About once a month | Facebook, Flickr, Google+, Twitter | My child, Other relatives |
| Dolls, Lego, Other construction kit / crafting toys | Two-three times a month | Facebook, Pinterest, Flickr, Google+, Twitter | Myself, A friend |
| Dolls, Plush toys, Other construction kit / crafting toys | About once a month | Facebook, Pinterest, Flickr, Twitter | Myself, Other relatives |
| Plush toys, Lego, Other construction kit / crafting toys | Two-three times a month | Facebook, Pinterest, Flickr, Twitter | Myself, A friend |
| Action figures | Rarely | Facebook | Myself |
| Other construction kit / crafting toys | No | | My child, Other relatives |
| Dolls, Lego, Other construction kit / crafting toys | Every day | Flickr, Google+, Twitter, instagram | My child |
| Action figures, Lego | Rarely | Facebook, Google+, Twitter | Myself, My child, Other relatives |
| Dolls | More than once a week | Facebook, Instagram | Other relatives |
| Plush toys, Lego | Rarely | Facebook, Twitter, Youtube, Path | Myself, Other relatives, A friend |
| | No | | Other relatives |
| Dolls, Plush toys, Lego | About once a month | Facebook, Twitter | Myself, My child, Partner |
| Action figures, Other | Two-three times a | Facebook, Twitter | My child, Other |

| | | | |
|---|---|---|---|
| construction kit / crafting toys | month | | relatives |
| Plush toys | Two-three times a month | Facebook, Pinterest, Flickr, Google+, Twitter, Vimeo, Youtube | Myself, A friend |
| Dolls | About once a month | Facebook, Flickr, Twitter | My child |
| Lego, Other construction kit / crafting toys | About once a month | Facebook | Other relatives |
| Lego | More than once a week | Facebook, Flickr, Google+, Twitter, Vimeo | Myself, My child |
| Dolls, Action figures, Plush toys | Two-three times a month | Flickr, Blogspot | Myself |
| Plush toys | Rarely | Facebook, Flickr, Google+, Twitter, Youtube | Other relatives |
| Other construction kit / crafting toys | Every day | Flickr, Twitter | A friend |
| Dolls, Action figures, Plush toys, Lego | More than once a week | Facebook, Pinterest, Flickr, Twitter, Vimeo | Myself, My child |
| Plush toys, Lego | More than once a week | Facebook, Pinterest, Flickr, Google+, Twitter, Vimeo, Youtube | Myself |
| Action figures, Plush toys, Lego | More than once a week | Twitter | Myself, My child, A business acquaintance |
| | Two-three times a month | Flickr, Twitter, Instagram | Other relatives |
| Lego | No | Twitter | My child |
| Action figures, Lego, Other construction kit / crafting toys | More than once a week | Facebook, Twitter, Youtube | Myself, A friend |
| Plush toys | Rarely | Facebook | Myself, A friend |

| | | | |
|---|---|---|---|
| Dolls, Lego | More than once a week | Facebook, Pinterest, Twitter | My child |
| Dolls | Every day | Facebook, Pinterest, Flickr, Google+, Twitter, Youtube | Myself, Other relatives, A friend |
| Action figures, Lego | Two-three times a month | Facebook, Flickr, Twitter | Myself, Other relatives |
| Dolls, Plush toys, Lego, Other construction kit / crafting toys | Rarely | Facebook, Google+, Youtube | Myself, A friend |
| Action figures | No | None | Myself |
| Dolls, Plush toys, Lego, Other construction kit / crafting toys | More than once a week | Facebook, Flickr, Twitter, Youtube, Own blog | My child |
| Other construction kit / crafting toys | More than once a week | Facebook, Pinterest, Twitter, Youtube | Myself, A friend |
| | More than once a week | Facebook, Pinterest, Twitter, Vimeo, Youtube | |
| Other construction kit / crafting toys | About once a month | Facebook, Pinterest, Flickr, Twitter | Myself |
| Lego | About once a month | Facebook, Google+, Twitter, Youtube | gf |
| Lego, Other construction kit / crafting toys | More than once a week | Flickr, Youtube | My child |
| Action figures, Lego, Other construction kit / crafting toys | Rarely | Twitter | Myself, A friend |
| Lego | More than once a week | Facebook, Flickr, Twitter, instagram | My child |
| Plush toys, Lego | Please choose | Facebook, Pinterest, Google+, Twitter | Myself, My child, A friend |
| Lego, Other | Rarely | Facebook, Flickr, | Myself, Other |

| | | | |
|---|---|---|---|
| construction kit / crafting toys | | Google+, Twitter, Vimeo, Youtube | relatives, A friend |
| Action figures | Rarely | Facebook, Google+, Twitter | Myself, Other relatives, A friend |
| Plush toys | Rarely | Facebook, Pinterest, Flickr, Google+, Twitter, Vimeo | Other relatives |
| Dolls, Other construction kit / crafting toys | About once a month | Facebook, Google+, Twitter, Youtube, Posterous | Myself, My child |
| Action figures, Lego, Other construction kit / crafting toys | More than once a week | Facebook, Pinterest, Google+, Twitter, Vimeo, Picasa | Other relatives |
| Lego, Other construction kit / crafting toys | More than once a week | Facebook, Pinterest, Vimeo, instagram | Myself, My child |
| | Rarely | Vimeo | |
| Dolls, Action figures, Plush toys, Lego, Other construction kit / crafting toys | Every day | Facebook, Pinterest, Flickr, Youtube, wordpress | My child, Other relatives, A friend |
| Other construction kit / crafting toys | Rarely | | Myself, A friend |
| Dolls, Plush toys, Lego | Two-three times a month | Facebook, Pinterest, Flickr, Google+, Twitter | Myself, My child, A friend |
| | Two-three times a month | Facebook, Youtube | A friend |
| Action figures, Other construction kit / crafting toys | About once a month | Google+, Twitter, Vimeo, Youtube | Myself, My child, Other relatives |
| Dolls, Plush toys | More than once a week | Facebook, Pinterest, Flickr, Twitter | Myself, My child |
| Dolls, Action figures | Two-three times a month | Facebook, Flickr, Tumblr | Myself |
| Action figures, Lego, | More than once a | Facebook, Flickr, | Myself, Other |

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|---|---|---|---|
| Other construction kit / crafting toys | week | Google+, Twitter, Vimeo | relatives, A friend |
| Dolls, Plush toys, Lego, Other construction kit / crafting toys | About once a month | Facebook, Pinterest, Flickr, Twitter, Youtube, Picasa | Myself, My child, A friend |
| Plush toys | About once a month | Twitter | Other relatives |
| Dolls, Action figures, Lego | Two-three times a month | Facebook, Youtube | My child |
| Lego | Every day | Facebook, Pinterest, Flickr, Google+, Twitter, Vimeo, Youtube, Picasa | My child, Other relatives, A friend |
| | More than once a week | Facebook | Other relatives |
| | More than once a week | Facebook, Pinterest, Twitter, Youtube | |
| Action figures, Plush toys, Lego | Two-three times a month | Facebook | Myself, My child, A friend, A business acquaintance |
| Dolls, Action figures, Plush toys, Lego, Meccano | About once a month | Facebook, Pinterest, Google+, Twitter | My child |
| Action figures, Plush toys, Lego, Other construction kit / crafting toys | Two-three times a month | Flickr, Twitter | Myself, Other relatives |
| Action figures, Plush toys | Every day | Facebook, Pinterest, Twitter | Myself, A friend, A business acquaintance |
| Action figures, Plush toys | About once a month | Facebook, Pinterest, Flickr, Twitter, Youtube | Myself |
| Dolls | No | | Myself |
| | Two-three times a month | Facebook, Twitter, Vimeo, Youtube | Myself, A friend |
| | More than once a | Facebook, Pinterest, | Myself |

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|---|---|---|---|
| | week | Flickr, Google+, Twitter | |
| Dolls, Plush toys, Lego, Other construction kit / crafting toys | More than once a week | Facebook, Pinterest, Flickr, Twitter | My child |
| Dolls, Action figures, Plush toys, Lego, Other construction kit / crafting toys | More than once a week | Facebook, Pinterest, Google+, Twitter, mok.me.uk | Myself, My child, husband |
| Dolls | No | | Myself |
| | Rarely | Facebook, Twitter, Youtube, Picasa | My child, Other relatives |
| | Rarely | Facebook, Flickr | |
| Plush toys | No | Facebook, Picasa | A friend |
| | Please choose | | |
| Dolls, Lego | Rarely | Facebook, Pinterest, Flickr | My child |
| Dolls, Action figures, Other construction kit / crafting toys | Two-three times a month | Facebook, Twitter, Picasa | My child, Other relatives, A friend, A business acquaintance |
| Dolls, Plush toys, Lego, Other construction kit / crafting toys | Every day | Facebook, Pinterest, Google+, Twitter, Youtube | My child |
| | Two-three times a month | Facebook, Pinterest, Flickr | |
| Plush toys, Lego, Other construction kit / crafting toys | Two-three times a month | Facebook, Twitter, Youtube | Myself, My child, other peoples children. |
| Dolls | Rarely | Facebook, Twitter, Youtube | My child, Other relatives |
| Dolls, Other construction kit / crafting toys | Please choose | Facebook | My child |
| Plush toys | Rarely | Facebook | My child, A friend |

| | | | |
|---|---|---|---|
| Other construction kit / crafting toys | Rarely | Facebook | Myself, My child |
| Lego | Rarely | Facebook, Youtube | My child, Other relatives |
| Dolls, Plush toys, Lego, Other construction kit / crafting toys | Two-three times a month | Facebook | My child, Other relatives, kids parties |
| Dolls, Action figures, Plush toys, Lego, Meccano, Other construction kit / crafting toys | Rarely | Facebook | My child, Other relatives |
| | Two-three times a month | Facebook, Twitter | |
| Dolls | Two-three times a month | Pinterest, Flickr, Google+ | Myself |
| Lego | No | | |
| Dolls, Plush toys, Lego | Rarely | Facebook | My child |
| Dolls | Two-three times a month | Facebook, Twitter, Vimeo, Youtube | My child |
| Dolls, Plush toys, Other construction kit / crafting toys | Two-three times a month | Facebook, Google+, Picasa | Myself, My child |
| Dolls, Action figures, Lego, Other construction kit / crafting toys | Rarely | Facebook, Picasa | My child |
| Dolls, Plush toys, Other construction kit / crafting toys | Two-three times a month | Facebook, Twitter, Youtube | Other relatives, A friend |
| Other construction kit / crafting toys | No | Facebook, Twitter | My child |
| Dolls | Rarely | Facebook | Myself, Other relatives |
| | Please choose | | |

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|---|---|---|---|
| Other construction kit / crafting toys | About once a month | Facebook, Google+, Twitter, Youtube | Other relatives |
| Dolls, Plush toys | More than once a week | Facebook, Flickr, Twitter, Vimeo, Youtube, Tumblr | Myself, Other relatives, A friend, ma femme |
| Plush toys, Lego, Other construction kit / crafting toys | No | Facebook, Google+, Twitter | Myself, My child, A friend |
| Plush toys | Please choose | | Myself |
| Plush toys, Lego, Other construction kit / crafting toys | Rarely | Facebook, Flickr, Google+ | My child |
| Dolls, Action figures, Plush toys, Lego | Rarely | Facebook | My child, Other relatives, A friend |
| Other construction kit / crafting toys | No | Facebook | Myself |
| Plush toys, Other construction kit / crafting toys | Rarely | Facebook, Vimeo, Youtube | Myself, Other relatives, A friend |
| Other construction kit / crafting toys | No | Facebook, Google+ | My child |
| Dolls, Plush toys, Lego, Other construction kit / crafting toys | Rarely | Facebook, Pinterest, Twitter | My child |
| Dolls, Action figures, Plush toys, Lego, Other construction kit / crafting toys | Please choose | | Myself |
| Dolls, Action figures, Plush toys, Lego, Other construction kit / crafting toys | Two-three times a month | Google+ | My child, Other relatives, A friend |
| Dolls, Plush toys, Lego, Other construction kit / | Rarely | Not yet - job change on the cards bringing more time and | My child, A friend, children |

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|---|---|---|---|
| crafting toys | | freedom | |
| Dolls, Plush toys, Lego, Other construction kit / crafting toys | More than once a week | Facebook | A friend |
| Dolls, Action figures, Lego | Two-three times a month | Facebook, Pinterest, Youtube | My child |
| Dolls, Plush toys, Lego, Other construction kit / crafting toys | No | Facebook, Twitter | My child, Other relatives |

**Part 2 of Prospective Consumer Survey data**

| How old are you? | You are: | Which of the following do you like doing? | As a TEENAGER, did you or do you buy any of the following? |
|---|---|---|---|
| 42 | Male | Drawing / Painting, Woodcrafting, Metalcrafting, Designing/making electronics (e.g. Arduino), Photography | Other construction kit / crafting toys |
| 26 | Male | Knitting, Filmmaking, writing | Lego, Other construction kit / crafting toys |
| 30 something | Male | Drawing / Painting, Designing/making electronics (e.g. Arduino), Photography | Action figures |
| 25 | Male | Drawing / Painting, Designing/making electronics (e.g. Arduino) | Action figures, Lego |
| 41 | Male | Drawing / Painting, Photography | Action figures, Lego, Other construction kit / crafting toys |
| | Male | | Lego |
| 30 | Male | Making clothes (full size or doll size), Painting figurines, e.g. Games Workshop, Playing an instrument / making music, Designing/making electronics (e.g. Arduino) | Action figures, Lego, Other construction kit / crafting toys |
| 42! | Female | Playing an instrument / making music, making stuff with my kids | Other construction kit / crafting toys |
| 39 | Male | | Action figures |
| 30 | Female | Knitting | |
| 25 | Male | Drawing / Painting, Painting figurines, e.g. Games Workshop | Action figures, Plush toys , Lego, Meccano, Other construction kit / crafting toys |
| 44 | Male | Designing/making electronics (e.g. Arduino) | Lego, Meccano, Other construction kit / crafting toys |
| 34 | Male | Drawing / Painting, Designing/making electronics (e.g. Arduino), Photography | Action figures, Lego, Meccano, Other construction kit / crafting toys |
| 33 | Male | | Lego |
| 32 | Male | Playing an instrument / making music, Designing/making electronics (e.g. Arduino), Photography | Action figures, Lego, Other construction kit / crafting toys |

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|---|---|---|---|
| 42 | Male | Photography | Action figures, Lego, Meccano |
| 43 | Female | Making clothes (full size or doll size), Knitting, Photography, Jewellery making, Revamping furniture | Dolls, Lego, Other construction kit / crafting toys |
| 24 | Female | Making clothes (full size or doll size), Drawing / Painting, Playing an instrument / making music, Photography, Jewellery making, writing, dancing | |
| 39 | Female | Making clothes (full size or doll size), Jewellery making | Dolls, Action figures, Plush toys , Lego |
| 33 | Female | Drawing / Painting | Action figures |
| 41 | Male | Drawing / Painting, programming | Lego, Other construction kit / crafting toys |
| 39 | Male | Drawing / Painting, Playing an instrument / making music, Photography | Lego |
| 42 | Male | Video Games | Action figures, Lego |
| 31 | Male | Drawing / Painting, Photography | Lego |
| 32 | Female | Knitting, Drawing / Painting, Photography, Jewellery making | Dolls, Plush toys , Lego |
| 56 | Male | Toy Industry Veteran | |
| 31 | Female | Making clothes (full size or doll size), Knitting, Drawing / Painting, Painting figurines, e.g. Games Workshop, Photography, Camping, reading, playing games -- video and board | Dolls, Action figures, Plush toys , Other construction kit / crafting toys |
| 41 | Male | Drawing / Painting, Making stuff with the kids | Action figures |
| 24 | Male | Drawing / Painting, Woodcrafting, Designing/making electronics (e.g. Arduino), Photography | Action figures, Plush toys , Lego, Meccano, Other construction kit / crafting toys |
| 33 | Male | Drawing / Painting, Playing an instrument / making music, Metalcrafting, Game design, making art | Action figures, Lego |
| 52 | Female | Drawing / Painting | Other construction kit / crafting toys |
| 33 | Male | Drawing / Painting, Playing an instrument / | Action figures |

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| | | making music | |
| 25 | Female | Making clothes (full size or doll size), Drawing / Painting, Photography, Crochet | Plush toys |
| 32 | Male | Playing an instrument / making music, Woodcrafting, Designing/making electronics (e.g. Arduino) | |
| 55 | Male | Photography | Lego, Meccano, Other construction kit / crafting toys |
| 35 | Male | Knitting, Drawing / Painting | Action figures, Plush toys , Lego |
| 33 | Male | Drawing / Painting, Designing/making electronics (e.g. Arduino), Photography | Action figures, Plush toys , Lego, Meccano, Other construction kit / crafting toys |
| 38 | Male | Drawing / Painting, Painting figurines, e.g. Games Workshop, Playing an instrument / making music, Photography | Dolls, Action figures, Plush toys , Lego |
| 36 | Female | Making clothes (full size or doll size), Knitting, Playing an instrument / making music | |
| 35 | Male | Playing an instrument / making music, Photography | |
| 27 | Male | Designing/making electronics (e.g. Arduino) | Lego, Other construction kit / crafting toys |
| 18 | Female | Photography, Jewellery making | Dolls, Plush toys , Other construction kit / crafting toys |
| 32 | Female | Making clothes (full size or doll size), Drawing / Painting, Designing/making electronics (e.g. Arduino), Photography, Jewellery making | |
| 49 | Female | Knitting, Drawing / Painting, blogging - I have a dollcultural blog | Dolls, Lego |
| 40 | Male | Designing/making electronics (e.g. Arduino) | Action figures, Lego, Other construction kit / crafting toys |
| 21 | Female | Making clothes (full size or doll size), Knitting, Painting figurines, e.g. Games Workshop, Playing an instrument / making | Dolls, Plush toys , Lego, Other construction kit / crafting toys |

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| | | music, Designing/making electronics (e.g. Arduino), Programming | |
| 39 | Female | Jewellery making | Action figures |
| 36 | Male | | Action figures, Other construction kit / crafting toys |
| 36 | Male | Drawing / Painting, Metalcrafting | Action figures |
| 19 | Male | Making clothes (full size or doll size), Drawing / Painting, Playing an instrument / making music | Lego |
| 33 | Female | Playing an instrument / making music, Designing/making electronics (e.g. Arduino) | Dolls, Action figures, Lego, Other construction kit / crafting toys |
| 32 | Male | Painting figurines, e.g. Games Workshop, games | Action figures, Lego, Other construction kit / crafting toys |
| 40 | Male | Playing an instrument / making music, Woodcrafting, Designing/making electronics (e.g. Arduino) | Lego, Meccano, Other construction kit / crafting toys |
| 31 | Male | Designing/making electronics (e.g. Arduino), board games and video games and writing | Action figures, Plush toys , Lego, Meccano, Other construction kit / crafting toys |
| 37 | Male | Drawing / Painting, Playing an instrument / making music | Other construction kit / crafting toys |
| 35 | Male | | Action figures, Lego, Meccano, Other construction kit / crafting toys |
| 40 | Male | Painting figurines, e.g. Games Workshop, Playing an instrument / making music, Metalcrafting, Designing/making electronics (e.g. Arduino), Photography | Action figures, Lego, Other construction kit / crafting toys |
| 32 | Male | Metalcrafting, Designing/making electronics (e.g. Arduino) | Action figures, Lego |
| 37 | Female | Making clothes (full size or doll size), Knitting, Drawing / Painting, Playing an instrument / making music, Jewellery making | Plush toys |
| 48 | Male | Designing/making electronics (e.g. Arduino), Photography | Action figures, Lego, Meccano, Other construction kit / crafting |

