The Legitimacy of the 3D Printer as both Artistic Tool and Artistic Medium

Assessing the Nature and Aesthetics of 3D Printing Artistic Output and the effect that 3D-printing may have on the borders of the Creative Landscape

by

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Contents

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Abstract

Keywords: Creative Agency; Workmanship; Craftsmanship; Creativity; 3D-Printing; Additive Manufacture; Algorithmic Creativity; David Pye; Digital-craft.

The purpose of this research is to establish the legitimacy of 3D printing as both artistic process and medium, and thereon its effect on the *Creative Landscape of Making and Causing to be made.*

Based on the preliminary project description, *'Exploring emerging practice at the boundaries between craft and design'* this research analysed the nature of emerging creative-practices, primarily associated with 3D printing, and sought to determine the boundaries by mapping the ontology of the creative landscape.

Using *Design Thinking* methods, those Processes, Outputs and Practitioners involved in Art, Craft and Design, were systematically cross-referenced, then assessed from the point of view of both the producer (agent and actor) and the end user (value).

David Pye's thinking, on the nature of Workmanship, forms the foundation of the initial landscape map, which is subsequently analysed through the 'lens' of 3D printing to identify where this technology may cause disruption.

The most significant findings are that:

- Isolating *Workmanship*, within the artistic process, identifies those actions that may be executed without agency and therefore could be carried out by machine (automated and/or computerised) without affecting the creative input.
- Identifying *Creative Agency*, as component of creativity, beyond the capabilities of the machine, validated the premise that 3D printers cannot disrupt processes, within the *Creative Landscape of making and causing be made*, that require Creative Agency

The methodology follows a pragmatic approach - it is grounded contextually but constructed generally in that the findings are transferable, and the reasoning mainly abductive.

This research attests the validity of 3D-printing as both artistic tool and artistic medium; it proposes that a definition of *Craftsmanship* should be: an attribute of an action where *Workmanship* and *Creative Agency* have been applied in combination;

and posits the hypothesis that: **there exists, a cross-disciplinary *Association* of artistic output, processes and practitioners, whose relationship is understood through the lens of 3D Printing.**

Abbreviations

3DP – 3D Printer

ABS - Acrylonitrile butadiene styrene

CLM - Creative Landscape Matrix

DLP - Digital Light Processing

DMT - Digital manufacturing technology

SLA – Stereo Lithography

SLS – Selective Laser Sintering

p.o.v. – Point of view

Note on access to contents

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Chapter One
Introduction

Overview

The initial, broad, research topic was: The effect of new manufacturing technologies on the boundaries between Craft and Design;

Focusing initially on 3D Printing Artistic Output, it was not readily apparent what defines the actual nature of this output and this gap led to the first part of the research body of this thesis: *The investigation into the nature and aesthetic of 3D printed artistic output.*

Several UK based research institutes and Universities have been/are exploring the potential of 3D printing: most notably, from an industrial/commercial point of view, The University of Nottingham, who run the 'Additive Manufacturing and 3D printing International Conference; from an Art/Craft point of view, the Centre for Fine Print Research, at the University of the West of England, Bristol and the 'autonamatic' research group at Falmouth University, all running relevant conferences and/or symposia. Additionally, international conventions on 3D printing are being held regularly, such as the 3D Printshow which bills itself as *"a business conference, educational symposium, an arts and fashion gallery and a networking meetup"*[1]

Following visits to two such events: *All Makers Now*, in Falmouth (July 2014) and the 3D Printshow, London (September 2014), the following questions were raised/remained unanswered:

- Is the 3D printer a *legitimate* artistic tool?
- Is the 3D printer *just* a tool (a manipulator of matter or a transferrer of energy)?
- Is there a 3D printed aesthetic?
- Does using a 3D printer create '3D printed art' or just 'art' that happens to be 3D printed?

At this time, serval books of note were published: *Digital Crafts*, Ann Marie Shilto (2013), *Printing Things*, Warnier et al (2014) and in particular, *3D Printing for artists, designers and makers*, Stephen Hoskins (2013). Other 'digital crafts' anthologies have emerged, cataloguing the myriad new practitioners, such as *Digital Handmade* (Johnston, 2015) and *Postdigital Artisans* (Openshaw, 2015), more visual than academic their scope is much broader then 3D printed artistic output.

[1] Acquired by the Tarsus group in 2014 and operating now as 'The Additive Manufacture shows'

Hoskins' book supports the conclusion that that there is *both* Art that happens to be 3D printed, ie: the 3D printer is used solely as tool, due to its relative advantage over other tools and processes (see page 121 - 'is the printer a legitimate artistic tool?') and; there is also Art that relies on its '3D-printedness' to be understood as artistic output. This thesis will demonstrate examples of both and go further to prove that '3D-printedness' is an independent aesthetic that need not require the 3D printing 'machine', it may have acquired its 3D printed aesthetic manually, or – (by applying a constructivist[2] approach to Art Appreciation) - may have had its 3D-printedness inferred.

This conclusion lead to the proposition that: **there exists, a cross-disciplinary *Association* of artistic output, processes and practitioners, whose relationship is understood through the lens of 3D Printing**. The umbrella term of "3D Printing Associated Artistic Output" is a suggested name.

The second part of the research looks at how this body of artistic output, along with its processes and practitioners, impacts on the existing Creative Landscape of *making* and *causing to be made*. This landscape is mapped, using a matrix, to analyse Art, Craft and Design, against practice, process and output - from the point of view of the Actors and Agents who 'produce', and the values of those who 'use'. The focus on 'making' restricts the landscape to those areas that can potentially be disrupted by new manufacturing technologies. Music, literature and other obviously creative practices are extraneous to this 'map,[3] however, analogies are occasionally drawn.

Previous research by John Marshall (2008) explored parallel themes to this research in that it examined artistic output from contemporaneous makers, who were applying 'new' digital making-tools to their existing practices, with the intent to identify, "what the significant characteristics of these objects might be". He also

[2] that the viewer 'constructs' their own meaning based on what the know and what they observe/sense. (see page 27)

[3] The often-truncated nature of the 'design' set, in the subsequent Venn diagrams, is indicative of expanse of creative practices beyond the creative 'making' practices discussed in this thesis. All the Venn diagrams herein are representative of the thesis point of view, they are not mathematically proportional to any specific data – *they are models not pie-charts*

aimed to develop a system of analysis from which to "derive evaluative criteria for these objects".

There was much, in the research, on the idea of transdisciplinary 'hybrid' output being driven by the technology, although it seemed to focus mainly on Art and Design, allowing definitions of the two fields to focus on function and purpose, but largely neglected the physical process of making (which as this[4] thesis will emphasise, is the true calling of the 3D Printer) searching for a new model of 3D Art and Design practice – but largely neglecting Craft as, practice, output or process. (which this[5] thesis does for, not only craft, but art, design and the existing 'hybrid' fields (called cross-over fields). (It is worth noting that the apparent exclusion of 'makers' was remarked up by one of the participants in the associated exhibition that Marshall curated as part of his research (Marshall. p.212) He also identifies by name new hybrid fields, whereas this thesis operates on the premise that the names are rarely analogous to the ontology therefore not necessary in recognising that a field, area, genre, process etc. exists.

However, Marshall's research took place before the seismic shift in awareness of 3D print technology, that came about as IP and copyright restrictions began to run-out and the technology was becoming available to artists beyond the academic field. This is most notable in the language: RP (rapid prototyping) is the term used to describe what this thesis refers to as 3D printing, but neither RP nor 'Additive Manufacturing' (a term still frequently used interchangeably with 3D-printing) are included as keywords (those that were used were: Art, Design, Digital, Hybrid, Technology, Transdisciplinary), this[6] research is set in the wake of this 'awareness'.

Putative understanding of these fields (art, craft, design and 'cross-over') is examined, as well as theoretic and academic definitions; however, the fluidity of the language within the creative landscape means that the nomenclature is not often analogous to the ontology. The Craft 'field' is the most flexible: practitioner titles are self-designated and output categorisation is arbitrary.

[4] The Legitimacy of the 3D Printer… etc, not Marshall's thesis
[5] ibid
[6] ibid

A re-reading of David Pye's definition of craftsmanship as "the workmanship of risk" (1968) but with an understanding that the meaning of 'risk' equates to 'responsibility', presented a very clear distinction between the roles of actors and agents.

Reviewing the Creative Landscape, using the 'Lens of 3D printing', the conclusion was drawn that 'artistically', the impact of new manufacturing technology could only be positive; apart from the possible negative disruption to those practices of artisans or technicians, where the processes are solely demonstrations of workmanship, and therefore involve no creative agency.

- Workmanship does not involve any creative agency
- 3D printers can only provide workmanship hence do not have creative agency

Therefore:

- 3D printers cannot threaten any practice that requires Creative Agency, however, those existing practices and processes that provide only workmanship, can be disrupted by this technology.
- Although 3D printing has the potential to disrupt the output activities of workmanship, this disruption will only diffuse as relative advantages are gained, in keeping with Rogers' diffusion theory (2003). This disruption will affect providers of workmanship across all areas of manufacture, not just artistic, but at differing rates.

These premises will be repeated throughout this thesis.

Assumptions/Definitions

The following thesis is not linear, chapters 3 and 4 can be read in any order, the following assumptions and definitions can be read before chapters 3 and 4, after, or during (when they are referred back to). Some explanations may seem convoluted or abstract, but they serve to remove ambiguity at other locations in the thesis and keeping them together here (though seemingly disparate) makes them easier to locate and re-read when necessary.

As the methodology will further elaborate, the research paradigm of this thesis is pragmatic. Certain assumptions are made, and definitions presented to establish this point of view. They are detailed here as a statement of intent with regard to this document and to reinforce it. Certain definitions will not concur with every existing theory, but with the exception of *workmanship* and *craftsmanship*, the definitions and assumptions present here are auxiliary and not postulates of new theory. Many of the words will have additional meanings, but only those of relevance to this document are detailed.

The Creative Landscape and the Artistic Domain

While the sets of Art and Craft (in the Venn Diagram below fig 1.1) are positioned in a putative relationship[7], the 'design' set is really on a different taxonomical level to the other two. This diagram shows how most art and probably all craft fall within it. While design, is undoubtedly a more disciplined field of study than either art or craft, largely because of the myriad specialised and *regulated* sub-divisions, (Ulrich lists 38, as a sample, 2017) the term *design* encompasses virtually all *planned* behaviour, carried out with forethought (however brief that forethought might be).

[7] The Venn diagram shows the 'commonly held' assumption of the relationship between craft and art.

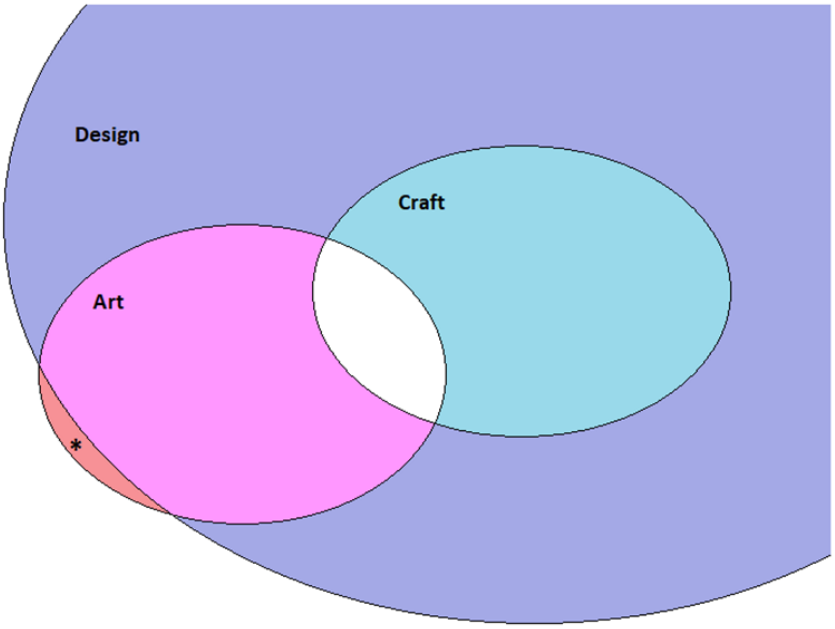


Fig 1.1: Artistic Domain, Venn Diagram

It would be difficult to dispute that all craft (output, process and practice) is intentional, however there are certain seemingly accidental or unintentional practices, processes and practitioners that may, according to certain theories, have art status conferred upon them. It could be contested that only when 'unintentional art' is identified as art is that art 'actually' created and that because this identification is intentional, it cannot exist beyond the 'design set'. Also, experimental work, where the outcome cannot be known in advance could still be considered 'designed' as the intention to create art was always there.

The position of this thesis is that when considering the broadest sense of art, craft and design, all art and craft output is the result of intended/deliberate action (even the action of conferring art status) and therefore falls within the set of design (Some could say that this conferring is the only intended action that matters: Institutional theory[8] would suggest that an artefact cannot be art until art status is conferred - by the 'art world' - therefore the intention of any art making processes, proceeding this conferring, is neither here nor there); and while this is the position of this thesis, it

[8] Institutional theory- see page 26 also see Danto (1964) and Dickie (1971)

does not seek to refute any argument that claims that some artworks may exist beyond this.*(on Venn diagram fig 1.1)

It will become evident, throughout this thesis, that many terms within the creative landscape of *art, craft* and *design* are insufficient, overused and/or inappropriate, the subsequent mapping of this creative landscape (Chapter 4) will attempt to strip away the nomenclature to identify 'what' the subject matter **is** rather than what it is called.

The intention is to use words that have universally accepted meanings, within and beyond these fields.

What fig 1.1 also demonstrates is the breadth of the *design field* beyond the 'artistic domain'. Further Venn diagrams are used to visualise the Creative Landscape with, regard to *practitioner*, *output* and *process,* in Chapter Three. In each, the 'entire' design field is represented; however, it should be noted that the greater focus of this thesis will be on the design of *artefacts* especially those closely associated with Art and Craft – this does not place restrictions on the field, but rather recognises that in additions to myriad 'design sectors'. There also exists many sectors which contain design subsectors, eg: pharmaceuticals, nano-technology, systems analysis, banking etc. Design is everywhere and not every incidence is relevant to this research.

Output

Output is the end-product of a process, whether deliberate or unintended, artificial or natural. It is any 'entity' that is attributable to a source, and can be communicated between other entities, via any medium. For it to be communicable it must be 'sense-able' ie: capable of being sensed (regardless of the capabilities of the 'sensor')

*It **must** have some tangibility or palpability* (a **Superficial Aesthetic**) - it can be touched, heard, seen, smelt, or tasted. Even the most conceptual abstract ideas can be considered output Lippard (1973) suggested that art could be 'dematerialized' down to concept only (which suggests no superficial aesthetic). But to be considered output it must be communicated via some medium - the act of simply 'saying' the idea is using the medium of sound - it can be sensed by hearing.

eg; Karin Sander's' 2005 work, "Zeigen. Eine Audiotour von Karin Sander" (Show - an audio tour by Karin Sander) Instead of the exhibits, only the names of the invited

artists were attached to the walls; the corresponding audio guide allows visitors to listen to short texts by the respective artists for their own works and *"By renouncing the physical presence of artefacts, the artworks are created in the imagination"* (Müller, 2014)

It is therefore impossible to have purely conceptual artistic output because purely conceptual 'out-put' implies no Superficial Aesthetic. Sanders' case demonstrates that the output and the concept are not the same thing - the 'output' is the audio guide, the medium is sound, the concept is what the artist 'hopes' the output can conjure up in the 'sensor's (listener) mind - in keeping with Beardsley and Wimsatt's position on 'The intentional Fallacy' (1954) and this thesis's view of the importance of the superficial aesthetic in the 'construction' of artistic meaning.

Therefore, output must be communicable, or it cannot be described as output; to be communicable it must be capable of being sensed.

All sensors (esp human) work on a superficial interface. To communicate an idea into a human's brain the information must enter via the senses - even subliminal concepts, and senses, communicate/transfer initially on a superficial level (premonitions, visitations, the heebie-jeebies and "I have a really bad feeling about this" - are not credible and do not count).

In addition, these sensory interfaces are analogue and as Cramer elaborates (Cramer, 2015) human beings can (currently) only 'sense' digital via an analogue interface (eg. a television signal may be delivered digitally but it must still be converted into analogue images and sound to be sensed by human eyes and ears.)

Therefore, a truly conceptual Art Piece would be a paradox, as to remain purely conceptual would mean it is non-communicable and cannot therefore be considered output - artistic or otherwise.

Artistic Output

From the p.o.v. of this thesis, *Artistic Output* is that *output* (as defined above) which is appreciated, (i.e. understood, analysed, considered and valued) mainly (but not necessarily exclusively) for what it *is* rather than what it *does.* Whether the output's 'artistic' attributes are intrinsic, or laterally conferred, and whether it applies

to the output's purpose, function, or both, is addressed on a 'case-by-case' basis in Chapter Four 'Creative Landscape of Making and Causing to be Made'

What it *is* versus what *it does* will be discussed in detail in *Function and purpose* (below), however is should be noted that, because it is a relative term, not all output within the 'Creative Landscape of Making and Causing to be Made' (Chapter 4) will be considered 'Artistic Output', (similarly, not all 'design' with the Creative Landscape can be considered part of the Artistic Domain (see fig 1.1).

Artistic versus Art.

> *"Art is perceived to be an object without significant functional purposes, created mainly to be admired"* (Costache 2012)

Standard methods of Art appreciation take/use all, or some, available information (be it fact, belief or other opinions based on how it is sensed or how it is understood) to determine whether or not a piece of artistic output is worthy of having the status of Art bestowed upon it, by applying the rules and regulations of one art theory or another. Indeed Weitz (1965) would suggest it is both impossible and unnecessary to even try to apply such arbitrary and conflicting theories.

Likewise, this thesis does not need to analyse what an artefact is other than what it is primarily appreciated as. Namely, if its purpose and function are primarily artistic - it can be considered 'Artistic Output'

Certainly, what it <u>is</u> can be established by describing it in terms of how it is sensed and how it is understood. However, it is not necessary to bestow art status or judge the quality or value of the artefact. (That is where institutional theory disappears into economics, market trends, capitalism and fashion.) (Grayson Perry, Reith lectures 2014)

Therefore, in this thesis, any output fulfilling the definition of 'Artistic Output' will generally be described as such, however on the occasion when the term 'Art' is used, is it done so because the 'Art' in question as met the requirements of the, herein contained, definition of 'artistic output' and not because of any other artistic theory that it may or may not adhere to.

Function and purpose (Teleology and the shoe hammer)

An Artefact's *purpose* is, generally, its intended function; it is subjective and intrinsic to how it is understood.

An artefact's *function* is its actual use and can be both objective and subjective.

Teleology is essentially the study of what an 'thing' (object, artefact etc) **is for**. In this respect, many academic sources, and educational resources, equate *purpose* with *function*, eg.: 'What is it *supposed* to be for?' and 'what is it *actually* used for?', are clearly two different questions when asked together; but if asked independently, they are hard to differentiate as both questions ask: 'What is it for?

Nomenclature problems are a recurring theme in this thesis, in this instance, the issue could be due the poor application of the subjunctive in the English language and the ubiquity of the verb 'to be'. (see below for a comparison with Spanish which has two different words for 'to be')

Were the use of the subjunctive-tense more common in English, the difference between the two would be easily understood and their incorrect conflation, avoided, i.e.: how an artefact is *intended* (ought, should, would, could) to be used, (its purpose), or how it is *actually* used (its function). Additionally, understanding function as a *verb* rather than a *noun* is helpful, i.e.: 'How does this function?' makes perfect sense, whereas, 'how does this *purpose*?' does not.

However, as the subsequent ontological and teleological 'deconstruction' of the Creative Landscape (chapter 4) is analysed using both *producer intent* and *user values*, it is important to establish the difference (between function and purpose). Also, in chapter 3 the difference between *maker* and *designer* are fundamental to understanding 'Creative Agency'. Bass (1968), recognised how the commonly understood definitions of both terms could lead to overlaps, especially when an object is used for its intended purpose (which is probably most of the time); but where a designer cannot be identified, usually in the case of natural structures, he cites anthropomorphism as a cause of this misunderstanding. Eg: A tree 'offering' shelter, suggests that the tree has the *intention* to offer shelter, or indeed that some higher power intended for the tree's purpose to be provision of shelter. Bass sees, as problematic, the idea that non-sentient objects and organisms can be considered as

motivated into purposeful action, based on outcomes that appear deliberate. A tree, responding to chemical and environmental stimuli, grows accordingly; the subsequent provision of shelter is a happy coincidence, due neither to a conscious decision of the tree, nor any other 'grand design'.

Bass's disapproval of teleology is made clear: assigning purpose to objects, that have none, (i.e.: they execute their natural action without prior intent) results in frivolous, unnecessary and superstitious anthropomorphism; a valid criticism when considering 'non-artefacts', however, in this thesis, teleology is important in establishing the primary drivers of creativity and the self-motivation necessary in Creative Agency (Chapter 4).

If all output were to be split into two categories: purely functional and completely non-functional, the majority of artefacts would be ignored. Purely functional does not really exist, according to Pye (1978) there are infinite ways the purely functional can be adapted (or designed) to make it 'more' than purely functional - smoother, sharper, rougher, heavier, stronger, lighter, more beautiful etc.

Function is often described as 'the intended purpose' of an artefact (Roy, 2013) but Risattii (2007) presents the example of 'using a cup to hammer-in a tack' as a clear dispeller of this over-simplification. He asks, *"does the cup also lose its identity and temporarily become a hammer?"*

What if it were a shoe being used as a hammer? The distinction is clear, the purpose of the artefact is 'being footwear', i.e: a garment; the function is 'being a hammer', implying that the purpose is *intrinsic*, and that the function refers to its current *state.*

Although misinterpretation - back-and-forth - between languages may be, historically, the cause of certain current nomenclature failures, (see Historical Nomenclature essay Chapter 2) conflation of word meaning is not uncommon in English. For example, using Spanish words, the statements: 'el zapato **es** una prenda' - means: 'the shoe **is** (intrinsically) a garment' and 'el zapato **está** un martillo' - means: 'the shoe **is** (currently) a hammer' - because Spanish has two words for *is*: **es** and **está** (from the verbs **ser** and **estar** - both meaning: *to be*,) the distinction is clear.

Whereas if these statements are translated into English they will be: 'the shoe **is** a garment' and 'the shoe **is** a hammer', both true however don't explain the difference

in the *intrinsic purpose* (its 'shoe-ness') and the *current function* (being used as a hammer).

This understanding of the difference between purpose and function, suggests that the *purpose* of an artefact is its '*intended function*', which sets up a circular definition of Roy's description, of *function* being the *intended purpose* - which cannot be correct as the words do not have the same meaning and are therefore not interchangeable.

There are, of course, exceptions: to describe the purpose as the 'Intended' function may fail to account for the shoe that was always intended (by its designer/maker/purchaser/user) to be used as a hammer.

While this seems to be straying into the realm of 'sea-side novelty' the purpose can be understood best, subjectively. Even though the designer intended the shoe to be a hammer, they would have been fully aware that the form it has been given will be understood as a shoe.

Which brings in an additional purpose/intended function: by producing a hammer that looks like a shoe, there was an intention *to amuse, confound or both* and these intentions would supersede the intended 'hammering' function because it is reasonable to assume that a serious hammer-user would prefer a hammer that looks like a hammer, rather than a hammer that looks like a shoe - therefore, for the 'hammer-that-looks-like-a-shoe', 'hammering' was neither the primary purpose nor the primary function.

While this study of *purpose* versus *function* might seem convoluted, Risatti (2007) discusses function and purpose at much length and includes *use* as a third object application, developing a *taxonomy of craft* (p27) based on application. For this research, the purpose or function of any output, be that design, artefact or other, is important because it closely linked to Creative Agency and control over output.

Workmanship

Despite the intention to use putative meanings, one word that will be used throughout, and may possibly be misinterpreted, is *Workmanship*, therefore the following, very specific, definition is provided. When the term *workmanship* is used, this is the intended meaning, unless there is explicit information to the contrary:

The demonstration/evidence of skilled material-manipulation and output-production, eg dexterity, complexity, attention to detail, accuracy of translation etc., in the execution of an independent and pre-determined design.

It may be subject to scalar evaluation based on the accuracy of the design's translation. The design itself, has no bearing on the quality of the workmanship, ie: a poor design executed exactly, demonstrates better workmanship than an excellent design, wrongly interpreted.

Note the 'wrong' interpretation may be *unintentional*, i.e.: poor workmanship, due to lack of skill; or *deliberate, i.e.*: possibly poor workmanship due to lack of discipline or possibly to the creation of a different design to that which was pre-determined (pre-determined-design is a tautological expression, but 'design' is one of those terms, mentioned above, that does not have a universally understood definition and will be further scrutinised)

In this thesis, the use of the word *workmanship* must not be equated with *craftsmanship*, they are not interchangeable, even though many of the sources, drawn upon for this thesis, will use them interchangeably. Indeed, this document will go on to identify *workmanship* as an element of *craftsmanship* (or at least the activity that this thesis will define as *craftsmanship*)

Aesthetic(s):

'*which "aesthetics" do you mean?*' is a short book by Leonard Koren, written in 2012, to address the author's exasperation at the "ostensible vacuity and confusion" in the use of the terms 'aesthetic' and 'aesthetics'. The following definitions are largely based on Koren's. At various points in the body of this thesis, after a derivation of the word 'aesthetic', there may follow (ref.1, 2,) etc, this is to avoid ambiguity and refers to the numbered definitions given below.

1. (an) aesthetic: (n) A particular style or genre of art, craft or design and the, usually, visual categorisation parameters that identify a piece of art, craft or design as belonging to, or as demonstrating, that particular aesthetic - it could be described as a quality possessed e.g.: The building has a Modernist aesthetic, (which could be understood as, the building possessed a 'modernist' quality)

2. Aesthetics: (n) The superficial appearance of things. An overarching term to describe general outward presentation, e.g. “I dress for comfort, aesthetics don’t concern me” could be interpreted as, “I dress for comfort, my outward appearance doesn’t concern me” (See ***Superficial Aesthetic*** below)

3. Aesthetics: (n) a Western Philosophical discipline; the Philosophy of Art (Koren: 24). ‘Digital Aesthetics’ may therefore be understood as ‘the Philosophy of Digital Art’ and ‘3DPrint Aesthetics’ as the ‘Philosophy of 3DPrint Art’. Various aesthetic theories exist, however most concern themselves with the nature and essence of art, not what it is, why it is or how it is understood, but how it is and how it is perceived by the senses.