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|---|---|---|---|
| | | | toys |
| 64 | Male | Drawing / Painting, Designing/making electronics (e.g. Arduino), Photography | Action figures, Lego, Other construction kit / crafting toys |
| 37 | Male | Drawing / Painting, Playing an instrument / making music, Designing/making electronics (e.g. Arduino), Photography, ceramics | Lego |
| 27 | Male | Drawing / Painting, Playing an instrument / making music | Action figures, Lego, Other construction kit / crafting toys |
| 31 | Female | Making clothes (full size or doll size), Knitting, Playing an instrument / making music, Woodcrafting, Photography, Jewellery making | Action figures, Plush toys , Lego, Other construction kit / crafting toys |
| 32 | Male | Painting figurines, e.g. Games Workshop, Playing an instrument / making music, Designing/making electronics (e.g. Arduino) | Dolls, Action figures, Plush toys , Other construction kit / crafting toys |
| 45 | Male | Designing/making electronics (e.g. Arduino) | Action figures, Lego, Meccano, Other construction kit / crafting toys |
| 39 | Female | Making clothes (full size or doll size), Photography, Jewellery making | |
| 44 | Male | Making clothes (full size or doll size), Drawing / Painting, Painting figurines, e.g. Games Workshop, Playing an instrument / making music, Photography, Animation | Action figures, Other construction kit / crafting toys |
| 43 | Male | Playing an instrument / making music, Designing/making electronics (e.g. Arduino), Photography | Action figures, Meccano, Other construction kit / crafting toys |
| 24 | Not telling | Making clothes (full size or doll size), Drawing / Painting, Painting figurines, e.g. Games Workshop, Photography | Dolls, Action figures, Plush toys |
| 41 | Male | Drawing / Painting, Painting figurines, e.g. Games Workshop, Woodcrafting, Metalcrafting, Designing/making electronics (e.g. Arduino), Photography | Action figures, Lego |
| 30 | Female | Knitting, Drawing / Painting, Photography, Jewellery making | Dolls, Action figures, Lego, Other construction kit / crafting |

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|---|---|---|---|
| | | | toys |
| 34 | Female | Drawing / Painting, Designing | Other construction kit / crafting toys |
| 37 | Male | Playing an instrument / making music, Designing/making electronics (e.g. Arduino), Photography | Action figures, Lego, Meccano |
| 50 | Male | Designing/making electronics (e.g. Arduino), Photography, Writing | Dolls, Action figures, Lego, Meccano, Other construction kit / crafting toys |
| 28 | Male | Photography | Lego |
| 33 | Male | music, travel and eating. | Meccano |
| 33 | Male | Painting figurines, e.g. Games Workshop, Playing an instrument / making music, masturbation :) | |
| 39 | Male | Playing an instrument / making music, Designing/making electronics (e.g. Arduino), Photography | Action figures, Lego, Other construction kit / crafting toys |
| 40ish | Female | Drawing / Painting, Metalcrafting, Jewellery making | Action figures, Lego, Other construction kit / crafting toys |
| 24 | Male | Drawing / Painting, Painting figurines, e.g. Games Workshop, Designing/making electronics (e.g. Arduino), Photography | Action figures, Lego, Other construction kit / crafting toys |
| 31 | Female | Painting figurines, e.g. Games Workshop, Designing/making electronics (e.g. Arduino), Photography | Dolls, Plush toys , Lego |
| 70 | Female | Drawing / Painting, Photography | Dolls |
| 32 | Male | Drawing / Painting, Playing an instrument / making music, Photography | Dolls, Action figures, Plush toys , Lego, Meccano, Other construction kit / crafting toys |
| 24 | Male | Woodcrafting, Metalcrafting | Lego |
| 41 | Female | Making clothes (full size or doll size), Photography, inventing and designing | Dolls, Other construction kit / crafting toys |
| 47 | Female | Making clothes (full size or doll size), Woodcrafting, Photography, Jewellery making, making miniatures for dolls | Dolls, Action figures, Lego, Other construction kit / crafting toys |
| 51 | Female | Drawing / Painting, Metalcrafting, | Dolls |

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| | | Photography, Jewellery making | |
| 46 | Female | games | Action figures, Meccano |
| 38 | Male | Photography | Lego |
| 37 | Female | Drawing / Painting | Plush toys |
| Very | Male | | |
| 47 | Female | Making clothes (full size or doll size), Knitting, Drawing / Painting, Jewellery making, Graphic design | Dolls, Lego |
| 62 | Female | Photography, writing, redesigning house | Other construction kit / crafting toys |
| 34 | Female | Making clothes (full size or doll size), Knitting, Drawing / Painting, Painting figurines, e.g. Games Workshop, Playing an instrument / making music, Photography, Jewellery making | Other construction kit / crafting toys |
| 29 | Female | Making clothes (full size or doll size), Drawing / Painting, Photography | Dolls, Plush toys , Lego |
| 35 | Female | Playing an instrument / making music, Photography | |
| 40 something! | Female | Drawing / Painting, Painting figurines, e.g. Games Workshop | |
| 38 | Female | Drawing / Painting | Other construction kit / crafting toys |
| 35 | Female | Making clothes (full size or doll size), Knitting, Drawing / Painting, Playing an instrument / making music, Woodcrafting, Photography, Jewellery making | Dolls, Action figures, Plush toys , Lego, Other construction kit / crafting toys |
| 39 | Female | Making clothes (full size or doll size), Knitting, Drawing / Painting, Painting figurines, e.g. Games Workshop, Woodcrafting, Jewellery making, Making anything and everything from anything and everything | Plush toys , Other construction kit / crafting toys |
| 56 | Female | Playing an instrument / making music | Dolls, Lego |
| 44 | Female | Making clothes (full size or doll size), Knitting, Drawing / Painting, reading | |

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|---|---|---|---|
| | Female | Playing an instrument / making music | |
| 27 | Female | Making clothes (full size or doll size), Knitting, Drawing / Painting, Playing an instrument / making music, Photography | Plush toys , Lego, Meccano |
| 28 | Female | Drawing / Painting, Painting figurines, e.g. Games Workshop, Photography, Making and customising dolls | Action figures |
| 41 | Female | | |
| 38 | Female | Drawing / Painting, Jewellery making, papercraft and altered art | |
| 38 | Male | | Meccano, Other construction kit / crafting toys |
| 38 | Female | Making clothes (full size or doll size), Knitting, Photography | Dolls, Plush toys , Lego |
| 39 | Female | Drawing / Painting | Dolls, Action figures, Lego, Meccano, Other construction kit / crafting toys |
| 52 | Female | Drawing / Painting, Playing an instrument / making music, Photography | Other construction kit / crafting toys |
| 48 | Female | Making clothes (full size or doll size), Knitting | Dolls, Lego, Other construction kit / crafting toys |
| 13 | Male | Making clothes (full size or doll size) | Dolls, Plush toys , Lego |
| | | | |
| 51 | Female | Drawing / Painting, Playing an instrument / making music | Dolls, Lego, Other construction kit / crafting toys |
| 27 | Male | making games; writing | Action figures, Plush toys , Other construction kit / crafting toys |
| 43 | Female | Playing an instrument / making music, Woodcrafting, Designing/making electronics (e.g. Arduino) | Plush toys , Lego, Meccano, Other construction kit / crafting toys |
| 11 | Female | Drawing / Painting, Playing an instrument / making music, Photography, netball | |
| 33 | Female | Making clothes (full size or doll size), Knitting, Jewellery making | |
| 44 | Female | Drawing / Painting, reading | Other construction kit / crafting |

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| | | | toys |
| 49 | Male | Drawing / Painting, Woodcrafting, Metalcrafting, sculpture | Lego, Meccano, Other construction kit / crafting toys |
| Fifty | Female | Drawing / Painting, Photography, Jewellery making | Dolls, Plush toys , Lego, Meccano |
| 29 | Male | Woodcrafting, Metalcrafting, Jewellery making | Lego |
| 45 | Female | Drawing / Painting, Playing an instrument / making music | Action figures, Plush toys |
| 11 | Female | Making clothes (full size or doll size), customizing dolls esp. Monster High | Dolls, Action figures, Plush toys , Lego, Other construction kit / crafting toys |
| 45 | Female | Knitting, Playing an instrument / making music | Plush toys |
| <50 | Female | | Lego, Other construction kit / crafting toys |
| 11 | Not telling | Making clothes (full size or doll size), Knitting, Drawing / Painting, Painting figurines, e.g. Games Workshop, Playing an instrument / making music | Dolls, Plush toys , Lego, Other construction kit / crafting toys |
| 48 | Male | Drawing / Painting, Playing an instrument / making music, Designing/making electronics (e.g. Arduino) | Action figures, Lego |
| grown-up | Female | | Action figures, Lego |

**Part 3 of Prospective Consumer Survey data**

| What is the coolest feature you'd like in a customisable action figure / doll? | How much would you be willing to pay for a highly quality, highly customisable action doll of your own design? |
|---|---|
| Face model from webcam pic(s). Also, I'd like to put a camera in the doll's eye. THis past weekend I built | $100-200 USD |

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|---|---|
| a Romo (romotive.com) kit with my sons and they LOVED the ability to see out the robot's "eye" via the iPad and snap pics. | |
| Voice recording and playback | £30 |
| Eyes that light up. | 40-50 pounds |
| having 4 arms | £100 |
| Other than a beard, I would like lights, sounds, and ADIDs (active digital identity) so my figure can be connected to others | 20 quid - gotta be top qual tho'. And have a beard. |
| Ability to add sound fx/noise/playback | £40 |
| I like the idea of marrying programmable electronics (e.g. Arduino) with action figures. | 80GBP |
| Any female figure who doesn't have huge tits and a tiny waist, for one. Any figures with glasses and minor accessories like asthma puffers but who are in themselves, totally cool. Female figures with bob haircuts rather than always long hair. I'm not saying non-feminine. I'm just saying vary it from the doll 'norm'. African dark black, lighter black / olive / pacific rim skin colouring action figures please. | £25-£30 ideally. That's one of my present cut off points but it very much depends on size. It would have to be incredible to be £50 and have lasting value to my kid (play value) |
| Secret arm-compartment like the Bionic Man had. | Pounds £35 |
| Lots of accessories. The best bit of Playmobil is all the cool little accessories. I really like that stuff. The kids also like setting that stuff up. | £30 |
| | £20-£30 |
| | 50€ |
| Wireless sensors like http://www.greengoose.com/ | £100 |
| | |
| | |
| My daughter would be constantly changing the makeup on her dolls | £35-50 |
| | £75 |
| Customisable face, clothes and hair that you could have designed to your requirements, in general, would be quite cool. | £45 |
| Custom colored skin. I'd love to be able to create my Glitch in physical form. | $75 |
| i would like to be able to paint the face (sell me a kit of exclusive colours!) and change the pose... such as gas heating, air brushing specialists do it in Japan. i never did it myself though...maybe I was always satisfied with what the "proper" designers sold me ;) | if it would be REALLY com,pleytley my own design (not just changing something someone else did to a minor |

| | |
|---|---|
| | extent like colour or garments) up to 1500 $ for just changing something already existing maybe nothing, i would go, buy a cheap plastic doll from a street market and change it completely myself. |
| Sentience | |
| Eyes that move of their own accord, tracking you across a room. Bit creepy, eh? :) | |
| Depends upon the basics. Great articulation is probably the thing I'd want the most - the ability to do good poses like with Stikfas. | 50 USD |
| | |
| To make it look like someone that I know. | 120 eur |
| Lookalike | £50 |
| Goggles and eye patches. And hats. Definitely hats. | $25 so a to be playable with - more and it would sit on a shelf |
| Vechiles. I want motorised Vechiles | £25 |
| | |
| Great articulation. Being able to position the figure in a wide variety of poses is the best feature. | 35 usd or so |
| movement, speech | £50 |
| the ability to recognise, and interact with, its environment in some way... | yikes! i don't know. i think it depends on what the toy does. |
| I am interested in wigs (for example, Odeco) as this can change the personality of the doll so quickly. Also an easy way to change the eye colour is a great feature (Odeco again and Blythe). Poseable dolls have also started to attract my interest as they have more possibilities when it comes to taking pictures or setting up dioramas. | £200 |
| | |
| Ethernet connectivity | £50 |
| Having my hand held in the design process, but being able to totally customize the doll if I want. Essentially pressing right up against what's | £25 |

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| possible, but in a lazy way...<br><br>Also, take a photo of something and then sticking it into a magic thing that makes a doll of it... | |
| | £30 |
| expressions/eye lids | $250 dollars |
| | |
| | |
| Voice programming / recording | £80-100 |
| | |
| Muscle mass/body shape | 35£ |
| poseability. Smooth materials. Likeness. | €50 |
| | |
| I saw one of your dolls with a lilypad inside it's head, that was an exciting moment! | £150/£200 |
| Be cool if she had an audible catch phrase in my voice | $35 |
| Recordables! | £30 |
| That you can put a photo of somebosy on the doll's face | 100€ |
| It would be to give it a unique hairstyle, thats usually someones most distinguishable feature imo. | £70 |
| Body shape - dolls/action figures seem to all fall into the very slender (if female) or bulked up (if male), not much inbetween. | 45 pounds |
| re action figure - battle damage and scars | 30GBP |
| Recyclability, reuse or second-life. Can i personalise it for a second 'owner' hand it down through the family, as my oldest child looses interest, but my youngest child gains interest. | £50 - £70 - depending on specification, modularity and embedded functionality. |
| Custom words embroidered on clothes like what you can get with Nike 6.0 skateboarding shoes. (Boo to Nike/Hooray to customisable trainers). | £30. Maybe £50 |
| | £20 |
| | |
| Articulated shoulder height ( so much mood in there) and good luggage/ rucksacks, webbing etc. | Thirty pounds? |
| | |
| their clothes | £30-50 |
| Actionable sound and movement. | US$100 |

| | |
|---|---|
| | |
| laser death ray eyes | £50 |
| | 30 euros |
| | $200 |
| | |
| | |
| To walk and talk | 100 |
| Choose face, clothes. Posable (for animation?) | £50 |
| I'm thinking Wurzel Gummidge here - customisable heads/appendage/outfits/accessories for creating your own narratives and worlds<br><br>I'm thinking fun, not freaky... like, say, the Borg. | £25 |
| Being able to interface with things such as a computer or media player. | 500.00 US dollars |
| attitude. | £50 |
| Um, tattoos? | £50-£100 |
| It's a secret. Maybe it's not that great - but it's kind of nice. And simple. And "linky". Anyhoo … | £50 |
| | £30 |
| Different sized versions of same figure for different play settings | £150 |
| | |
| Recorded speech to be inserted. | £150 |
| I think creating a mini-me would be really cool. | 20 euro |
| | |
| lasers. creepy levels of realism. griping hands and eagle eyes. | dunno |
| Photo upload and then get a personalized doll would be awesome, but pretty hard on the tech side i guess. | 50-100$ |
| Make it say something in my voice. | £50 |
| | |
| Maybe, customising texture of the meterial? | Up to 300 pounds |
| Abitlity to Stretch. Stretch Armstrong doll was the best! | $30 |
| Based on my own memories (the moveable head was pretty cool) - mainly because I could imagine the doll was answering questions I was asking her etc. For my daughter it would be lots of 'costume and character' options - ability to change hair style and a different 'look' that | £25-30 |

| | |
|---|---|
| suited each character. I will ask my daughter too this evening what she would like to see and let you know. My eldest daughter has actually spent many many more hours playing with a small group of 'Playmobil' figures than her dolls although less so in the last 6 months - and she much prefers the small children characters to the 'adult' characters - she likes the small size of them and the fact that she can get them all to move around easily and play the roles she has assigned to them. | |
| | |
| | |
| | |
| | £40 |
| | |
| | |
| hair that you can style. | £200 |
| flexibility - ability to create poses that are beyond real. | $50 (but really $10) |
| | 100 |
| Lots of face and hair options. To be able to replicate real life outfits would be nice. And the ability to order multipal outfits over time so it's wardrobe can evolve with the child's wardrobe. | £35 |
| moveable expressions? facial expressions i mean | £30 |
| recordable and playback-able voice (you could use your own voice) moving eyes and mouth synched to speech.... | £60 |
| the face | between 30 and 35 pounds |
| I really like the Manga aesthetic but would like more traditionally European/African features as an option as well - it would make a great present for friends/colleagues/children to have a doll that looked like them.<br>Templates for making own clothing? | £15-20 basic |
| I'd really be impressed if you could design dolls with different body shapes. People are all different after all. | £20-£40 |
| How about getting them to actually look like a photo of someone real? Bit like a 3D avatar - which is what they are really isn't it? I'm thinking I would get them of people I know - I could then have son and daughter dolls, but others might prefer to get Brad Pitt dolls - but that doesn't appeal to me and would probably take away from their "coolness" so maybe don't do that! | £50 - £90 |

| | |
|---|---|
| You know your speaking to a Mum here as I am going to say nothing to annoyingly noisy! Hair that doesn't knot too easily so the kids can manipulate the dolls hair and outfits that are multi functional, tattoes, nails, accessories as much imagination left up to the kids as possible, eg. no annoying accents or incorrect english. More important than anything is you can manipulate them to sit well, do yoga poses and stand... a doll who is always falling over especially for younger hands can be frustrating | £50 |
| | |
| | |
| Loads of poseability and interesting jointing. | Depends on the material, appearance, size |
| facial expression | £30 |
| I would like it to be even more customisable at home - can I dye the hair myself paint on tattoos body art etc | £80 |
| I guess it depends on the age-range you'r targetting. Glow in the dark stuff always used to appeal to me as a young kid. Maybe eyes could glow? Or the whole doll? Or the hair etc... | £30 |
| being able to make them look like somebody or to change the appearnce to fit my imagination. | £30 ish |
| Wouldn't it be great if you could make action figures that look exactly like the person that they are made for... taking features from photos and replicating them. I'd like them to have realistic body dimensions too - a true representation of a real human being! | £40-£50 |
| To be able to make it look like a particular individual and dress it accordingly. | £30-£50 |
| My fourteen year old son is very into arduino and so if there was a way of controlling the doll (making it's eyes turn evil for example) he'd definitely be up for it. | Don't know. |
| | |
| | |
| probably putting on features of a loved one | 40 pounds |
| I'm not used to thinking this way. Is it meant to be an avatar of sorts? I suppose seeing it in recognizable clothes. Facial similarity could be off-putting -- the uncanny valley and whatnot. | $100 USD |
| Voice recorder. | |

| | |
|---|---|
| The make up and clothes. being a passionate fashion desinger i really like the way they look | £25.99 |
| eyes that close when the doll lies down! | £40 |
| sucky hands and feet to sick to things and a tongue that flick out and grabs stuff. | £100 |
| Look a like. | £19.95 p&p incl. |
| Figure shape, fat thin short tall | ? |
| eye & hair colour and type | 80 -100 ukp |
| OUTFITS | £50 |
| Wings, with my black eyes | Don't get much pocket money but 25-30 pounds |
| Being able to do a handstand, and spring like movements are also a bit hit. | £20 |
| Skin-tone | £50 |
| gothic eyes&clothes | £50 |
| | |
| Looks and sounds like someone you know. | £30 |