4. Aesthetics: The science and philosophy of perception by the senses (chiefly Kantian philosophy) (OED) broadly speaking this is almost the same as 3.(above) but not restricted to art.

5. Aesthetic (adj), Aesthetically: (adv): Relating to sensory perception, how something is perceived by the senses. “Of or relating to perception by the senses; received by the senses”. (OED) An aesthetic reaction, aesthetically pleasing, disturbing, awe-inspiring etc.

6. Aesthetics(s): (n) A synonym for taste, often qualified on a scale from good to bad. E.g. the unappealing room echoed the family’s poor aesthetics. (Koren: 22)

7. (the) aesthetic(s): (n) A measure or synonym of beauty (usu. of art) as sensory perception. (Koren: 40); “Of or relating to the perception, appreciation, or criticism of that which is beautiful.” (OED) E.g. The aesthetics of the painting was particularly moving, could be read as, the beauty of the painting was particularly moving.

8. (the) aesthetic(s): (n) “A cognitive mode in which you are aware of and think about, the sensory and emotive qualities of phenomena and things” (Koren: 46) An extension of meanings 4 & 5 beyond physical sensations, to include the ‘cerebral’ - A sense of trepidation, fear, humour, awe. All the sensations that an *an*aesthetic would diminish.

Superficial Aesthetic

David Pye claims that a sailor rarely ever sees a ship - at best they see a coat of paint. *"We see one thing and one thing only: surface, the frontier of something invisible."* (Pye, 1978. P.80)

Superficial aesthetics are those tangible attributes which may be sensed (by sight, smell, touch, taste and hearing), where no other information or prior knowledge is required, all information is empirical, objective and 'sensed' by the observer.

Historical theory

When the term is used in this thesis it is in adherence to Levison (1990), in that artistic output should be appreciated as Art, for the same reason as art proceeding it has been appreciated as Art.

Institutional theory

When the term is used in this thesis, it is in (loose) adherence to Danto (1964) and Dickie (1971) in that, artistic output is considered Art if it has a point of view, it is engaging and 'the artworld' concurs with any art-status conferred upon it.

Constructivism

Not to be confused with the Constructivism Art movements (Tatlin, Rodchencko, El Lissitzky etc.) Constructivism is a learning theory that equates learning with creating meaning from experience and prior knowledge based, attributed to on ideas first put forward by, Swiss psychologist and epistemologist, Jean Piaget (1896-1980). In the context of this thesis, it mainly describes the meaning that viewers of artistic output, construct for themselves, based on what they already know combined with how they sense/experience/interact with a particular piece of artistic output.

Methodology, Method and Technique

Methodology

This thesis follows a pragmatic research paradigm (Dudovskiy, 2016), in that it recognises the post-positive, constructivist requirement to homogenise positivist and relativist approaches - but applies it less prescriptively. In this instance the nomenclature problems, within creative dialogue, have required a systematic, ontological analysis of the creative landscape. This has provided a grounded framework to construct a relational map of the processes, practice and output of *art, design* and *craft;* and subsequently, the potential for disruption upon this landscape, that 3D printing has, as both a process and a medium.

> *What's in a name? that which we call a rose*
> *By any other name would smell as sweet;*
>
> W. Shakespeare, *Romeo and Juliet*, c.1595

The nature of objects cannot be changed by the *given names* applied to them. Taking a *positivist* point of view, the nomenclature is largely irrelevant. The best ontological analysis would use only words that are not open to interpretation. However, taking a *relativist* approach, the nomenclature is an essential aspect of how objects are understood, and how their place in the world is communicated. For example, if a container of liquid's temperature is 37°C, ontologically speaking that is an unambiguous datum, describing the nature of the liquid in terms of its temperature, and no further relational information is required to interpret or understand this fact. However, if this liquid were a cup of tea - relatively speaking, it could be *called* 'cold', or if it were a glass of beer it could be called 'warm', and if it were a bottle of milk for an infant, its temperature would be understood as 'just right'. In this example, a range of many different words are available to communicate the myriad ways that a container of liquid at 37°C can be interpreted, communicated and understood, based only on how its temperature is relatively described; however, none of those 'relative interpretations' changes the fact that the liquid's temperature is 37°C.

Where the confusion arises, is in the language that is used to communicate this temperature. An answer to the question, “Is this liquid warm?” would be meaningless - unless the respondent and questioner both have the same understanding of the word warm; however, the response: “37°C”, to the question: “What temperature is this liquid?” is universally understood.

The terms *art, craft* and *design* are analogous to ‘warm’ in this context, and arbitrarily nailing them on to various activities and outputs - often by mistranslation - has resulted in continuous misunderstanding, misinterpretation and misperception of creative practice, process and output.

While a post-positivist approach may seem appropriate because it is clear that no object can be understood in isolation; the temperature analogy, however, demonstrates that establishing an ontological understanding of an object provides a factual and unambiguous foundation for any subsequent interpretive analysis.

This pragmatic paradigm is the approach that this thesis follows. A systematic analysis of art, craft and design as practice, process and output, will provide a grounded ‘creative landscape’ on which to construct the research findings - in this case, a syllogistic analysis of the way that 3D printing affects this landscape and its boundaries.

Method

Design thinking

Design thinking is the use of designers’ ‘tools’ to identify and solve problems.

Tim Brown COE of IDEO’s often quoted definition is: *“Design Thinking is a human-centred approach to innovation that draws from the Designer’s toolkit to integrate the needs of people, the possibilities of Technology, and the requirements for business success”,* in IDEO world this is probably true, but this approach is grounded in finding opportunities to lucratively exploit. Design thinking is much broader than this. Design thinking uses divergent approaches to explore problem fields and systematically tests solution spaces, deconstructs the manifestations of problems to differentiate the symptoms from the causes; it uses convergent

approaches to test compare and evaluate potential solutions, it makes changes and repeats the process with each iteration adapting and altering parameters. Browns' approach is the pathway to identify needs the customer did not know they had; however, in this thesis the design 'tool' of choice is *elemental deconstruction* – where process and practice can be traced back to core elements, fundamental insights can be gained and then applied to the original 'problem field'.

Deconstruction of the processes, practices and outputs of the *Creative Landscape of Making and Causing to Made* has led to hypotheses on the nature of workmanship in relation to Creative Agency and on the subcategorization of Creativity – both of which can be applied beyond the scope of this thesis.

Additionally, while the elemental deconstruction process was intended to set up syllogistic analysis is has also allowed for a dialectic approach.

Technique

Chapter Three

Observation

To identify the superficial aesthetic of 3D printed artistic output, more than 14 pioneering and/or current practitioners were evaluated based on: relevant output; their pathways to this practice; their use of the 3D printer; the relevance of the 3D printer in their output; and the superficial aesthetic of their output. This allowed the practitioners to be divided into three groups based on three overriding superficial aesthetics of 3D printed artistic output:

The Impossible Aesthetic: those pieces that look as though they could not be manufactured any other way.

The Coded Aesthetic: those pieces where the 3D printer operates in the service of computer generated work.

The Extruded aesthetic: where the extrusion lines remain visible - deliberately.

Experimentation

To identify which (if any or all) superficial aesthetics exist independently of 3D printer, several material experiments were undertaken using various materials including clay slip, tubing, wax and insulated wire.

Chapter Four

Human Participants

Early research proposals included questionnaire-based evidence gathering from various user groups, however the emerging information could only be classified, based on self-declared understanding of the fields in question. The subsequent introduction of 'set-up' information (to establish bench-marks) effectively added bias to responses. Attempting to establish the gap between what participants *believe* they know and what they *actually* know, based on what they *claim* to know, could not be undertaken with any academic rigor that was cost- or time-effective in the scope of this research. Instead, one group of people (attendees at the National Crafts and Design Fair, RDS, Dublin, from 7pm - 9pm on Thursday 1st December, 2015) were asked four questions:

The generalised category was chosen because: the fact that the participants were at the venue, at that time, meant that they were engaged to some extent, with Irish Crafts. The goal was to establish a putative understanding of the perception of 'Craft', necessary because general 'dictionary' definitions of Art and Design are readily available, they also have specific parameters in terms of field of study; but, a broad general agreement of Craft does not exist (and this thesis later goes on to suggest reasons for this), therefore getting a sense of the expectations of Craft, from the 'engaged public' via this method of enquiry was the most appropriate. The first question: *"What are you expecting from the Crafts on sale here*?" addressed this issue directly, however three other questions about their perceptions were asked, namely:

2. How do you think people generally define *art*?
3. How do you think people in general define *design*?
4. Do you think that people listen to experts about Art, Craft and/or Design?

The questions were phrased specifically to ask participants their expectations and perceptions, rather than what they know. In market research, under questioning, people tend to give unreliable accounts of themselves - the tendency is to respond with what they believe is expected,[9] however if respondents are asked about how they feel (hopes, expectations, perceptions etc, including their feeling about other people) they tend to be more reliable. The sample size was 30 people, participants were given a brief explanation of why they were being approached and were offered follow-up information; no-one who appeared to be under 25 was approached. The sample was not completely random as there was a slight bias away from people who appeared stressed, in a hurry or un-forthcoming - these people were not approached. No definitive statistical analysis of this 'market research' is being presented, other than a summarised account given in the putative definition of 'Craft' in Chapter 4 (p.156)

The questions were as follows: (with indicative responses in italics)

1. What are you expecting from the Crafts on sale here? (this question is making the assertion that the goods on offer fall into the category 'crafts')

- *There's two types really, the handicraft craft and the arty craft, but the 'handicraft' stuff doesn't mean 'home made' it's more, traditional looking, made-by-hand but high quality at the same time – made by an expert.* [prompt: "and the arty craft?"] *the stuff you don't use, it's for display really.*

- *Better quality than, local, church hall craft fairs. A lot of these crafts are for sale in shops, so buying here means the maker gets a bigger cut and we* [buyers] *get a better price – so shop quality goods but cutting out the middle-man.*

- *None of that old tat – stuff that looks 'crafty' but imported,* [prompt: "looks crafty?"] *the sort that looks rustic and hand-made, but here, it is made by qualified craftsmen, its genuine, each one is a bit different.*

[9] respondents want to appear better than they are: infosurve.co.uk (n.d), BBC.co.uk (2014)

- Quality products, made by skilled craftspeople, using the right equipment. The work here is very professional, it doesn't look hand-made, it doesn't look like I could make it myself.

Overall the tendency was to distinguish between *applied art* and *traditional craft*, mainly in terms of function, in that the applied art was not expected to have an additional function, whereas the traditional craft did carry this expectation. Both types of output sat happily under the umbrella of 'crafts' because of their commonality, being: quality workmanship (although this term was not frequently used) individuality (or a sense that each artefact was made, one at a time, by a specific craftsman,). There was also an acute awareness of the hand-made, hobbyist output, all respondents were clear that was not really what they would consider 'crafts' but were clear that they believed that 'others' (possibly those who are not as well informed as they) might think 'hobbyist' output is 'craft'. The use of tools was not an issue.

2. How do you think people, in general, define art? (most respondents, added their own definition without being prompted to)

- I think everybody regards paintings, old paintings, in galleries, as art, but maybe some people don't really think modern, or conceptual art is proper art

- I don't know what other people really think, but fine art is supposed to include sculpture and architecture which are more applied art and design, than fine art. Everyone would probably agree that pictures in the national gallery are art, and probably accept modern art as art if they see it in the Tate modern or somewhere.*

- Most people probably think it is just paintings, although lots probably accept stuff like Tracy Emin's bed, actually I think nowadays, many people know that art is more than just paintings, they mightn't like, or think is it any good, or skilful, but they know it makes millions of dollars, so somebody must think it's worth it.

Overall the respondents tended to think that the *general-public*, knew less about art than they did, but those that reflected for longer, began to suppose that the public are probably aware of 'high value' modern art but may not understand it. The overall sense was that the respondents believed that the less well-informed public subscribed to a

traditional theory view point, whereas they themselves appear to subscribe to something closer to an institutional theory.

3. How do you think people in general define design?

- *Well architecture would be design, even though it's supposed to be fine art *(same respondent), but people might just think it is something, maybe special or better, made on purpose, for one person. Custom made perhaps? I suppose that's Design**er** rather than just design. There are lots of Designer/makers here, they make craft according to their own design they don't use other people's patterns. Is design even a thing? It's really just a... verb. I don't know how other people define fine, I'm not even sure how I define it. This is the Crafts and Design fair so...* [respondent ran out of 'thought' here]

I suppose design is what sets good things apart from ordinary things, ...if something does its job very well, or feels good when you use it you might say it is good design, or buildings, or cars – you probably notice bad design more quickly than good design.

They probably just think of a design as a pattern. [prompt: "but what about design compared to Art and Craft?"] *I don't know if art is designed, craft probably, I don't know if people see it like that. Is it not just something you do?*

Respondent had problems predicting what 'design' means to others, probably because they were uncertain themselves. Overall the consensus was that design is a process rather than anything tangible.

4. Do you think that people listen to experts about Art, Craft and/or Design?

- *Yes*

- *Definitely*

- *Yes, they have to, most people wouldn't know what art even is, never mind what it's worth, if the experts didn't tell them* [prompt: "do you listen to experts"?] *Well I'd like to think I know my own mind and I know what I like, but if an expert told me something horrible was very valuable, I would probably dislike it a little less.*

Overwhelmingly the answer was yes, especially for art.

Syllogistic analysis and the expanded problem field.

Chapter 4 *(The Creative Landscape),* uses a divergent approach to set out an expanded problem field matrix, (a systematic 'design thinking' problem identification tool) to map and analyse the *Creative Landscape of Making and Causing to be made*.

Four 'fields of study' will be examined:

Art, Craft, Design, and *cross-over* fields, eg: applied art can be considered an overlap of Art and Craft; each will be defined firstly in putative terms and then from the perspective of this thesis; they will then be cross-referenced against three separate approaches to each field, namely: Output, Process and Practitioner.

For each field, these three approaches will be further subdivided into their constituent parts, from the perspective of the *producer* - as both agent and as actor, and from the perspective of the *user* and the relative values they place on these approaches.

On the basis that all creative output requires making (largely driven by workmanship) and causing to be made (largely driven by creative agency), each location on the 'map' will be evaluated based on the balance of dependency on either or both workmanship and creative agency.

By applying the hypothesis that workmanship is separate from creative agency and that the 3D printer can only provide workmanship; the potential impact 3D printing can have on each location will be directly proportionate to the dependence (or lack thereof) on workmanship

Putative Definitions: It may at first seem counter intuitive to include anything putative in a research document, however, regardless of what 'objects' actually *are* and the exact definitions of the words we use to describe these 'objects' (either rightly or wrongly), it is important to understand what the widely held (or putative) beliefs are, regarding what objects *are* and what they are *called.* Tenacious misunderstandings are often self-fulfilling if they prevail for long enough.

For this research, it is equally important to ontologically analyse 'what' is being described by various terms and how these terms are generally understood, before assessing the effect of an external factor (3D printing) upon them. For Art and for Design this will largely be based on consensual dictionary definitions, for craft, the

‘dictionary’ definition will be augmented with some first-hand inquiry (see *human participation*, above)

Thesis position: In order to identify any effect caused by the addition of any external affect, a benchmark must first be established. For each field under consideration, the position of this thesis will be drawn from a conflation of theories, so suit what this thesis is attempting to demonstrate. Each of these benchmarks will be a datum against which change can be measured and not postulates for new theories.

Output Description: for the purpose of this thesis, **Output** is defined previously as: any ‘entity’ that is attributable to a source, and can be communicated between other entities, via any medium; and that it must have some tangibility or palpability (a Superficial Aesthetic)

Each of the following sections, and sub-sections (where valid) is used to consider each of the four fields.

Definition

- Putative
- Thesis p.o.v.

Practitioner

- Agents
- Actor
- Agent/Actors

Output

- Maker p.o.v.: Medium, Message, Purpose, Function
- User p.o.v.: Collector, Investor, Other Buyer, Commissioner, Student/academic, Critic, Intentional viewer, Incidental viewer and Passer-by

Process

- Causing to be made
- Making

Assessing the effect of applying the ‘Lens’ of 3D printing

On the basis that all creative output requires making (largely driven by workmanship) and causing to be made (largely driven by creative agency), each

location on the ‘map will be evaluated based on the balance of dependency on either or both workmanship and creative agency.

By applying the hypothesis that workmanship is separate from creative agency and that the 3D printer can only provide workmanship, the potential impact 3D printing can have on each location will be directly proportionate to the dependence (or lack thereof) on workmanship

Context

The following chronology relates mainly to the pre-thesis influences and the search for a research ‘gap’. In particular, it highlights background to where and when the notion of identifying a ‘3D printed aesthetic’ originated.

The subsequent sections then address the issue of semantics: suggesting possible historical reasons for the current unhelpful nomenclature conventions, and how current practitioners perpetuate these contradictions - in particular the conflation of *craftsmanship* with *workmanship.*

Background

In the first instance, this investigation was to be a reply to a research invitation, proposed by Ulster University’s Research Institute for Art and Design (RIAD):

> *At the Boundaries between Design and Craft*
>
> *Exploring emerging practice at the boundaries between design and craft: between making and ‘causing’ to be made and the potential of new relationships in and between craftsmanship and digital technologies in manufacturing: manufacturing in service of design rather than design in service of manufacturing*

Prior to the beginning of this research, an entrenchment in what could be easiest understood as the *craft community* in Ireland, or at least Northern Ireland (designing and making both decorative and functional ceramics, art works and commissions, supplying retail, exporting and exhibiting); preceded by ten years in design, as an

architectural technologist and consultant; and a currently lectureship in Design and Innovation, meant that the research proposal was grounded in a *certainty* of where the boundaries of craft, design, and indeed art, lay. However, as the investigation began, it became apparent that, across the 'creative landscape' of *art, craft and design* there was no consensus on either nomenclature or boundaries. Sennet suggests even further delineation, proposing a difference between boundaries and borders, on the basis of their permeability, the latter being the more porous. (Sennet, 2008, p.227)

The breadth of the nomenclature 'problem' initially came into focus at a conference on *'Craft values in 21st Century Production',* run by Falmouth University's 'Autonomatic Research Group', (All Makers Now, 2014); researcher, Matthew Tyas, after delivering a paper on *The Creative and Economic Benefits of Digital Technologies,* as explored through his research collaboration with Leach Pottery, (Tyas, 2014) referred to his output (fig.1.2) as having a 'digital aesthetic', when questioned about the 'deliberateness' of this description - namely was there much reasoning behind this description or was it merely a convenient way to suggest that the output had a 'digital' look or feel and would it be better described as a '3D printed aesthetic' or even a 'sliced' aesthetic? (Because the resultant output looked like the 'sliced' format an .stl file uses to communicate with a 3D printer.) He conceded that an alternative descriptor may have been more appropriate - the subsequent discussion began to address whether or not there is still a need to use the word 'digital' at all, as a manufacturing adjective.

Fig. 1.2 http://www.autonomatic.org.uk/wp-content/uploads/2014/05/Tyas-2-300x300.jpeg

This topic was not isolated. At the concluding plenary session[10] it emerged that a separate session group had also been discussing the appropriateness of using 'digital' as a qualifier.

Furthermore, Geoffrey Mann, Edinburgh University, had a paper presented, outlining the collaboration of the processes he uses to produce his moulded glass pieces "Otherwise Unobtainable" (Mann, 2014)[11], the output of which had a similar superficial aesthetic to Tyas's work. Although the final output was moulded glass, the development of the mould used a laser-cut 'sliced' wooden form (fig.1.3) designed using AutoCAD's 123D Make. stl software to slice up the design, and producing a similar effect to Matthew Tyas's work (fig.1.2). Both Tyas and Mann present interesting opportunities to examine the use of a 3D printed aesthetic output applied to a traditional craft process.

It also became apparent that the importance of output versus process varied considerably when discussing the 3D printer (noun) as a tool as opposed to 3D printing (verb) as a medium.

[10] The plenary session was videoed, but the recording has yet to surface. Is should currently reside in the archives of the 'autonomatic' research group at Falmouth University,

[11] While these pieces were exhibited as Mann's, he later clarified that they were not his work, but rather part of research on which he had been named as co-author.

Fig.1.3 'Otherwise Unobtainable' (supervised by) Geoffrey Mann. Photo C. Scott, 2014

Mann posits *"Pixilation, blob-morphic and faceted"* as appropriate adjectives for the 3D Printed aesthetic. (Mann, 2013) He argues that there is an aesthetic homogeneity in the artistic output from the digital manufacturing process where the *"technology is directing the makers' aesthetic, instead of the other way around."*

This is echoed by Stephen Hoskins, in his publication *'3D printing for artists, designers and makers'*, (2013), he says,

> *"One of the indicators that a technology is gaining credence and creates artwork of standing, is the point at which artists begin to use technology as a means to an end, rather than for the demonstration of what the process itself can achieve"*

Not only does this pull into focus the question of ‘what is the 3D printed aesthetic?’ It also addresses the essence and nature, or Aesthetics, of 3D Printed Art, Craft and Design.

Tobias Klein, speaking at the 3D Printshow, (2014) also voiced his concerns. He questioned the reasoning behind hiding the processes of 3D printing - why would anybody chose to use DMT to produce artistic output if conventional methods are ‘better’? Simply using the technology as a tool is perfectly logical if its performance and output is quicker, cheaper, cleaner, more accurate or intricate, but Klein fails to see the sense in using the technology to either make poor replicas or to produce work that is indistinguishable from work produced conventionally, and then herald it as an exemplary piece of 3D printed art. This identity crisis, of the 3D printed aesthetic, is a core element in the overall research of the thesis subsequent to this document.

Alex Christie, an Australian PhD student, directly addresses the 3D printed aesthetic - but focusing on errors in the making of either intermediary artefacts or final pieces. (Christie, A. 2013) [a], Starting with accidental errors - a major risk with unsupervised FDM/FFF printers (fig 1.4), and

Fig. 1.4. Print errors using Freeform Fabrication (FFF)

subsequently printing shapes beyond a material's self-supporting capability to deliberately distort the outcome - in this instance Christie is attempting to map a 3D geographical representation of Dublin as a function of frequency of 'street mentions' in Joyce's Ulysses. The web page suggests that this 'map' exists currently only in the 'virtual' world. (Christie, A. 2013) [b]

Christie says that his research is (amongst other things) a response to Yuriko Saito's *'Everyday Aesthetics'* and "moral-aesthetic judgments and theories of classification". It would seem that Christie wants to explore the notion of the 'everyday-aesthetic' reaction to 3D-printed printed objects, especially now that 3D-printing is set to enter the domestic realm.

However, the influence of ubiquity, on how 3D printed Artistic Output is perceived, is not the focus of this thesis. In the absence of further published evidence on the aesthetics (superficial or otherwise) of 3D printed artistic output, a literature review exploring the driver of this line of enquiry was undertaken: *What defines the Digital Aesthetic?*

Literature review on question: What defines "The Digital Aesthetic"?

Note: This literature review is included in the 'Context' section as part of the early chronology of the research process, and evidence as to why the term "Digital" is not an appropriate descriptor for the Aesthetic of 3D printed artistic output. As such it has no direct bearing on the subsequent research, however it was pivotal in dictating its direction.

Holtzman, Steven (1997) *Digital Mosaics: The aesthetics of Cyberspace.*

In this book, Steven Holtzman aims to "Develop a new…digital aesthetic that reflects the essence of digital worlds". In 1997, 'cut & paste' were not universally understood processes, however, they signified to Holtzman the growing ubiquity of using existing material to create new work, not only in visual art but also in audio sampling. He suggests that traditional values no longer apply, that authenticity can barely be defined never mind verified.

He makes the point that the digital reproduction does not, unlike analogue reproduction, result in deterioration of the copy (no loss of what Benjamin (1936) called 'Aura') Although he does not directly reference Benjamin, he does entitle a sub-section of the book "Art in the Age of Digital Reproduction" a clear acknowledgment of Benjamin's similarly titled 1936 essay. An essay that identifies 'place' as an essential element in an artwork's unique existence. It follows logically therefore, that if Holtzman is correct to say that digital art is perfectly replicable and it exists in a virtual world - it must therefore be true that, for digital art, the need for 'place' can be negated - therefore allowing it to retain its 'aura' regardless of the number of replications. Although infinite replicability is a significant feature of digital art, Holtzman does not regard it as its 'essence'. Recognition of digital art's ethereal nature is a key identifier of Holtzman's digital aesthetic and the fact that it can exist in worlds without constraints, where scale is entirely arbitrary. Not only is lack of 'place' not a drawback - it is essential.

Discontinuity is another of Holtzman's digital aesthetics essentials. It describes the discrete steps that potentially unique pathways follow and, he believes, that this is the key to interactivity. The digital artist sets the parameters and gives the user, viewer, 'you'…the permission to engage with it in a way that alters the digital pathway - suggesting that this 'non-repeatability' means that each interaction can be individual,

wholly personal and ephemeral. In 1997, interactive digital art will have had ‘ephemeral’ restrictions, in the main due to limited processing capabilities. Now, in 2014, the permanence of digital art is in the control of the artist, infinite ‘undos’ and easy data capture allow for a more extensive and controlled parameters. An irony of this greater processing power means that as the artist’s freedom expands the viewer’s becomes more restricted.

Holtzman’s book is concerned mainly with ‘cyberspace’ and does not really address the digital aesthetic beyond the virtual world(s) however he does believe that the “uniquely digital qualities” will produce an “epiphenomenon”, although he refuses to offer a definitive example of the digital aesthetic, nor nominate a canonical candidate to typify digital art. He does however, maintain that the interaction between “you” and the digital word will be the key to the “depth and beauty” of this medium.

There is a naivety in Holtzman’s book, or perhaps it is excitement at the possibilities opening up before him, which may be due to the time of writing (1997). He sees the minimum quantum of digital matter as the ‘bit’ - it’s either yes or no, on or off, black or white. The first half of the book discusses what digital worlds are; the second tries to grasp how they are (and will be), he concludes with what he considers the essence of digital art - It can all be represented by abstract code - or more precisely: the art (or any digital output) is a representation of the code.

Most subsequent attempts at defining the digital aesthetic largely agree with Holtzman’s predictions, one example is Chris Meigh-Andrews, in his introductory letter for the “Digital Aesthetic3 2012” conference, who says,

> *“It is important to acknowledge that, whilst digital media art has the power to redefine the role and scope of art to create new opportunities and potentials, it has also presented new challenges and difficulties for curators and galleries, as well as for the public and gallery visitor.”*
>
> (Meigh-Andrews, 2012)

He is highlighting the dichotomy of ‘place’ that Holtzman identified as essential - how do you physically place something that only exists virtually? Claudia Giannetti, however considers interactivity as the most important factor.

Giannetti, Claudia (2002) - *Digital Aesthetics: Introduction*

Giannetti identifies a notable transference (from 1960s onward) away from conventional art positions, attempting to restrict the parameters of art to traditional techniques and confine "aesthetics to ontological foundations" - Evident in both visual media: from photography through film and video to computer; and communication media: from postage to the internet via the telephone and television. She adds that these changes (in artistic output) were often misunderstood and subsequently not accepted citing divergence between art theory and art practice, ironically noting the often predicted 'end of art'.

Her claim is not that failings in the artistic 'status quo' pushed this change - but that there was an intellectual drive to experience, analyse and assimilate contemporary technology rather than dismiss it (artistically). And that access to this type of art is aided by the 'fact' that:

> *"aesthetic theory is no longer focussed exclusively on the art object itself, but on its process, on system and contexts, on the broad linkage of different disciplines, and on reformulating the roles of the maker and the viewer of a work of art."*
>
> (Giannetti 2002)

She concludes that focusing solely on the "epicentre" of the art is not sufficient to describe it and that concurrent and historical, adjacent fields must also be considered. Her aim is to identify *"an aesthetic concept inherently formed by the context and creative experience of interactivity-based works, as well as their presentation and reception."* She sees art, technology and science collaborating in ways that will change the relationships between art, aesthetics and spectator.

Mayo, Dr Sherry. 2008 - *The prelude to the Millennium: The Backstory of Digital Aesthetics.*

Dr Mayo agrees with Giannetti, in identifying the 1960's as the origin point for digital art, although she refers to it as 'new media' and cites the introduction of CAD programs in the late 60's as the catalyst, she specifically claims that "Simulation and interaction are attributes that differentiate a digital experience from an analog [sic]

one". She also emphasises the progression from photography through to computer graphics again highlighting the "immersive simulation environments" as being focal point. Driven by combined R&D of scientists and artists together. (Similar to Giannetti's claims of 'intellectual drive') She also acknowledges the effect of Sputnik and the 'space race' at this time.

She proceeds to give examples of how each new wave of visual technology has been adopted, adapted and exploited in the last three decades of the 2Oth century being variously acclaimed and rejected by changing art points-of-view. Mayo, identifies a shift from 'new media' to digital aesthetic when transmission starts to shift from one-way to two way, but notes considerable trepidation from commentators such as McLuhan, Enzensberger & Youngblood.

The 1980s and the exponential advancement of visual 'effects' was the start of 'main-streaming' the digital aesthetic. CGI (Computer Generated Images) seemingly integrated the virtual and impossible with reality (Mayo cites Jurassic park as an example and identifies the defining elements as "the quest for realism, the development of simulated experience, and image manipulation in post-production"

Also the transition from arcade to home of computer games, is a further factor in the transition to a 'digital aesthetic' - directly manipulating visual output - in real time. She suggests that the interactivity and depth within the virtual 3-dimensional reality is analogous with the renaissance re-discovery (and use) of perspective. "Singular point perspective and the flatland of modernist aesthetics have been surpassed."

Mayo has also identified (or predicted) a move from the 1980's mass-collective experience to individual connections and networks such as MySpace (written in 2008 - she was not incorrect). She goes on to describe Manovich's definition of the New Media (2011) and likens his prescriptiveness to Greenberg and his rules for modern art (1955). "if it is made of pixels, variable in scale, and transmitted across the Internet, then it is new media". Asserting also, that Manovic identifies time as "the distinguishing attribute in the aesthetics of new media." Her concluding statement on Manovic is that "today integrated media is what is making cultural impact, not purity of form." Although, it is unclear if this is Mayo's inference or Manovic's explicit opinion.

Mayo goes on to discuss the exhibiting of new media - the curator of 'Bitstreams' at the Whitney Museum, New York, Larry Rinder, claimed that 'bits and bytes' do not restrict the digital age - the process is not as important as the out-put. (Although this raises the question 'is the process needed at all to achieve the effect?) Rinder sees the digital artist as a hybrid. According to Mayo he (and/or she) believe that the 'new' aspect of new media is the ability distribute, collaborate and research globally, claiming interactivity and collaboration in themselves are not new.

The latter third of this article descends into doom-mongery, again Mayo's inference as opposed to explicit references are unclear, but she portrays a fated point-of-no-return where the human/computer interface is seamless, where the human consciousness will be incapable of self-recognition as it is "subjugated to the machine". (This implies that an aesthetic response can longer no exists)

Mayo concludes that "artists incorporating postproduction practices provide critiques of the technology they use and actively create new knowledge within their art making". Her final argument is that regardless how 'digitised' artworks become, the art-makers don't lose their ability to communicate with their audience. However, she seems to claim that the close ties with entertainment and industry are a bar to academic enquiry.

A possible inference from Mayo's article is that the 'Digital' is no longer something to respond to (ie Digital Aesthetics) but something to be part of (ie Digital Culture) - she proposed that *"this intersection of digital lifestyles…offers the artist a role as researcher and resurrect the avant-garde"*

Nalven, Joe; Strawn, Mel. *The Digital Aesthetic: what it is and what it is not***.**

A short article which does not really deliver on the promise of the title, however, Nalven argues against describing the digital aesthetic as simply a tool set, using an Aristotelean discussion on form, pointing out that neither the tools nor the hand alone can achieve the output of the tools and hand together and that the 'cultural milieu' that surrounds the hand and tools as they come together is influential on the output.

His co-writer, Mel Strawn, also identifies the ability to manipulate the discrete ‘bits and pixels’ at an unseen level as an aspect of the aesthetic - similar to Holzman’s ‘discontinuity’, as discussed previously.

Andrews, Ian. (2002) *Post-digital Aesthetics and the return to Modernism*

Andrews starts by noting that ‘post-digital’ could refer to works that reject “digital revolution” and seek to embrace the analogue, or it could mean an evolution of digital perfection to enhancing errors and glitches. The implication of both is that for a post-digital aesthetic to exist there must, logically, have been an actual digital aesthetic.

He suggests that the digital movement is (was) striving for perfection and that this outcome was both increasingly transparent and illusory at the same time. Using sound and music as an example he cites the dissatisfaction with sterile digital sound needing to have analogue effects added to make it sound more authentic. Highlighting the paradox of striving for purity and transparency and having to use deception to make it appear more honest. Subsequently, post-digital music can either be an output that uses complex technology to make it sound analogue (hidden technology) or produce sounds that can only be the result of contemporary digital sound equipment (exposed)

Andrews recognizes similar ‘dichotomies’ in many art forms: an ‘abyssal irony’ growing from media saturation, being reacted to with a naïve reversion to modernist purity. Explaining that the temptation of modernist singularity is bound to be tempting compared to continuous regurgitation and reuse of existing output, where the post-modern ‘kitsch and camp … pastiche and parody” are informing themselves.

Much of the latter two-thirds of Andrew’s paper concerns itself specifically with audio but concludes by recognising some of Benjamin’s concerns with the dilution of ‘aura’ through reproduction and replication and its opposition to originality.

Ian Andrews has written a follow-up to this paper for the 19th International Symposium of Electronic Art entitled “Post-digital aesthetics and the function of process” (Andrews, 2013)

In this he reiterates the dialectic evolution of the post digital - one reaction to digital perfection by reintroducing analogue ‘flaws’ and authenticity, the other stripping back the digital to reveal what can only be achieved by the digital process.

Ten years on, Andrews believes that ‘discovery’ is a leading factor in the post-digital rather than ‘expression’ (an almost accidental approach) - following a mainly phenomenological agenda, however he also recognises a strong ‘neo-modernist reductivism’ - an intentional approach looking for answers. Andrews reflects that his 2002 view was that post-digital aesthetics were heavily concerned with process, but now appears to see these processes as generative and questions their authenticity as art processes, although acknowledges a trend in the latter half of the 20th century (Le Witt & Morris) to “remove the arbitrary” in art making processes to reduce subjectivity. While Andrews focus mainly on the difference between sound art and music with particular regard to the ‘unintentional’, he does consider the argument that the “process of art-making can never be entirely non-intentional”

He makes the point that that an artist can make the initial decision to proceed and then put a predetermined set of “rules into action, after this point the artist has relinquished control.” Andrews suggests that this puts authorship into question.

Morgan, Trish. (2013) *Sharing, hacking, helping: Towards an understanding of digital aesthetics through a survey of digital art practices in Ireland*

Morgan has sought to contextualise current digital art practice in Ireland and has identified three distinguishing characteristics, namely: (1) Collaborative potential; (2) Knowledge sharing with the Open Source and Creative Commons movements; and (3) the reconfiguration of existent materials. One of her respondents talked about an online, peer-review, iterative process, resulting in work that has essentially been a collaboration and Morgan argues that this “community ethos is a strong feature of digital art practices”. This is not an idea that has arisen in the other reviewed literature on digital art, and may well be specific to Ireland, it is however, very much the ethos of the ‘Makerverse’ community (those hackers, adaptors and de-constructors of open source, 3D printing, hard and software.) Again, specifying the ‘open source’ share-ability as a characteristic of Irish digital art practice, draws more similarities with the 3D print community. Repurposing and reconfiguration echoes back to Holtzman’s

(1997) excitement about ‘cut and paste’ and some of Andrew’s (2002) comments on sampling. Morgan refers to ‘data mining’ and using freely available or artist-generated data sets to act as seed for generative art.

Morgan also draws on Lister et al (2009) who identify digital aesthetic characteristics as “digital, interactive, hyper-textual, virtual, networked and simulated”, and contrasts them with Manovic’s (2001: 27-48) suggestions, “numerical representation, modularity, automation, variability and transcoding”. She concludes that in addition to the three practice characteristics, the ‘aesthetic specificities’ of digital art are (1) Object characteristics (which could be based on Lister et al) (2) Where it ‘resides’ (echoing Holtzman’s earlier thoughts on the virtual world and (3) Technical quality (drawing on characteristics identified by Manovic)

Tavares, M. (2011) *The digital aesthetics: Its origins and paradigms*

Travares sees technology as an aesthetic phenomenon, inspired by the modernist machine and that digital aesthetics is responsible for the ‘patterns’ that we live amongst. She addresses Huyssen’s (1996: 31-32) notion about acceptance verses fear, of modernist aesthetics and Rutsky’s (1999: 9) statement on this opposition that ‘aesthetics is being technologized[sic]’ and that ‘technology is being aestheticized [sic]’ As noted previously, ideas and opinions on the digital aesthetic (as with anything disruptive - including 3D printing) are continually polarized.

Much of Travares’s paper is concerned with the evolution from the modernist machine aesthetic in to the digital aesthetic. However, her concluding paragraphs echo the ‘deception’ concerns of Mayo (2008), Andrews (2002) and to an extent Baudrillard (1994)

Literature review Summary

To summarise the ideas about digital aesthetics (definitions 3, 4 & 5 - appendix ii) Holtzman (1997) had a straight forward approach, he posits, ethereality, discontinuity and interactivity as essentials of digital aesthetics. He also suggests ephemerality, however that was more a restriction of circumstance than a deliberate decision. Artists are now in the position to dictate the level of ephemerality by controlling the number of backward steps a 'participant' is allowed. Chris Meigh-Andrews (2012) and Morgan (2013) echoed the importance of ethereality and the virtual 'place' within which the art exists; Gianetti and Morgan, identified interactivity as the most important factor and Strawn (Naven, 2012) recognised Holtzman's, discontinuity characteristic.

Others had a more sceptical view, several of the commentators, Mayo (2008), Andrews (2002) and Travares (2011) had concerns about deception and refer to simulation and the blurring between the real and the hyper-real. These ideas echo Baudrillard's treatise on Simulation and the Simulacra (1994) and if applied to Greenhalgh's (2002.b) ideas on genre, this would put the digital aesthetic firmly in the ironic camp. However, it does not suggest that the 3D printed aesthetic could not belong there too. Although the technology, even when using high resolution scanning equipment, is far from producing any enhanced reality output.

None of the literature, with the exception of Morgan (2013) has directly addressed the idea of a digital aesthetic style. What is the popular understanding of the 'Digital Aesthetic' when applied to design, fashion, architecture etc.? There are popular ideas about what a digital look is: pixels, eg Minecraft (fig. 1.5); streams of ones and zeros, e.g. The Matrix (fig.1.6.); a Google image search for Digital Art returns mainly fantasy art? (fig 1.7)

Fig. 1.5 Minecraft

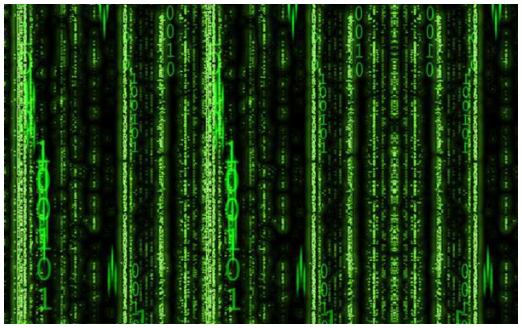


Fig. 1.6. The Matrix

Fig. 1.7. Jerico Santander - Own World

When these visuals are viewed on screen as a representation of code, they adhere to the visual digital aesthetic (def. 1) but also to the sensory 'essence' of digital aesthetics (def. 3, 4 & 5). While on-screen they are ethereal and potentially interactive, when printed, possibly in 3D or simply on a piece of paper, they become a fixed point - much like the waveform collapse in quantum mechanics - once the system's exact position has been identified or 'fixed' all the other positions or places in which it could potentially exist are no longer available. (Al-Khalili, 2004)

Another example of the moment when digital art becomes analogue can be seen in the following images. Both were taken, on a digital camera, at the 'Digital Revolution' Exhibition at London's Barbican Centre. One image, of the installation *'This Year's Midnight'* by Rafael Lozano - Hemmer (fig. 1.8), can be considered hyper-real, the viewer sees a 'real-time' reflected image of themselves, it feels to all intents and purpose that they are looking in a mirror - but 'real' smoke seems to be pouring from their eyes, the other, *'Mirror No. 10'* by Daniel Rozin, is a real time figurative abstract, in a 'finger-painterly' pixelated style. (fig 1.9)

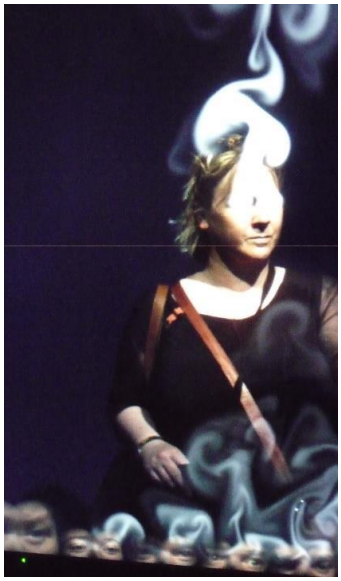


Fig. 1.8. This Year's Midnight - Rafael Lozano- Hemmer

Fig 1.9. Mirror No. 10 Installation by Daniel Rozin

Both 'experiences' were, interactive and ephemeral - the images on this page are not, however, they retain their hyper-real and pixelated appearance when captured on paper. As this document is being written these digitized images are being viewed on a computer monitor - but the code behind these captured images is not the same code behind the art. These images were generated using light bouncing from the visual representation of code, in the gallery, through the lens and onto the light sensors in the camera. Taking the photograph - even with a digital camera was the point where the artwork could be considered to have lost its 'digital essence' (aesthetics - def. 3, 4, & 5) - even though it still retains a digital appearance (aesthetic - def. 1 – see page 25)

What makes this idea of the switch between digital and analogue more interesting, is the fact that data generated by the code behind these images could be captured as bits and bytes, either in an instant or as a data stream and translated directly into DMT software language then printed, in some completely unrecognisable manifestation, as a piece of 3D printed art.

There are clearly fundamental similarities and differences between digital aesthetics and DMT/3D printing aesthetics, it could be said that 3D Printed Art is the physical manifestation of Digital Art. The process of producing 3D printed artworks necessarily involves an ephemeral and interactive process - however, will the 3D

printed aesthetic only apply after the print has been made, or will it apply to 'ante-print'?

What is apparent from this review is that Digital Aesthetics and 3D Printing Aesthetics share some characteristics and that 3D Printing Aesthetics has a level of dependence on Digital Aesthetics. The extent of this dependence, and the 'autonomy' of 3D Printing Aesthetics, will underpin the next stage of the research as it seeks to establish the legitimacy of 3D printing as both artistic process and medium.

Summary

Within the three intertwined fields of art, craft and design, practitioners tend to self-identify; output and process are no more defined. The taxonomic levels for Art, Craft and Design are different and variable, seemingly dependent on producer (agents and actors), end user (observers, consumers and all other judges of value) and even on grammar: whether nouns (output) or verbs (processes) were under consideration.

However, once it became clear that within the 'creative landscape' the nomenclature was not analogous to the ontology, the methodology of this thesis followed a 'Design Thinking' structure in order to systematically map the ontology of this landscape, then use this ontological matrix to analyse the effect of 3D printing across this landscape.

The following thesis firstly explores the Nature and *Aesthetics of 3D Printing Associated Artistic Output,* followed by a mapping of the existing creative landscape of making and causing to be made, which is subsequently analysed under the lens of 3D printing, and revaluated based on the impact such output might have.

Chapter Two
Workmanship, Craftsmanship and Creativity

In keeping with the ‘design thinking’ methods applied in this research, this thesis developed over many iterative cycles; the following essays, both arose *from* the research and *informed* further iterations.

They are part introduction, part narrative-support and part conclusion - they are accompanying texts, to the subsequent chapters, and should be read in parallel.

Historical Nomenclature and how it may be driving current misuse and misunderstanding of terminology

To draw on Diderot's *Encyclopédie, ou dictionnaire raisonné des sciences, des arts et des métiers (Encyclopaedia, or a Systematic Dictionary of the Sciences, Arts, and Crafts)*[12]*, in 1780,* as some sort of early identification of the notion of 'craft', is erroneous, as are earlier differentiations based on the medieval notions of Mechanical Arts versus the Liberal Arts. Liberal Arts were those 'pursuits' deemed appropriate for those with [at?] *liberty,* therefore the Mechanical Arts were those unbecoming of a freeman.

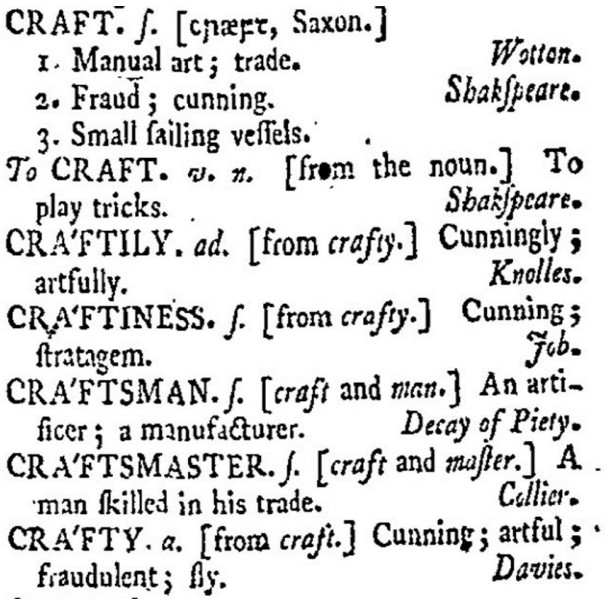
'Métiers' is frequently translated as 'crafts'; Ruskin & Morris's 'Arts and crafts' movement was concerned with 'Métiers' which is more accurately translated as 'trades'. The New Britannica Academic data-base[13] opts for 'trades' rather than 'crafts'.

Diderot's work precedes Ruskin's and Morris's writing by 100 years, with the Industrial Revolution falling between them[14], the former described the skills of 'trade' as the workmanship required to carry out the 'trades' and Ruskin and Morris feared for the preservation of these skills; they undoubtedly meant the workmanship skills and somehow (perhaps, because of the mistranslation of métiers as crafts) it has been referred to as craftsmanship (maîtrise is the French word for workmanship, which also translates as control, mastery or proficiency - which is also an original meaning of the word 'craft'). Johnson's contemporaneous definition supports this. More than two hundred years after Johnson defined craft as 'trade', the Chambers dictionary (Schwartz, 2015) still maintains that definition: "*a skilled trade*" but precedes it with: "*creative artistic activity involving construction, carving, weaving, sewing, etc as opposed to drawing"* and the synonym 'craftwork'. As a verb, contrary to Johnson, Collins gives: "*to make or construct, esp with careful skill*." The nomenclature shift could be due to arts and crafts 'doctrine' but also its retrospective analysis.

[12] Edited by Diderot from 1747-1765, by 1790 it ran to 35 volumes, and completed in 1832 with its 50th volume – 50 years after compilation began.

[13] "Encyclopédie" Britannica Academic, Encyclopædia Britannica, 7 May. 2017.

[14] Diderot (1713 -1784) and Ruskin (1819 -1900)



CRAFT. *ſ.* [cpæft, Saxon.]
1. Manual art; trade. *Wotton.*
2. Fraud; cunning. *Shakſpeare.*
3. Small ſailing veſſels.

To CRAFT. *v. n.* [from the noun.] To play tricks. *Shakſpeare.*

CRA'FTILY. *ad.* [from *crafty.*] Cunningly; artfully. *Knolles.*

CRA'FTINESS. *ſ.* [from *crafty.*] Cunning; ſtratagem. *Job.*

CRA'FTSMAN. *ſ.* [*craft* and *man.*] An artificer; a manufacturer. *Decay of Piety.*

CRA'FTSMASTER. *ſ.* [*craft* and *maſter.*] A man ſkilled in his trade. *Collier.*

CRA'FTY. *a.* [from *craft.*] Cunning; artful; fraudulent; ſly. *Davies.*

From:
'A dictionary of the English language: in which the words are deduced from their originals, explained in their different meanings, and Authorized by the Names of the Writers in whose Works they are found. Abstracted from the folio edition, by the author, Samuel Johnson, LL.D. To which is prefixed, A grammar of the English language.' (1794)

Although this edition was published 10 years after Johnsons death, there is no reason to assume that these definitions changed in the intervening years.

Morris and Ruskin's emphasis on the decorative (in particular Gothic revival[15]) adds sway to craft having more 'aesthetic' sensibilities than basic trade-skills; additionally, Ruskin's and Morris's social science points-of-view, seemed to be an attempt to elevate manual work into something more cerebral or at least worthy of consideration by those at liberty, using the goodness and guileless nature of 'craft' to explain how self-fulling it is. Pye (1968 p.119) thought this romantic notion of 'workmanship' was because, "perhaps [Ruskin] had never had to work for a living".

The problem with using the term 'craftsmanship' to describe workmanship skills, arises when agency is introduced. At no point, prior to, and including, the Arts and Craft (A&C) movement, is there a suggestion that the artisan (skilled maker, métier) has any design input. (Of course, many makers 'make' to their own design - but there was no suggestion that design input was required, to be considered an artisan.)

Subsequent to the A&C movement, (post WW1) there emerged the practitioner who both designed and made their output (akin to contemporary designer/makers), (Adamson 2007, p8) the output was also identified, usually quite correctly, as craft. This new type of producer had taken on a role that differed from to the 'actor' role of the artisan (who traditionally carried out a set of instructions, set out in the design)

[15] Discussed in the *Stones of Venice* -Vol II – Ruskin 1851-53

this new maker also had agency. In particular, agency over their output - it's design, distribution, material, etc.

It is reasonable to assume that these two types of 'producers', the actor (maker) and the agent/actor (designer/maker) always existed, but, the advent of industrialisation and mass production, magnified through the lens of the Arts and Crafts movement, served to highlight the plight of the skilled artisan/métier/maker/workman without opportunity. Any maker with agency over their output, could continue to 'design and make', but the actor (maker) requiring external employment/instruction/design to instruct and/or employ them were at a disadvantage.

While the difference between these two modus operandi are apparent, the actor (maker) and the agent/actor (designer/maker) were increasingly understood by the same description: **Craftsman.** Subsequently, and enduringly, the definition of 'Craftsmanship' has been applied to the activities of both makers and designer/makers.

Craft writers and theorists have long recognised the difference in 'actor', 'agent' and 'actor/agent' and sociologists, from Marx to Sennet, discuss agency at great length with respect to motivation: why do men work, what makes them produce quality work, how is pride engendered into workforce? This is addressed later in the thesis, but it is not the same as agency over design. However, appreciating the difference between agency and action (or designing and making) has failed to recognise the broader implication on the understanding (misunderstanding) of its boundaries.

David Pye, however has come close, by making a clear distinction between workmanship and craftsmanship; or rather identifying craftsmanship as particular type of workmanship: the *Workmanship of Risk*; and those 'making processes' that do not meet the requirements of his definition of Craftsmanship, he identifies as the *Workmanship of Certainty* and *Regulated Workmanship.* Though often quoted, his ideas are not university understood or applied. This thesis will adapt and build upon his ideas to equate *making* with *workmanship* and to recognise craftsmanship as *agency driven* workmanship or designing and making.

Perpetuating the conflation of Craftsmanship and workmanship

Regardless of any definitive markers this thesis puts down, on what the specific differences between workmanship and craftsmanship should be, the words will continue to be applied in whatever way their users see fit. However, even when the terms are conflated, the two separate processes of ***making*** (action *only* or ***workmanship***) and ***designing and making*** (action *combined* with creative agency or ***Craftsmanship***) can be individually identified. Although, accurate interpretation can be difficult and often raises more questions than it answers.