**Part 4 of Prospective Consumer Survey data**

| How do you feel about action figures / dolls that you can design yourself? |
|---|
| Yay! Really want to let my daughter have a hand at it. Looking forward to it as a father/daughter activity. |
| Excited! |
| I love them. |
| that would be very cool |
| Me like! |
| Great idea - susprised none of the big toy brands haven't done it yet |
| I think it's an exciting development and one that I wish was available when I was a child. |
| "It depends". I think I want to show it to my 8 year old daughter, and also my 6 year old son to see what they make of it. Anything where there is a degree of control is cool for kids. It will be useful if they can save multiple designs before choosing, and even save those designs without having them made - having created personalities, they might not want to let them go, but it might not necessarily follow that the parental object will actually be able to afford to get them all. |
| |
| Amazing. My youngest son (6) will go especially crazy for this. |
| Intrigued, but often put off by price point |
| I'D LOVE TO DO IT WITH MY KIDS. |
| Nice. http://www.youtube.com/watch?feature=player_detailpage&v=HAaFUoiOM-Y#t=22s |
| |
| |
| My daughter loves to design clothes and is constantly making up her dolls so its more of an interest for her |
| Awesome. |
| Fantastic! |
| I think it's important for kids to be able to see things that look just like themselves out there in the world to know that they're not alone. |
| i do not have to tell you that garage kits (especially female dolls) are extremely widely spread among Japanese males, model kits of vehicles among Western males. Strange that grown-up women of any world seem not to have the same urge, maybe Makie can change this! |
| |
| Neat idea - very Japanese in approach. |

| |
|---|
| Intrigued, though skeptical. |
| |
| Very interesting, as I have no previous experiences, I am eager to see how it feels/makes me feel. |
| Brilliant |
| Love! I tend to customized anyway. |
| Excited and intrigued. Will be interesting to see how the kids enjoy it. |
| |
| That's pretty cool! |
| interesting- at the right price might be useful in Key Stage 1 and 2 education - Design and Technology and Science. |
| i love the idea, and the potential feels super-exciting.<br><br>i guess the things i can see are:<br><br>1. the interface has to make you feel really good and accomplished as an amateur toy designer.<br>2. as a parent now, the idea of having some kind of content controls for younger kids (if relevant) feels important.<br>3. how much can you continue to redesign and hack the toy after it's first done? |
| I currently collect Blythe dolls which I sometimes customise myself. I find this very enjoyable although it can be very time consuming and get expensive. I also enjoy making clothes for my dolls and I spend many hours prototyping and making the final designs. I'm not entirely sure how I would feel about someone else making a doll to my specifications as I enjoy the feeling of bringing my doll to life and seeing a character develop over weeks or months. There is also a feeling of accomplishment from creating your own character with your own hands. |
| |
| Very interested — interaction + bringing things to life through their interaction with my data (informatics) and data from elsewhere … |
| Bring it on... |
| |
| super excited to incorporate my own ideas/personality to bring it to life |
| |
| |
| 100% support |
| |
| I always thought Barbies were boring as a child so would have liked to have designed them myself, |

| |
|---|
| especially 'cooler' dolls that did cool things |
| I'm very interested in this opportunity. I'm very interested in the "body of the dolls" subject, and I invite you to search such tag in my dollcultural blog http://dollculture.blogspot.com |
| |
| Great. I often customise dolls so it's nice to go a step further |
| Meh |
| Just like when you try out a pen, you end up writing your name, my gut feeling is that adults would get these designed based on themselves. |
| It's great & cool |
| Seems like a cool idea if you're into that kind of thing. |
| Excited! |
| v cool |
| it is a great concept, that adds ownership and belonging, but also instils a sense of understanding about how a product goes from concept to production. |
| Mixed. I love it in theory, and I love the idea of those 'kit-mash' customisations, but I don't have faith in my ability to design something cool. Part of me feels more inclined to buy dolls/figures designed entirely by the experts. Maybe a toolbelt/bag for the doll where I could pick 'n' mix the accessory contents. |
| |
| |
| Intrigued |
| |
| that would be cool |
| Excellent. |
| |
| AWESOME |
| |
| awesome!!! |
| |
| |
| A liitle scared |
| Supercool! |
| Very cool - I probably wouldn't do this for myself would love to design characters and worlds with my daughter as an alternative to playing with ready made toys/dolls |
| Love them, customization for endless possibilities is something I'm way into. |
| Very cool, but even better with some inspirational input. |

| |
|---|
| Super excited!!!!!!!! |
| I think that's a flipping marvellous idea! |
| |
| Enthusiastic -offers enormous opportunities for creativity and play |
| |
| Think its a perfect gift for a a loved one. |
| It is cool but I rahter ahve full controll.. I can create the models in 3d myself.. and there are various 3d printing services.. |
| |
| I'm interested in the 3d printing aspect of it more than the doll collecting bit - which in all honesty I find creepy. |
| Awesome! |
| I love the idea. The fact that it will be a sort of extension of me..I always feel you project yourself on to stuff you create in some way. Also the fact that it will be made *by* me. There'll be a sense of ownership. |
| |
| I would love them. |
| AWESOME!! |
| I have two girls of my own now (6.5 and 2.5) - I've never pushed the 'princess' thing with them and actually detest most of the 'cheaper' toys available to girls (the gawdy pink colours and gender stereotyping). My eldest girl has a couple of barbies (bought as gifts) and likes to change their clothes a lot. She'd probably love to be able to design her own doll though as she's quite a 'tomboy' and really into Star wars, Superhero characters like Spiderman/Batman. She'd probably love to design their costumes into her favourite characters from Star Wars etc and re-enact scenes that she loves and do this with her friends too. As she gets older I can imagine her wanting the 'doll' to change too, so it remains as a 'friend' with her and someone she can relate to (ie get new hair styles, have different character outfits, and loads of accessories to go with each character change - she likes putting and taking off lots of things!). |
| I love to design miniatures for fashion dolls and find it challenging to try and get to authentic as possible. |
| |
| I think it's an interesting idea - especially if one is trying to buy a doll for a girl and you don't want to buy in pink or an excessively pop culture one. |
| Really good idea! |
| |
| |
| This what I like doing most and dream about. I have worked on a few books as an editor or book |

| |
|---|
| designer but we are always limited by the abilities of our target audience and space. |
| Sounds terrific. But would rather let kids in my circle DIY. |
| Love the concept, id like to make a doll of myself lol! |
| I would have adored this as a child. I'd love to give my baby girl this opportunity when she's old enough. I hope it's affordable. |
| i think they sound ace - id be looking for excuses to make and give them all the time. |
| My daughter would probably love it. Her friends too, probably. I wonder if they'd like to make a doll of themselves? Will ask her. |
| I think that it is brilliant and cant wait to do it myself with my girls |
| Love the idea - see above |
| Fantastic. Love designing and making things generally, but also very disappointed with what is available for children generally, I want my little boy to have a "it's-a-doll-not-an-action-toy-get-over-it" he can enjoy, without people getting all wierd about it, and a doll that my daughter can get involved in, she has so many but none have kept her interest for more than about 5 minutes. Plus, I can't stand Barbie. |
| Fabulous idea!!! I want one and one for my 21 year old daughter. |
| In Australia where I grew up their was alot of peer pressure to be blonde and bronzed, I am a redhead as my daughter is. I hated it as a youth but celebrate in my daughter and realise now my mothers pride of an auburn child. I have been looking for a doll that celebrates individuality but is still aesthetically appealing I find the bratz dolls a bit freaky and barbie well she really has had her day! |
| interested |
| |
| They're the only ones that really interest me. I'm not into keeping action figures pristine in boxes, I like to make my dolls into exactly what I want and be able to change their appearance whenever I want. |
| Children have been designing their own toys forever. I think it is great they can now use the latest technolgy to do this. The problem with a lot of home made toys made by children is that they do not look as "finished" as what they can buy in the shop. I hope this gives kids the chance to design something that looks as good as if it came from a shop, but individual to them. |
| heard Alice on radio4 this morning and thought it sounded brilliant - too many dolls are sexualised and kids (and adults) need something different. this sounds like an extension of the american girl doll where you can get one that looks similar to you in hair colour etc but not as customisable as this looks likely to be. I am also interested from a craft perspective for myself. |
| Interested for my daughter |
| very excited about all the possibilities |
| I think it is an excellent idea. Barbie dolls etc today seem less than 'innocent' - all marketed at the teen range and not necessarily appropriate for younger girls. There is little to fill this gap. The possibilities of |

| |
|---|
| making dolls specific to the needs of an individual child is very appealing and well overdue. I would like to try to keep my 4 and 6 year old daughters (I also have a one year old so not just yet for her!) as innocent as I can and not to have them exposed to the current hyper sexuality of toys, which Barbie, Moxie Girls, Bratz etc currently do. |
| Can't wait to have a go. |
| Very excited. My soon to be eleven year old daughter - a keen crafter - thinks it would be really cool. We have a subscription to Make and I am looking forward to seeing galleries of your dolls in there. My twelve year old son is very keen on drawing endless anime characters and I'm |
| |
| |
| Love it |
| Mixed. Creation is a powerful tool, but so is the design of others. I tend to under-value customized toys, but that may be a historical bias. |
| I always hated traditional "girly" dolls and babie dolls in pink frou-frou. I think dolls that you can design yourself are a fantastic idea. |
| so amazed. The idea of designing my own doll is brilliant. i have always wanted a doll that looks like me! |
| Looking forward to it - but disappointed I can't do it tonight following radio 4 piece.<br><br>Doll on cover of this web page looks a lot more spooky than I would hope to spec for my little girl. |
| intrigued - i thinkthe kids will totally love it and the potential for piss take cariacature dolls for friends/family/colleagues is also not to be ignored |
| My memories are from young teenager years, mid seventies, before PC's, but would have loved it then. Whilst children are into screen games big time, physical, 3D, 'real' things are still important. Too be able to design in your personnal preferences sounds like a winner. |
| Always wanted the doll or toy that was different drove my mother crazy always chose the different one with the wonky eye. It's a chance to use imagination be individual |
| verry cool and desirable. would the price tag restrict these to adults only or it it something that kids can get into with a series of |
| Very excited for my children! |
| So exciting! |
| I'm not sure about myself, but my daughter (6) and son (3) already enjoy designing their own computer avatars and regularly update them. |
| At first a little creepy but it allows children to play or later be accompanied by their own personal friend - forever as we never grow-up, any of us will always have a child inside or at least be there to help another child at some point in our lives! |

| |
|---|
| cool |
| |
| fab, want one! |

**Part 5 of Prospective Consumer Survey data**

| Do you have any favourite memories of an action figure or a doll? |
|---|
| As a kid, my friend and I shopped more at the local hardware store than the toy store, for GI Joe accessories. We had pulley driven tree-houses, ziplines, rail cars.... all of which were built buy hand. After my friend's older brother mutilated GI Joe with a bunsen burner, we crafted our own cyborg prostheses from stuff found at the ahrdware store! |
| |
| I once built a model of the Millenium Falcon, and that was fun. |
| |
| Stringing up a naked, bearded Action Man by his left leg and hanging him from the banister rail... |
| |
| |
| Playing with a Han Solo action figure in a really hot summer age 6 or 7 in the seventies, making cardboard tube tunnels and half burying them in the garden |
| Playing all-day games against friends who had figures from the same collections; inventing mythologies around them. |
| I liked making shoe box houses for my dolls more than the dolls themselves. |
| Loads of fond memories of Thunderbirds toys, and some scratch-built barbie-scale Thunderbirds made with Action Man/Ken dolls that my Gran sewed costumes for. |
| |
| http://www.youtube.com/watch?v=4I4hDoEIMRs (star wars speeder bikes) |
| |
| |
| Action Man - plenty of memories being in the garden with |

| |
|---|
| him buried up to his arm pits :) |
| Pippa was awsome, loved the size, and wish someone would make something a similar size - tricky to make clothes for. |
| I always loved plush toys and dolls as a child. My favourites were a Baby Born doll, a toy rabbit called Clifford, and china bay dolls with beanbag bodies that my mum bought me. |
| I got the Princess Leia and C3PO action figures from Empire Strikes Back. C3PO had 0 moving parts, and I always had amazingly boring scenes, where Leia could do stuff, and C3PO just stood there (in retrospect, much like the movie). Until one day, one of the neighbor kids must have dropped his Luke figure while playing. (I can even picture where I was when I found it, I was so elated.) Even, better, Luke had been "modded" with red nail polish, so he'd clearly seen some battles. After that, all my imaginary scenes were epic. |
| the American 80s brands (Masters of The Universe, My Little Pony, Princess of Power) shaped my sense of design. If there hadn't been Japanese video games I would have been totally fucked up. Loved the universe they built around their brands, still strong today. |
| |
| Six Million Dollar Man |
| Magnetic Batman & Robin were huge favorites. (http://www.megomuseum.com/wgsh/12/batman.html) Subsequent to that, all things Micronauts. Getting Micronauts Rocket Tubes set for x-mas is one of my favorite memories. |
| |
| |
| Playing with and collecting the very first Action Man products. |
| I had a cabbage patch kid that my grandmother made clothes for -- to match me. Also the wooden doll I took to |

| |
|---|
| school during third grade, with a lunch box full of material to make clothes during recess as a way to make friends. A long line of troll dolls that went everywhere, and likewise playmobile figures -- the latter, I could give the cool " boy" accessories to fierce, red haired, female figures. A Padme figure was my navigator during college, sat on the dash with Jabba, a troll doll, and a plush snake. Padme and co have been replaced by Chris Ex as the doctor, and a purple dragon I found in the parking lot. |
| I was an evel knievel kid. I loved making him fly |
| |
| As a kid I borrowed GI Joes from friends. Wasn't allowed to play with the guns, but enjoyed the figs anyway. Lots of acting out adventure. Later, building environments (outdoors mostly) for them to live in.<br><br>In college, I remember the very first Hellboy figure being really cool. I posed it and took pics. Those were the first pics posted to the Hellboy forum at the time. Made me feel like part of the community in a way I hadn't before. |
| |
| i remember having a gi joe/action man figure called zartan when i was nine or 10.<br><br>it was the first toy i had that had a behaviour that wasn't battery-driven, and for that reason i loved it.<br><br>the character was basically a mercenary who lived in a swamp, and had some innate ability to disguise himself by changing the colour of his skin based on heat or sunlight.<br><br>just found him on wikipedia! here he is: http://en.wikipedia.org/wiki/Zartan |
| I remember my first doll, Cherry very well. I don't have any specific memories of her other than the time one of her eyes fell out. I also have a teddy bear which I have kept |

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|---|
| since I was a baby and slept next to him in my bed for many years. When I say many, I mean way too many. |
| |
| |
| My favourite action figure was a toss up between "Battle Armour He-Man" and his colleague "FISTO". Both for the obvious battle damage and elasticated power punch features... |
| |
| funny enough my favorite memory is within last 8 years when I purchased the Spinal Tap collectible figures.... what stood out to me was the great articulation. Other then that as a kid the KISS dolls were great because of the costuming/outfit quality.<br>I also recently received some figures from Japan that were given to me... I don't have the fact name here at the moment but the number of options that came along was amazing! almost 3 of every possible gesture! |
| |
| |
| Making things for them/around them |
| |
| |
| I'm a Barbie collector with a preference for vintage. I've memories and memorabilia about my dolls. |
| |
| Te first time I saw the first collectible doll I bought was pretty special |
| Best friend gave me her original Leia Organa when we were 6, and I was diagnosed with juvenile diabetes; began a lifelong collection of female action figures. |
| |
| petete |
| Not really but id usually only ever get Action Men. |
| I collected all of the Thundercats action figures when I was about 10 - completely obsessed with the series, and also |

| |
|---|
| had two of my letters published in Thundercats magazine (both complaining about lack of female representation...) |
| I really liked to melt them and check out the damage! |
| Action man commando - making a zip wire from the bedroom window to the garden using a washing line. It melted his hands, but that just made him look tougher |
| Playing in the dirt with those bags of small plastic WWII-style soldiers. Preferring the guns, bags, tools and other accessories to the actual action figures. Getting my own codename when I joined the Action Man club in the late 1980s.<br>Away from war; spending hours posing robots (I was an only child). Painting Warhammer but never playing a full game (That's war again).<br>At 31, since toddler-hood I've never had a bedroom or living room without a few action figures and plastic soldiers out. |
| |
| |
| Making star wars movies with my cousin every summer for years. Lego films shot on a cheap point and shoot with my nephew. Tauntaun races on white bed sheets o sleepovers. Christmas morning the Christmas after empire- my brother and I got Hoth Luke and Han. |
| |
| having fashion shows with my Barbies when I was about 8 or 9 years old. |
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| Bunty - paper doll - picking, cutting and fitting clothes |

| |
|---|
| Cindy - making and adapting clothes. Hair Girl's World. - make up |
| Action Man, original Star Wars figures, Tintin dolls / figures |
| Used to love to swap the heads of actions figures and dolls to create new, er, possibilities. And freak out my sister.<br><br>Think Action Man with Barbie's head on. |
| |
| (as a child) dressing up action man, fine detail of accessories and hats, mum's knitted sailor outfit (big knit); Setting up Play People (playmobile) in scenarios, making them (knights, cowboys and Indians) accessories as inspired by Blue Peter.<br><br>Latterly, collecting strange and wonderful Japanese action figures, particularly Kaiju, Astro Boy and Masked Rider. |
| the hair!!! I loved the hair |
| Sindy - with her big 'ead she was superior to weedy little Barbie. |
| |
| Action man in parachute outfit |
| |
| Used to love my A team figures in the 80s, they used to fit in their van. |
| I used to paint lego figures with camo patterns.. Mom didn't allow GI-Joe in the house.. The I had some M.A.S.K. But the figures where not poseable that good.. |
| |
| action man explorer with his butch polo neck and exciting range of accessories. |
| |
| |
| |
| I used to watch japanese animation series alot. I used to assambled the plastic Gundam action figures by myself. It |

| |
|---|
| satisfied my desire of owning my favorite robots from the animation. |
| I saw my first naked Barbie at the age of 9. |
| I always cut the hair off my dolls much to the annoyance of my older sister!! I liked taking the dolls outside in the garden to go on adventures - in mud and long grass usually - kind of doing stuff that boys probably did with their 'action men'.  I loved playing games more (board games etc) and making stuff (making clothes, cardboard box houses, playing in den's, setting up my tent in the back garden and playing in there, playing with the kids in my street (when you could do that in the 70's/80's!!) . One day my parents gave me a full plastic bag full of donated doll's - and I clearly remember the one doll I loved had a lever on its neck which made the head move up and down - I LOVED that!! I also had a doll that wore a national costume from Greece which I loved because it had a removable skirt and tights on eventhough it was a man which I thought was cool! |
| |
| |
| I loved action figures and was obsessed with horses - so most things revolved around that.  I had girl action figures, that went with horses - Anna (the figure) and Happytime (the horse).  I also had an action man who I loved - never liked Ken! |
| Action Man forced to wear Gran-knitted jumpers and even pants. He didn't get much in the way of action. |
| |
| |
| I starting designing clothes on a doll called Pippa. It is the reason I learnt to knit and crochet. |
| Howdy Doody (and ventriloquist dolls - no I can't throw my voice). Miss Revlon (precursor to Barbie). Baseball (real life action). |
| |

| |
|---|
| Being given a pram one Christmas and walking my favourite doll along Felixtow prom. |
| nope |
| I had a lovely big doll called "giggles" who wore a pink and orange striped mini dress. She had a cheeky face and freckles and straight blonde hair with a fringe. If you held her hands and pulled her arms outwards her head moved from side to side her eyes moved and she laughed. I LOVED that doll. One day I came home from school and found her with her head broken off. I never found out who did it! |
| |
| I loved making clothes and homes for dolls. It was always the customisation element that appealed. Two great doll designs that I remember from childhood were the Sasha dolls, and the Amanda Jane range. Both looked more like 'real' (albeit stylised!) people than the artificial colours and physique of Action Man/Barbie etc... The Flower Fairies basic doll was also beautifully designed. |
| I set myself up a toy hospital, I used to sew, glue, improvise and invent to fix or renovate poor broken dolls and other toys. I was about 8 or 9. mind you, saying that, I also used to "operate" on some toys too, could be why I had so many patients.... |
| Loved my Cindy dolls who had many interactions with my brother's Action Man. :) My Cindy dolls had a bed that I made out of a shoebox, a wardrobe, fridge etc and lots of other accessories which I loved as much as Cindy herself. Played with them for hours until I was about 12 or 13. |
| I wasn't allowed barbie and was given cindy instead, the doll I really remember though was this doll from around the world that was about barbie sized but had a stand so it was really supposed to be ornamental and a collectable series. It had a dress that poked out like a bustle, I think it |

| |
|---|
| was supposed to be in russian folk dress. I remember pawing over the mini catalogue fantasizing about having more of these dolls, something that drives me crazy with my own kids as when you give them one thing they are already talking about what they are going to have next! |
| |
| |
| Getting my first BJD when I was 20-something! Never played much with dolls when I was a kid. |
| I used to make my own dolls when I was a child. Never used a kit, just stuff I found at home. I didn't like sewing (too girly) but found glue covered most bases! They were quite good too. Also made puppets. |
| wasn't allowed many toys as a child (muffled sob!). |
| no |
| |
| Hours of fun with my barbie and sindy dolls (where did they go?) and my brother's action men... I had the sindy caravan and beachbuggy and my brother the action man jeep so many hours in the garden on safari! |
| I always wanted a Barbie of my own but never got one as a child. But now have a vintage Barbie for whom I buy a new outfit each year. Recently bought a Madmen Barbie of Joan Holloway. My psychiatrist says there's nothing to worry about ;-) |
| As a youngster growing up in Stepney, London E1 I had something of an obsession with the Princess Daisy doll in the Bethnal Green museum. I just loved the fact that she had so much kit - clothes, accessories etc. I was always making rag dolls with loads of clothes from about the age of 8. |
| |
| |
| I enjoyed action man, always seemed more realistic than barbie! |
| I built massive K'nex structures, which later were |

| |
|---|
| destroyed, and spent weeks playing within the ruins with self-made K'nex figures, as well as the five Voltron lions. I built massive starships out of cardboard boxes for my Star Wars figures. I still talk to my stuffed animals on a semi-regular basis. |
| |
| i remember i took my favourite teddy out for some ice cream ( i was 4) and he got ice cream all over his face and in the car he managed to get under the booster seat: the ice cream took hours to clean up!!!! |
| Pamela's' eyes would close when she lay down, until my brother pulled out her eyelashes. Not sure if that is a favourite or just traumatising memory! |
| yes - dicovering action man with moving eyes was a revelation. His kit was so much better than action girl - parachuting off walls kept me amused for days |
| spent yonks building lego forts for action man, took lots of bricks 'cause their huge, all scales considered ! |
| Playing with My daughter and pollypocket |
| |
| Yes, customising Sindy by cutting her hair and making her wear Action Man's boiler suit. My favourite had to be the Jaime Sommer's Bionic Woman doll with roll back plastic so you could see her circuits :-) |
| Trick or treat crafts! |
| Playing hairdressing, would also loved to have played dentist if there had been a doll, we had to play dentist on the crumbling patio concrete instead. |
| Following my brothers launching their action men out of the bedroom window - only my inherited china doll was too heavy for it's hankerchief parachute - you can guess what happened!<br><br>So I tried to repent by knitting/making clothes for friends |

| |
|---|
| dolls and action men. |
| no |
| |
| I played with pippa dolls as a youngster.  They were pocket money toys, so easily accessible. They didn't have knees. Standing up or lying down, you could act out stuff but they couldn't sit! |

# *APPENDIX 3: SPECIFICATION FOR CONVERGENT MEDIA PLATFORM GAME*

Location: Apartment, Loft, Shed, Workshop, and Studio
Do: Design, create, craft, make
Themes: Fashion, Jewellery and Beauty (M&F)
Originality: Maker aesthetic. Hipsters. Kookiness. Personal originality.

The game consists of two areas: the player's home (which consists of a garden and a make space), and a world map. Home is visualized from the side, and is swipeable from side to side. Imagine a classic 2D side view scroller, only done using 3D. The main activity here is to grow resources in your Garden, and then Make Stuff in the Make Space, which consumes those resources.

The map is <isometric?> view where Makie is small, and tapping on locations makes her walk to that spot. The map doesn't scroll; tapping on a gateway spot causes Makie to walk to that spot, then load a new Map screen. All locations except for Home, which are accessible on the Map, are menu driven.

Game start

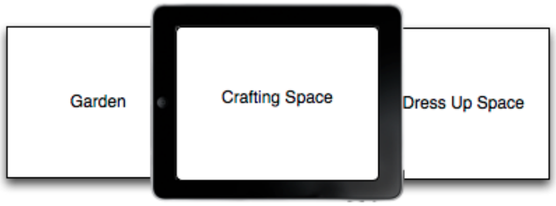
When the game starts, the player gets the following items free of charge:

- 50 cash
- 200 coins
- seeds
- pots
- machines
- Home

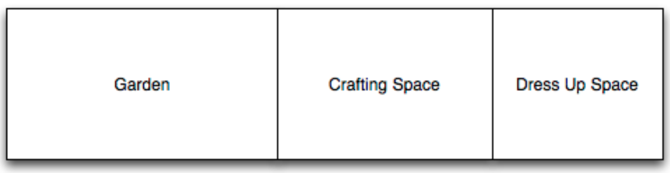
The player has a home loft building. The building consists of three areas, one for crafting, one for gardening and one for dress up / sales. The player's Makie character stands in the Dress Up Space (similar to Doll Factory - animation to be explored later).

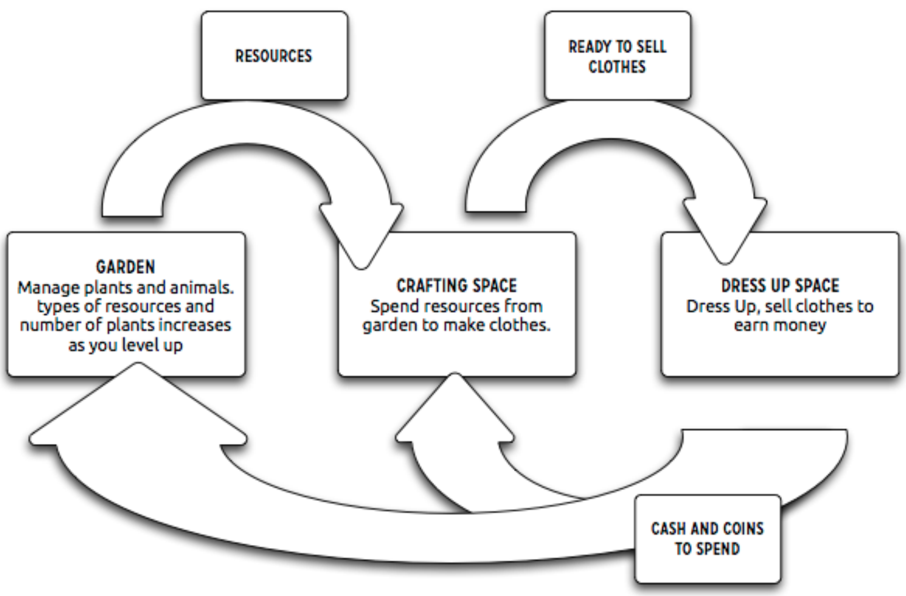
The play area is split to three sections

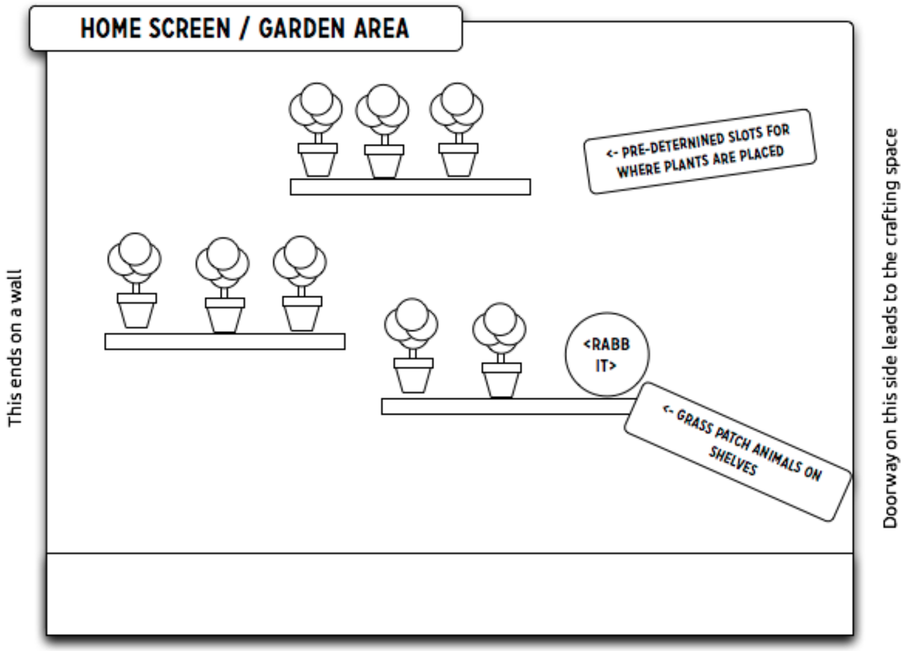

The game is played on the iPad, with 4:3 screen aspect ratio, where the player only sees part of the play area at once.

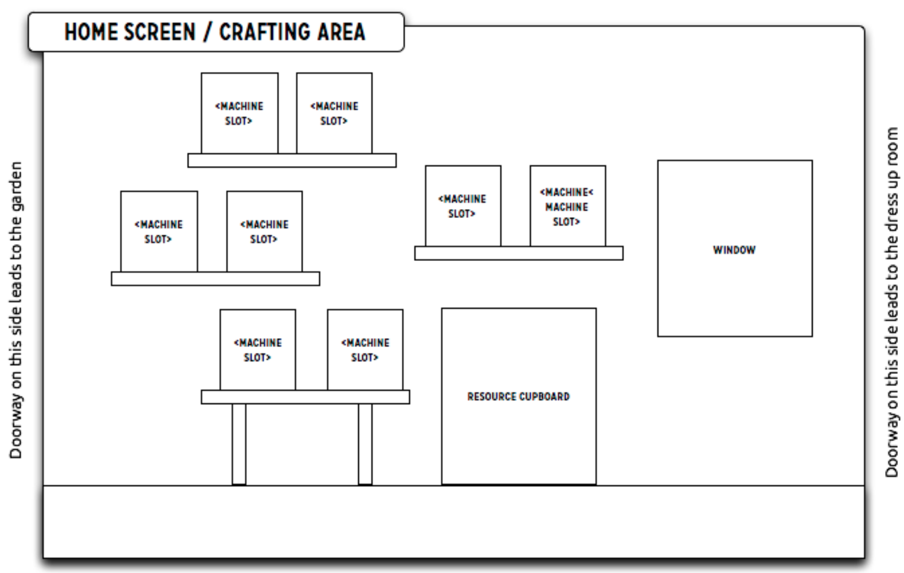


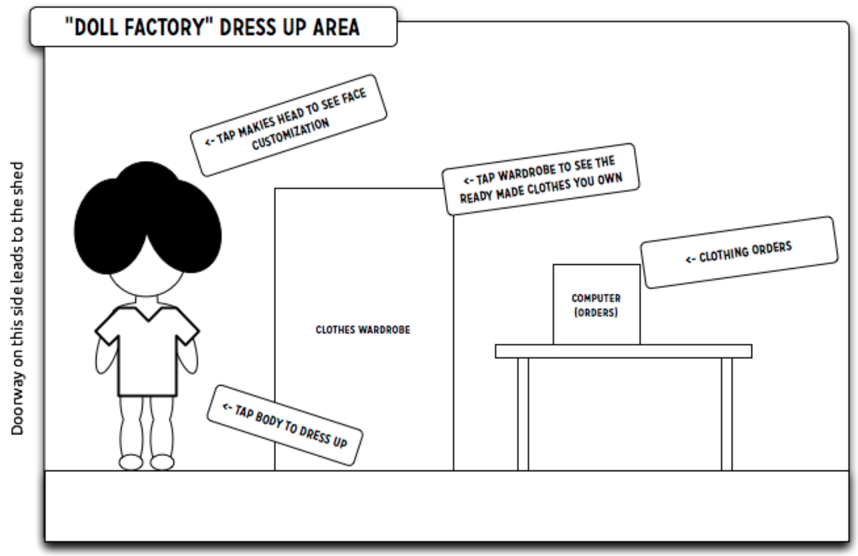

The play areas are all expandable in width, as the player gains more things that fill up the space.




HOME SCREEN / GARDEN AREA
<- PRE-DETERMINED SLOTS FOR WHERE PLANTS ARE PLACED
<RABB IT>
<- GRASS PATCH ANIMALS ON SHELVES
This ends on a wall
Doorway on this side leads to the crafting space

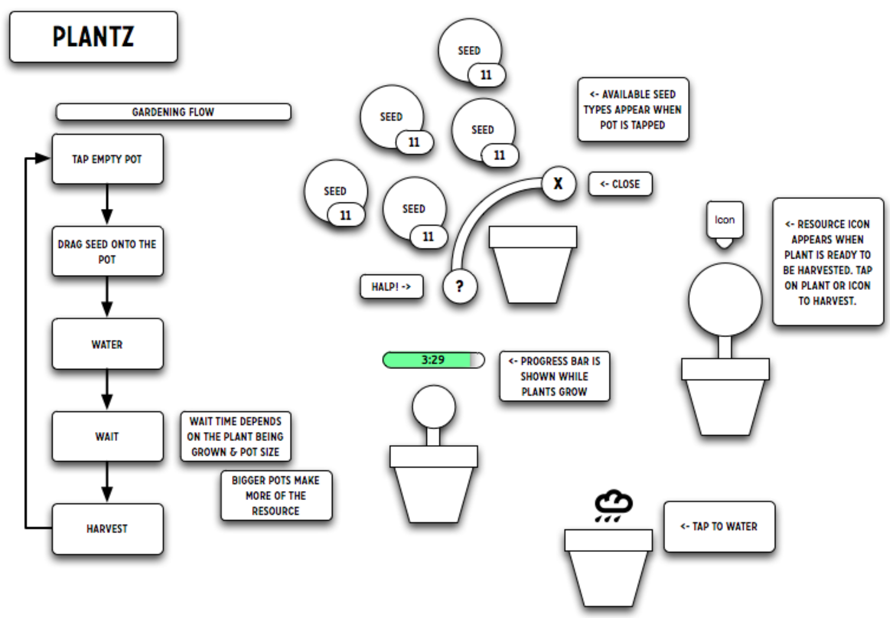

HOME SCREEN / CRAFTING AREA
<MACHINE SLOT>
<MACHINE SLOT>
<MACHINE SLOT>
<MACHINE SLOT>
<MACHINE SLOT>
<MACHINE< MACHINE SLOT>
WINDOW
<MACHINE SLOT>
<MACHINE SLOT>
RESOURCE CUPBOARD
Doorway on this side leads to the garden
Doorway on this side leads to the dress up room




### Texture customisation

The user can purchase wallpapers from the store to customise the textures in the shed.

### Gardening




The garden is used to create resources. Resource production happens through pots and animals.

### Pots & Plants

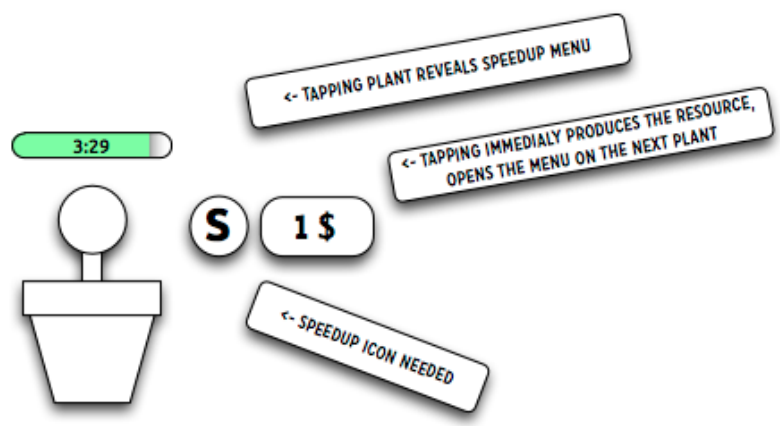
When a pot is empty, the player can tap on the pot to **Plant** seeds. Tapping opens the seed selection menu. Drag seeds onto the pot to plant the seed. After planting, the player has to tap the plant to water it, which takes 5 seconds. After that, the plant grows for *n* minutes, after which it's ready to be harvested. See the data excel for plant data, including growth times. Harvesting the plant happens by tapping it, which again takes 5 seconds.

There are 5 different sizes of pots. The user can upgrade the pots to larger sizes. Larger pots grow larger plants. The larger pots are unlocked by the player leveling up.

The first plants in the game are:

- Cotton
- Flax
- Silk
- Rubber tree
- Lettuce

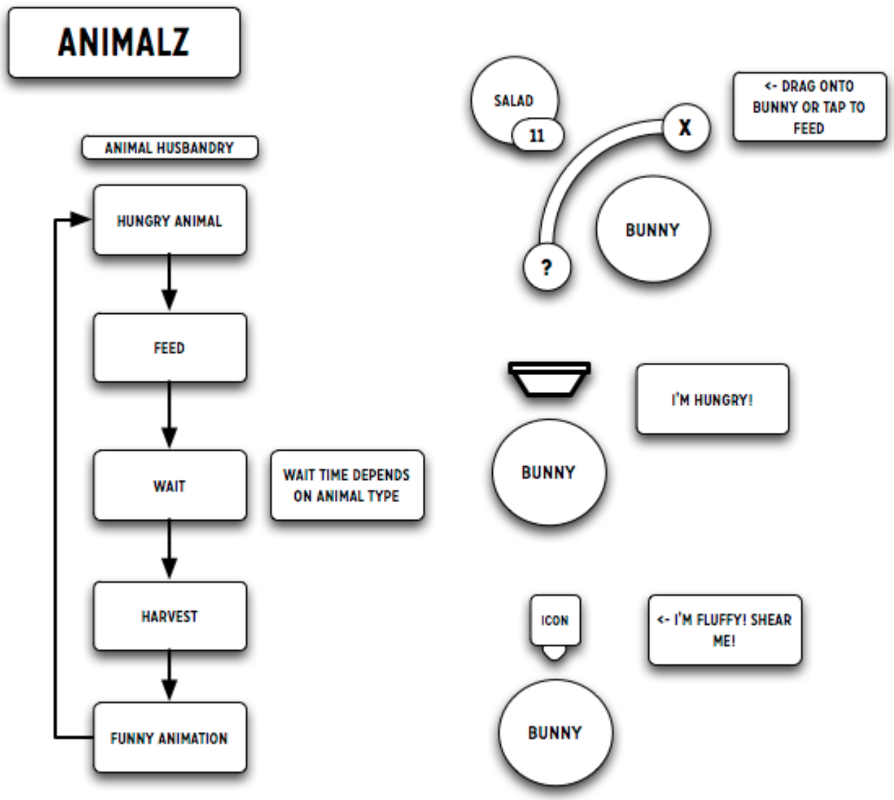
The player can tap a plant that's growing to speed up the production. See illustration below. The speedup costs 1 unit of the paid currency.




Player gets some seeds for free when the game starts. More seeds can be bought from the

Farmer's Market on the Map. Which seeds are available, plant growth speeds, pot sizes etc. are in the Spreadsheet.

**Animals**




The player can purchase **Animals** from the Farmer's Market. The amount of Animals the player can have in the Garden is restricted. The Animal harvesting flow is similar to Plant harvesting flow; the main difference is the animals eat plants as part of the growing process. See chart and spread sheet.

The animals are implemented as mini size animals that never leave a grass patch, which is placed on a shelf the same way as the pots are.

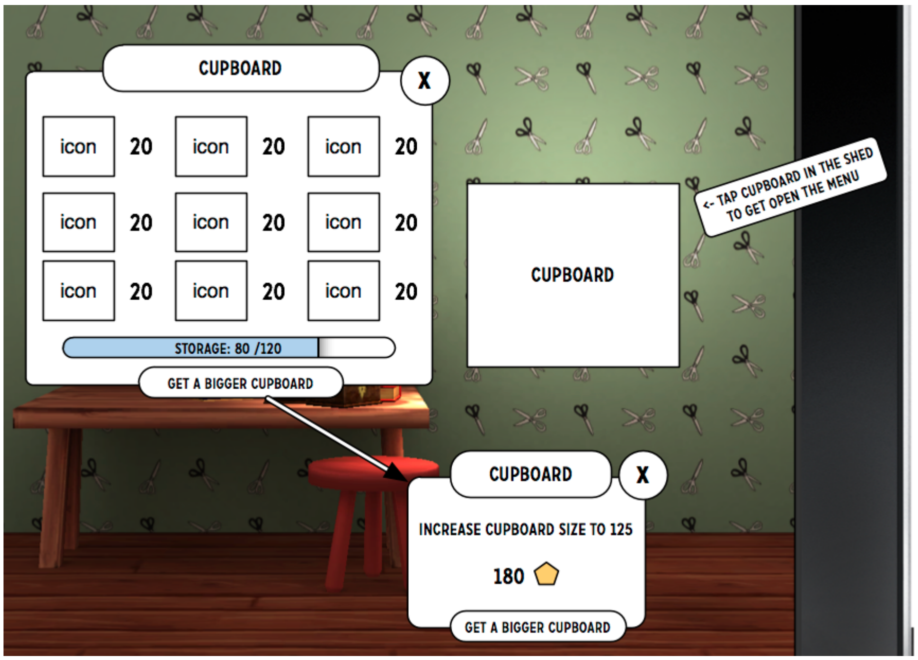
The animals are:

- Angora Bunny (Angora)

- Kashmere Goat (Kashmere)
- Sheep (Wool)

Produced resources are put into the player's Inventory.

**Inventory**




The player has an inventory for resources. The inventory can contain:

**Cupboard**

- Resources
- From plants
- From animals
- Refined, from machines

**Wardrobe**

Ready made clothes

(Constrained space -> Do we need storage for Machines?)

The patterns a player has created are stored in the Texturizer interface.