For example: In his essay, "Are computers killing off Craft? Not a chance", Grayson Perry (2015) distinguishes technique from artistry, and by technique, here he means 'craft skills'. He defines craft (probably the process) as something that can be taught, were as art 'skills' are inspired. If, in accord with the point-of-view of this thesis, he means 'workmanship' when he says, 'craft skills' then so far there is no conflict. He goes on to state: "Many artists are extremely poor craftsmen while many great craftspeople are rubbish artists", he has witnessed many artefacts that although well executed, he finds them ugly. Does he actually mean that many artists are lacking in 'craft skills' (workmanship) and that many with 'craft skills' or 'makers' - can often lack artistic ability? That is undoubtedly a correct observation, but has he neglected the artist who makes with skill, or the skilled maker with imagination and insight?

> *"One of my pleasures … is commissioning and working with great craftsmen and craftswomen. I like nothing more than designing a dress, some shoes or a motorcycle, collaborating with highly skilled individuals or teams to bring my ideas to life."*

Perry is quite explicit, he employs great craftspeople to bring *his* ideas to life; but he also says that they collaborate - would it be more truthful for him to say: "to bring **our** ideas to life" (i.e. his initial idea, combined with the creative input of his collaborator) rather than just "**my** ideas"? Is he describing an activity that involves more than just making with skill? Is he expecting design input (creative agency) from his 'craftspeople' or will he be retaining total control? It's not clear.

Perry's essay is not making any statement about workmanship versus craftsmanship, or actors versus agents; it's a validation of new technologies, within the creative landscape, as legitimate tools for both the craftsman and the artist (a concept analysed in Chapter four: the creative landscape), pointing out the relative advantage of filling gaps in the skills-set of both. This time, he seems to be using 'craftsman' to describe the designer/maker - and the skills gap refers to their missing 'workmanship skills'. He goes on, "The results of digital production often have a lifeless feeling – that is because the machine will do exactly what is asked of it and no more." Which can be interpreted as, unadulterated 'workmanship' - direct translation rather than interpretation. If a machine is producing lifeless work, *because* it is following exact instruction, then the output-fails lie with the 'instructor'.

Does the language matter? Artists, designers, creators, craftspeople, can call themselves whatever they like, it won't affect their output. Perry's apparent contradiction is omnipresent throughout 'creative conversations' and beyond. The fact remains that the activities of people who 'make' and people who both 'design and make' have been conflated in to one all-encompassing term: *craftsmanship*. Which in the first instance diminishes the agency of the designer/maker, but also confers unwarranted agency onto the maker. Incorrectly conferring unwarranted responsibility onto a 'maker' allows blame for poor output to be placed upon the maker. There is a saying: "the bad workman blames his tools", a more accurate version would be "the bad *issuer* of instructions blames the *executor* of the instructions".

The *issuer* of instructions has control, they have the creative agency over the design, the *executor* of the instructions is merely an actor in the production of the output.

Pye would describe the 'executor's' actions as the *workmanship of certainty*; only when the actor also has agency (or responsibility and control), could their actions be described as '*the workmanship of risk*' which is Pye's definition of 'Craftsmanship'.

Based on these premises it would be correct to say, in order to demonstrate *craftsmanship* there must be control over both the design and the making. Therefore, if the maker is also the designer, they may be considered a *craftsman*, but is the converse true? If the designer is in complete control of the making, are they to be

considered a *craftsman* - even if they are instructing a maker/technician who is following that designer's instruction without deviation?

Assuming 'no' – then a *craftsman* is not necessary in the process of *craftsmanship*. (see the thought experiment about Frank's pottery in Chapter Four p.203)

In the Artist/technician relationship, the artist's agency and subsequent authorship is readily accepted; but for a craftsman there is an expectation that their 'hands' must be involved in the making. While the two aspects of craftsmanship, making (workmanship) and designing (creative agency) can be identified (and thus provided) separately, to be considered a craftsperson/man/woman – both process must be performed by the individual, (either consecutively or concurrently for an individual artefact.)

The conflation of craftsmanship with workmanship will always be difficult to unpick, specifically because, within the contemporary craft/applied art field, most producers are designer/makers (ie both agent and actor); even the hobbyist, following a pattern, is likely to inject some degree of their own design agency into their output. Which leads to the assertion that, in reality, a 3D printer is the epitome of workmanship - specifically because they can have no agency.

Creative Agency

It is clear the there are two separate aspects in the production of tangible artefacts (whether they are classed as craft, art or other is not important). The causing to be made (*the why*) and the process of making (*the how*) (these are analysed across the Creative Landscape in Chapter 4). The Process of making (*the how*) can be further deconstructed into two distinct 'parts':

X. The design, the idea, the instruction, the conception, the invention. (*Creative Agency*)

Y. The other 'part' is *reification* - making the abstract concrete, manipulating a medium to realise the idea of the designer. (*Workmanship*)

As the previous essay, on the conflation of the terms *workmanship* and *craftsmanship* points out, the person who executes out both process X and Y, (either concurrently or consecutively) can rightfully call themselves a *craftsperson;* what the essay also says is that the executor of X and Y can be different.

Agency

There are two paths the 'making process' can take:

1. Making by following a predetermined design, without any design decisions being made by the maker, and where the maker is not the designer

2. Making being controlled by the designer. Eg: where the maker is following their own design

Both are following a predetermined design, however in the second case, the design is the maker's own and each design decision can be taken individually, as the making progresses – as frequently as each action is executed. The discrete 'design and build' process could be used in the first example too, if the designer is closely monitoring each action taken and issuing instructions accordingly. Making to a pattern, without deviation versus making up a design as the work progresses.

Both pathways could produce the same results however the processes are clearly NOT the same.

Pathway 1, is *making with workmanship* - **the quality** of which can be gauged on the adherence to the design and also the difficulty of the design. Many would look at the result of this and call it workmanship, many would call it craftsmanship, likewise many would call it either or both – however, the facts are:

- There is no *creative agency* here on the part of the maker.
- This is definitely *workmanship*

Which draws the question: Why use waste the term 'craftsmanship' on this when 'workmanship is perfectly adequate?

Pathway 2 also involves *workmanship* - the designer's instructions are being carried out, whether they were completely decided on before the 'making' began or whether the instructions were incremental, or as frequent as an action by action decision, is irrelevant. What differs here is that the designer retains control over the process, their *Creative Agency* remains active throughout the making process as well as the design process. Again, many would look at the result of this and call it workmanship, many would call it craftsmanship, likewise many would call it either or both - this time, the facts are:

- This process is **different** from *workmanship*
- There **is** *Creative Agency* involved, on the part of the maker, (because, in this instance the maker *is* the designer)

Which draws the further question: If this process is different from 'workmanship' and the process is already referred to a 'craftsmanship' by many, what not use 'craftsmanship' to exclusively describe this process and leave workmanship to exclusively describe the former process?

This distinction between workmanship and craftsmanship is not new - much of David Pye's writing explores this and the view of this thesis, on 'workmanship', does not differ from Pye's. However, his definition of Craftsmanship is 'the workmanship of risk' and it is the interpretation of 'risk' as 'responsibility' that allows this thesis to suggest that: **'output, where the designer remains in control of the making (ie: the workmanship), can be considered a demonstration of craftsmanship'**

To address the questions raised, the problem with nomenclature maybe because, in many designer/maker relationships, these two roles are not easily distinguishable (even Grayson Perry conflates the terms (see previous essay p.60); the person in control (ie the agent) may not always be apparent, each actor may well be the agent to their own fortune. The designer fully in control of every aspect of his or her work: from the initial creative discontent or spark from some seemingly random generator - right through to a clear vision of the completed artefact, may not 'make' the final piece. They may hand-over the 'vision' to the maker/artisan/technician, who will receive detailed and precise instructions to carry out and have no need to add anything - they are required only to act. In this instance, it would seem that they (the makers) have no agency (especially if the designer remains in control) However, if they have taken the design (maybe purchased it) and have full control over its implementation they will have *agency*, and be in a position to exercise craftsmanship, but if they stick rigidly to the design, the output will be an example of 'workmanship'. The implication here being that: *the capacity* to exert agency is not enough to elevate *workmanship* to *craftsmanship*, the agency over the design must also be implemented. This is perhaps were Pye's definition of craftsmanship is less clear, even when risk is understood as the burden of risk, and that burden (or responsibility, or agency) can clearly be demonstrated and recognised in the actions of the maker - without some degree of intervention in the actual design - the making, regardless of how expert, can only ever be 'workmanship, ie., having the agency (the authority, or right) to alter a design, certainly gives the impression of having agency over design (Creative Agency), but in order for the 'making' to be understood as 'craftsmanship' that agency must be implemented.

The decision to not alter a design but to instead to follow it accurately, is clearly an implementation of 'agency of action' (the agency Sennet (2008) means) and could also be understood as an implementation of 'agency over design' *if* it were to be accepted that, the decision not to alter a design is, as valid a demonstration of agency, as deciding to make a change. However, and this brings up the problem of insufficient nomenclature again, deciding to not alter a design means that the agency (or responsibility) over the design *remains with the original designer.* The only way to claim agency of design, over an object, is to add design input.

Why is this important?

By making a change to the design, a new design is created which affects authorship.

A maker can decide: "I have before me a design, I am entitled to change it anyway I see fit, I may:

- Follow it exactly as instructed, therefore I have no design input, I have not exercised any agency over the design - I cannot claim I have demonstrated craftsmanship - and the author of this work remains the original designer."

- I can make some changes, which will involve some (or much) design input, I will have exercised *Creative Agency* and I may have demonstrated craftsmanship - at the very least I am now a co-author of this work."

Also, if the designer remains in control (ie retains agency) then the maker is still only applying workmanship.

Therefore, there is *designing* (usually with agency - but not necessarily)[16] - And there is *making* (usually without agency, but again not necessarily).

As long as these are separate, they are easy to understand, especially the role of the maker/technician/artisan/métier *without* Agency. Their role is to execute instructions precisely (even if those instructions result in output that appears to be poor workmanship); however, there are also cultural expectations and agreed upon standards that generally identify workmanship (making) as good or high quality; in those instances, an awareness of how the output is *supposed* it appear, will exist.

[16] The drivers of design can be diverse (see Chapter 4 – Causing to be made)

An example might be that a design instructs a brick-layer to use occasional uneven spacing between bricks and leave some apparently random bulges in the pointing - precisely in positions dictated by the designer and to give it the impression of accident rather than intention. In this case the bricklayer's execution will have been perfect and subsequently too, his workmanship - however the general/cultural understanding of quality bricklaying *workmanship* would suggest that the execution was poor.

In another scenario, the bricklayer defies the designer and lays the bricks in a way that demonstrates the conventional expectation of *good* workmanship.

The maker without agency - who carries out the task *as instructed* has displayed the better workmanship.

If a bricklayer (A) were given precise instructions to produce a wall that appears as 'perfect' as culturally expected and another bricklayer (B) was instructed to make the 'flawed' wall, and if the bricklayer (B) took it upon himself to defy instructions and produce a 'perfect' wall, identical to the one requested from bricklayer (A), which has demonstrated the better 'workmanship'?

The difference here is *agency*; could the second builder's actions be described as 'craftsmanship'? If both look identical it would seem unfair to label the work of the second as 'poor - workmanship'. Rather than judging workmanship on a scale from good to bad, perhaps it should be from correct to incorrect, (or a scale of accuracy.)

This scenario also brings up motivational agency - why did the bricklayer (B) defy instruction? Had (B) the right to take agency over the design? It could be said that (B) has not taken over the agency of the design, but, by *disregarding* the design instructions they have eliminated the 'design' from the equation and are simply making <u>something else</u> - following a design they do have the right of agency over. This raises the question, who owns the materials, and who is paying for the builder's time? Could it be that taking agency over the design of the wall (and subsequently the execution of the design) the builder has demonstrated 'incorrect workmanship', although the making skills demonstrated in the incorrect workmanship could be considered 'good' workmanship. (There are many examples of seemingly good actions also being incorrect actions, in every walk of life - therefore there is no conflict in apparently poor workmanship, actually being correct, or apparently skilled or good workmanship, actually being incorrect). Without knowing the designer's (agent's)

intention/design, it is impossible for a subsequent observer to know what level of workmanship skill, or correctness/accuracy they are witnessing.

It is for this reason that the systematic analysis undertaken in this thesis, reflects on more than just Creative Agency. Although it will be argued that it is Creative Agency alone that differentiates *workmanship* from *craftsmanship* - there could be an argument that craftsmanship is not just **having** agency, but also **applying** that agency.

Risk and 3D printing

Craftsmanship (or rather, what this thesis is calling Craftsmanship: the combination of *workmanship* and *creative agency* in the making process) applies across the Creative landscape – it is not just about 'craft' (although a craftsperson is an individual who applies craftsmanship in making – which could apply equally to a maker of art, as a maker of craft, and all the 'cross-over' artistic output in between). It also applies when a 3D printer is the source of *workmanship.*

Romantic ideas about craft drivers, (see the essay on historical nomenclature, p.57) suggest that the slow diffusion of 3D printing into the realm 'craft' is down to the need to 'make' and the link between the mind and the hand (Sennet 2008). However, there is a more logical and tested reason: Relative advantage (or lack thereof). Rogers' Diffusion Theory (2003) backs this up, and as Chapters 3 and 4 will, demonstrate, 3D printers are used for artistic output where they are either better than an existing tool or process (A disruptive, but often sustaining innovation) of presenting a brand-new process/output (radical innovation). If (romantic) commentators on craft developed a greater understanding of the actors involved in creating craft (and artistic output in general) they could clearly define the difference between workmanship and craftsmanship. Pye's ideas about 'risk' help to make these distinctions, and laterally, Risatti's theory of Craft also expounds these notions. Pye uses 'risk' to distinguish between craftsmanship and workmanship

Firstly, it is important to understand what Pye means by risk. He describes workmanship as those tacit skills, learnt from years of practice. Sennet (Sennet, 2008) refers to these as *craft-skills*, and is often (wrongly) attributed with the idea of 10,000 hours required to hone them. (Gladwell (2008) made the claim before Sennet, citing

K. Anders Erickson (1993) - and it is apparently without foundation anyway (Hambrick et al., 2014)

An excellent workman (or *maker*) will know how (or at least rightfully expect how) a particular material will react when manipulated in a particular way, with a particular tool. The better the workmanship the more assured the outcome - or the lower the 'risk'.

However, the converse is not true - high risk does not mean poor workmanship. It would seem that 'risk' here means the risk of failure and it is certainly true that the more accomplished the *workmanship* the less likelihood of failure exists

But, Pye describes craftsmanship as the workmanship of risk. (1968, p.20)

However, risk could be understood here to mean agency and responsibility rather than the *danger of mistakes.* If a 'maker' is not up to the task that the designer or artist has commissioned, the risk is the artist's not the 'makers'. **The risk of poor workmanship is not the workmanship of risk. (**Nor must poor workmanship be passed off as 'craft' - it excuses the poor workman and demeans the craftsman) That is not to say that much so-called 'craft' is beyond fault - for it is not.

Where is the analogy to 3D printing?

If the artist does not know what a machine can do and how it will handle particular materials or indeed presents poor, unclear instructions, then they (the artists) are to blame if there is a problem.

The workmanship can only be assessed against the intended design (Pye, 1968)

It could be, in the case of deliberate use of superficial aesthetic, that the artist knows that the 'workmanship' will provide an artefact with striations due to the extrusion process. (see chapter 3, superficial aesthetics). Knowing, expecting and wanting this result will produce good workmanship, the machine has produced what was intended.

However, if the artist has produced a virtual model as smooth as glass and is then presented a print with extrusion lines, the workmanship will be considered *poor,* but through no fault of the machine/workman.

On the other hand, the 'maker' may be well-aware of their own limitations.

In a normal artist/maker set-up, the artist trusts the technician to 'know' what is needed and pays him accordingly (like session musicians or indeed artists' workshops across the centuries, from Titian to Koons) or even publicly recognises their contributions, (uncommon.)

Sending code to a 3D printer with no idea about its capabilities is tantamount to handing a monkey a paint brush. The reality is that when an artist (or designer) hands over instructions to a to a technician or machine they are essentially issuing a set of parametric constraints within which they accept and claim responsibility (and/or the associated shame or glory)

The acceptable range of these parameters is largely arbitrary and the level of acknowledged agency even more so. If a machine does not do what the artist intends - but the result is aesthetically interesting - can it be art and if so whose? Is the machine afforded any credit? (Quora.com has some interesting posts on accidental art[17].) This thesis is not going to judge either way, only accept that the *unintended* output of a 3D printer can be *Art* - but Art of whose making is an argument for someone else.

Accepting errors and glitches as art is also problematic. Again, who has created the Art? Setting something (or someone) up to fail seems incongruous with normal behaviour, so the very naming of the output as a failure identifies it as unintended.

If poor workmanship is the result of poor design (or incomplete instruction) the designer must take the blame. But if the poor design is deliberate and therefore intended, can the designer take credit for the subsequent failure? (Which is not actually a failure but a success.)

If the poor workmanship is down to the maker's lack of skill, then the failure is either the designer's fault for not appreciating the maker's abilities (A) or the maker's

[17] www.quora.com/Is-accidental-art-possible

The argument varies between intent and discovery, whichever camp you fall into dictates its artistic credibility.

If the output is not what the artist intended, it may be collaborative or may be discovered (that would mean a passer-by could claim authorship - Much like Eugeine Scrase who won the BBC 'School of Saatchi' after she plonked "a tree trunk impaled on a set of railings that she'd spotted on an errand." Into the corner of the Saatchi Gallery (Higgins, 2009)

for not doing what he was quite rightly expected to (perhaps he has demonstrated a high level of skill on previous occasions) (B)

This is analogous to a 3D printer in that: if the designer knows what the capabilities of the maker (3D printer) are and he (A) gives it a job that is beyond its capabilities - therefore the unknown but predicted failure can be attributed to the designer - or (B) if the machine has thus far completed admirably, similar tasks - many times - the designer will 'quite rightly' expect it to do so again. So, any failure in workmanship in this instance must be blamed on (or credited to) the machine.

Therefore, just as a designer cannot take the blame for 'uncharacteristic poor workmanship' - nor can the artist take credit for a random glitch[18]. If it is intended, then it is not a glitch - Just as a deliberate accident is an oxymoron. An accident can be caused by a deliberate action (most are). But if the outcome is deliberate then it is *not* an accident.

The conclusion is that art, resulting from glitches and errors (caused deliberately), with unknown (but intended) outputs, cannot be considered accidental and if the output is indeed unknown then the machine must be credited in the production of the art and have its status elevated to more than just a tool or an extension of the hand. This does not suggest that the machine has creative agency - but it could be a demonstration of 'algorithmic creativity' - algorithms being series of instructions which can react instantly to feedback (do A - is result B? if yes, do C, if no, do D - is result E? if yes etc – see next essay on 'Deconstructing Creativity, p.75) - could this be the distinction between the tool and the medium?

Consider the following: a man carrying a bucket of paint, is deliberately tripped, and the subsequent spillage is considered artistic - who made it the art? Was it the tripp-er or the trip-ee. (the tripper did so with the intent of creating 'art'. The trip-ee had no part in the plan nor any advance warning)

Consider also, a printer 'randomly poked' in the middle of a task (likewise the poker did so with the intent of creating 'art.' – See Shane Hope, p.119) -The printer had no part in the plan, nor advance warning)

[18] *Noun:* a sudden, usually temporary malfunction or fault of equipment.

The poker and the tripper both instigate the ‘error’, the actions of the tripped man and the poked printer dictate the manner in which the error unfolds. Both the tripp-ee and the printer had no intentions other than to keep doing what they were doing and their reactions to the deliberate sabotage was to try to continue with that and compensate wherever possible.

In the case of the tripped man it would be wrong to call him a mere ‘tool’ manipulated by the artist because the man’s unknowable, and not-predetermined (re)actions played a part in the outcome, while not directly active in the concept, he was at least part of the media used to transmit the concept. It would be valid to consider him an art medium as opposed to an art tool.

Likewise, then the 3D printer, forced from its intended path (to just keep on doing its thing) to produce a desired but ‘unknowable, and not-predestined (re)action’ also played a part in the outcome, while not directly active in the concept, he was at least part of the media used to transmit the concept. It would be valid to consider him an art medium as opposed to an art tool.

It is with this argument that this thesis hypothesises that while a 3D printer is a valid craft tool, it also has the potential to be more than ‘just’ a tool - it can also be a valid artistic medium; more than manipulating materials to transmit a message, it can affect how the message is understood – as many of the artist/makers in Chapter 3 demonstrate.

Relinquishing Creative agency

Regardless of the makers intent - does the maker have any say over the function once ownership has exchanged? In principle, yes, if their name remains attached to it - However, the practicality of enforcing such caveats would be prohibitive; if Manolo Blahnik[19] included, as a condition of sale of every pair of shoes bearing his name, the clause: “under no circumstances may these shoes be used as hammers”, there would be no reasonable way to ensure it is adhered to, or the example given in Chapter Four, External Craft drivers, p.202

[19] Maker of wildly expensive shoes

Were a ceramicist to offer a service that transfers a customer's image onto a plate, the implication is that they are merely providing the 'workmanship' necessary to 'make' the item, and no extra creative input is expected – therefore they have no real control over the output and cannot refuse to put an image or message onto that plate because of any personal views they have over the content; however, if the customer is commissioning a personalised ceramic plate, in the particular style of the ceramicist (which would be clearly recognised as such) then there is an implicit agreement that the ceramicist will be using their Creative Agency and should therefore have control over the output. In this latter case, the artist should have the right to refuse to add content that they would not want associated with their brand

The creative agency of the designer remains for as long as the designer **has control** over the artefact executed by following their design.

Examining knitwear production, can demonstrate various scenarios and combinations:

- A knitwear designer may sell their knitting patterns - the designer only has *Creative Agency* over the pattern, once it is sold the 'pattern owner' can do what they want with it (as long as they don't pass it off as their own design)

- A knitwear designer/producer may produce the design and have several people doing 'piece-work' ie; one making sleeves another making the body and another assembling. The designer has retained *Creative Agency* of the design and control over the *workmanship*. The finished piece is an example of 'craftsmanship' - produced without an actual 'crafts-person'. The quality of the 'craftmanship' will be dependent on the success of the design and the skill level of the *workmanship* provided by the piece worker. The designer - who has retained control (therefore *Creative Agency*) of the entire manufacture process, can reject any piecework that does not meet their required standard. Control ends when ownership is passed on. A new owner can use it as a cat blanket, even if it is clearly intended to function as a jumper.

- A knitwear designer/maker, who designs, makes and sells their work, they do everything themselves they have retained *Creative Agency* over the design and the execution of the design - but their control ends when (or if)

ownership is passed on. This is an example of *Craftsmanship* carried out by a ‘craftsperson’

- A knitter buys a pattern, they have *Creative Agency* over the execution - if they follow the pattern exactly, they have chosen not to exercise any *Creative Agency* over the design - this is an example of *workmanship* (highly skilled if the execution is faithful to the design - poorly skilled if there are unintentional deviations), not however algorithmic creativity - they are not creating ‘anew’, (see following essay – Deconstructing Creativity.) If the knitter decided of make adaptations to the design, they have employed *Creative Agency* and created a new design. The knitter is certainly a ‘craftsperson’ as they have used both *workmanship* and *Creative Agency* -the finished piece can also be considered ‘craftsmanship’, the quality of which will depend on the design choices they have made and the skill level of their workmanship - some of these factors will be objective, such as fitness for purpose, uniformity of stitch etc.; other factors will be more subjective, such as appearance.

Creative Agency is control over the design and making of an artefact.

It ends when ownership (and therefore control) is passed on - In practical terms *Creative Agency* ends once manufacture is complete, but the option to tweak or adjust some artefact exist after manufacture.

Creative agency is not the same as the *personal agency* of a designer, artisan, or technician; that which controls their reasons and motivation for carrying out work, be they financial, artistic, pride, duress, pleasure. Creative agency is purely about control over the form of an artefact. It is driven by independent creativity, it is separate from, and different to, algorithmic creativity.

Workmanship is the making (following the design)

Creative agency is the cause of making (control of the design)

Personal agency could be considered the reason for making (control of the designer and/or control of the maker).

Deconstructing Creativity within the Creative Landscape

As with much of the nomenclature *surrounding* 'creativity', the meaning and understanding of the word 'creativity' itself is the one of the most fluid.

Mumford's (2011) 'stocktake' of creativity research (based largely on handbooks by Marc Rinco (1996) and Robert Sternberg (1999). Suggests that pinpointing a definition for creativity is largely impossible, much like Wietz's views on art theories (1956). He claims there is a general consensus that, "Creativity involves the production of novel useful products". Why 'useful' he does not make clear, however, the difference between *use, purpose* and *function* are thoroughly discussed elsewhere in this dissertation, (p.21) and *useful* can mean 'to be for' something/anything rather than having any functionality, simply having 'user-value' makes an artefact 'useful'. Boden's definition (2010, p.70), combining novelty with *value* and *surprise* rather than usefulness; most ideas on creativity, especially with regard to Artificial Intelligence (AI) draw on Newell et al (1962 – first presented in 1958) where they analyse the creative nature of problem solving, (they also use the term *value* rather than *useful*), indeed many contemporary 'design thinking' principles are laid out their work. The conditions they identify are:

- Novelty and usefulness, for the thinker of their culture; what Boden calls P-creativity (psychological) and H-creativity (historical)
- Presentation of a new (unconventional) ways of thinking – or rejection/alteration of existing ways of thinking (similar to Boden's *improbabilistic* creativity)
- Motivated and persistent thinking (Agency)
- Problem Identification [In the opinion of the author **the** most important element of the design process]

The premise of this thesis' main hypothesis it that: because 3D printers can only provide (at best) *workmanship* – and therefore have no capacity for ***Creative agency*** - they cannot disrupt any element of the creative landscape that requires ***Creative agency***, in particular, *Craftsmanship.*

However, for this premise to remain true, the 3D printer (and any subsequent artificially intelligent 3D printing machine that can 'learn') must also remain incapable of ***creative agency.***

In one of the first iterations of this thesis/hypothesis – the craftsmanship process was deconstructed into the components of workmanship and creativity; however, the extrapolated premise at that time read:

> *The premise of this thesis' main hypothesis it that: because 3D printers can only provide (at best), workmanship – and therefore have no capacity for* ***Creativity*** *- they cannot disrupt any element of the creative landscape that requires* ***Creativity.***
>
> *However, for this premise to remain true, the 3D printer (and any subsequent artificially intelligent 3D printing machine that can 'learn') must also remain incapable of* ***Creativity.***

While this premise may have been valid at the time of writing (2017), conversations about machine learning, Artificial Intelligence (AI) and the creative abilities and potential of *the machine*, are widespread, eg: in February 2017, the Royal Society, held a panel discussion entitled "Can Machines ever be truly Creative?"[20] , and the evidence is that machines are definitely 'creating' (Google's Deep Dream)[21], and if properly understood and exploited, destined to be a collaborative force for good, rather than something to be feared (McCaffery et al, 2017).