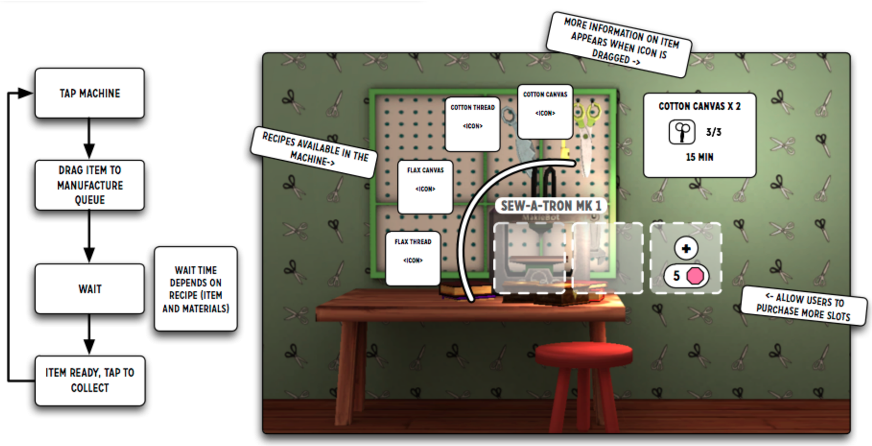
The player can add items to her garden and crafting space by dragging the objects out from the menu. (Indicate the available item slots?)

The Inventory is openable at any point from a button on lower left hand corner of the screen. Items are categorized by the screen / menu the user can drag the items onto:

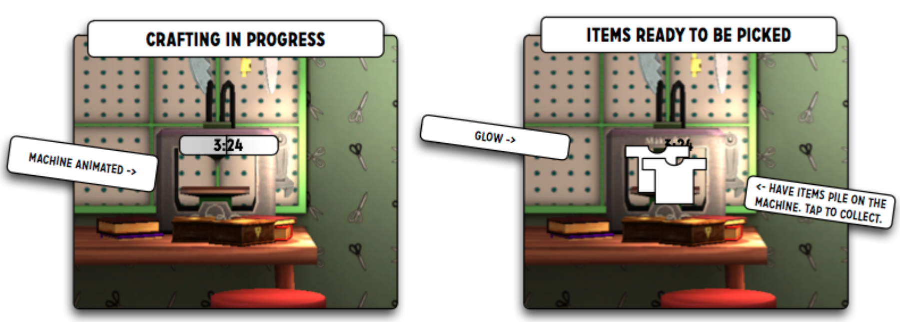
**Garden**, **Crafting**, **Materials** and **Clothes**.

For items where user has multiple identical items, the items stack and the inventory shows the number of items the user possesses.

## Crafting




The player can craft items from the resources available from the Garden, using Machines in the crafting space.




When the user taps on a machine, a **Crafting** menu is presented to the user. The machine lists the items it's capable of making and indicates which items you have resources for.

The machine has a queue of up to three items, last slot of which is purchasable by the player. The player can drag items to be made into the queue. When dragged, the item shows more information about the item, such as full name and resources needed to make it.

Each item takes a certain time to manufacture. The player can choose to speed up the manufacture using paid currency. When an item is ready to be picked, it appears on top of the machine, waiting to be tapped by the player. Tapping the item results XP points to float toward the XP bar.

For items, manufacture times etc., see the data spreadsheets.

The player has access to more than one machine type, each of which is used to manufacture different item types (i.e., use different recipes).

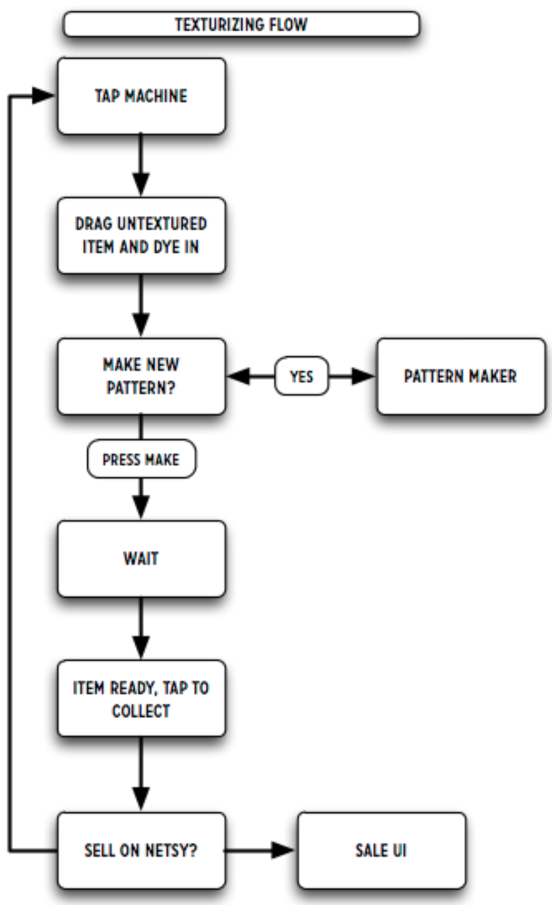
The core machines are:

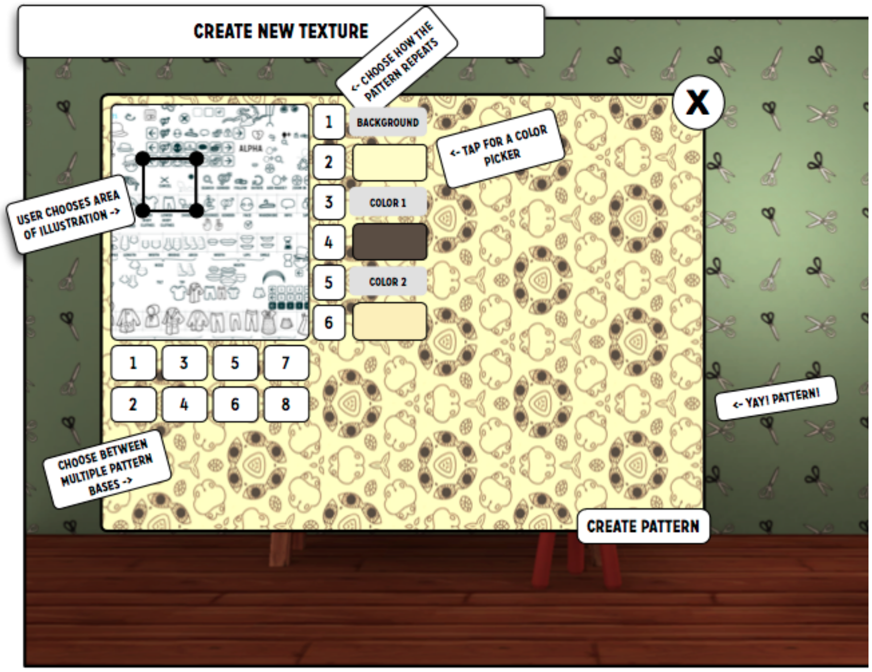
**Knit-Wit**: Turns raw resources like harvested raw cotton into thread and canvas
**Sew-a-Tron**: Sewing machine, which turns thread, canvas and accessories into clothes
**MakieBot**: Accessory creation machine turns resources into non-cloth pieces used for some clothing items (zippers)
**Texturizer**: Allows texturizing the clothes with user-made patterns. Consumes dye.

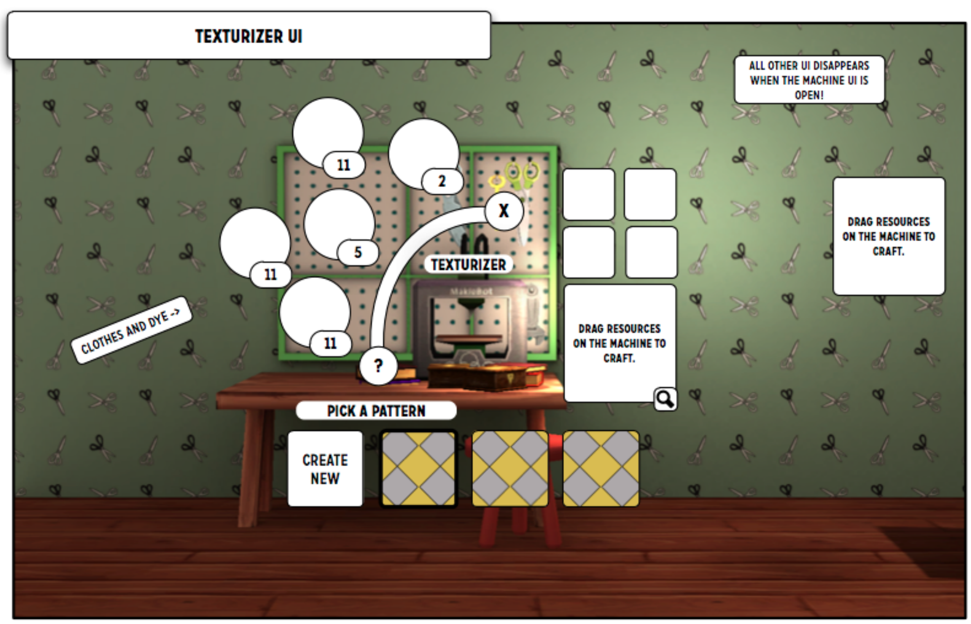
When a player manufactures a clothing item, the game asks the player if she wants to see it in Netsy. The sale price of items is based on the amount of time it takes to craft the item, including materials production. See Spreadsheet. See more details on Netsy further down.

One of the machines is the Texturizer. The texturizer allows the player to re-texturize any clothing piece she has in her inventory, using a texture pattern she's made herself. The texturizer requires Dyes to work, which are made by refining flower pollen into colour dye. For the sake of simplicity, the actual colour of items is not considered in the dye requirements.

As a starting point for the Texturizer, use the Repperpatterns style UI where user can pick a part of an image to be replicated onto the pattern, and the kaleidoscope style reflection/rotation pattern. **Use multiple images for variety**. (Use dye colour to determine which Texturizer bitmap is used.)





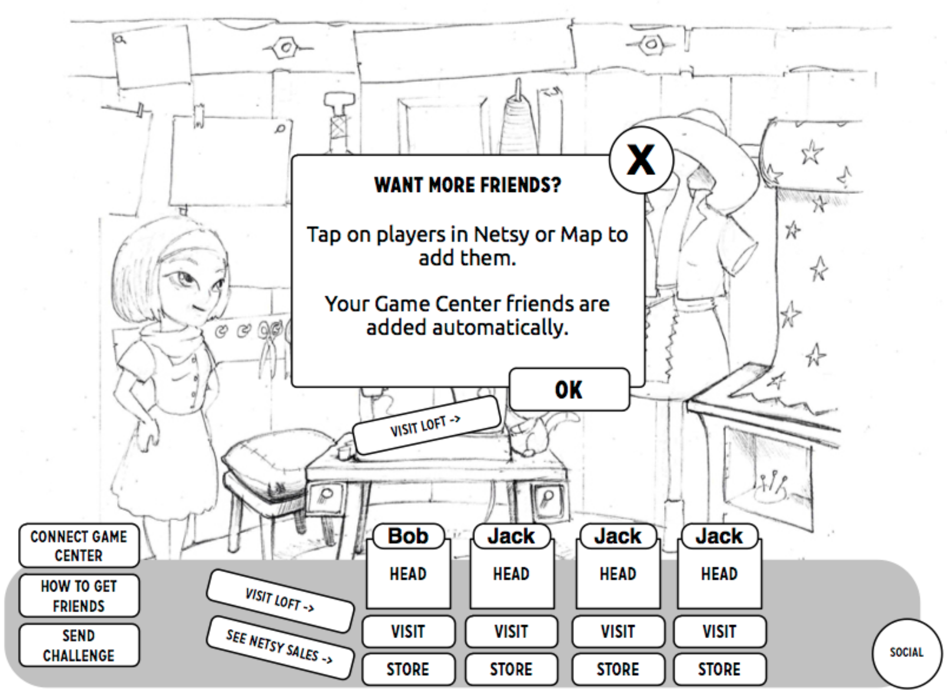




**Makie Customisation**

There are UI buttons in the player's Home, that allows changing your character's face (mirror?) and clothes (wardrobe?). The wardrobe shows the clothes the user has manufactured or Bought from the Market.

**Social**

Players can make friends. The Friending uses the follow model, no need to accept friendships. Auto-populates from Game Centre. (See how challenges on Game Centre works.)




Tapping a friend shows buttons to visit her Home, and seeing what she's posted on Netsy.

When you visit a friend's house, you can leave notes on her notice board, which sends a push notification to your friend.

The Towns is meant to give players a group identity to feel part of, and the Town Competition gives that group a common goal to aim at.

**Achievements**

The game has a set of Achievements tied to the Crafting system. The achievement goals are in the Spreadsheet.

- Number of items of different type that have been made
- Sales
- Amount of friends
- Outfit achievements - bundle clothing into outfits and give achievements when user has made them all

**Levelling**

The players gain XP as part of farming and selling activities. The levels unlock items in the store and grant users free items. The level gifts, XP requirements and level unlocks are described in the sheet Levels, Shop, XP Events tabs.

**Virtual Currency**

The game has two currencies:

**Atoms**

Earned through Achievements

The cost of all speedups is 1 gem / 2 minutes of time remaining, minimum 1 gem.

Used to purchase the most exclusive additions in the game and help with gameplay.

**Currency - Bits**

Earned by selling crafted items and resources

Spent on seeds, getting more machines and pots, other player's crafts

**Push notifications & local notifications**

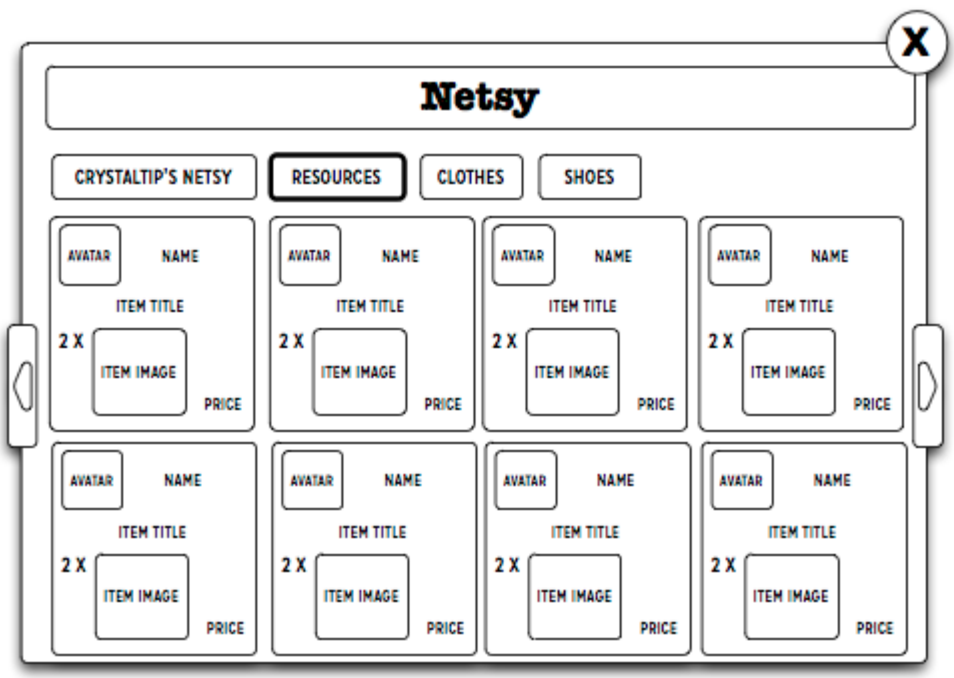
- The game shows the player a notification upon the following events:
- Successful sale on Netsy
- Machine having completed manufacturing
- Plant growth is complete
- You have been added to someone's friend list
- Someone visited your Home

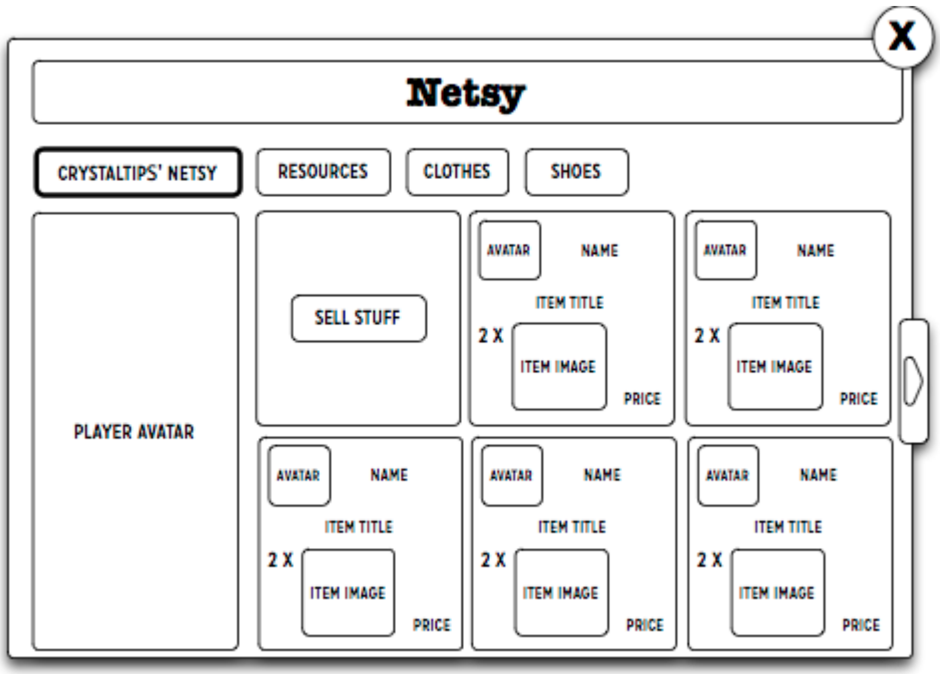
**Netsy**

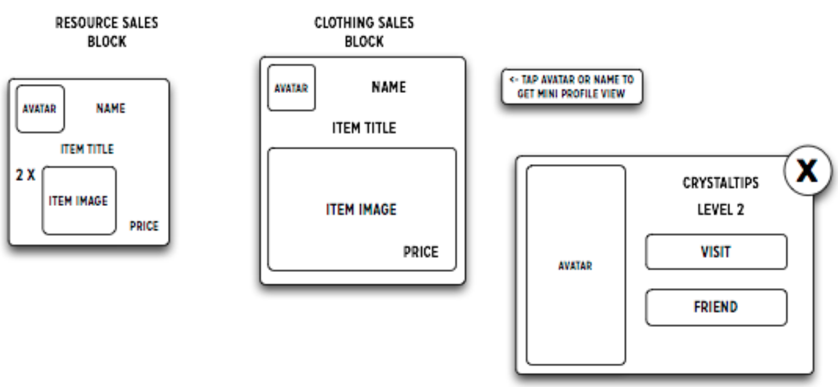
Netsy is the marketplace. Players can see all items being sold by all players. The Netsy UI is structured by item type. Players can post anything they have for sale in Netsy. On each item on sale, player can see who's posted it, and access a little social interaction menu on the user, allowing the player to visit the other player's home, or add her to friend list.

Netsy uses Bits for all sales.

**Guaranteed sales:** Whenever a player has anything on sale on Netsy, the game starts to accumulate Bits at speed of 25 Bits per hour, and uses the Bits to purchase the items on sale from the player. Clothing items are always bought first, in order of price (lowest to highest). Items are also not bought within the first 10 minutes of the item being posted. Players can purchase the items immediately. When an item is bought by the Game, the purchaser is labeled as the Mystery Shopper.






**Town Competition Event**

- Weekly competition where you need to make two item types
- Bring items to judges in the City
- High Score list for best villager and state between towns
- Top townspeople get gems
- Everyone in the winning town gets gems

**Map**

The player can walk out the door in her Home. The outside world is rendered as a map, where Makies walk around on paths. The Makies walking on the map are other player's characters, who are tappable, to reveal the Social Menu, which allows the player to friend & visit the other player.


The map has following areas, accessible by tapping on a spot on the screen (your Makie walks on a path to the spot, then screen changes to the new Map):

- Home Town
- Home
- Factory (where dolls are made)
- Friend-Player Houses
- Generic Houses
- Farmer's Market

- Machinery Store
- Guild Hall?
- Jay's House
- Outside World
- Opposing Towns

On the Home Town view, the player can see the Factory, Farmer's Market Store, Machinery Store, Guild Hall and Jay's Home. Tapping on these opens a menu-driven interaction. The Stores allow the player to purchase items using Bits and Atoms. Guild Hall allows user to submit creations for the Guild Elders and see player rankings on this week's challenge (see Town Challenge, below). Jay's Home is a menu where the player can find Jay, who flirts with the player.

The **Factory** is where the player is presented with a version of the doll builder UI, where she can choose purchasable clothes and accessories, and order her Makie. Some outfit and accessory options are locked unless the player has completed certain Achievements.