Which begs the question: if machines can ***create***, must they not therefore be ***creative?***

Assuming the answer is *yes*, would mean the (initial) premise of this thesis would be short-lived; therefore *creativity* was deconstructed it into components that would isolate the type of creativity machines are capable of and that which is (and will remain) beyond them.

Looking at the nature of *creativity*: i.e. creative agency, creative drivers, what can be taught and what appears to be innate - concluded with two components of

[20] Held at The Ulster Museum, Belfast, as part of the NI Science festival (2017) /
[21] https://deepdreamgenerator.com/

creativity: *Creative agency* and *algorithmic creativity.* Either or both can be present in the creative process.

Boden (p164) recognises the importance of agents within the creative process, she suggests that novel and 'surprising' things are either "improbabilistic" or "impossibilistic"; the former derives from what already exists, but which is presented or re-created in a wholly surprising new way and the latter, impossible without the intervention of a *change agent*; which has parallels with the thesis position on the difference between Algorithmic Creativity and Creative Agency.

Instinct robots

An interesting view on the agency of creativity has been explored in an exhibition (Jan-Mar, 2017) *Animal Intent* curated by Emily Falvey. The premise was that aesthetically astounding creations produced by animals should be considered art. The question surrounded the level of intent and potential for creative collaboration. Favely said, "*If you believe that animals are ruled by instinct—that they are just going about their business mechanically without the self-consciousness required for 'depth of being'—then they don't make art and they cannot collaborate creatively in a meaningful way,"* however states her own point of view as, *"If you believe, as I do, that animals are not instinct-robots—that they improvise, play, and develop forms of meta-communication such as symbolic gestures, then they are creative entities and potential creative partners."*

Believing that animals might be trying to communicate some greater truth, from within, maybe one anthropomorphising step too far; however, producing 'art-for-art-sake' – or more specifically – making, for the pleasure of making - cannot be disproved. Animal lovers will likely insist their pets do 'stuff' just for fun.

There is clearly a level of agency in the animals' actions, their actions are deliberate, and they carry out the actions because they are motivated to do so. There is a *reward*, whether it be their own pleasure, their keeper's approval, some treat or display of affection. These are the same things that motivate humans to do a good job – (e.g,Sennet's ideas on the motivation of craftsmen) – They create because they want to, because they have been motivated to do so, to carry out the act of making.

But maintaining the agency over whether or not to 'make or create' is not the same has having the creative agency to dictate and control *what* is made. It would be difficult to believe that any animals who make/create, because they want to, are doing so with any foresight. Favely may disagree, however she is clear that animals are not '*instinct-robots'* ie: not automated reactors to external stimulus. Favely considers 'instinct-robots' to be without self-consciousness, incapable of meaningful creative collaboration. Is this perhaps the level of creativity that machine can reach? That of an 'instinct-robot'. Presumably an instinct-robot could learn infinite ways of reacting, making minute adaptations to complex strings and patterns or stimuli, to the point where it appears to be acting by its own volition.

Creativity is clearly possible from both animal and machines, in that they are capable of original output. But it cannot be proven that any *creative agency* was involved. They did not use their imagination, to 'dream-up' an end-point, before they set about making.

However, while both the animals' actions, and those of a computer, are deliberate responses to external stimuli, the animals are motivated by reward, an abstract need (usually attributed to humans – see Maslow's pyramid of human needs, p.198); but machines don't experience abstract needs, so how could they be motivated to create? Computers do the job they are instructed to do – in this instance they merely need a set of instructions that tells (teaches) them how to create.

Teaching creativity

Ward et al (1999) identify two necessary cognitive capabilities for creativity, 'Conceptual Combinations' and 'Idea Generation'. Mumford suggests that the two feed off each other, but miss out on 'late cycle skill' as well as the ability to identify problems.

Ward et al's 'Conceptual Combinations' and 'Ideas Generation' sound similar to the myriad *creative problem-solving techniques* that are ***taught*** on Design training courses: e.g.: free association, forced relationships, functional deconstruction, morphological analysis. The majority of these are based on making connections - something computers are much better at than humans because of their ability to

quickly read large data sets. The TRIZ[22] method combines many of these approaches by systematically applying existing solutions to similar problems (heuristics, adaptation, transfer, combination, analogy)

Design (as a practice) solves problems or meets needs. In teleological terms, *design is for* a particular 'function' - Art on the other hand has purpose, if does not require a 'function' to justify its purpose. In teleological terms, *art is for* 'being (appreciated as) art, (see 'Are art, craft and design comparable p.147) There are three stages in design (as a practice):

A. Understanding the existing situation and recognising the problem (or need or opportunity)
B. Envisioning (and recognising) the situation once the problem has been solved (what Mumford would describe as a 'late cycle skill')
C. Getting from A to B - or solving the problem. (applying Ward et al's "necessary cognitive capabilities."

Understanding and recognising *actual* problems (as opposed to *apparent* problems) requires *empathy, insight, intuition*; and envisioning a 'problem solved' involves, *foresight, imagination, an appreciation of appropriateness* and the *capacity for abstract thought*; to solve a problem, what is required is the starting point (A) and the end vision (B); there are myriad algorithmic pathways that can be followed to get from A to B - these are the aspects of creativity that can be taught. These creative problem-solving techniques are part of the 'design thinking toolkit', they are largely divergent and systematic (the mapping of the creative landscape, as an expanded problem field is one such technique) they combine and adjust and adjust and combine, looking for connections. To assess how successful the combining and adjusting is, the result is continuously compared to the end goal. If the starting and finish points have been properly defined, there is every likelihood that computers will (have) become much better problem solvers that humans can ever be, because they have access to exponentially expanding data-sets and the increasing computing power to 'run the numbers', as author Erica Wagner observes, "you can get computers to do tasks …, which are very sophisticated, but very bounded tasks" (David, 2015)

[22] A proprietary problem-solving system used in schools and colleges, by engineering students, but also promoted as a broader business problem solving tool.

If the ability to solve problems is considered an application of creativity (Pasteur says no, Stravinsky says yes (Harnad, 2001)) then computers will be (are) capable of creativity.

However, *empathy, insight, intuition, envisioning, foresight, imagination, the capacity for abstract thought* or *that eureka moment* - are all considered aspects of creativity - but those that *the machine* is not capable of - *the creative 'spark'!* It will likely become possible to ask a computer to demonstrate fear or angst or happiness with some sort of analogue output, but only because they have learnt what these things mean and how to present output recognisable as such – but not because they have *felt* these things.

Creativity can be deconstructed into two, non-exclusive, components: that which machines are (or will be) capable of: ***Algorithmic Creativity***; and that which they are not capable of: *spontaneous* or *independent creativity*; ***Creative agency*** is driven by this spontaneous, or independent, creativity (and the consensus, beyond sci-fi, is that machines won't develop these capabilities.) (McCaffery, 2017) (David, 2015)

Creative Machines

Janelle Shane (n.d.), a research scientist who 'trains' artificial neural networks, recently gave such an Artificially Intelligent, Neural Network, creative freedom to invent new names for a bank of 7,700 paint colours. (Shane, 2017)

The network was set with a predetermined 'creativity' level. At the lowest level, the 'AI' was tasked with "inventing new paint colours and giving them attractive names". The initial suggestions were nonsense (e.g., Caae Blae 117 118 115), but as the creativity settings were raised, some colour descriptions were more accurate and the associated adjectives more recognisable, (*Ghastly Pink* 231 137 165) and some practically Carrollian, (*Burple Simp* 226 181 132) [the numbers are the RGB codes].

Shane concluded that the neural network, "liked brown, beige and grey" and that it has, "really, really, bad ideas for paint colours". What this actually demonstrates is that the neural network was better able to identify brown, beige and grey, and therefore make more accurate and appropriate connections. This is due to the data set that the algorithm is using, eg; if it were told to ignore faces the results night not have been

skewed in favour of skin tones. To say that the network has 'ideas' whether "really, really, bad", or otherwise, conflates *making connections* with *inspiration.*

The creative process involves envisioning at the start and assessing the success of the solution in meeting that vision, i.e. knowing the end goal and being able to *judge* when that goal has been met. Most of the problem solving can be deconstructed into a set of discrete steps, but those 'boundary tasks' often require qualitative value-based judgments e.g.: a sense of appropriateness when assessing possible solutions (something Shane's neural network was incapable of.)

Value judgment

Computers appear to be good a guessing, but it is not down to luck, it is an ability to make predictions based on previous behaviours, (abductive reasoning.) Internet programmes, such as AdSense and AdChoices, predict what a user might like to buy, based on browsing history and stored 'cookies': eye-tracking software[23] can detect what part of a screen attracts a user's glance and adapt the next page they look at accordingly. But the machine has no way of knowing why someone has looked or searched for some particular images/text and its subsequent actions may be entirely inappropriate.

Value judgements require creative agency.

The French term '*je ne sais quoi'* has rarely been more appropriate. If an attribute, or sense, cannot be quantified, it cannot be deconstructed it does not have discrete components, it cannot be turned into a coded algorithm.

The *'je ne sais quoi'* factor, book-ends the creative process.

Shane's AI neural network, at its highest level of creativity, combined recognisable adjectives with actual colours, but it would appear to owe more to the 'infinite monkey cage' than any line of instruction. How else could labelling bright turquoise, 'Gray Pubic (6 193 214) be explained - *'je ne sais quoi'.* The vision was for new colours with attractive names – the results require non-coded evaluation to assess the success of the creative process.

[23] http://www.ogama.net/

Contemporary dramas, *Ex Machina*[24], and *Westworld*[25] examine agency in machines, using the Turing Test as their crossover point; the machines, humanoid androids, pass the test but, [Spoilers] ultimately follow their initial programming even though they seem to 'believe' they have taken decisions of their own volition. While fictional, it is still an extrapolation of creative machine learning, therefore not unfeasible and mirrors the Determinism view of the 'human condition'[26]. If this argument is taken to the logical conclusion, based on the assumption that real freewill does not exist and that we are all products of our environments, then *creative agency* does not exist and somewhere, deep within each person's personal 'code of instructions', nurture (and probably nature) programmed a set of algorithmic instruction that could completely explain and predict our every action - the counter argument is that, even if freewill were restricted in this way, our environments would (must) continually re-write this algorithm - to the extent that our belief in our own freewill would be so great that it would equate to freewill - making the entire 'no free will' argument rather spurious.[27] To put it another way: if machines develop the ability to 'get lost in their own thoughts' they will have the capacity for Creative Agency – But should that situation ever arise then the 'machines' probably wouldn't be considered *machines* any longer. (think 'Bicentennial Man' [28], where Robbin William's sentient android, goes on a 200-year quest to have his humanity recognised). It could be posited that: Machines will never have *creative agency*, because once they do, they will be more than mere machines. By virtue of having *creative agency* they will exclude themselves from the 'category of machine'.

A main difference between *Creative Agency* and *Algorithmic Creativity* is that *Creative Agency* is aligned with abstract thought and qualifiable process whereas *Algorithmic Creativity* is dictated by quantifiable, logic-gate type instruction – this algorithmic process fails when creative agency is required. A necessary condition of creative agency would be ***'the ability make non-logic decisions.'*** (obviously the ability to make logical decisions does not remove creative agency).

[24] Alex Garland (2014)
[25] HBO (2016-)
[26] The idea that humans only 'think' they have freewill.
[27] To be clear: This research does **not** subscribe to a determinist paradigm
[28] Chris Columbus (1999)

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Defining ‘craftsmanship’ as ‘workmanship + *creativity*’ may seem synonymous with ‘workmanship + *Creative Agency’* (and to a large extent they are the same) – however, to allow the main tenets of this thesis (that machines are not capable of craftsmanship because they are not capable of creative agency) to remain valid, and relatively future-proof - the distinction between *creativity* and *creative agency* is vital.

Chapter Three

The Nature and Aesthetics of 3D Printed Artistic Output

Why use the term '3D printing'?

Digital manufacturing, 3D printing, additive manufacturing, rapid prototyping, computer aided manufacture (CAM), computer aided design (CAD), computer numeric control (CNC) - All terms used generally to describe a particular type of production process, most have specific industry meanings, and some can be applied even more broadly. The nomenclature is far from precise and its importance depends on the agenda. In summer 2014 three conferences took three different approaches: (1) *All Makers Now*, in Falmouth, (All Makers Now, 2014) was coming from the point of view of artists and designer/makers and the impact of the technology on their practices - they used a variety of descriptions such as "digitally designed and made objects", "digital tools" and "digital manufacturing technology", and were happy for each contributor to name their own process however they deemed appropriate - although the ubiquitous use of the term 'digital' was questioned, as discussed in the context section of this thesis (p.36). (2) *The 3D Printshow* - held in London (3D Printshow, 2014) which describes itself as "*a business conference, educational symposium, an arts and fashion gallery and a networking meetup*[sic]" - is happy to use the term 3D printing as an umbrella to encompass almost all forms of additive manufacture being exhibited, however, it is aware of the ambiguity that exists in the definition of 3D printing and address it on its website (3dprintshow.com). (3) *The Additive Manufacturing and 3D Printing International Conference*, held at the University of Nottingham, has a slightly more prescriptive approach. Conference chair, Richard Hague points out (Hague, 2014), originally, in 2005, called the *"International Conference on Rapid Manufacturing"*, it was soon changed to *"... Additive Manufacturing",* and by 2012, in acknowledgement of the industry's increasing consumer product focus, added *"and 3D Printing"* to its title. By paying lip-service to the popular face of additive manufacturing (AM) there was concern about 'dilution' - but Hague waves this aside, having absolute confidence in the conference's position of representing the forefront of the research and science behind the technology. They are also helping shape the official terminology. An ASTM[29] 'committee F42 on

[29] ASTM International is an international standards organization that develops and publishes voluntary consensus technical standards for a wide range of materials, products, systems, and services. (ASTM.org)

Additive Manufacturing Technologies' meeting was held at the conference (ASTM F42) the scope of the F42 committee includes industry nomenclature.

Additionally, additive manufacture is *not* new; it is one of three general categories of making: *manipulation* of materials, from one form into another eg. throwing clay on a potter's wheel or casting; *subtraction* of superfluous materials, eg carving or milling; and/or by the *addition* of extra material (coiling pottery, building a wall, knitting a garment). *3D printing* as terminology, is specific enough to provide recognisable categorisation at the same time being general enough to avoid excluding certain processes, practitioners and outputs. It will become apparent that rather than being a convenient umbrella term for a disparate group, it has become a *lens* to explain how seemingly separate and different entities are associated.

As discussed in Chapter 1., (p.14) Marshall (2008) makes few mentions of 3D, instead referring to 'Rapid Prototyping'; and in their 2007 examination of work by contemporary artists, using digital design technologies Walters and Thirkell refer to specific types of 3D-printing methods (but not *3D Printing)*, it is gives equal *keywords* billing to Stereolithography (SLA) Laser Sintering (SLS) and Fused Deposition Modelling (FDM) and refers only to binder-jet 'printers'. Walters and Thirkell (2007) are searching for disruptive practice rather than hoping for radical innovation. This is not surprising, as innovations diffuse disruptively if they have a relative advantage over the existing, but a radical innovation does not need to compete in this way - it is presenting something entirely new. At this time, digital manufacturing process were being tested comparatively, the threat of displacement was clearly a worry, and radical innovation is often only recognised retrospectively. However, they start by acknowledging that creative practices can be extended - (they also say that art and design boundaries are pushed but don't say how.) Stephen Hoskins uses the term *3D printing* in a more general sense in his 2013 book "3D printing for Artists, Designers and Makers", as Hoskins (at that time) was a research colleague of Walters and Thirkell at the Centre for Fine Print Research, at the University of the West of England, Bristol - it is reasonable to infer that 2012/13 was the point where a convergence of terminologies was adopted (in the UK at least)

It is worth noting that '*3D Printshow',* organisers of the similarly named series of global conventions was acquired by media group 'Tarsus' in 2014 and incorporated the 3D Print Show into their *"Additive Manufacturing Shows"* which do not appear to include any artistic output. While this would seem to contradict the previous assessment on current nomenclature, in his book '3D printing will rock the world', John Hornick (2015) contends that "*3D printing* is the best name for layered manufacturing. As… the other contender, *additive manufacturing*, is inaccurate and overly broad."

What does 3D printed artistic output look like?

To establish what a 3D printed *superficial aesthetic* might be, a variety of established practitioners have been reviewed to identify any common visual attributes. Starting with 3D printing 'artistic pioneers', Karin Sander and Keith Brown, who had access to enormously expensive machines (c. end of the 20th Century), due to their academic positions, established craftspeople, such as Jonathan Keep and Michael Eden, both potters but exploiting the technology in entirely different ways, to high-profile makers such as Joshua Harker and Bathsheba Grossman whose emphasis on impossibility make their work intriguing and popular.

Each practitioner is assessed on their use of the 3D printer, its relevance to their work, the superficial aesthetic of their output, and to some extent their pathway to 3D printing Associated Artistic Output. They are loosely grouped based on the following three evolving aesthetics: (although most fall into more than one category)

- First the *Impossible Aesthetic,* where artists and makers have used the 3D printer to make manifest their virtual artworks, that, until this technology was developed would have been practically impossible to execute. Their focus is on pushing the machine to its limits.
- The next group are those for whom the 3D printer is simply the best process for the capturing the ephemeral and ethereal - for turning code of the virtual into the analogue of tangibility. It is the *aesthetic of code* - more than just the pixelated appearance of the digital, but the sliced and faceted aesthetic of the language between the computer and the printer much like making a physical 2D print of a digital image. The focus here is on using the printer in service of

the design. The printer provides replication - or *workmanship* (more on this in Chapter 3).

- The third group is the *extruded aesthetic*. Laying bare the process, where the workmanship and fingerprint of the machine, are on display. The focus is on what *new* things can the printer do, when it becomes a creative tool, in its own right, or even a legitimate artistic medium.

There is a potential fourth aesthetic, based on a surface texture common to 3D printing, it is a sandstone-like, *granular* texture, a result of laser sintering processes, however this could be considered analogous to the resolution of a digital camera, a surface detail being increasingly engineered out, in order to increase the precision of the output. Its feel is similar to a piece of unglazed bisque ware. Where this effect is desired in ceramics, the piece is left as it is, if it causes surface issues (eg: for hygiene reasons), then it is glazed - a similar coating treatment can be applied to these prints. Many of the pieces come under the *impossible* and the *coded* alethic groups will have been produced using this technique, but it cannot (in the context of this thesis) be considered a type of superficial aesthetic.

The Impossible Aesthetic

Karin Sander

An internationally renowned German contemporary artist, Sander's work often exploits the specific potential of her chosen medium (Schipper, n.d.) and challenges technology to explain its *relative advantage.* Her *3-D bodyscans of the living person* project, started in 1997, adapted scanning technology used in the fashion industry and used 3D printing to make tangible the virtual scanned models of living people.

An Art academic based mainly in Germany but with guest professorships as far reaching as Auckland, New Zealand and Los Angeles, USA. Access to what, at the time, was expensive and exclusive equipment was due of the well-equipped educational faculties in which she was employed.

How is printer used: the printer, was the process used to reify the ephemeral - much like a inkjet printer produces physical 2D photos from a 2D digital image. The process of capturing the image converting to code then decoding it to make a scales replica need no intervention of interpretation, she let the technology do the 'work'

Relevance of printer: Reify the ephemeral - Sander has investigated several different approaches to this 'hands-free' art production process. Her 1997 exhibition the first in the 'body scans of the living person series featured 1:10 'statuettes' of actors, essentially portraits. Using an extrusion method (FDM with ABS filament) the small white models underwent extensive post-printing finishing, airbrushed to match clothing colours and skin tones. Sander was using the technology purely as a tool, as a means to an end, however, her subsequent exhibitions (or sequels) have removed her a step further, the July 2010 '*museum visitor 1:8*' exhibition (Fig 2.1) at K20 GRABBEPLATZ (Kunstsammlung Nordrhein-Westfalen, Düsseldorf), (kunstsammlung.de) scanned and 3D printed 1:8 scale models of visitors, who could decide their own poses, expressions and print colours. What started in 1997 as an enquiry into what the technology could offer the artist, has grown into a test of how far the artist can remove herself from the making process, to the extent that the process is evolving into performance.

Fig. 2.1 Karin Sander, Museumsbesucher 1:8, installation view at Labor, Kunstsammlung Nordrhein-Westfalen

Hoskins (p81) says that Sander uses the printer only as a tool, particularly because she initially removes the superficial aesthetics of the process, but the 3D printing is intrinsic to the understanding of this work, it could be argued that the process *is* the art, and the models are the medium.

Superficial aesthetic: in the first 1:10 scale series, significant effort was taken to remove the striations[30] of the FDM extrusion process. Later series. such as the 1:8 shown above, (fig. 2.1) and in particular the (2002) 1:9.6 (Walters and Thirkell, p.7), produced using a 'binder-jet' deposit method, have a granular surface texture.

[30] Extruded aesthetic (see p.90)

Keith Brown

Another pre-millennium adopter. Just as Sander's work with 3D printing was in response to an invitation - the 7th Triennial of Small Sculpture in Fellbach in 1997 (Müller, 2014) - Brown was selected to participate in the CALM (Creating Art with Layer Manufacture)[31] project. CALM sought to bring artists and engineers together to test the limits to which art could exploit rapid prototyping technology; engaging and challenging all participants equally (ie: engineers as well as artists) was a more important goal than the artistic merit of the output (Hodgson 2001). Selected artist participants were required to make a CAD model of their proposal, some struggled, but Keith Brown, already well-versed in computer visualisation software, took full advantage of the opportunity to reify forms that, up to that point had seemed impossible to manufacture.

Again, in common with Sander, Brown's academic position afforded him access to cutting edge computer graphics soft/hardware, from as far back as 1981 (Hoskins, p.87), he could test and exploit the possibilities of innovative technology before it was associated with any particular artistic output. Graduating with an MA in Sculpture in 1975 (3ders.org (a)), Brown followed the same pathway as most of the 'pioneering digital sculptors' practicing in 2004 (according to Ganis 2004), who first trained to sculpt with traditional physical materials, moving on to virtual construction then exploring 3D printing "later in their careers".

How is printer used? Brown has used 3D Printing to make manifest his virtual sculpture. The printer applies the laws of physics to otherwise impossible constructs, fusing wildly differing scales, such a blood cell with a model of the universe (Brown, 2001). Having low expectations of the aesthetic qualities that the machine output could offer, Brown intended to use the 3D prints for investment casting, however when the completed print was returned to him (from his CALM engineering partner) he underwent something of an epiphany:

> *"I could not have been more mistaken about the aesthetic qualities of the material. I have been making sculpture for 35 years, but never have I seen*

[31] A joint project from HEFC, JTAP and JISC - following the 'Computers in Art and Design Education' conference in Brighton in 1995 - set up to introduce CAD and rapid-prototyping technologies to Art and Design Academics in the UK. The final report was published in December 1998 (CALM)

> *objects that possess the qualities evident in this piece. [It was] an immaculate object in itself and not just a prototype.*
>
> *It... had completely transcended any preconceptions that I had formed about it as a CAD object."*
>
> *(Brown 2001)*

Despite his delight in the printed artefact, many of Brown's early pieces were ultimately cast in bronze.

Relevance of printer: Although Brown seems to suggest that an object is **not** 3D printed if it is cast in Bronze (Hoskins, p.88) (taken from a 3D print) it would be untrue to say they are not examples of *'3D printing Artistic Output'* (see page 143) - because, as Brown says, it *"can't be made any other way"* (3ders.org), therefore the process is intrinsic to its existence.

Brown's ongoing work uses the MCor ARKe colour printer. (mcortechnologies.com)

Superficial aesthetic: Impossible and Coded (ie: it would be impossible to transfer the virtual art to the physical world by any other method)

Joshua Harker

Harker's filigree skulls and 'tangles' sculptures have grabbed the public imagination, his 'Crania Anatomica' (fig. 2.2) has subsequently become the most successful 'sculpture' Kickstarter[32] campaign to date and *"an icon of the 3D printed medium.* (joshparker.com (a))

[32] An online, crowd-sourcing platform (kickstarter.com)

Figure 2.2 Kickstarter screen-shot for Crania Anatomica campaign - taken from joshuaharker.com

Harker's "unmakeable" pieces, in virtual form, preceded their 3D printed versions - The "perfect storm" of software and technology that his art was "waiting for" had finally "mature[d] into a usable medium" (joshparker.com (b))

While Warnier et al (2014 - p155) question the artistic nature of this type of mass production (the Crania Automica project) Harker is in no doubt. He uses the software as an artistic tool and sees no difference between it (and the lengthy skills development process) and any other sculpting of modelling tool - similar to a view taken by Grayson Perry (2015) (which is discussed further in Chapter 2, *Perpetuating the conflation of Craftsmanship and workmanship*, p60) - The 3D printer is merely the means to make his virtual work tangible.

How is printer used: Harker uses SLS (Selective Laser Sintering) to fuse a nylon-based powder (polyamide) to form his prints. These are often the finished pieces (as in his filigree work) or they undergo a further investment casting process to produce metal (usually bronze) cast pieces - fig. 2.3

Fig. 2.3 Permutation Prime (2004) (Joshua Harker 'Tangle Sculpture) Copyright © 2017 Joshua Harker

Relevance of printer: While Harker insists the 3D printer is a means to an end, that does not diminish the importance of the technology. This output would not exist without the 3D printer, it is intrinsic to the understanding of the pieces. This is backed up by a typically aggrandising statement on Harker's website:

> *"To fully appreciate the gravity of the pieces one must understand the practical impossibilities of their existence. This has been considered a landmark event in the history of sculpture & the chronology of the 3D printed medium & has made him one of the most recognized artists in the field."*
>
> (*joshparker.com (c))*

Superficial aesthetic: The overwhelming superficial aesthetic is that of 'impossibility', however, the raw prints, using SLA polyamide, are subject to some post-printing dusting and present a the typical 'granular' surface that results from this process.