# *APPENDIX 4: MAKIEWORD PATENT - MANUFACTURING PROCESS FOR 3D PRINTED OBJECTS*

US009346219B2

(12) **United States Patent**
**Taylor et al.**

(10) **Patent No.: US 9,346,219 B2**
(45) **Date of Patent: May 24, 2016**

(54) **MANUFACTURING PROCESS FOR 3D PRINTED OBJECTS**

(71) Applicant: **MAKIEWORLD LIMITED**, London (GB)

(72) Inventors: **Alice Taylor**, London (GB); **Luke Petre**, London (GB); **Joanna Roach**, London (GB); **Sulka Haro**, London (GB)

(73) Assignee: **MAKIEWORLD LIMITED**, London (GB)

( * ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **14/326,988**

(22) Filed: **Jul. 9, 2014**

(65) **Prior Publication Data**

US 2014/0336808 A1 Nov. 13, 2014

(30) **Foreign Application Priority Data**

May 9, 2013 (GB) .................................. 1308343.1

(51) **Int. Cl.**
***B29C 67/00*** (2006.01)
***G06F 17/50*** (2006.01)
***B33Y 50/00*** (2015.01)

(52) **U.S. Cl.**
CPC ............ ***B29C 67/0088*** (2013.01); ***B33Y 50/00*** (2014.12); *G06F 17/50* (2013.01)

(58) **Field of Classification Search**
CPC ............ B29C 67/0092; B29C 67/0051; B29C 67/0088; G06F 17/50; G06F 2203/04802; G06F 17/5018; B33Y 50/00
USPC .................... 700/98, 119; 715/744, 765, 826; 345/420
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

| | | | | |
|---|---|---|---|---|
| 5,557,527 | A * | 9/1996 | Kotaki et al. | 700/131 |
| 6,271,856 | B1 * | 8/2001 | Krishnamurthy | 345/581 |
| 6,762,757 | B1 * | 7/2004 | Sander et al. | 345/420 |
| 6,862,374 | B1 * | 3/2005 | Nagai et al. | 382/285 |
| 7,075,531 | B1 * | 7/2006 | Ando et al. | 345/420 |
| 7,079,114 | B1 | 7/2006 | Smith et al. | |
| 7,391,420 | B1 * | 6/2008 | Coyne | 345/473 |
| 8,139,068 | B2 * | 3/2012 | Isner et al. | 345/474 |

(Continued)

FOREIGN PATENT DOCUMENTS

| | | | | |
|---|---|---|---|---|
| EP | 1077431 | * 8/1999 | | G06T 17/20 |
| GB | 2389764 | * 12/2003 | | G06T 7/40 |
| WO | WO 2009/128898 A1 | 10/2009 | | |

OTHER PUBLICATIONS

Pixar, “OpenSubdiv Architecture”, Dec. 4, 2012, pp. 2.*

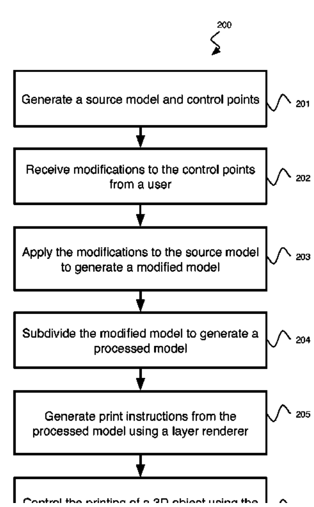
(Continued)

*Primary Examiner* — Carlos Ortiz Rodriguez
*Assistant Examiner* — Olvin Lopez Alvarez
(74) *Attorney, Agent, or Firm* — Nixon & Vanderhye PC

(57) **ABSTRACT**

The present invention relates to a computer-implemented method of manufacturing customized 3D objects. The method includes retrieving a source model for a 3D object and a plurality of defined control points for the 3D object from a database; receiving modifications to at least some of the control points from a first user; automatically applying the modifications to the source model to create a modified model; and automatically generating print instructions for manufacture of a customized version of the 3D object. A system and 3D models generated by the method are also disclosed.

**21 Claims, 9 Drawing Sheets**



(56) **References Cited**

U.S. PATENT DOCUMENTS

| | | | | |
|---|---|---|---|---|
| 8,174,539 | B1 * | 5/2012 | Samaniego et al. | 345/619 |
| 8,266,546 | B2 * | 9/2012 | Candrian et al. | 715/815 |
| 8,314,790 | B1 * | 11/2012 | Zeiger et al. | 345/419 |
| 8,515,826 | B2 * | 8/2013 | Norman | 705/26.5 |
| 8,654,121 | B1 * | 2/2014 | Yu et al. | 345/423 |
| 8,730,231 | B2 * | 5/2014 | Snoddy et al. | 345/419 |
| 8,791,942 | B2 * | 7/2014 | Rivers et al. | 345/419 |
| 2001/0056308 | A1 * | 12/2001 | Petrov et al. | 700/98 |
| 2003/0074174 | A1 | 4/2003 | Fu et al. | |
| 2003/0201992 | A1 | 10/2003 | Wang et al. | |
| 2004/0157527 | A1 * | 8/2004 | Omar | 446/268 |
| 2006/0023228 | A1 * | 2/2006 | Geng | 356/601 |
| 2006/0023923 | A1 * | 2/2006 | Geng et al. | 382/116 |
| 2006/0098008 | A1 * | 5/2006 | Holberg | 345/420 |
| 2007/0011982 | A1 * | 1/2007 | Swift | 52/604 |
| 2007/0198118 | A1 * | 8/2007 | Lind | 700/138 |
| 2007/0198230 | A1 | 8/2007 | Wang et al. | |
| 2007/0273711 | A1 * | 11/2007 | Maffei | 345/630 |
| 2008/0006273 | A1 * | 1/2008 | Thornton | 128/206.21 |
| 2008/0111816 | A1 * | 5/2008 | Abraham et al. | 345/420 |
| 2010/0305909 | A1 * | 12/2010 | Wolper et al. | 703/1 |
| 2011/0060438 | A1 * | 3/2011 | Stoddard et al. | 700/97 |
| 2011/0234581 | A1 * | 9/2011 | Eikelis et al. | 345/419 |
| 2011/0298897 | A1 * | 12/2011 | Sareen et al. | 348/47 |
| 2012/0079378 | A1 * | 3/2012 | Goossens | 715/706 |
| 2012/0224755 | A1 * | 9/2012 | Wu | 382/131 |
| 2012/0255663 | A1 * | 10/2012 | Holroyd et al. | 156/64 |
| 2012/0314021 | A1 * | 12/2012 | Tsang | 348/40 |
| 2013/0046511 | A1 * | 2/2013 | Tayal et al. | 703/1 |
| 2013/0096708 | A1 * | 4/2013 | Danks | B29C 67/0088 700/98 |
| 2013/0159866 | A1 * | 6/2013 | Dirsa et al. | 715/738 |
| 2014/0074272 | A1 * | 3/2014 | Cowden, IV | 700/97 |
| 2014/0092090 | A1 * | 4/2014 | Fleury | 345/420 |
| 2014/0163710 | A1 * | 6/2014 | Moreau | 700/98 |
| 2014/0184599 | A1 * | 7/2014 | Quilot et al. | 345/423 |
| 2014/0274458 | A1 * | 9/2014 | Kronenberg et al. | 473/342 |
| 2014/0279177 | A1 * | 9/2014 | Stump | 705/26.4 |
| 2014/0337779 | A1 * | 11/2014 | Davis et al. | 715/771 |

OTHER PUBLICATIONS

Youtube.com, "meet the makies custom 3D printed dolls", Sep. 1, 2014, pp. 1.*

Lai et al, "Feature aligned quad dominant remeshing using iterative local updates", 2009, pp. 109-117.*

Guthe et al, "GPU-based trimming and tessellation of NURBS and T-Spline surfaces", Jul. 2005, pp. 1016-1023.*

Niebner et al, "Feature Adaptive GPU Rendering of Catmull-Clark Subdivision Surfaces", 2012, pp. 1-11.*

Autodesk, "autodesk MAya, Subdivision Surface Modeling", 2011, pp. 68.*

De Rose et al, "Subdivision Surfaces in Character Animation", Oct. 19, 2003, pp. 10.*

sculpteo.com, "Prepare your model for 3D Printing", ttp://www.sculpteo.com/en/prepare-your-model-3d-printing, pp. 2, downloaded May 2015.*

sculpteo.com, "Prepare your model for 3D Printing with Inventor", http://www.sculpteo.com/en/prepare-your-model-3d-printing-inventor/, available Online 2014, pp. 9.*

Donley, "Best 3D Printing Plugins for Sketchup", Jul. 30, 2013, pp. 6.*

Pereira et al, "Boolean operations on multi-region solids for mesh generation", Jun. 28, 2011, pp. 15.*

Cantwell, "Find holes in your Sketchup mesh easily with the Solid Inspector plugin", www.ponoko.com, Aug. 7, 2011, pp. 1.*

Shapeways.com, "SketchUp STL export tutorial", Mar. 5, 2013, pp. 10.*

Ritland, "8 Tips for 3D Printing with Sketchup", http://mastersketchup.com/8-tips-for-3d-printing-with-sketchup/, Oct. 2012, pp. 6.*

Arruda et al, "Boolean Operations on Non-Manifold and B-Rep Solids for Mesh Generation", 2006, pp. 19.*

Search Report mailed Oct. 21, 2014 in Great Britain Application No. 1308343.1 (4 pages).

* cited by examiner

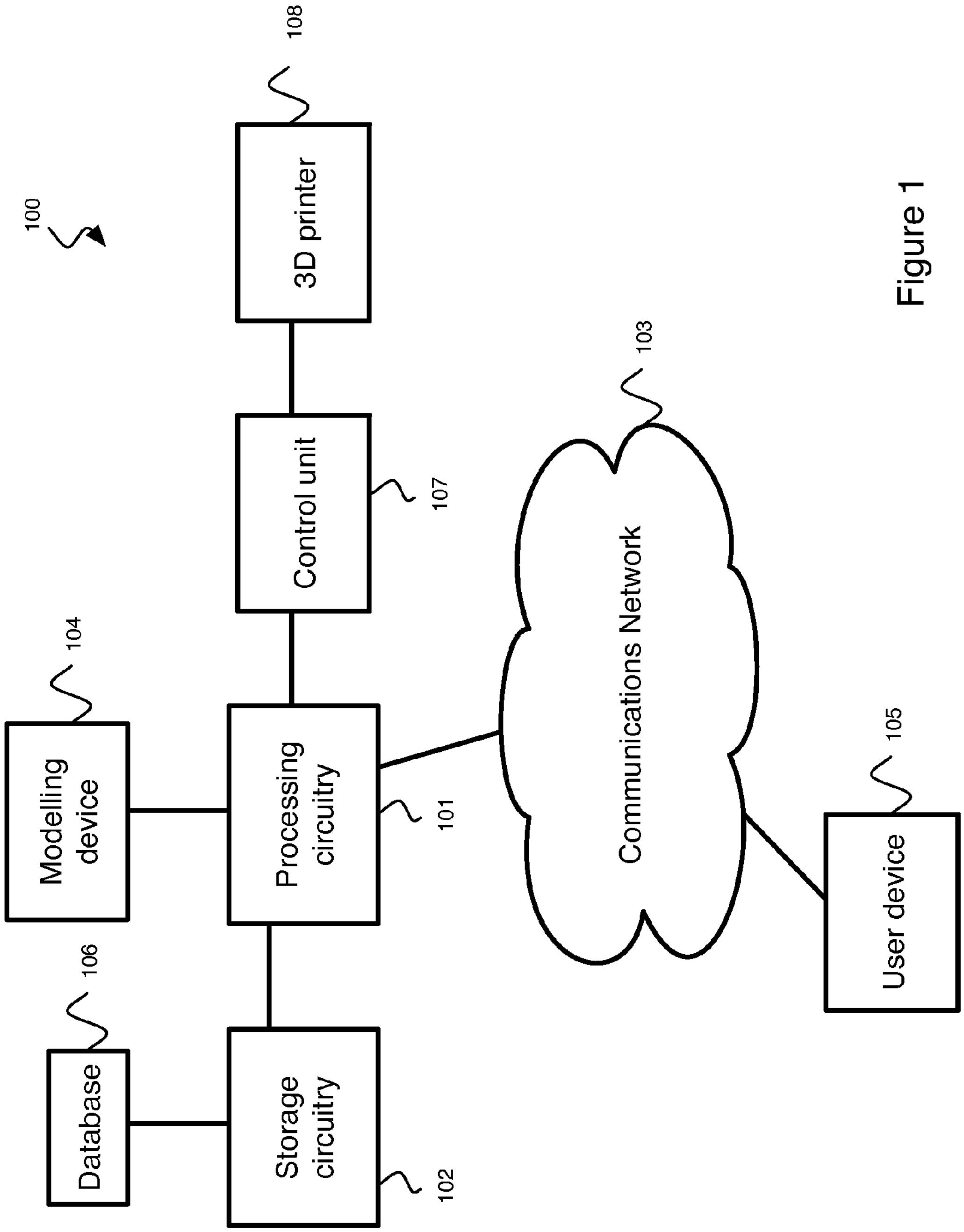

100
108
3D printer
Control unit
107
Modelling device
104
Processing circuitry
101
Database
106
Storage circuitry
102
Communications Network
103
User device
105

Figure 1

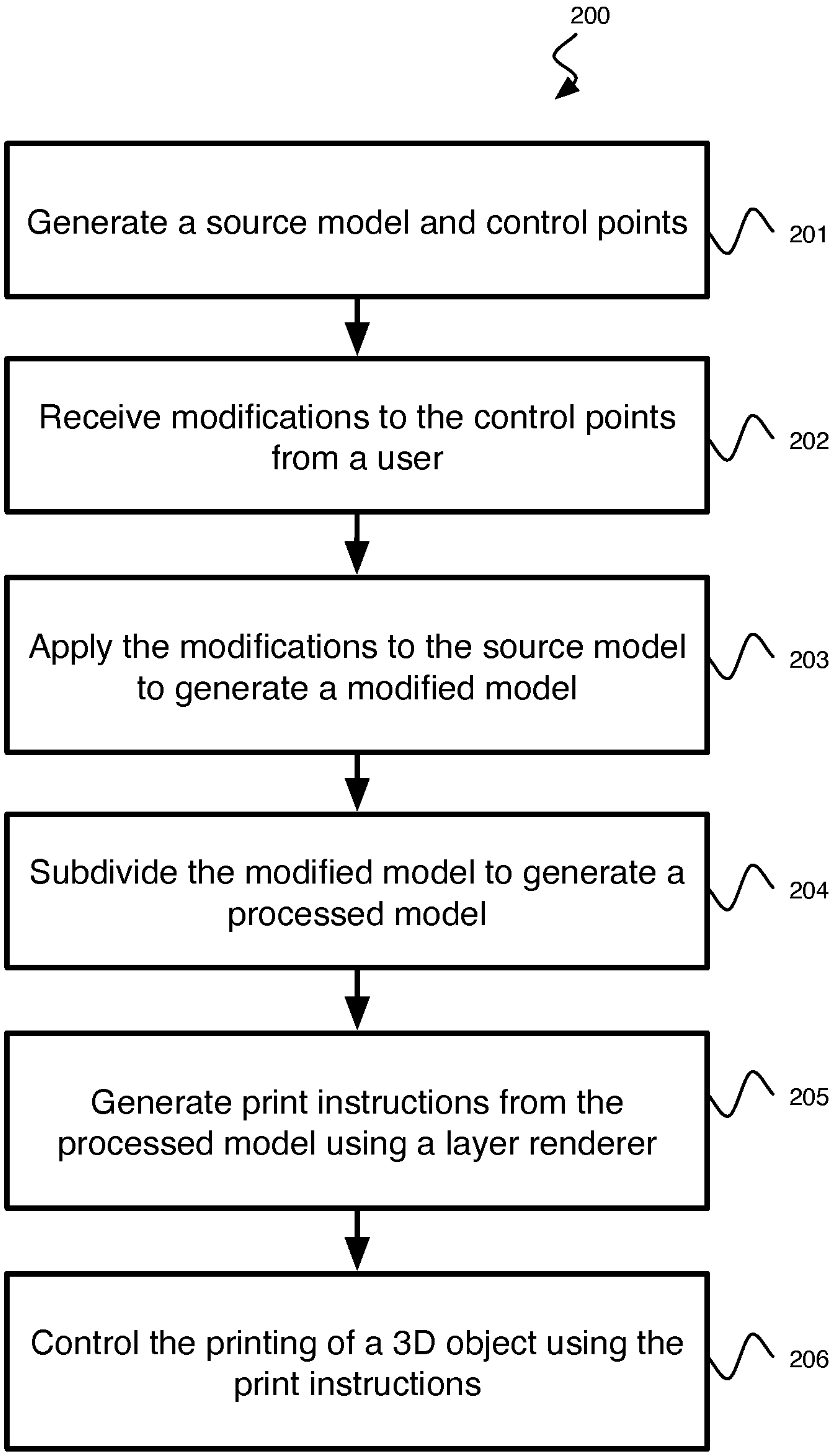

200
Generate a source model and control points
201
Receive modifications to the control points from a user
202
Apply the modifications to the source model to generate a modified model
203
Subdivide the modified model to generate a processed model
204
Generate print instructions from the processed model using a layer renderer
205
Control the printing of a 3D object using the print instructions
206