Bathsheba Grossman

A Californian artist who is best known for her small-scale 3D printed, mathematical models. Whether or not her gyroids (fig 2.4) and Klein bottles (fig. 2.5) are considered *Art* is an argument for elsewhere, however her output has artistic intention and therefore worthy of consideration here. Another 'pioneer' of the 3D printer, like Harker and Brown, she has developed a practice, and gained recognition, through her production of 'impossible objects'.

Fig. 2.4 Gyroid © Bathsheba Grossman

Fig. 2.5 Klein Bottle © Bathsheba Grossman

Hoskins voices concerns about the ubiquity of these impossible mathematical forms as 3D prints (Hoskins p88) however Grossman's ideas have followed a similar route to Karin Sander's; both have taken computer generated images, of existing 'objects' (people in Sander's case and mathematical formulae in Grossman's) and reified them with a 3D printer. Now even ASDA shops are to offer walk-in portraiture booths (fig 2.6) and Grossman herself, offers free gyroid stl. files for download from her website. (bathehba.com); but this is the natural consequence of artistic output that demonstrates a technology - others can only emulate and/or appropriate it, but rarely help it evolve.

Fig. 2.6 ASDA 3D printing booth image ASDA/YouTube

With the turn of the millennium, began the reduction in cost of 3D printing, this accessibility drew Grossman to the medium. Initially a mathematics undergraduate she was influenced by sculptor, Erwin Hauer, and began exploring the modelling of "freewheeling biomorphic shapes" (McCrum, 2015)

How is printer used: Grossman's preference is to produce work in archival materials (glass, metals and ceramics), producing her 3D prints ether in printed steel or by investment casting. However, she does not limit her pieces and prices her work to sell. By using the Shapeways print bureau, (shapeways.com) buyers have the option to purchase her work, printed-to-order in high-cost precious metal or a few dollars' worth of nylon.

Superficial aesthetic. 'Impossible'

Relevance of printer: As with the previous 'impossible' artistic outputs. The printer is both incidental and intrinsic. If there were a process that offered a clearer relative advantage, to reach the same end, then that alternative would be used, However, it is that fact that this technology exists that Grossman's output also exists.

What sets Grossman's work apart from the other 'impossible' makers is that it is, essentially, craft. The differences in Craft and Art are further examined in Chapter 4, *The Creative Landscape*, however Grossman's pieces offer functionality beyond their

own existence, e.g. jewellery, bottle-openers and ornaments. How disruptive this practice is, however, will also be explored in Chapter 4.

Michael Eden

Like Bathsheba Grossman, Michael Eden appears to be producing 'impossible craft' however, Eden's classification as a crafts producer probably has more to do with a maker's association with a particular material (in this instance clay) despite the level of utility of their work. He specifically identifies as a 'maker' stating, "I do not define what I do as Craft". (Eden, 2012)

(It could be said that Keith Brown and Michael Eden produce equally experimental work, employing a 3D printer in their process making output of similar scale - however as Eden is known as a craft potter - his output is considered craft and as Brown is known as a sculptor his work is Art. Stephen Hoskins has followed this convention with the chapters they have been assigned to in his book.[33])

It is hard to argue that his output is not in fact 'Art' as he says his "aim is to communicate an idea or tell a story".

Michael Eden, a successful potter of 20 years, explored combining his craft skills with digital design and manufacture, during an MPhil. His first 3D printed output was the beginning of his 'Wedgewoodn't series of 'tureens' (michael-eden.com)

How is printer used? Michael Eden designs his pieces virtually and sends the coded files to 3D print manufactures to make. The majority of his output is SLS nylon, encased in various coatings to give ceramic or metal-like finish, although he does experiment with ceramic prints and investment casting.

Relevance of printer: Michael Eden is the 'designer' of his pieces and he retains Creative Agency over his output until such times as ownership passes to someone else, however the *workmanship*, used in the execution of his design is carried out by another - in this instance the 3D printer. In sending his digital designs to a print bureau (for example) it is largely irrelevant to Eden, whether or not a 3D printer is used to

[33] Eden is in 'Crafts and Craftspeople' and Brown is in 'The fine arts' chapter, of Hoskins book *3D Printing for Designers, Artists and Makers.*(2013)

make manifest his design. However, this doesn't mean that the process is irrelevant in the understanding of his work. The designs are made to meet the capabilities of the 3D printer, in the knowledge of what those capabilities are.

Superficial aesthetic. Impossible (for the same reasons as previous practitioners) and also a *coded aesthetic*, the 'fingerprint' of the craftsman's tool is on display - which in this instance is the computer - that is the tool that the creative agent uses.

Coded aesthetic

In Chapter 2, the isolation of *workmanship* within the creative process is discussed more thoroughly, however, it is of particular importance when considering the *coded aesthetic.* These pieces maybe 'otherwise unobtainable' in practical terms, in that it is possible to make them by other process but because of the relative disadvantages of other methods, 3D is the only way that they are likely to ever be made. The *relative advantage* these machines have over other methods is their unadulterated *workmanship* capabilities - they have no agency, creative or otherwise, to interfere with the computerised, virtual design. The code is *translated* from one machine to the other, not *interpreted*, which is the drawback when the workmanship is carried out by a 'person' (even that of the designer).

Johnathan Keep

Another maker assigned, by Hoskins (p.63) to the craft field. Keep self-identifies as potter, not because he aligns himself with craft as a separate entity, but because he sees crafts as a legitimate form of artistic output, deserving of equal consideration. Also, similar to Michael Eden, but differing from Joshua Harker, Keep exploits the generative potential of algorithmic design, recognising analogies with nature; the symmetry, geometry and relative progression and attempts to include these in his coding.

Keep followed a similar pathway as Michael Eden: Degree, practice, Masters, then further practice.

Fig. 2.7 Johnathan Keep's 'Delta' Printer - idling at the 'All makers now conference' - Falmouth 2014 Image Catherine Scott

How is printer used: Keep is the first in this list to extrude his print material (clay), but by using a 'delta' printer (fig 2.7) rather than the flat-bed plotting systems that are currently (c.2017) the basis of home 'desktop' printers', using FDM or more correctly FFF (Free Form Fabrication) (FDM is a proprietary name).

Relevance of printer: The printer, for Keep, is part of the whole making system, reifying his virtual designs, the computer and printer are tools of equal import. However, what Keep has done differently from the previous 'makers' is stayed loyal to his material - clay. Connection to material is often seen as a trait of the craftsman rather than the artist.

The original meaning of the word *craft* (and not the mistranslation attributed to Diderot[34]) described a specific skill[35] - the craft of any occupation or activity is the expert knowledge that a practitioner, in that field, needs to be properly skilled in that field. (e.g.: the real *craft* of being a 'shepherd' is knowing how sheep think)[36] Likewise the real *craft* (or skill or specialist knowledge) that a potter needs, to be properly skilled in their field - is an understanding of what clay *does*. Jonathan Keep is acutely aware of the effect of real world physics on his prints as they transition from the ethereal to the earthly. He knows how coils of clay at the bottom of a structure, support the subsequent layers above them, he knows that printing too quickly may

[34] See essay p 57
[35] according to Merriam-Webster (n.d.)
[36] This is a fabricated example which may be true - but probably isn't

result in collapse and printing too slowly my cause uneven shrinkage (and collapse). So, while his fingers may not physically manipulate the clay, he is still able to retain control over the making, through his knowledge of the material. This ‘faithfulness’ to the material in turn exposes the process - both the code and the printer.

Superficial aesthetic. Keep’s pieces may seem *impossible* to make by any other method, however, were a hand able to control an extrusion device, with the same precision of his delta printer, it could produce the same work (whether that be Keep’s hand or the hand an extruding technician) - but the printer holds the relative advantage, over the hand, in the precision and accuracy stakes; the most striking aesthetics at play here are the manifestation of the code and the striations of the extrusion. Some pieces may seem to take the form of a standard clay pot, but the truth of the extrusion still shows through (fig 2.8) and (fig 2.9)

Fig. 2.8 vase - J Keep (image c.scott)

Fig. 2.9 close up of extrusion striations from fig 2.8

The extrusion lines are even more prominent on other pieces, such as his iceberg series (fig 2.10). the contrast between this inside and outside show the effect of glazing on these lines. These pieces also demonstrate a ‘coded’ aesthetic. In this instance Keep is exploring how, “The natural structures have an underling logic that computer code can mimic so a different and original object is created each time the code is run.” (keep-art.co.uk)

Fig. 2.10 'Iceberg' by Jonathan Keep. On display at 'all makers now' conference Falmouth 2014 (image Catherine Scott)

Sophie Khan

Khan credits a combination of new and old technologies for the fragmented aesthetic of her work. (fig 2.11). After undertaking a BA in Fine Art and History of Art she studied architecture followed by an MFA in Art and Technology studies.

How is printer used: The 3D Printer is used to reify Khan's 'virtual work', sometimes used in final pieces, sometimes as casts for clay or metal. The 'fragmented' nature of her pieces allows her to make life-size sculpture from a small print bed, by assembling the pieces after printing.

Relevance of printer: The 3D printer is incidental to Khan's output, the exploitation of 3D scanning and the capture of a body in motion is central to her work. It remains to be seen how much of an influence the limitations of the equipment make on her artistic practice. It is important to the extent that process is important to Khan, where the 'making' done some other way that would then be important.

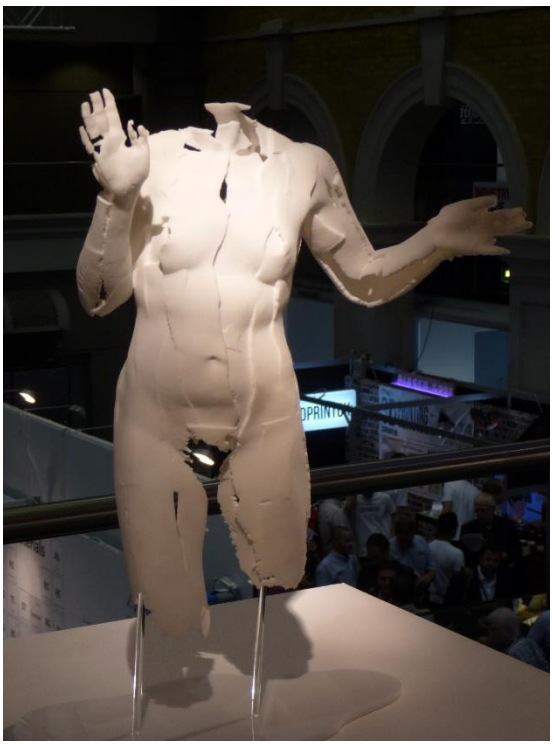


Fig 2.11 Sophie Khan - Periode des Attitudes Passionelles, 2014 3D print (from 3D laser scan) Image Catherine Scott

Superficial aesthetic. Post printing finishing has removed any evidence of the particular process used and pieces themselves do not present the level of 'intrigue' that would warrant an 'impossible' aesthetic. There is no particular 3D printed, superficial aesthetic here, other than sense that this *could* be 3D printed -which could only be inferred by those with prior knowledge

Tobias Klein

The Garden of Earthly Delights (fig 2.11.1) is Klein's "revision" of Bosch's late 15th century triptych (museodelprado.es), he explores the juxtaposition of manmade architecture with nature overgrowing, and nestling within, it. He also uses the colours from magnetic resonance images, of his own body, to dictate the colour gradients on the 'organic' shapes. 3D printing has afforded him the *best* way to communicate his message.

Fig. 2.11.1 – Tobias Klein – the garden of Earthly delights – printed by Stratasys – image C. Scott

Primarily an architect, Klein has continuously used computer interfaces to develop creative output.

How is printer used: as is typical for this group, Klein's printer is a tool to make physical versions of his virtual art works. There is also feedback, knowing the capabilities of the printer influences how the virtual designs develop. (Output - 2014 -YouTube c.1.55)

Relevance of printer: Klein's work is *not* a demonstration of the printer's capabilities, he does not use the printer for the sake of it - he sees it as the best tool for the job. However, there is clearly some dialogue with his tools - more noticeable in those pieces that also fit with the impossible aesthetic. Such as in 'synthetic syncretism' Fig 2.12

Fig 2.12 (above) Tobias Klein Synthetic Syncretism (façade) © Tobias Klein
fig 2.13 (top right) Casa Batlló, Barcelona. © Casa Batlló
fig. 2.14 (right) 3D print/modelling workshop, La Sagrada Familia, Barcelona. Image: Catherine Scott

Superficial aesthetic. While Klein's work clearly falls into the 'coded' aesthetic, he exploits the printer's capabilities too. The printer does not drive the design, and many pieces seem otherwise impossible, however the above image of 'Synthetic

Syncretism' (fig 2.12) has similarities to Gaudí's 'Casa Batlló' (fig 2.13). Over a century ago, Gaudí did not have the rapid prototyping technology available but still managed to make models of his work. Co-incidentally, the ongoing work at La Sagrada Familia, in Barcelona (Gaudí's unfinished masterpiece) relies heavily on 3D printing to make test models of architectural features, (fig 2.14) (plaster models were made by Gaudí but were destroyed by Catalan anarchists during the Spanish civil war).(sagadafamilia.org) It is reasonable to assume Gaudi would have been an enthusiastic proponent of this technology had it existed.

Nervous system

A partnership, formed in 2007, between Jessica Rosencrantz, and Jesse Louis-Rosenberg, their vision brings together process and form using generative design. Their work is distinctive such as their recent Kinematics project, a sort of modern 'chainmail' that takes advantage of limited print volume my being printed 'crumpled-up' only to unfurl into a fluid 'fabric'(nervous.com). However, their earlier 'cellular structure' project, was (is) a truly radical innovation in the field of 'mass customisation'.

Below is a design for a bangle, as result of collaboration between Nervous System and Catherine Scott using the interactive (and very intuitive) web site. The parameter controls sit at the bottom and the cursor (mouse or fingertip controlled) pulls and pushes the shape the via the nodes shown in the screen shot (fig.2.15) the output variations are practically infinite.

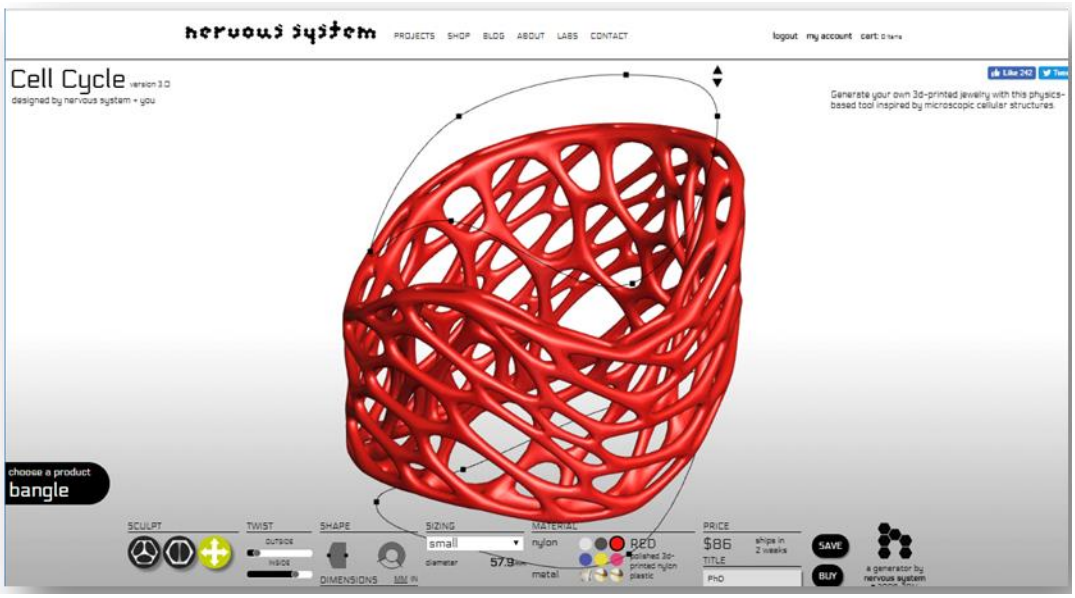
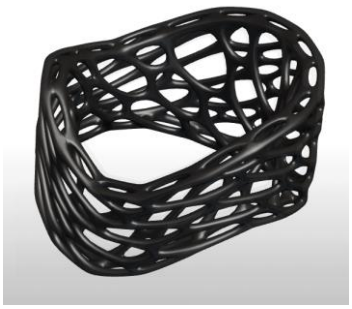
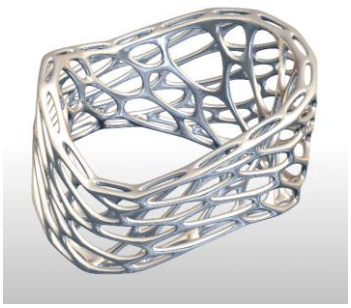


Fig 2.15 A screen shot of Nervous System's online customisable jewellery, interactive design tool. (14/07/2017)

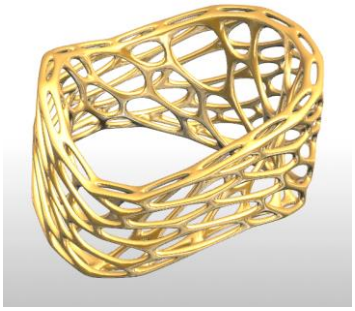
The design can now be printed in a variety of nylon colours, polished and dispatched in 14 days for the sum of $86, or printed in wax and then cast in silver for $1,494 or even gold for the princely sum of almost $15,000, and the turnaround still within 14 days. (fig 2.16)



$86 -polished black nylon



$1,494 - sterling silver



$14,844 - 14k gold

Figure 2.16 costed variations on fig. 2.15 model

Rosencrantz has degrees in Architecture and Biology, Louis-Rosenberg, in Maths. Like Harker and Grossman, Nervous system are selling direct to the public, however, they are using their own platform rather than an intermediary print bureau.

How is printer used: Most of nervous system ‘retail’ output is either, direct printing (Nylon SLS with post printing finishing to get rid of surface issues (ie: granular texture) or wax prints for investment casts. Their ‘fabric’ prints make full use of the available print that volume even smaller printers can offer (fig: 2.17)

Fig. 2.17 Nervous system Kinematics Link Bodice © Nervous System

Relevance of printer: to the collaborator, the 3D printer is entirely incidental, to Nervous system, it affords greater manufacturing scope as the ‘workmanship’ the technology offers improves and increases. One of their kinematic ‘fabrics’ is made from many individual triangles, hinged to form a dynamic tessellated surface. This could be made by hand, but the complexity of assembly gives the 3D printer an increasing relative advantage.

As Chapter 3 will explore, this is where the 3D printer threatens to disrupt the Creative landscape - the areas where it offers a relative advantage in the provision of workmanship.

Superficial aesthetic. Coded.

Geoffrey Mann

Mann's pieces[37], in his 'otherwise unobtainable' exhibit at the 'all makers now' conference, are not 3D printed, (see fig 1.3 chapter one) however, they exploit and embrace 3D printing processes, they are intrinsic to the artistry of the work. It could be the software, the image capture/scanning, printing of moulds or forms. His material of expertise is glass; however he is not disrupting existing methods, he is introducing radical new process, that can be used alongside traditional method. His work has implicit 3D-printedness. Some pieces have explicit 3D superficial aesthetic: sliced representation of the code or the impossibility of capturing "the erratic behaviour of a moth upon the stimulus of light"[38]; and those that do not, can be understood more completely through the lens of 3D printing.

How the printer is used: As with many practitioners in this 'coded aesthetic' group, the ability to permanently and physically capture, ethereal and ephemeral coded artistic output is where the 3D printer's greatest relative advantage lies. As with much of Sophie Khan's work, the 3D scanner is the tool exploited to the greater artistic end. An example of this is Mann's 2010 piece 'Shine' (fig 2.18); it is an investigation of the 3D scanner's inability to distinguish the surface of a polished candelabra from the reflection caused by the scanner - the scanner did not 'translate' the image of the candelabra - it 'interpreted' it - the 3D print was used to make a mould so that the coded representation could be cast in bronze.

[37] While these pieces were exhibited as Mann's, he later clarified that they were not his work, but rather part of research on which he had been named as co-author.

[38] 'Attracted to Light' at MoMA (2005)

Fig. 2.18 Shine 2010, G Mann. image © Nick Moss

Relevance of the printer: For 'Shine' the 3D printer was vital in the reification of the coded image, but it is not intrinsic to understanding the piece. Without knowing Mann's intended meaning, but understanding some of the processes involved, the viewer could *construct* their own meaning to be, 'an exploration of what is lost (or gained) in translation between the virtual and physical worlds' - and applying the lens of 3D printing *does* affect how this meaning is constructed.

Superficial Aesthetic: Coded (and often impossible)

Mathew Plumber Fernandez

"*a British/Colombian artist that creates sculpture, software, online interventions, and installations, often in connection, producing and reflecting on contemporary socio-technical entanglements and their comical discontents."* (plummerfernandez.com). Algorithmic feedback, as a generative art process, features heavily in Plummer Fernandez's work, his design training (dezeen.com, 2012) may be responsible for his 'what if' approach to coding experimentation.

He has followed a continuous educational pathway: BEng Computer Aided Mechanical Engineering, BA Graphic Design, MA Design Products and is currently undertaking PhD research at Goldsmiths, University of London .

How is printer used: 3D printing his work is simply the logical conclusion to his process - if a physical conclusion is required. In his pieces that explore authorship, by testing copyright limits (Warnier, et al. p91), perceived difference between the ethereal and myriad iterations of a coded file and the concrete tangibility of its subsequent print, logically, require a physical print. (fig 2.19)

Fig: 2.19 Matthew Plummer Fernandez - sekuMoi Mecy (2012) image M Plummer Fernandez

Regardless of the message of these pieces, the use of a tessellated superficial aesthetic is a reflection of 3D modelling code, and one that the 3D printer can understand. Plummer Fernandez's 'digital natives' (fig 2.20) series demonstrates this further - buy taking an everyday object with a smooth surface (eg: a detergent bottle) and progressively reducing its surface resolution, via a distorting algorithm - the exact opposite of 3D printer developers, who seek to 'engineer-out' surface issues.

Vessels are arguably the lowest common denominator for man-made objects across all cultures, these objects however have no storage function other than to embody the stored digital data that describes them.

M Plummer Fernandez

Fig. 2.20 Digital Narratives 2012 - image Matthew Plummer Fernandez

Relevance of printer: Again, typical of this aesthetic group, the printer is a means to an end, however, as with Geoffrey Mann, applying the lens of 3D printing does affect how meaning is constructed by the viewer.

Superficial aesthetic. Coded

Extruded aesthetic

Dave Lobser

Dave Lobser's 'vessel' project (dlobser.com), sought to treat printers as, *"not just a prototyping tool, but a new expressive medium"* (3ders.org (b)). The G-code is the numeric instruction a computer sends to a printer to describe the geometric pathway the print-head must take. Usually, the software slices up a geometric shape, writes the matching G-code to instruct the printer to replicate the geometric shape, layer by matching layer. Lobser makes adjustments to the code making consecutive layers follow different paths.

Dave Lobser attained a BFA in Animation followed by a Masters in Interactive Telecommunications. He is currently an artist, animator and creative coder based in New York. (dlobser.com (b))

How is printer used: Although the printer follows precise instructions, it does not translate a shape from screen to printer, the final shape is dictated by the resulting extruded form. Lobser developed an interactive web tool (fig 2.21) with numerous variable parameters. The code is sent directly to the printer and the output can vary from wild nest like shapes to textures that look like knitwear or basketry (fig 2.22)

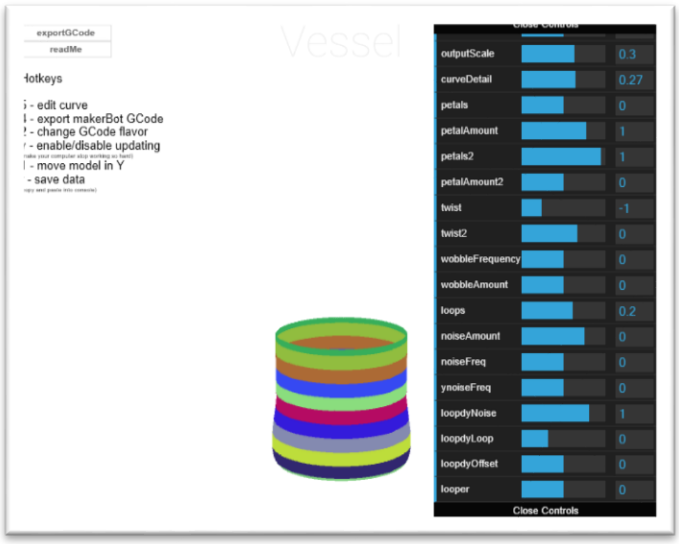


Fig 2.21 Interactive webtool for Dave Lobser's 'vessel' project

Fig 2.22 Dave Lobser G-Code 'Vessels' images, David Lobser

Relevance of printer: The printer is more closely connected to the hand than in the previous two 'superficial aesthetics'; in the *coded* and *impossible* groups, the printer acted as a studio technician, carrying out the precise workmanship required to execute a predetermined design. Here, there is no workmanship involved,

> *'The process was experimental in the sense that I couldn't be sure what the end results would be. I traced paths which intentionally did not overlap or create*

> *clean contours in the service of happy accidents. Sometimes the results look woven, sometimes they become tangled birds' nests, but they're always surprising*." *Dave Lobser* (3ders.org (b))

Superficial aesthetic: the material is very exposed in Lobser's pieces, the residual stress within the non-Newtonian fluids used in the extrusion process, dictates the surface curvature (meniscus) typical of the extruded aesthetic.

Dirk Vander Kooij

Vander Kooij's approach to 3D printing is 'low-resolution', not only does he expose the aesthetic produced by the extruding nozzle, but he emphasises it. His 'world's first' *"robot which can extrude furniture pieces from 100% recycled material",* (dirkvanderkooij.com (a)) allowed him to print to an anthropomorphic scale, as opposed to being restricted to a print-bed, with a relatively large nozzle, exaggerating the extruded aesthetic.