Figure 2

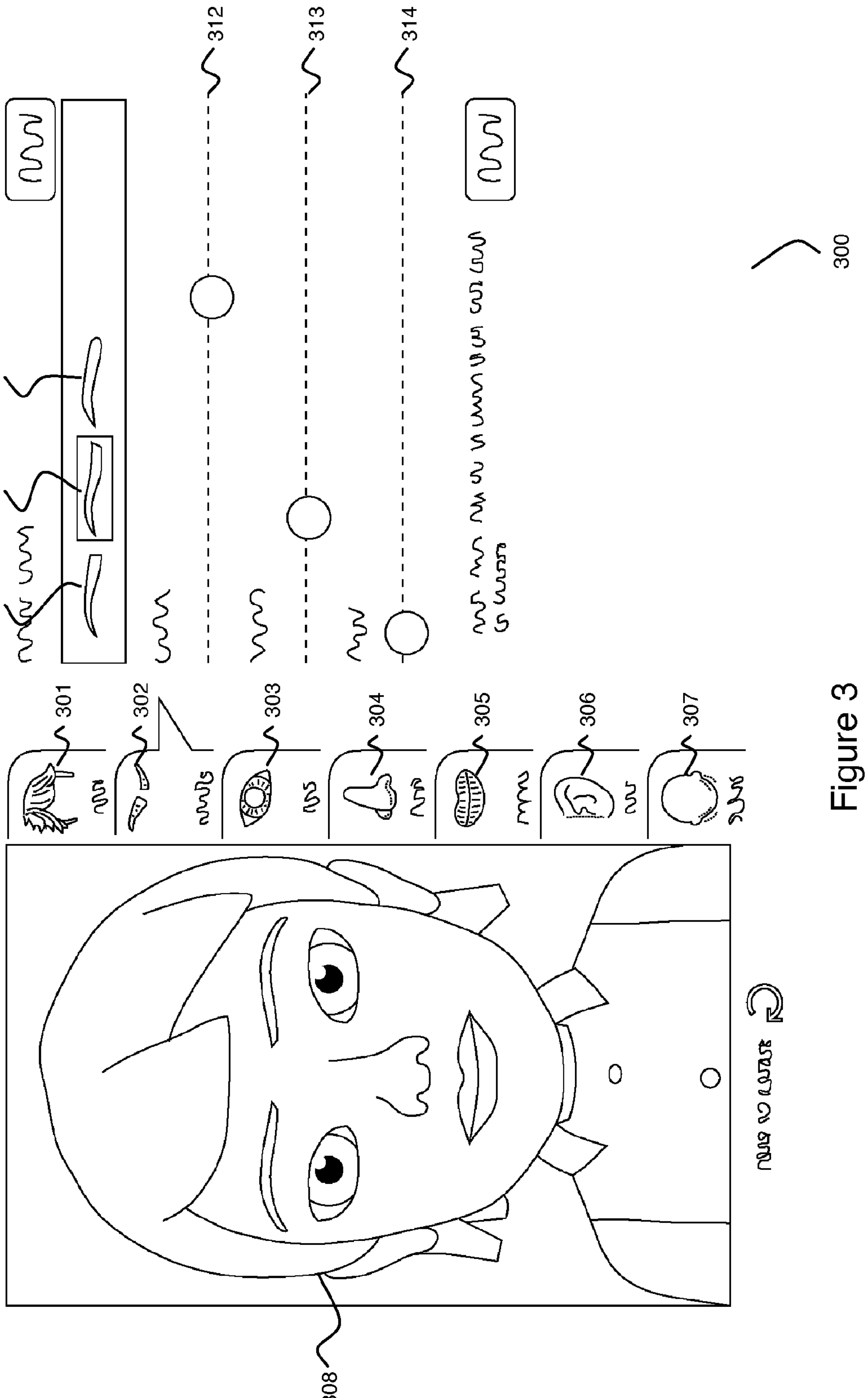



Figure 3

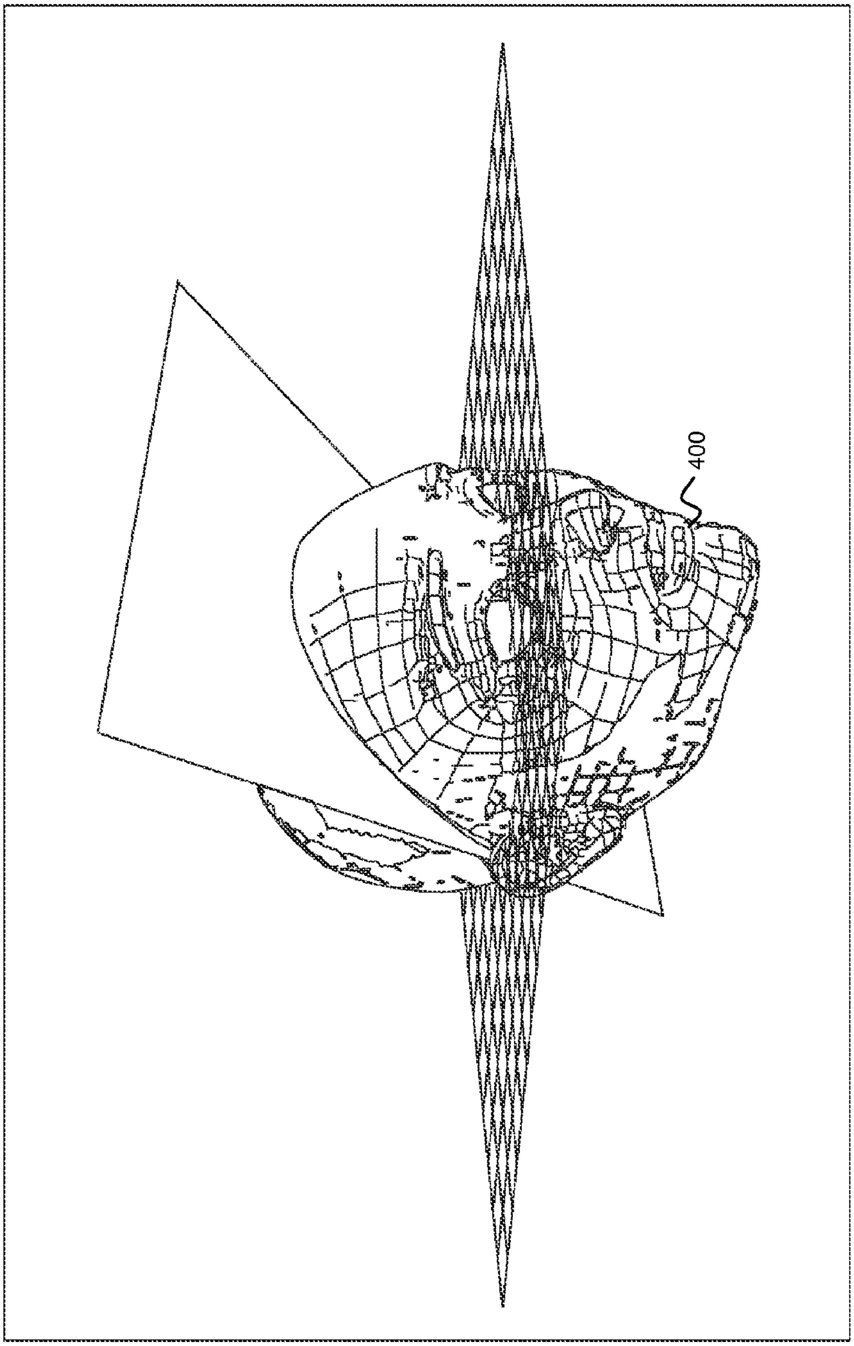



Figure 4

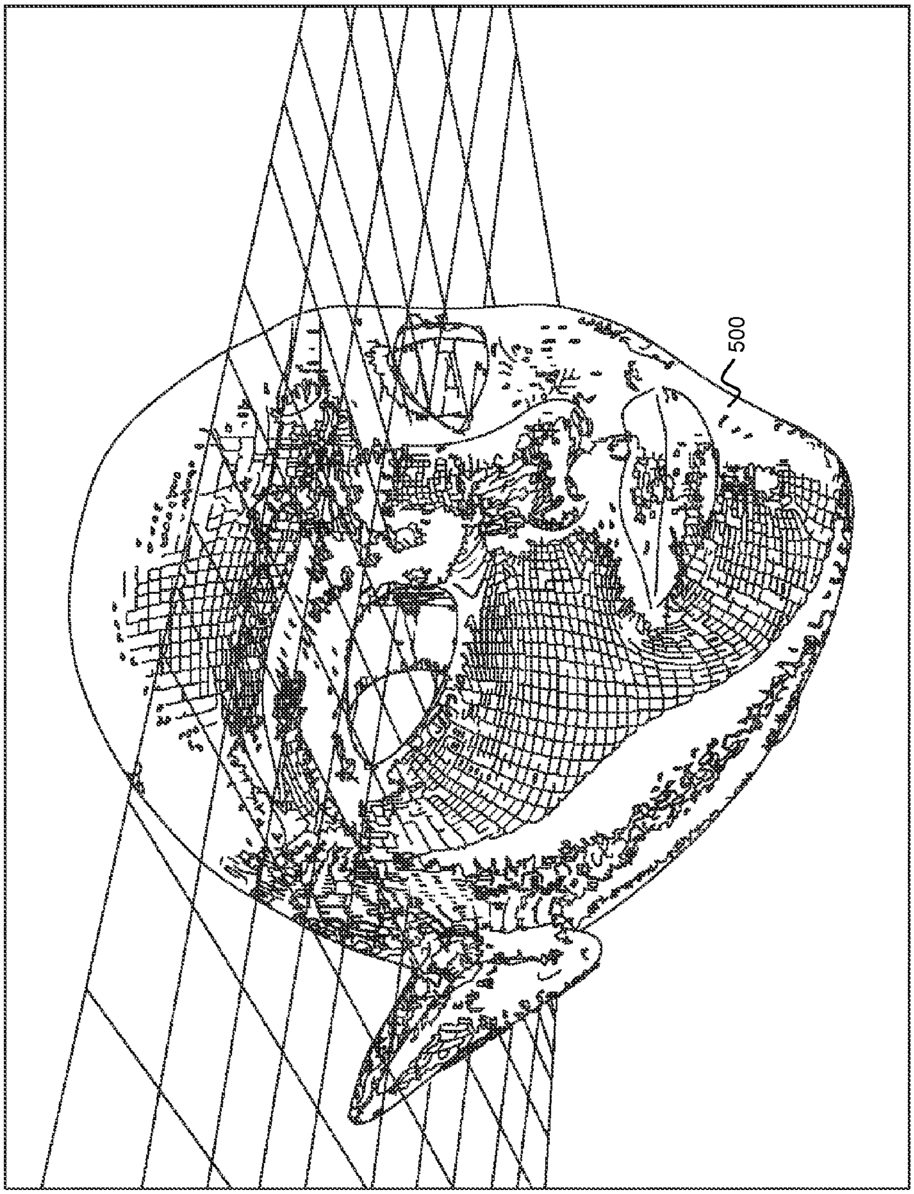



Figure 5

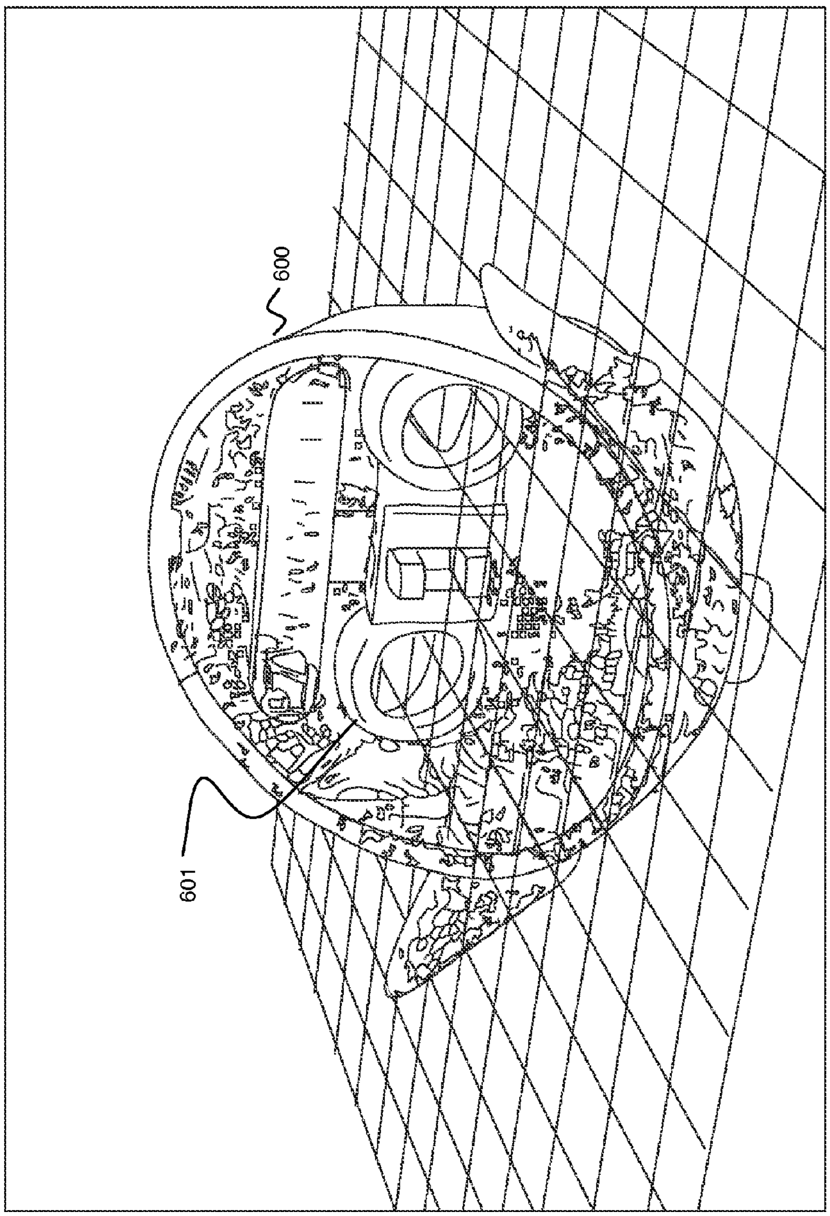



Figure 6

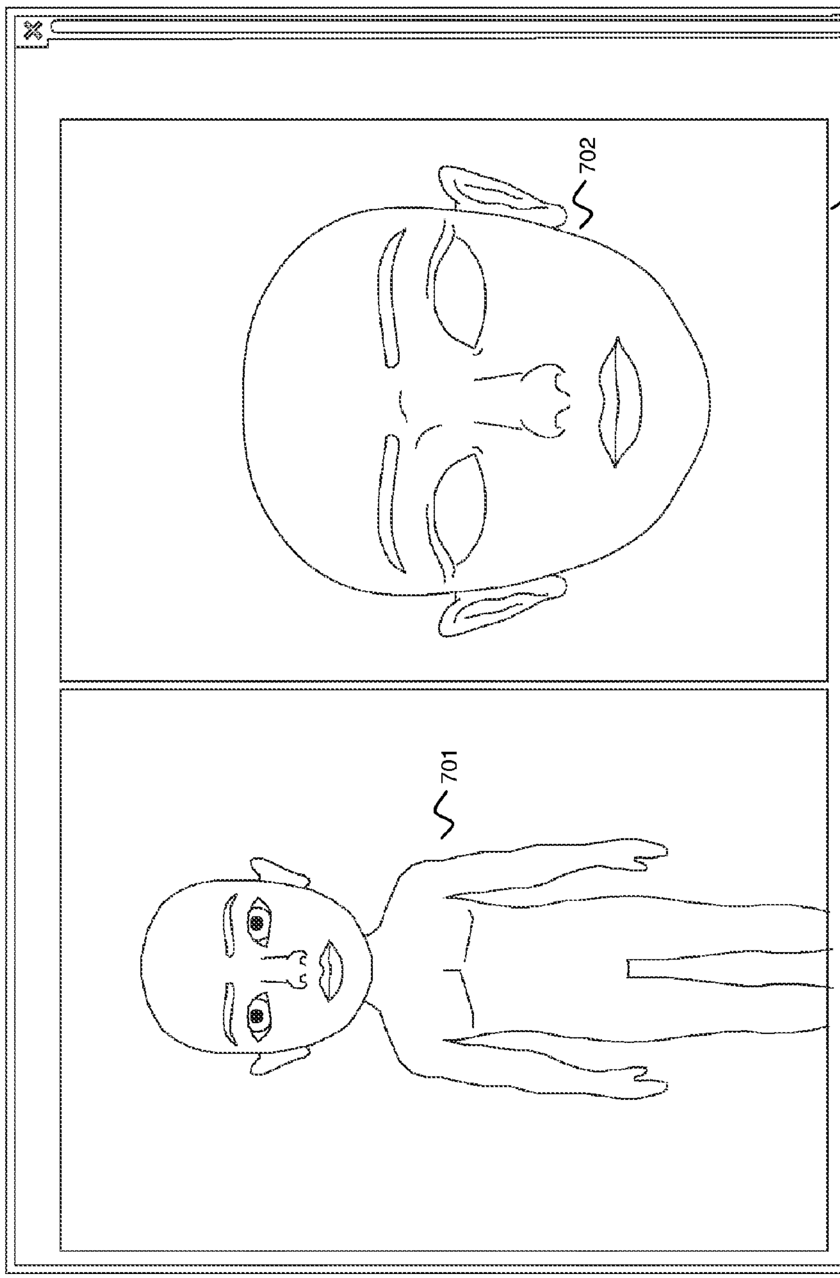



Figure 7

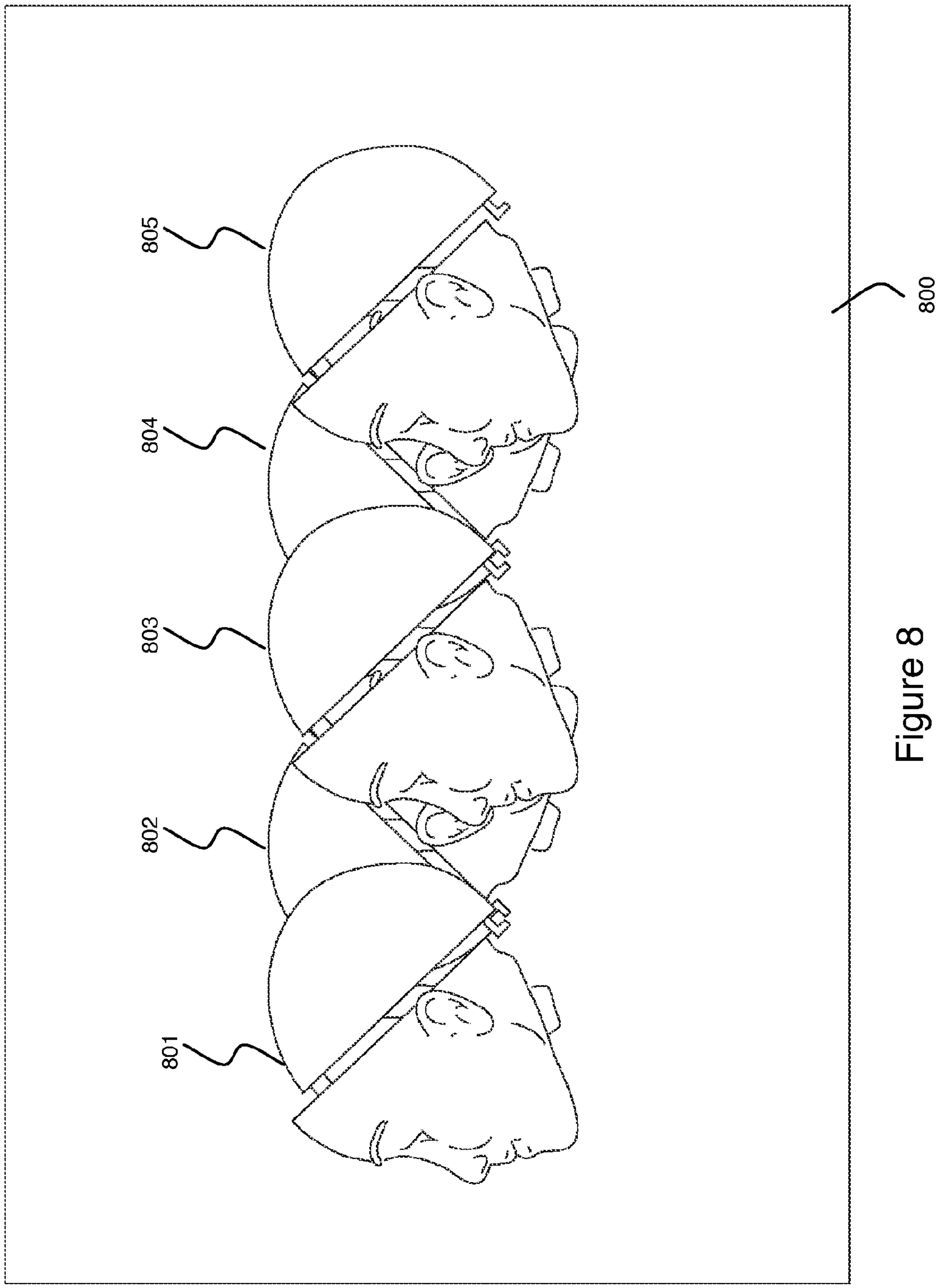
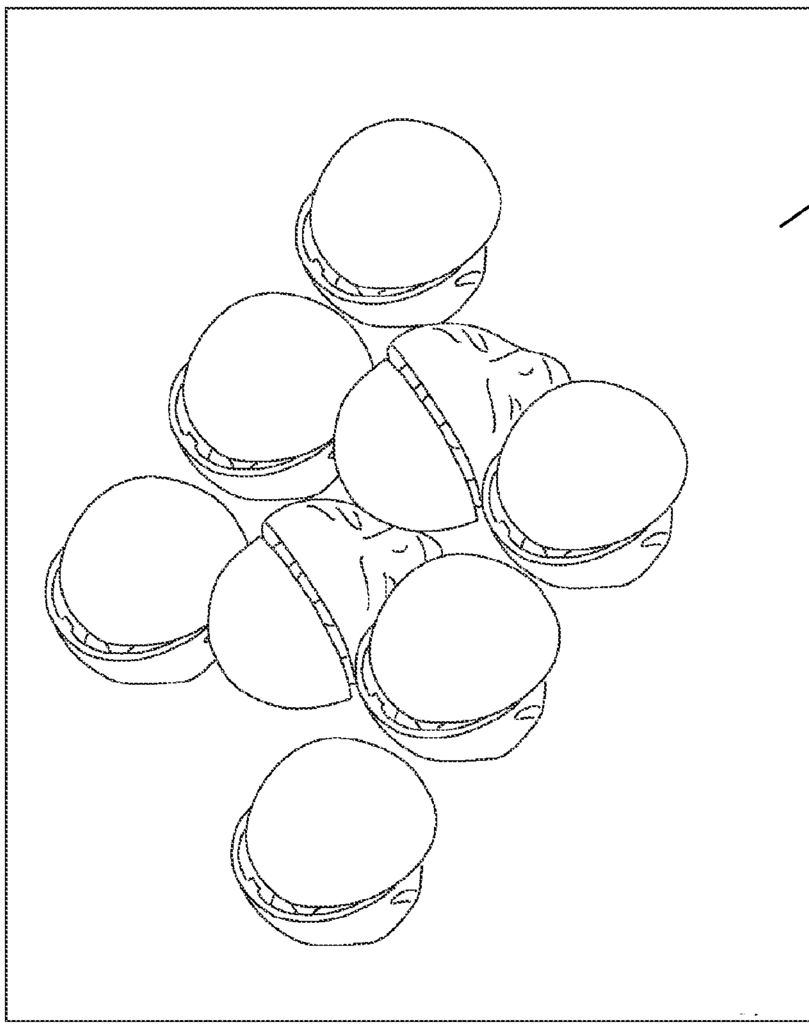



Figure 8



800

Figure 9

## MANUFACTURING PROCESS FOR 3D PRINTED OBJECTS

This application claims priority to GB Application No. 1308343.1, filed on May 9, 2013, the entire contents of which is incorporated herein by reference.