His 'endless chair', shown in production (fig 2.23) and closeup (fig.2.24)

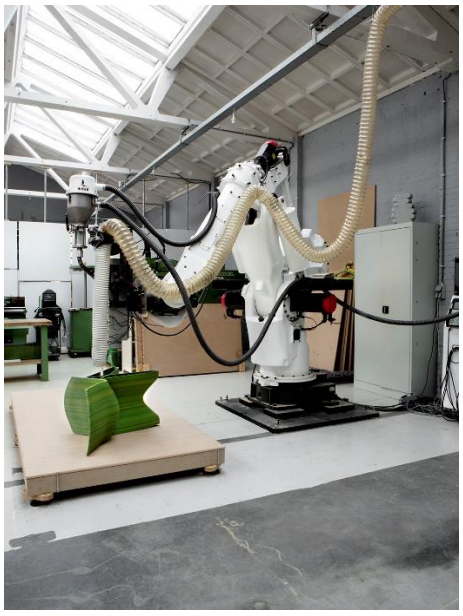


Fig 2.23 Endless Robot © Vander Kooij

Fig 2.24 Endless Chair, close-up © Vander Kooij 2017

According to Vander Kooij's biography: "In 2009 Dirk graduated from the Design Academy in Eindhoven (NL) with a giant robotic arm, designed to extrude large objects like furniture from recycled material."

How is printer used: With the extruder nozzle attached to a six-axis CNC-controlled arm (fig 2.23) the option also to lay the extruded layers over moulds also exisits. Many of Vander Kooij's pieces are not the result of horizontal layers only, the Chubby Chair (fig.2.25) is extruded and bent into shape. before the material hardens.

Relevance of printer: Vander Kooij has said that the extruded plastic sting has been *"crafted by a robot"* and that he *"taught a robot his new craft"*. However, even though *"most of the things he produces are not made by hand",* he very clearly considers himself the *craftsman* in this process, *"one who embraces technology and machines".*

Fig 2.25 . Dirk Vander Kooij - Chubby Chair, Design Museum, London. Image Catherine Scott

> *He is not interested in standardization or mass production, but in a way to produce industrial quality products that are actually beautiful without using strict production systems, huge investments in tools and materials and long production lines. .... As the contemporary craftsman develops more knowledge and skills thanks to the constant iteration, as a result the design process remains smooth and flexible.* *dirkvanderkooij.com*

The printer, in this relationship, provides the *workmanship*, while Dirk Vander Kooij, as the craftsman, provides the *Creative Agency.*

Superficial aesthetic. With very low-resolution extrusion lines, the apparent making process is on display. However, it is worth noting the work of *Front Design*, a Swedish design group producing mainly interior pieces and furniture,

(frontdesign.se), in their ‘Sketch Furniture Performance Design’ pieces (fig 2.26) have been produced by using motion capture of ‘light writing’ which has subsequently been converted into digital files and printed using stereolithography. They certainly have an extruded aesthetic, however what is presented here is the pathway the light took, not the pathway of the nozzle. These Front Design pieces probably have more in common with the ‘coded aesthetic’ group. However, Dirk Vander Kooij’s pieces, definitely belong in the ‘extruded aesthetic’ group.

Fig 2.26 Sketch Furniture Performance Design. Image Front Design

Emerging Objects

Like Dave Lobser, *Emerging Objects* (A creative 3D Printing MAKE-tank, based in California) have investigated G-Code manipulation. Their GCODE.clay project disrupted the g-code sent to a clay extrusion printer, "creating a series of controlled errors that create new expressions in clay defined by the plasticity of the material, gravity and machine behaviour." (emergingobjects.com) On the printed object, the surface extruded aesthetic resembles textiles, at first glance they look like Aran tea cosies[39] (fig. 2.27)

Fig 2.27 Extruded clay vessels © emerging objects 2107

Co-founded by Ronald Rael, Associate Professor of Architecture University of California Berkeley, and Virginia San Fraello, Assistant Professor of Design San José State University - Emerging objects innovate with 3D printing and its potential materials at a human - architecture scale.

[39] *Aran* being a traditional, highly textured traditional Irish knitting method - and tea cosy being a tea-pot jacket to keep the contents warm.

How is printer used: For the same reason Jonathan Keep uses a machine to extrude clay: namely, this method does it in a way that even the most practiced hand never *will* - never *could,* would be, strictly speaking, a wrong assumption but because these pieces are driven by an experimentation in machine code, and the fact that this method now exists, there would be no advantage (or reason) to attempt to do this by hand (apart from perhaps in the name of academic rigor - see p 132, *Printer-less Prints.*)

Relevance of printer: It is important to understand, with this project, that machine language and how it can be manipulated and subsequently interpreted rather than translated buy the printer, is key to the output. This is a similar sensibility to Mann's 'Shine' (see fig 2.18)

Superficial aesthetic: Despite the project being called 'GCODE:clay', the aesthetic is very much *extruded.*

Shane Hope

Hope's largely impenetrable artist's statement, (shanehope.com) states that his artwork:

> *"can be considered an oblique form of future studies. It's from contemporary technoprogressive, transhumanist, H+, hard sci-fi and singularitarian ideas that I'm filtering-out fodder for forward-looking visual responses… Species-Tool-Beings, Nano-Nonobjective-Oriented-Ontographs, Free-Range Femtofacture-Lures, Speculativernacular Signage and Transubstrationality Tool-Being-Chains"*

Fig, 2.28 shows a detail of one of his 2014 series, 'Species- tool-beings: '*protocol-onization-of-commons-clusters'*, this and similar pieces can be viewed on Hope's website: http://shanehope.com/wp/

Hope has studied New Genres at San Francisco Art Institute, and Information Arts at San Francisco State University.

How is printer used: Similar to Dave Lobser and Emerging Objects, Hope manipulates G-code, and other auxiliary machine codes (M-Code), he has coined the term 'prainting', to describe the output, as he sees it as a cross-over between printing

and painting. He describes it as “how hot-mess molecular modelling [sic] and 3D printing translate one another” (although according to the definitions applied in this thesis - the output is more likely an interpretation rather than a translation). This *interpretation* is influenced in the main by Hope’s intervention during the print process, eg: switching filaments, moving the print-bed and adding external pigments such as paint or felt-pen ink.

Fig 2.28 Detail of ‘protocol-onization-of-commons-clusters’ - image Catherine Scott (2014)

Relevance of printer: From a *constructivist* point of view (rather than making inaccurate inferences and assumption about Hope’s message), Hope appears to be using the 3D printer in the most ‘painterly’ way of all the practitioners reviewed, as a tool to apply and manipulate his media. The artist’s hand is clearly visible in this work, however his claim that 3D printers, “exhibit expressionistic potential and misbehave more like my painting assistants.”, while concurring with this thesis’s assertion that, *3D printers take the role of studio technicians*; he starkly contrasts with the base hypothesis of this dissertation[40], by affording the printer the agency of ‘mischievousness’. Hope appears to suggest that he *collaborates* with the 3D printer.

Superficial aesthetic: The predominant aesthetic is ‘extruded’ and as such, Hope’s work displays the process; what is seen in his pieces are the brushstrokes of his tools.

[40] that 3D printers are not capable of ‘Creative agency’ and provide only ‘workmanship’

Unanswered Questions

The questions that arose at the start of this part of the investigation, can now be addressed, namely:

- Is the 3D printer a *legitimate* artistic tool?
- Is the 3D printer just a tool (a manipulator of matter or a transferrer of energy)?
- Is there a 3D printed aesthetic?
- Does using a 3D printer create '3D printed art' or just 'art' that happens to be 3D printed?

Is the 3D printer a legitimate artistic tool?

For all of the featured practitioners, the 3D printer is seen as a legitimate tool in their practice, they tend to subscribe to the idea that the skills involved, in learning to manipulate form and create 'virtually', is analogous to any other dexterous skill that has the hand in closer proximity to the artefact, as Harker says,

> *"All forms are designed, developed, and executed by me in a similar creative process I use when sculpting in clay, stone, or wood. The software & peripherals I use are simply new tools in my art and require no less skill to learn and use than the traditional variety."* (joshparker.com (b))

a sentiment espoused by McCullough (1996), and Perry (2015) almost 20 years later.

Other practitioners, whose output does not fit into any of the thee identified *Superficial Aesthetics* but could still be understood as '3D Printing Associated Artistic Output', fall into two categories; those who hide the association and those to whom it is <u>just</u> a tool (see below). The reasoning behind this apparent denial has been addressed by Brigette Mongeon (2016). Mongeon is a sculptor and uses new digital manufacturing technology as tools. She either sculpts virtual maquettes using ZBrush software[41] or makes her maquettes by hand and then scans them into digital form. Scaled-up versions of these models are CNC milled in foam, which are then used for investment casting, usually resulting in bronze pieces. The advantage in her process is that the work, and time invested in developing the work, is not lost in the scaling-

[41] http://pixologic.com/

up of the final piece. This process may impact negatively on a technician whose primary skill is scaling-up sculptors' models to produce full size moulds for casting (which will be examined in greater detail in Chapter 4.) however, the sculptor can avoid the technician 'interpreting' their work, thus retaining creative agency over the entire production process.

In her section "Is it Art? (p.44) Mongeon claims that the subjectivity of this question depends on the viewer and goes on to compare artisans by 'art-worthiness'. Echoing a quote, she uses from Keith Brown, that the "art should rise above the medium in which the artist creates", she insists that this new technology is "just another medium, another tool", but asks*: Does the art created with the 3D tools somehow have less value because of the process?* (user value will also be addressed in Chapter 4). As this thesis will later reiterate, using a 3D printer to translate an artistic design, from virtual to concrete, is similar to employing a technician/artisan to execute a design, and because a machine can only translate, rather than interpret, then the output will be a more faithful representation of the work of the artist. If a print seems more of an interpretation than the designer was expecting, the fault lies in their (mis)understanding of the level of workmanship the printer (technician/artisan) was capable of; additionally, any technician/artisan, who is wont to apply some unsolicited *creative agency* to someone else's design, may be demonstrating poor *workmanship.* Within many art practices, using technicians to complete tasks, which do not require creative agency, is acceptable practice (Petry, 2012); from the renaissance workshops described by Cennini[42] to Jeff Koons 'assistants' painting by numbers (Powers 2012), however, Mongeon, feels this is more of a guilty secret for sculptors,

> *"…there are many artists who embrace the technology in their workflow, and sell their artwork as fine artwork. The museums, galleries and patrons collect the work and the artisans simply do not publish how they create the art. The collectors never know."* Mongeon 2016, p.45

There is an implication that sculptors, working from a digital staring point would churn out endless *identical* copies, compared to a series of pieces made from the traditional lost-wax process, were each would be slightly different because they each

[42] A late 14th Century, Florentine painter, whose book *"The Craftsman's Handbook (Il libro dell'arte)"* details the working practices of Italian painters' workshop (OU, 2007. p.9)

made ‘by hand’ (either by the sculptor of by their technician) But this argument does not hold up to scrutiny; it suggests that the value of a cast bronze sculpture lies in the workmanship involved in making the mould, in particular the differences caused by poor workmanship (which the sculptor may have no creative agency over, other than to discard it) whereas each ‘wax-print’ is a direct translation of the sculptors design and each can be *deliberately* modified to make each unique. She suggests that artists can add in *differentiations* to make the pieces look less ‘manufactured’ - but adding in ‘imperfections’ to make a piece look hand-formed is more akin to ‘cheating at art’ than admitting that 3D printing (or similar) was used in the production process.

It is not the intention of this thesis to confer or deny art status on any piece of artistic output, however, it is evident from the examples presented, that the 3D printer is a legitimate tool in the production of Artistic output - regardless of the significance of that tool to the practitioner and to the understanding of that work. Which brings up the second question:

Is the 3D printer just a tool (a manipulator of matter or a transferrer of energy)?

Some of the featured makers insist that the 3D printer only serves the design; purely a translating tool to reify ‘virtual/coded/digital’ artistic output. Saying so, seems disingenuous as it is clear that the works in question either *cannot* be made by any other means, or *would not* be made. The ‘<u>just</u> a tool’ test would be the relative advantage of the printer to each practitioner. If a different method of production were available (and ‘better’ in relative terms), would the practitioners switch? For the featured practitioners, what might constitute a *relative advantage* may be difficult to define: Michael Eden (for example) sends his work to a 3D Print Service, how they *actually* execute his work is largely irrelevant, it is essentially a ‘black box’ process, where the inputs and outputs are known, and the ‘internal workings’ accepted on the basis of those inputs and outputs. This suggests that, were the print company to develop a completely different way to produce the same outcome, it should be of no consequence to Eden, or any of the other practitioners who appear to use the printer in service of their designs (the *coded* aesthetic group in particular). However, despite their current processes, the capabilities of the 3D printer have influenced their work, either, as in the case of the *impossible* aesthetic group, to push their designs to the limits of the printer, or as in the case of the *coded* aesthetic group, set their design

parameters to the printer's constraints. These constraints are most noticeable in the innovative ways the practitioners work within the parameters, especially: *Nervous System's* printed 'fabrics', scrunched-up with in the print space volume (see fig 2.17); or Sophie Kahn's 'fragmented' pieces (see fig 2.11) dictated by the print space volume, but still retaining the fragmented aesthetic in her assembled pieces. Pye (1968, p.17) understood this, it was his assertion that designers owe a debt to *workmanship* because it dictates what *can* be done and therefore drives design.

The *extruded* aesthetic group best (but not only) demonstrates how the 3D printer is more than just a tool, they have sought out new tasks, asked questions of the printer, they have not limited the printers' output nor allowed the printers' constraints to limit them. In this instance, the 3D printers are not providing workmanship, they are part of the experimentation process. This does not mean they are taking on any *creative agency* in the artistic process, just that they are not following instructions with a pre-determined outcome.

Is there a 3D printed aesthetic?

Evidently there are at least three 3D printing Aesthetics (impossible, coded and extruded) but do any, in isolation, identify an artefact as 3D printed and to what extent are they superficial?

The impossible Aesthetic.

As the examples demonstrate the impossible aesthetic applies to those artefacts that engender intrigue in the viewer, the things that cannot, or at least *look* as though they cannot, be made by any other means. However, without some knowledge of manufacturing, and what processes are currently available, an observer may not be suitably impressed. A gyroid by Bathsheba Grossman could be made, relatively easily, by assembling many identical, tessellating components; without being aware that these pieces are made in on solid piece, they may not seem as impressive. Essentially, an observer will need to know what **is** possible to appreciate what **is not**.

Therefore, knowing that an 'impossible' artefact is 3D printed will affect how it is understood - or put another way: viewing it through the 'lens of 3D printing' allows the observer to construct, or confer, a particular meaning to the piece, eg: fig 2.29 shows a rotatable cog device, with balanced weights, resembling a carriage clock

mechanism or old-fashioned ship's sextant - *knowing* that this has been printed in one single, yet dynamic, piece forms the basis of its intrigue.

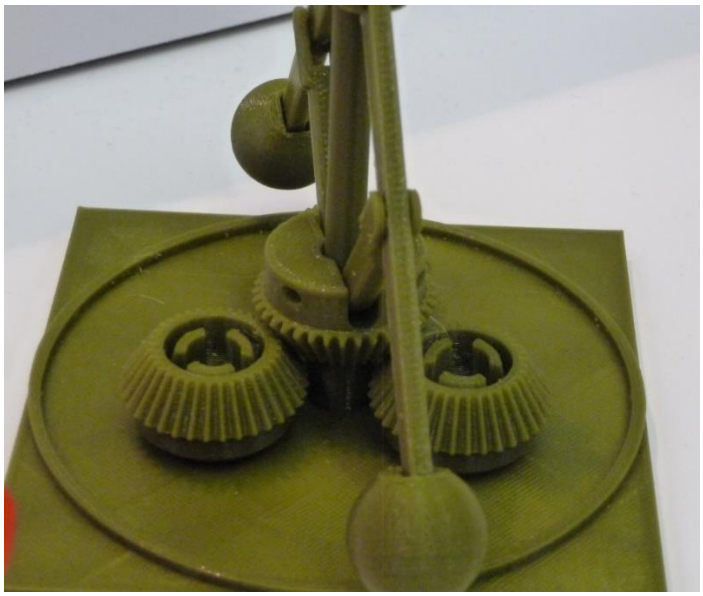


Fig. 2.29 FDM single print dynamic 'machine' image: Catherine Scott

Alternatively, carved ivory puzzle balls (fig. 2.30) consist of concentric intricately carved, rotating spheres, within rotating spheres. Those familiar with 3D printers and unaware of traditional Chinese carving skills, may assume the 'impossible' objects have been 3D printed.

Fig. 2.30 Carved ivory puzzle ball. image courtesy of
" The Puzzle Museum http://puzzlemuseum.org"

The Coded Aesthetic

This is least recognisable aesthetic in a broad sense, although, where the software characteristics are on show, its superficial attributes are obvious. Plumber Fernandez's use of faceted surfaces (fig 2.20) is one example, as is the 'pixelated' appearance of Francis Bitonti's sculptural shoes (fig 2.31). This aesthetic is dictated by the practitioner's tool, as noted above for Michael Eden, (who displays both the impossible and coded aesthetics) *the 'fingerprint' of the craftsman's tool is on display - which in this instance is the computer - that is the tool that the creative agent uses*.

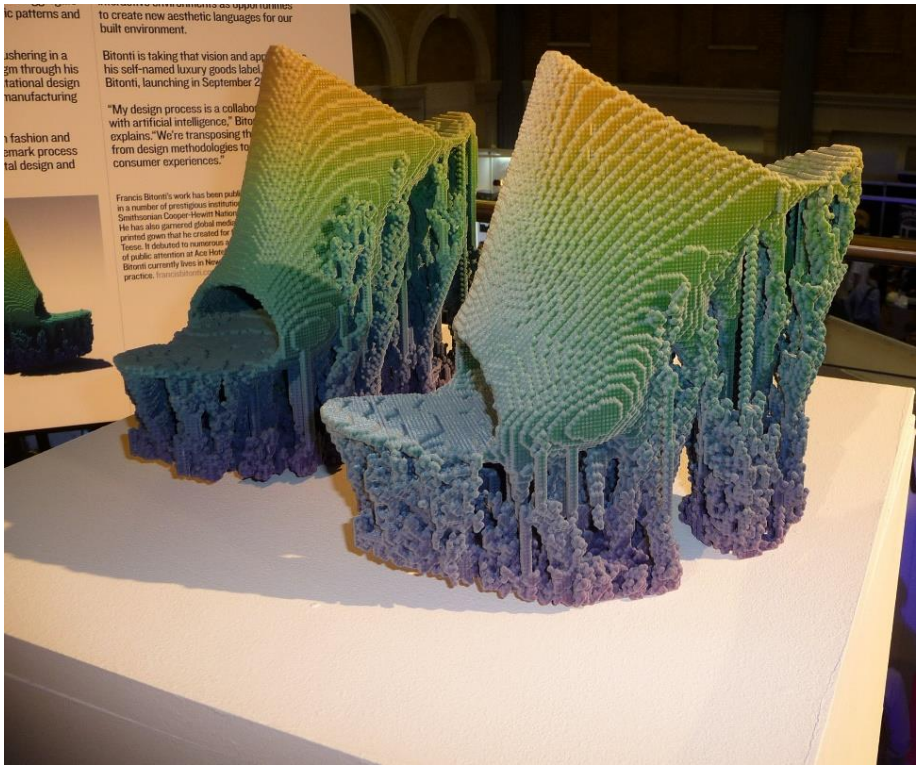


Fig. 2.31 'Molucule' shoes, Francis Bitonti (2014). Image -. Catherine Scott

The 'software slices' of Geoffrey Mann's 'otherwise unobtainable' (fig 1.3 page 36 ch 1) are evident, although neither the wooden form nor the glass vessel were 3D printed.

The Extruded Aesthetic

In contrast to the other two, this superficial aesthetic 'explains itself', like a skeleton watch or an un-rendered house, displaying the stone or brick work, providing evidence of the process and workmanship that went into its construction.

Conventional wisdom (or at least the goal of 3D printer developers) is to reduce this unwanted effect, by trying to constantly increase print resolution. The Bigrep[43] printer, 'replicates'[44] Rococo side tables in lurid orange nylon, (fig 2.32) a close-up clearly shows it has surface issues. (Fig 2.33) (a visit to their website, bigrep.com shows how far they have come in the three years since these images were taken - what was once the show piece of their trade displays is no longer used in the online material)

Fig 2.32 - Bigrep's florid side table. Image: Catherine Scott

[43] https://bigrep.com/
[44] In the loosest sense of the word

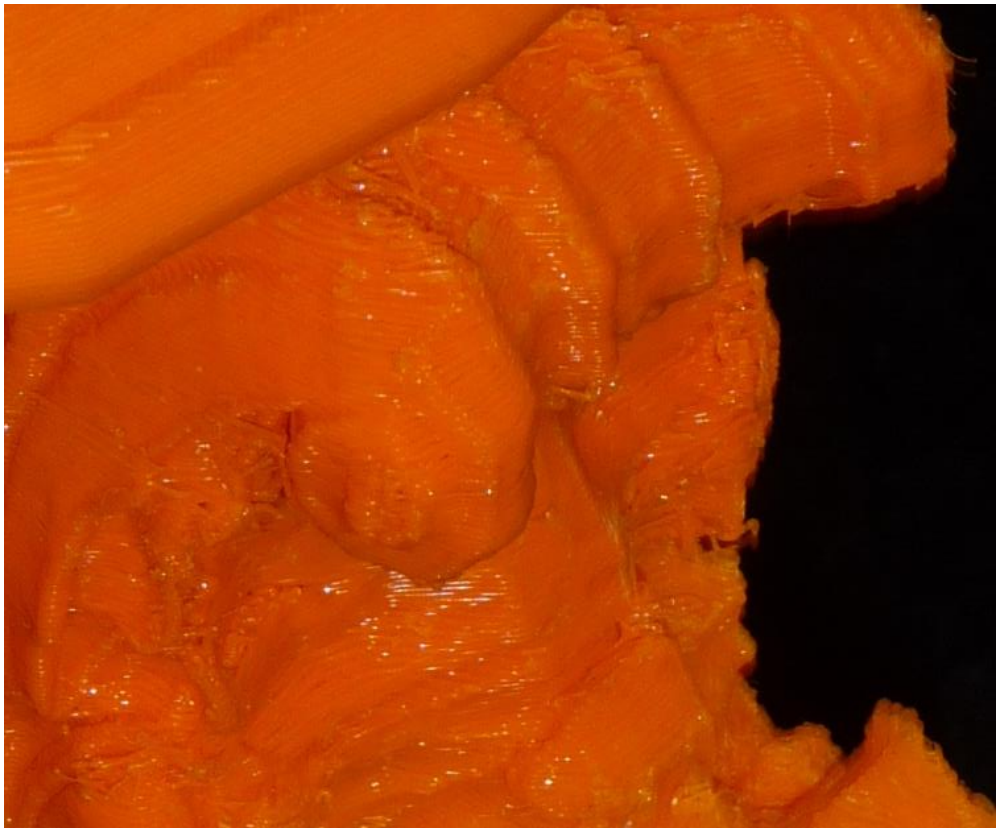


Fig 2.33 close-up showing unwanted striations. Image: Catherine Scott

However, while industry maybe seeking to increase resolution, as the earlier examples show, there is a definite move to embrace lower resolution prints. The rheology of the non-Newtonian fluids, suggests the elimination of print 'striations' is a futile task, (Scott, 2015) whereas embracing what the material 'tends' to do naturally may become the most widely recognised and accepted aesthetic, especially for large scale works. At the recent Barcelona Building Construmat[45], the Institute for Advanced Architecture of Catalonia (IAAC) demonstrated their *Pylos 3D printer*, by constructing a pavilion over the four-day conference. (YouTube, 2017) (fig 2.34)

[45] http://www.construmat.com/en/

Fig. 2.34 IAAC 3D printed pavilion, mid-print. image © 2017. 3DR Holdings.

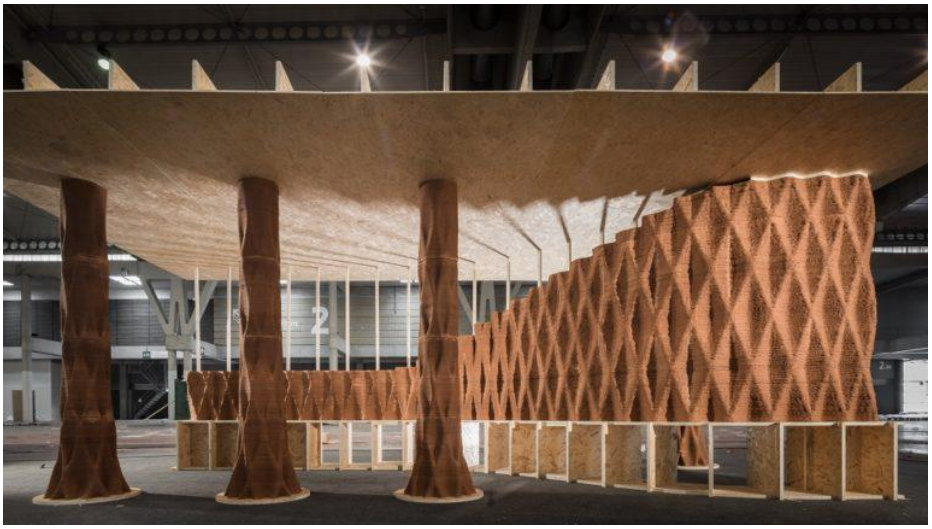


Fig. 2.35 IAAC 3D printed pavilion, mid-print. image © 2017. 3DR Holdings.

Does using a 3D printer create '3D printed art' or just 'art' that happens to be 3D printed?

It is clear from the examples given that both propositions exist, and in keeping with the thesis's use of the term Artistic Output for all work with artistic ambition (however minor) there is also 3D printed artistic output that that falls into neither grouping. (see *Independence of the aesthetic* below). The problem arises with how to collectively describe this work as well as, what would be the sufficient and necessary criteria for association? (see *Categorisation* below). Additionally, it would appear that all of the artistic output and practitioners considered, could probably find another 'category' to fit into - chapter three divides the Creative landscape of making in to the fields of *Art*, *Craft* and *Design*, but also recognised that there are cross-over fields, proving that

belonging to one ‘grouping’ does not exclude membership of another. This is not unusual, people may self-identify as one thing (perhaps simply their given name) but, to be recognised, placed, understood etc, by others they also need to identify by association. Eg: someone’s mother, son, cousin, friend, partner; or by race, nationality, employment, alma mater etc., and as one person may belong in many group, so too can artistic practitioners.