### FIELD OF INVENTION

The present invention is in the field of manufacturing of 3D printed objects. In particular, but not exclusively, the present invention relates to the manufacturing of customisable 3D printed objects.

### BACKGROUND

Small batch manufacturing of objects has become more viable with the development of 3D printing, or additive manufacturing, where a printing apparatus layers substrate to build up a 3D object.

In light of such manufacturing techniques, it would be desirable to generate very small batch or one-off designs. However, to create the instructions for a 3D printer to create a 3D object requires knowledge and expertise in 3D modelling software.

One method to enable consumers to create unique objects is to construct a service to permit them to customise existing models.

The consumer can instruct the service to make certain modifications to existing models which can be implemented by designers using 3D modelling software.

Clearly this methodology involves significant human input by skilled 3D modellers. The methodology cannot simply be automated due to the skill required by the 3D modellers. Therefore, a new manufacturing process is desired which manufactures 3D objects customised by users.

It is an object of the present invention to provide a 3D object manufacturing method which overcomes the disadvantages of the prior art, or at least provides a useful alternative.

### SUMMARY OF INVENTION

According to a first aspect of the invention there is provided a computer-implemented method of manufacturing 3D objects, including:

a) retrieving a source model for a 3D object and a plurality of defined control points for the 3D object from a database;

b) receiving modifications to at least some of the control points from a first user;

c) automatically applying the modifications to the source model to create a modified model; and

e) automatically generating print instructions for manufacture of a customised version of the 3D object.

The method may also include the step of automatically subdividing the surface of the modified model to create a high resolution model which is used to generate the print instructions.

The print instructions may be generated by a layer renderer using the modified model or high resolution model.

The method may also include the step of automatically controlling a 3D printer using the print instructions.

The source model may comprise a shell portion and an internal components portion. The control points may relate to aspects of the shell portion. The shell portion may comprise at least one low resolution mesh and the internal components portion may comprise at least one high resolution mesh. The



method may include the step of modifying the high resolution model by combining it with the internal components portion.

The shell portion may also comprise an exterior surface mesh and an interior surface mesh. Modifications may be applied to each of the exterior and interior surface meshes. The exterior and interior surface meshes may be combined after the modifications are applied.

A stereo-lithography check may be generated on the high resolution model.

The high resolution model and the source model may be displayed to a second user for quality control purposes, for example.

The modifications may be delimited by constraints defined within the source model.

A low resolution representation of the source model may be displayed within a graphical user interface to the first user. Customisations may be received from the first user via the graphical user interface. The customisations may be converted into modifications of the control points. The customisations may relate one or more within a set of physical features of the source model.

According to a further aspect of the invention there is provided a system for manufacturing 3D objects, including:

Processing circuitry configured for receiving modifications to control points for a source model from a user device, applying the modifications to the source model to generate a modified model, and rendering print instructions from the modified model;

Storage circuitry configured for storing and retrieving a plurality of source models and associated control points within a database; and

A control unit configured for controlling a 3D printer to create a 3D object from the print instructions.

The processing circuitry may be further configured to subdivide the modified model to generate a processing model from which the print instructions may be generated.

The print instructions may be generated using a layer renderer.

The system may include a database configured for storing the plurality of source models and associated control points and a communications circuitry. The processing circuitry may be further configured to transmit a representation of the source model and the control points to the user device via the communications circuitry.

Other aspects of the invention are described within the claims.

### BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments of the invention will now be described, by way of example only, with reference to the accompanying drawings in which:

FIG. **1**: shows a block diagram illustrating a system in accordance with an embodiment of the invention;

FIG. **2**: shows a flowchart illustrating a system in accordance with an embodiment of the invention;

FIG. **3**: shows a user interface for a model customisation system;

FIG. **4**: shows a 3D model before modifications or subdivision has occurred;

FIG. **5**: shows a 3D model after modifications and subdivision has been applied in accordance with an embodiment of the invention;

FIG. **6**: shows a 3D model after combination of the modified and subdivided shell portion with the internal components portion of the model in accordance with an embodiment of the invention;

FIG. 7: shows a graphical display of the 3D models in accordance with an embodiment of the invention; and

FIGS. 8 and 9: show representations of a print layout for multiple 3D models generated by a layer renderer.

## DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

The present invention provides a manufacturing process for 3D objects.

Referring to FIG. 1, a system 100 for manufacturing 3D objects will be described.

The system 100 may comprise processing circuitry 101 and storage circuitry 102. The circuitry 101 and 102 may be collocated at a server. It will be appreciated that the processing and storage circuitry 101 and 102 may be distributed across a plurality of physical hardware components which may be collocated or connected by one or more communications networks 103.

A modelling device 104 is shown. The modelling device 104 may be a computing device comprising a processor, a memory, an input and an output. The device 104 may be configured for use by a user, such as a designer, to construct a source model and to define within the source model a plurality of control points. The source model and list of control points may be transmitted to the processing circuitry 101.

The source model is preferably comprised of a series of interconnected polygons (a source mesh). The source mesh may be defined as a series of instructions specifying the vertices of the polygons. The control points may relate to specific vertices of the mesh.

The source model may comprise an exterior surface mesh and an interior surface mesh.

The source model may further comprise internal components. The exterior and interior meshes may be created at a first level of resolution and the internal components may be created at a second level of resolution higher than the first.

Another user, such as a consumer who may be unskilled in 3D modelling, may access a representation of the source model using a user device 105. The representation of the source model may comprise only the exterior mesh. The representation of the source model may be generated from the source model by the processing circuitry 101 and transmitted to the user device 105 via a communications network 103. In an alternative embodiment, the representation of the source model may be generated at the user device 105. The user device 105 may be a computing device such as a personal computer, a laptop, a smart-phone, or a tablet computer. The communications network 103 may be the Internet, a cellular network, a LAN, or a combination of networks.

The source model and list of control points may be stored in and retrieved from a database 106 by a storage circuitry. It will be appreciated that the database 106 may distributed across a plurality of physical hardware.

The user device 105 may be configured to receive input from the user to modify the control points defined for the source model and to transmit the modified control points to the processing circuitry.

The processing circuitry 101 may be configured to apply the modifications to the source model to generate a modified model.

The processing circuitry 101 may apply the modifications by shifting the vertices within the meshes to correspond to the modified control points. Both the exterior and interior surface meshes may be modified.

The processing circuitry 101 may be further configured to process the modified model to subdivide the polygons within the source model. The polygons may be subdivided using an algorithmic subdivision method such as opensubdiv. The subdivision will result in a greater set of instructions and the resulting model will be of a higher 3D resolution. Where the source model comprises an exterior and interior surface mesh at a first resolution and internal components at a higher resolution, the polygons within the surface meshes may be subdivided.

The processing circuitry 101 may also be configured to apply a layer rendering process to the processed model to generate a set of print instructions. The print instructions will define how the processed model may be printed using an additive manufacturing method. The layer renderer may be configured to define different processed models based upon the type of recipient 3D printer.

The print instructions may be transmitted to a control unit 107 which controls the printing of a 3D object on a 3D printer 108.

Referring to FIG. 2, a method 200 of 3D manufacturing will be described.

In step 201, a source model is generated and a series of control points (or morph targets) are defined. The source model defines a specific type of customisable 3D object. The control points define the customisability of the 3D object. Alternatively, the generated source model and control points may be retrieved by the processing circuitry 101 from a database 106.

The source model may comprise two parts as previously discussed:

a) a shell; and

b) internal components.

The shell of the object may be modelled and then exported for use by a designer user. The shell may built to allow for algorithmic subdivision, in order to provide a lower level of detail to facilitate lower bandwidth transmission to a consumer's user device and to enable lower-powered devices to render the shape, and to facilitate higher levels of detail in a final solid shape suitable for 3D printing. In one embodiment, a Catmull-Clark subdivision algorithm is used and 4-sided polygons are used where possible to accommodate that algorithm.

The internal components may be modelled by a designer user to be used within the shell in a physical version of the object. These do not need to be displayed to the consumer user as part of the shell, so can be created with a high polygon count.

In step 202, modifications to the control points of the source model are received. The modifications may be received from the user device of a consumer user. A graphical user interface (such as shown in FIG. 3) may display the exterior shell of the object to the consumer user. The consumer user may also be provided with input controls within the graphical user interface. The input controls may provide the ability for the consumer user to adjust features of the object. Adjustments to the features may be converted into modifications to the control points of the object.

In step 203, the modifications are applied to the source model to generate a modified model.

The shell of the source model may comprise an exterior and interior mesh.

The interior mesh is adjusted to match the exterior mesh by applying the same set of modifications or "morph data" to the internal mesh as are applied to the exterior mesh. The internal mesh may interpret these modifications differently (e.g. the morph data may affect different areas of the mesh, or have no effect if required). The designer user may configure the application of the modifications to the exterior and interior meshes.

After the modifications have been applied, the exterior mesh is combined with the interior mesh to form a solid by perform a boolean operation, such as intersection, on the meshes.

In step **204**, the modified model is subdivided to generate a processed model. For example, the polygon count of the solid may be programmatically increased during subdivision using, for example, subdivision of the polygons (such as opensubdiv).

The solid may then be combined with the internal components by performing a boolean operation, such as union, on the solid and internal component meshes. In some embodiments, specific Boolean operations may be defined for each internal component.

In one embodiment, the positioning of the internal components may be modified by the modifications to the control points of the source model. In this embodiment, constraint information may be included for the internal components within the source model.

For example, constraint data attached to specific external features, and constraint data defined on the model as a whole, may be used to programmatically place and modify the internal components. It may use metadata attached to features and the model, and custom code to parse and interpret that metadata, using it to define and apply a set of move and morph operations to be applied to the internal components(s) (so that, for example, the resulting solid model skin were of the right thickness, and internal components were of the right size and shape).

A STL (StereoLithography) check operation may be attached to the solid mesh before saving. This check allows the software to verify that the solid has a complete and closed surface, which will be required if the solid is going to be sent to an additive manufacturing machine. The check operation can be executed automatically or manually.

In step **205**, the processed model is further processed using a layer renderer to generate print instructions for the 3D object. The layer renderer may chain together the component parts of the processed model to facilitate efficient manufacturing.

In step **206**, a 3D printer may be controlled using the print instructions to create the physical 3D object.

In one embodiment, after the processed model has been generated, it may be displayed next to the source model to a user to enable the user to make a quality control assessment.

In one embodiment, the processed model may be verified to ensure that a resulting solid has a complete and closed surface for physical printing.

FIG. **3** shows a user interface **300** configured to receive input from a user to adjust features **301** to **307** of a 3D model **308**. In one embodiment, once the user selects a particular feature **302**, several predefined options **309**, **310**, or **311** for the feature are available for the user to select. In an alternative embodiment, only a single predefined option is provide.

The predefined options **309** to **311** may correlate to predefined modifications to a subset of the control points. In one embodiment, the subset of the control points is the same for each option. In one embodiment, the subsets of the control points for each feature comprise at least one common control point across at least some subsets.

One or more adjustment means **312** to **314** may be provided to receive input from the user to the selected option **310**. The adjustment means may be a virtual scroll-bar, a virtual wheel, a physical slider or switch, or another abstract input device configured to receive input from a user within a defined range.

The adjustment means may, alternatively, comprise the receipt of user input via a pointer device or touch-screen directly to a representation of the 3D model.

In the user interface shown, the adjustments are converted into modifications to control points.

The user interface may comprise a representation of the 3D model. The representation may reflect modifications to the 3D model made in response to the user input.

FIG. **4** shows a 3D model **400** that may be modified in accordance with the present invention.

FIG. **5** shows a 3D model **500** that corresponds to 3D model **400** to which modifications have been automatically applied and then which has been subdivided.

FIG. **6** shows a 3D model **600** that corresponds to 3D model **500** which has been combined with the internal components portion **601**.

FIG. **7** shows a graphical display **700** of both a representation **701** of a low resolution, modified 3D model and a representation **702** of a subdivided, and therefore, high resolution modified 3D model. This graphical display **700** may be generated and displayed to a second user for quality control purposes before the physical model is printed.

FIG. **8** shows a layer renderer output **800** which combines multiple customised 3D models **801** to **805** laid out together into a print layout suitable for 3D printing.

The print instructions may be generated from the print layout.

FIG. **9** shows a 3D representation of the layer renderer output **800**.

It will be appreciated that the method of the invention may be implemented within hardware or may be defined within software.

A potential advantage of some embodiments of the present invention is that unskilled users can create unique 3D objects. A further potential advantage is that because the process is deterministic, the same 3D object can be printed from the same source model using the same modifications. A further potential advantage is that because 3D printers have physical limitations, the source model, defined control points, and processing methodology restrict the generation of user-modified 3D models to physically possible models suitable for physical printing.

While the present invention has been illustrated by the description of the embodiments thereof, and while the embodiments have been described in considerable detail, it is not the intention of the applicant to restrict or in any way limit the scope of the appended claims to such detail. Additional advantages and modifications will readily appear to those skilled in the art. Therefore, the invention in its broader aspects is not limited to the specific details, representative apparatus and method, and illustrative examples shown and described. Accordingly, departures may be made from such details without departure from the spirit or scope of applicant's general inventive concept.

The invention claimed is:

**1**. A computer-implemented method of manufacturing 3D objects, including:

a) processing circuitry at a server retrieving, from a database, a source model comprising a shell portion and an internal components portion for a 3D object and a plurality of defined control points relating to aspects of the shell portion for the 3D object, wherein the shell portion comprises a low resolution exterior surface mesh including a series of interconnected polygons with the control points relating to vertices of the exterior surface mesh and the internal components portion comprises at least one high resolution mesh having a higher polygon count than the low resolution exterior surface mesh;

b) transmitting the low resolution exterior surface mesh of the shell portion and the control points relating to aspects of the shell portion from the server to a user device;

c) displaying a representation model of the received low resolution exterior surface mesh on a display associated with the user device;

d) receiving, via a graphical user interface provided on the user device, user specified modifications to at least some of the control points, wherein the user specified modifications are correlated to one or more selected predefined options;

e) transmitting the modifications from the user device to the server;

f) processing circuitry at the server receiving the modifications from the user device;

g) processing circuitry at the server applying the received modifications to the source model to create a modified model;

h) processing circuitry at the server subdividing a surface of the modified model to create a high resolution model;

i) processing circuitry at the server modifying the high resolution model by combining it with the internal components portion of the source model, wherein modifying the high resolution model by combining with the internal components portion of the source model includes modifying positioning of the internal components portion in accordance with the received modifications to the control points and based on internal components portion constraint data included in the source model using metadata attached to specific features of the source model; and

j) processing circuitry at the server generating print instructions based on the modified high resolution model for manufacture of a customised version of the 3D object.

**2**. A method as claimed in claim **1**, wherein the print instructions are generated via a layer renderer.

**3**. A method as claimed in claim **1**, further including:

automatically controlling a 3D printer using the print instructions.

**4**. A method as claimed in claim **1**, wherein the shell portion comprises the low resolution exterior surface mesh and an interior surface mesh.

**5**. A method as claimed in claim **4** wherein the modifications are applied to each of the low resolution exterior mesh and the interior surface mesh.

**6**. A method as claimed in claim **5** wherein the low resolution exterior mesh and the interior surface mesh are combined after the modifications are applied.

**7**. A method as claimed in claim **1** further including:

generating a stereo-lithography check on the modified high resolution model to ensure that the modified high resolution model has a completed and closed surface.

**8**. A method as claimed in claim **1** further including:

displaying on another display the modified high resolution model and the source model.

**9**. A method as claimed in claim **1** wherein the modifications are delimited by constraints.

**10**. A method as claimed in claim **1** wherein

the model including the received low resolution exterior surface mesh is displayed with a low resolution representation in the graphical user interface provided on the user device.

**11**. A method as claimed in claim **1**, wherein the modifications to the at least some of the control points customize a set of physical features of the source model.

**12**. A 3D object manufactured by the method as claimed in claim **1**.

**13**. The method as claimed in claim **1**, wherein the exterior surface mesh is displayed on the display associated with the user device with a low resolution and without the internal components portion of the source model.

**14**. A system for manufacturing 3D objects, including:

processing circuitry of a server configured to:

retrieve, from a database, a source model comprising a shell portion and an internal components portion for a 3D object and a plurality of defined control points relating to aspects of the shell portion for the 3D object, wherein the shell portion comprises a low resolution exterior surface mesh including a series of interconnected polygons with the control points relating to vertices of the exterior surface mesh and the internal components portion comprises at least one high resolution mesh having a higher polygon count than the low resolution exterior surface mesh;

transmit, to a user device, the low resolution exterior surface mesh of the shell portion and the control points relating to aspects of the shell portion;

receive, from the user device, user specified modifications to at least some of the control points relating to aspects of the shell portion for the source model, wherein the user specified modifications are correlated to one or more selected predefined options;

apply the received modifications to the source model to generate a modified model;

subdivide, a surface of the modified model to create a high resolution model;

modify the high resolution model by combining it with the internal components portion of the source model, wherein modifying the high resolution model by combining with the internal components portion of the source model includes modifying positioning of the internal components portion in accordance with the received modifications to the control points and based on internal components portion constraint data included in the source model using metadata attached to specific features of the source model to define and apply a set of move and morph operations applied to the internal components portion to obtain a desired shape and size for the internal components portion; and

render print instructions from the modified high resolution model; and

a control unit configured for controlling a 3D printer to create a 3D object from the print instructions.

**15**. A system as claimed in claim **14**, wherein the processing circuitry is further configured for subdividing the modified model to generate a processed model which is used to render the print instructions.

**16**. A system as claimed in claim **14**, wherein the processing circuitry is further configured to render the print instructions by using a layer renderer.

**17**. A system as claimed in claim **14**, wherein

the database is configured for storing a plurality of source models and associated control points, each of the source models comprising a shell portion and an internal components portion.

**18**. A system as claimed in claim **14** further including:

a communications circuitry;

wherein the processing circuitry is further configured to transmit a representation of the source model and the control points to the user device via the communications circuitry.

**19**. The system as claimed in claim **14**, wherein applying the received modifications to the source model to generate the modified model includes (1) adjusting the vertices of the polygons in the exterior surface mesh of the shell portion based on the received modifications to the source model, and (2) adjusting an interior surface mesh of the shell portion to match the exterior surface mesh by applying the modifications to the interior surface mesh of the shell portion.

**20**. The system as claimed in claim **19**, wherein the exterior surface mesh of the shell portion is combined with the interior surface mesh of the shell portion to form a solid portion by performing an intersection operation on the interior and exterior surface meshes.

**21**. A non-transitory computer readable storage medium having stored therein instructions, which when executed by processing circuitry of a server cause the server to perform operations comprising:

retrieving, from a database, a source model comprising a shell portion and an internal components portion for a 3D object and a plurality of defined control points relating to aspects of the shell portion for the 3D object, wherein the shell portion comprises a low resolution exterior surface mesh including a series of interconnected polygons with the control points relating to vertices of the exterior surface mesh and the internal components portion comprises at least one high resolution mesh having a higher polygon count than the low resolution exterior surface mesh;

transmitting, to a user device, the low resolution exterior surface mesh of the shell portion and the control points relating to aspects of the shell portion;

receiving, from the user device, user specified modifications to at least some of the control points relating to aspects of the shell portion for the source model, wherein the user specified modifications are correlated to one or more selected predefined options;

applying the received modifications to the source model to generate a modified model;

subdividing a surface of the modified model to create a high resolution model;

modifying the high resolution model by combining it with the internal components portion of the source model, wherein modifying the high resolution model by combining with the internal components portion of the source model includes modifying positioning of the internal components portion in accordance with the received modifications to the control points and based on internal components portion constraint data included in the source model using metadata attached to specific features of the source model to define and apply a set of move and morph operations to be applied to the internal components portion to obtain a desired shape and size for the internal components portion; and

rendering print instructions from the modified high resolution model; and

controlling a 3D printer to create a 3D object from the print instructions.

* * * * *