Independence of the aesthetic

Referring back to the given definitions of ‘aesthetic(s) (p.23) definition 1:

> *(an) aesthetic: (n) A particular style or genre of art, craft or design and the, usually, visual categorisation parameters that identify a piece of art, craft or design as belonging to, or as demonstrating, that particular aesthetic - it could be described as a quality possessed e.g.: The building has a Modernist aesthetic, (which could be understood as, the building possessed a ‘modernist’ quality)*

This suggests that the aesthetic should be able to exist independently to be considered a ‘style’. As the example given with the definition above demonstrates, a building may have a *Modernist aesthetic* with being a Modernist Building - This raises issues of time and chronology, as discussed further in the follow subsection on genre, style and categorisation, where ‘period’ categorisation can define a style, and, as could be the case with a modernist ‘style’ building, the building may be an entirely faithful representation of a modernist building, but because it is produced ‘out of period’ it can never me more than ‘in the style of’. Although this has much to do with architectural styles falling into ‘periods’ (which are usually named in retrospect). Whether or not 3D printing becomes categorised in such a way, remains to be seen, future generations may look back on the ‘Great (or not so Great) 3D Printing Age’.

The Chinese puzzle ball is a demonstration of a 3D printed aesthetic existing independently of 3D printing, but it could not be considered *associated* with 3D printing, unless it is presented as a found or readymade component of artistic output.

Similarly, the following examples of an independent 3D printed aesthetic can only be *associated* by applying the lens of 3D printing (which by their inclusion here

probably means it is already being applied); some accidental (figs 2.37 - 8) others deliberate (fig 2.39)

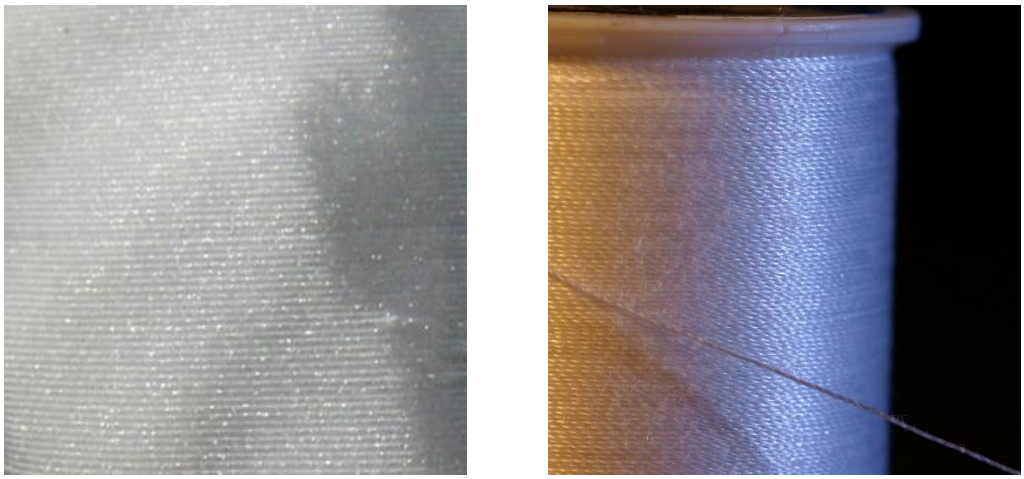


Fig 2.37 Close-ups Left: FDM print, right: a spool of cotton thread.

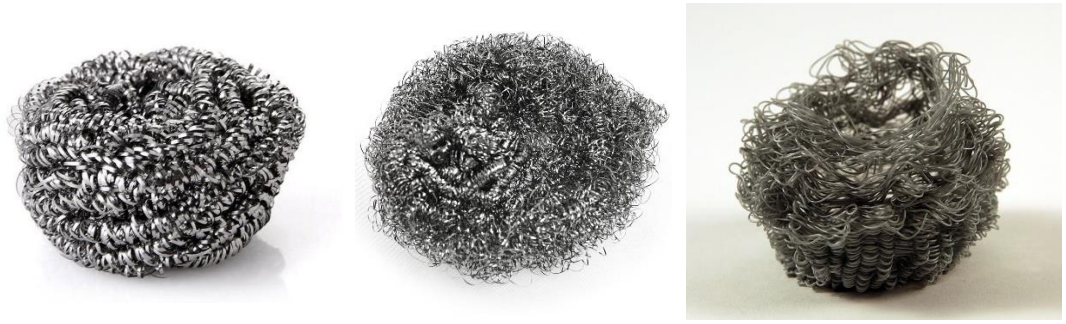


Fig 2.38 Left: Steel pan scourer (Aliexpress), Centre: Tangled Steel pan scourer (Walmart), Right: Dave Lobser, tangled G-code print

Layered fabric soft print © Disney

Card board layers using Autodesk 123D Make software © Autodesk

Wax and water 3D 'print', image: Catherine Scott

Fig 2.39 3D Printing 'Associated' Artistic output

The wax and water 3D print (Fig 2.39, right) is a deliberate attempt to produce an artefact that looks 3D printed, without using the machine or software.

Printer-less prints

The process of making the wax and water print involved feeding molten wax on to a secure 'print bed' (fig. 2.40) while simultaneously filling the entire print space (glass bowl) with water, ensuring both liquids rise at the same level, forming layered meniscuses as the form grew (fig 2.41) giving an 'extruded superficial aesthetic'

Fig 2.40 (opposite) wax and water 3D ‘Printer’ (images Catherine Scott)

Fig 2.41 (right) Final wax ‘print’ by Catherine Scott

(image Claire Scott Photography)

Other than academic proof of concept, there is no relative advantage over any other process and little artistic merit. Synchronising the wax and water, while maintaining an appropriate and safe temperature for liquid wax was particularly difficult. Even with the addition of a powered extruder to maintain a steady flow rate, no useful degree of control over the output could be achieved.

Clay slip was used in the second attempt at achieving printer-less prints.

The main difficulty with this experiment was achieving the correct viscosity of slip: too runny, it would not hold its shape, to thick it would be impossible to extrude by hand. Two ‘form types’ were undertaken, the first was a series of roughly geometric shapes, produced by building up layers and using various geometric (star-shaped) foot-prints to give the walls stability, three pieces (after bisque-firing) are shown (fig 2.42), with two of these shown following glazing (figs 2.43 and 2.44)

Fig 2.42 Catherine Scott - Bisque-fired, extruded clay slip, manual 3D prints (S.1). Image Catherine Scott (2014)

Fig. 2.43 Catherine Scott - Glazed, extruded clay slip, manual 3D print (S.1). Image Claire Scott Photography (2015)

Fig. 2.44 Catherine Scott - Glazed, extruded clay slip, manual 3D print (S.1). Image Claire Scott Photography (2015)

These ‘prints’ followed a predetermined design and, as such, are the product of workmanship, albeit rather poor. They back the earlier statement (see p.32) that while

this method of production is possible, the printer offers the relative advantage in its ability to provide highly skilled workmanship.

The second series was an attempt to inject some *Creative Agency* into the process. This time the appearance had a more continuous and consistent flow. Rather than trying to adhere to a predetermined shape which relied on accuracy and lead to thickness variations at corners and changes of direction, and instead moving the nozzle to match the flow of the slip, which resulted in reactive and expressive pieces of artistic output. (figs. 2.45, 2.46) The level of workmanship amounted to little more than keeping an even pressure on the extruder, (fig. 2.46) but despite the seemingly random result, the actions were deliberate, purposeful and informed by *Creative Agency.*

The aesthetic is undoubtedly ‘extruded’ (for both series of clay manual prints), however the second series also has a degree of impossibility, in that an exact replica would be impossible by any means. (which is not the same as the 3D printed ‘impossible’ aesthetic).

Fig. 2.45 Catherine Scott - Glazed, extruded clay slip, manual 3D print (S.2). Image Claire Scott Photography (2015)

Fig. 2.46 Catherine Scott - Glazed, extruded clay slip, manual 3D print (S.2). Image Claire Scott Photography (2015)

The manual 3D printer consisted of an icing nozzle added to a circle of baking parchment folded in to a piping bag. (fig 2.47). It is worth noting that experts in sugar craft, extrude sugar paste, by hand, with a much higher level of expertise than 3D 'food' printers. An interesting research route could be to explore how these 'expert hand extruders' would cope with some of the free-hand 3D 'Pens' currently available, such as 3D Doodler.[46]

[46] http://the3doodler.com/

Fig. 2.47 Manual '3D Printer'. (image Catherine Scott)

In addition to the extruded aesthetic existing independently form the 3D printer, it also exists *independently of the extruder*. Similar to Front Design's furniture (see fig 2.26) Helena Lukasova's 'I am the Venus' project produced art works that *look* extruded but were made using different processes.

Fig 2.48 the virtual VEKVA generated models for Helena Lukasova's 'I am the Venus' project

Lukasova forms were made using VEKVA (Virtual Environment Kit for Visual Arts).[47] Hers hands, as they moved over and around her body, were tracked by imaging software and the pathway they followed was represented onscreen as long, intertwined 'extruded' flows (fig.2.48)

These were 3D printed to the scale shown in fig 2.48 for the 3D Printshow, London 2013

Fig 2.49 3D prints or fig 2.48 models for Helena Lukasova's 'I am the Venus' project

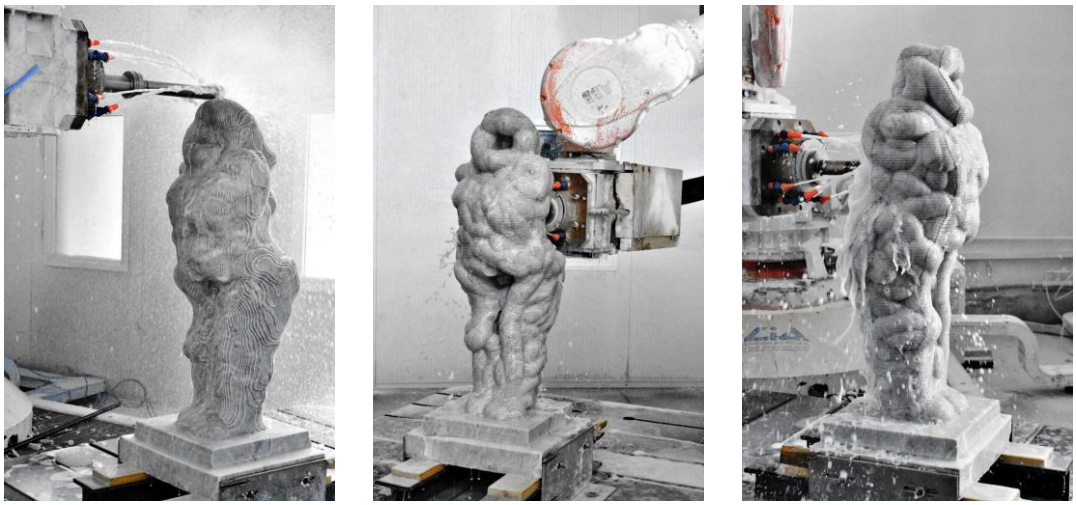


Fig 2.50 3D transformation into stone, Lukasova's 'I am the Venus' project collaboration with the Digital Stone Project and the Garfagnana Innovazione in Tuscany

[47] http://vrecko.cz/

Fig 2.51 VEKVA model and subsequent marble statue from Helena Lukasova's 'I am the Venus' project

In collaboration with the Digital Stone Project (digitalstoneproject.com) Lukasova was able to see one of her models produced in Italian marble at the *Garfagnana Innovazione*[48], a state-of-the-art technology centre with robotic stone-cutting equipment.

More details of Luksova's project at cargocollective.com/helenalukasova/I-AM-THE-VENUS (*All images 2.48-51 courtesy of Helena Lukasova)*

Categorisation

It has become clear that there is a broad group of artistic practice, practitioner and output associated with 3D printing, and many methods of classification are available. Style, genre, movement, school, -ism?

Style is a "...distinctive manner which permits the grouping of works into related categories" (Fernie, 1996. P361) but does it have connotations of resemblance and mimicry rather than of authenticity? If 3D printing were to be 'a style' what would it

[48] http://www.garfagnanainnovazione.it/en

be? There is also the implication that style is a superfluous addition to the rigor of method,

> *"Method aims at excluding what style embodied: Method is supposed to lead anyone who follows its rules to the same results, whereas style is essentially personal and historically rooted, Lang says, 'style gives method a voice that method by itself would not have or even allow for'"*
>
> *van Eck et al (and Lang in van Eck et al) 1996 p2*

Essentially, style is what places method *in time.* Initially a method and style are intrinsically linked, however this will change with time, especially as the method changes. Market pull and technology push (the forces that dictate innovation and its diffusion) will ensure that 3D printing methods evolve rapidly, however the original 'style' will not *disappear.*

Using 'style' for categorisation would lead to description such as: late century 3D printing style, Millennial 3D printing Style, 'noughty' 3D printing style - it can only get worse - Trump Era 3D printing Style? Pre-Brexit and post-Brexit style 3D printing? Clearly, when a method evolves so rapidly, *style* naming becomes impossible (of course specific years *will* be used to describe this evolution, however relative descriptions tend to more tenacious than positivist descriptions.)

Therefore, this thesis is rejecting 'Style' as the appropriate method of classicisation.

<u>*Genre:*</u> current Genre theory focuses largely on film, television and literature, and perhaps traditional art theory's very specific *academic painting genres* excuse why the fields of art, craft and design have come under less scrutiny in this respect. However, the following overarching genre theory themes could be applied to 3D printing Associated Artistic output:

- Reinforcing cultural ideas and values
- Creating audience expectations
- Creating characteristics that audiences recognise

However, artworld genres are constructs of institutions, established to 'ringfence' what belongs and what does not, or to protect cultural identities. Greenhalgh (2002),

says, “New [genres] come into being when new technologies become available and when audiences demand new sensations, genres develop and consolidate themselves”. the implication is that the institutions can make genres irrelevant by setting out overly prescriptive, necessary and sufficient conditions of membership, so that when technology, fashion or the audience want to move on, the ‘genre’ is stuck within its self-limiting parameters.

The problem with describing *3D printing Associated Artistic output* as a *genre* is that, it will restrict its evolution; as with *style,* the march of time eliminates *genre* as a contender for classification.

Movement and *school* give a sense of being lead or instructed, but there is no 3D *artistic champion* and no theory of method to be taught - the diverse learning pathways of the practitioners discussed earlier in this chapter proves that.

Could *3D printing Associated Artistic output* be considered and *-ism?* (or is an ‘-ism’ just a way to describe a movement?) #Additivism, is a movement that, “*By considering the 3D printer as a technology for remodeling [sic] thought into profound, and often nightmarish, new shapes #Additivism aims to expose in-betweens, empower the powerless, and question the presupposed*.”[49] It’s ‘instigators’ Morehshin Allahyari & Daniel Rourke wrote their manifesto in 2015 and invited over 100 ‘world-leading artists, activists and theorists’ to submit imaginative, provocative works that ascribe to their manifesto for inclusion in their compendium ‘The 3D Additivst Cookbook’ (Allahyari et al 2017). An essay entitled, ‘The Honesty of Extrusion’, based on this chapter, was published in The 3D Additivist Cookbook, and while *3D printing Associated Artistic Output* undoubtedly comes under the #Additivism umbrella, it is evidently not one and the same thing.

[49] http://additivism.org/manifesto

Summary: 3D printing Associated Artistic Output

Throughout this thesis the broad term of *3D printing Associated Artistic Output* has been used, therefore the logical 'category' is *Association*. It is not ideal because it has connotations of a formal society, however assessing 'membership terms' as the sufficient and necessary criteria for association will provide the appropriate *Lens* to move on the second part of the research: How 3D printing Associated Artistic Output affects the existing Creative Landscape of making and causing to be made.

The criteria

- *Intent*: The creative agent (artist, designer, designer/maker) intends the output to be viewed using 'the lens of 3D printing' because that was the maker's viewpoint during conception and production,[50]
- *Conferred meaning:* An observer constructs a 3D printed associated meaning for the output
- *Superficial Aesthetic*: The output should have the superficial aesthetic that fits one of more of: Impossible, Coded and/or Extruded, as detailed previously.
- *Process*: Apparatus recognised as a 3D printer, should be used somewhere at some stage in the process.

Rules of association:

- If *Intent* is present, then that criterion alone is sufficient to meet the requirements of *3D printing Associated Artistic Output*
- If *intent* is not present, then *Conferred* meaning along with either or both of *Superficial Aesthetic* and *Process* are necessary to meet the requirements of *3D printing Associated Artistic Output.*

Assumptions:

- The Output being considered already meets the criteria of *Artistic Output*, these rules only assess whether that *Artistic Output* can be considered to have *3D printed Association.*

[50] as noted earlier (definitions ch.1) Beardsley dismisses the requirement of the 'user' to understand the maker's intent, and constructivist theory (discussed several times in relation to the superficial aesthetic) dictates that the user 'construct' their own meaning (of art) based on the evidence before them. However, neither point of view can detract from the intention of the artist (the intent of whomsoever confers art status is considered to be different)

- Where the association appears to be tenuous, the makers' intent has been taken into account. A jeweller or woodworker, who sees their use of new, usually computer aided, manufacturing technology as having no more relevance than and of the myriad processes involved in the production of their work, may quite rightly disassociate themselves from the 3D printing process, if they so wish.

Conclusion

The investigation of this Chapter led to the proposition that**: there exists, a cross-disciplinary *Association* of artistic output, processes and practitioners, whose relationship is understood through the lens of 3D Printing.** The umbrella term of "3D Printing Associated Artistic Output" is a suggested name.

Chapter Four

The Creative Landscape of Making and Causing to be Made

Are Art, Craft and Design Comparable?

Art, Craft and Design are everyday words with meanings that are often arbitrary and used to suit the speakers message. How they are used and understood, and between whom, is entirely circumstantial. To identify where, or if, the borders between the three exist, it is important to understand under what terms that are comparable.

Art, Craft and Design can be defined within by one or more of the following categories: *Output*, *Process*, and *Field of Practice/Theory/ Study;* and to understand the practice, some insight into the *practitioner* is also required.

As Output

Art, as a mass noun, can describe output - that is, the artefacts produced by artists: paintings, sculpture, video, interpretive dance, shit in a tin; the sort of thing that is put on display to provoke a reaction, whether that be aesthetic, explicit, conceptual, literal, implicit, cultural, sublime, explosive or restrained[51]. Whatever way the 'interactor' responds, the Artistic Output under consideration will have the main purpose of simply existing - being itself. Whatever its subsequent function is, is neither here nor there - If Duchamp's Fountain was reinstated as a pissoir, or used as a doorstop, is irrelevant. At the time the ***artwork*** *was* ***made, designated*** or ***identified,*** it's ***purpose*** was to be an ***artwork.***

Craft, as a mass noun, is slightly more ambiguous that *art*. Once more it describes output but not necessarily that of a 'craftsman' (nor is all the output of a craftsman to be always considered craft). Many craft theorists (Adamson, 2013, Sennet, 2008) emphasise the link between craftsmen and their output when trying to understand craft, however, others such as Pye (1968) and Risatti (2007) look at the artefacts in isolation. Risatti's definition in particular is useful, identifying that a craft artefact must contain, cover or support, or be a tool for manipulating materials into a functional craft artefact. It is reasonable to add the function 'to decorate' although an artefact's decorative quality and potential is more likely to be judged by the ultimate 'user'

[51] Not an exhaustive list.

rather than the designation of the maker. In addition to being functional, there is a general perception that craft artefacts are hand-made individually, by one person, using minimal mechanical interference, maybe traditional methods, perhaps slightly imperfect and definitely one-of-a-kind. Within the 'craft' industry itself, this vagueness can be extremely nuanced and superciliously hierarchical.

While art and craft, as mass nouns can describe output, they are also the words that describe the entire field of output.

Design, as a mass noun, can only describe that field. However, design, as a descriptor of output is a discrete or quantifiable noun; it requires a definite, indefinite or numerical article, eg: a design, the design or four designs. A *design* is simply the set of instructions to be followed to make an artefact, or a piece craft or an artwork. Anything made deliberately could be understood as having been made by design, however, the *field* of design refers to the process of arriving at a set of instructions in a careful and considered manner.

The more 'designed' an artefact appears to be is a reflection of the perceived depth of planning that goes into a deliberate action (ie the plan)

A *piece* of Design cannot be obtained in the same way that a piece of Art, or a piece of Craft, can. Although the level of design is an attribute of an artefact that will make it more suitable, desirable, functional etc, it is not however a descriptor of the artefact itself. Design output is the instruction or description of an intended outcome - not whatever is produced as a result of following the design.

As process

To Craft and *to design*, are verbs

To craft, as a verb, can be considered the manipulation of one, or a set, of materials or components into something else. It differs from 'make' in the sense that there is an element of skill involved.

To Design, as a verb, has many dictionary definitions, it is simply to plan an action

To Art - not a verb

As a Field of Practice/Theory/Study

Myriad art theories abound, to the extent that almost any*one* can declare almost any*thing* as art, with the reassurance that some theory or other will concur with their assertion. Weitz goes even further and suggests that 'Art' is such an open concept that it is "*logically impossible to ensure any set of defining properties*"(Weitz, 1956)

For the purpose of this thesis, it is unimportant which theory is best/worst/right/wrong, suffice to say the 'Art' as a field of practice/theory/study is simply the consideration of all these aspects - its *Nature.*

By the same vein, both Craft and Design, as fields of theory/study, are in essence the consideration of the *Nature* of each.

As fields, they can be considered and studied individually, but not exclusively; they are interdependent: The nature of Craft and the nature of Art cannot be considered without understanding intent, forethought and deliberate action, ie: Design - of course not *all* Art is deliberate, some is merely 'found' and occasionally accidental; The majority of craft is 'caused' (design again) but sometimes repetitive work can be automatic and therefore the active involvement of design with each manifestation is questionable.

Design serves to add value to the necessary functions of an artefact, …there are no new actions (until teleportation, telepathy and telekinesis have been mastered)

The common thread between art, design and craft is artistry - that is the attributes (or process, output and theory) that are considered **beyond** the purely functional. Pye is very clear that the mechanical 'primary requirements' of any designed artefacts are basic mechanical operation: lift, push, squeeze, carry etc. and it is design - providing those attributes which give pleasure, distinction, improved performance, affordability - they are not strictly necessary to perform the basic functional requirement but instead add value by enhancement - which Pye claims makes them 'unnecessary - a claim that is frequently levelled at art.

When considered in this way, the field boundaries overlap, rather than forming distinct borders between fields. Therefore, shifts in the boundaries of one do not necessarily affect the boundaries of the others, instead the scope of the 'over-lap' is altered.

Are expert hand skills, manual dexterity, tactic knowledge, automatic response - craftsmanship or workmanship? Many believe that these two words mean the same thing (see chapter two) Craftsmanship is inherently connected with material knowledge, (this is probably why material specific artists are often described as craftsmen and their output is referred to as craft - rather than calling the output of a ceramics artist, or a textile artist - applied art - or even just art). There could also be the implication that multimedia artists simply could have not put in the requisite 10,000 learning-hours needed to become expert in more than one material. (see risk and 3D printing, p.68)

It is hard to imagine that a designer can properly provide instructions on materials manipulation unless they have intimate knowledge of those materials

Imagine the scenario where a designer/maker has demonstrated an expert understanding of their material, through their designs, and also demonstrated expert workmanship (hands-kills) in the execution of their designs - this designer maker clearly demonstrated craftsmanship in the production of their 'artistic output' - expert head skills (design) and expert control of the hand-skills (manual-dexterity, workmanship)

Now imagine that same designer/maker with severe arthritis in their fingers.

Their material knowledge is as comprehensive as ever and is demonstrated, as ever, in their designs - their workmanship skills are not as good as they once were and in order to retain the expert level of control over their materials, they employ a skilled artisan to execute their designs exactly to the letter.

The designer maker is still entirely in control of the design and the making.

Artists often employ technicians to execute their ideas/designs - but the artist may not know the material well and will rely on the artisan to add the craftsmanship, likewise designers who focus entirely on user needs may rely on the input of material scientists to test their designs. But there are designers who do not need further 'craftsmanship' input - just the actions of a highly skilled artisan who can follow instruction and demonstrate excellent workmanship.

A designer can produce a poor design and an expert artisan can choose to carry out the work as directed (workmanship); apply a degree of craftsmanship (ie agency in

respect of the design); or they can refuse the work because it will affect their reputation as a skilled artisan (agency over themselves - but not the design).

Likewise, if the design is excellent, the skilled artisan can choose to do a poor job - this again is agency over themselves and how they go about their work - but not agency over the design. Ultimately if the execution of a good design is poor, the work can be rejected by whom ever has agency over the design.

Mapping the Creative Landscape

A divergent approach has been used to set out an expanded problem field matrix, mapping three mains 'fields' of the creative landscape of Making and causing to be made: *Art, Craft* and *Design*, against *Output, Practice and Process*[52]

The framework will be grounded ontologically, deconstructing the output into: *medium, message, purpose* and *function*; and Process into: *making* and *causing to be made*. However, each 'node' of the matrix will also be analysed using a relativist approach: from the perspective of the producer, (as agent, as actor and as agent/actor) and from the perspective of the user, (Collector, Investor, Other Buyer, Commissioner, Student/academic, Critic, Intentional viewer, Incidental viewer and Passer-by) and the relative values they place on these approaches.

Each analysis section will be visually represented by a Venn diagram which will indicate where the boundaries cross and over-lap – these 'cross over' regions will be analysed as a fourth field in the landscape matrix. These Venn Diagrams are not mathematically proportional; however, a degree of proportionality is represented in the comparative size of each 'set'. The significance of workmanship and the potential effect of the 3D printer has, in each instance been 'boxed'.

It is important to understand that what follows is a *systematic deconstruction* of the creative landscape. *Art, Craft* and *Design,* along with 'cross-over' fields, are examined individually with respect to *Output, Practitioner* and *Process* and then further examined from the p.o.v.s of maker and end-user. Each sub-section will be assessed

[52] Co-incidentally, but not dissimilar to Rhodes' 4 Ps of Creativity (Rhodes 1961) Product (output), Person (Practitioner), Process and Press (relative to environment)

using the same criteria and parameters and as such may appear repetitive. The matrix below (table 1.) lays out the parameters of analysis for each section, with their position in the subsequent chapter indicated at each cell.

Field Definition: p.153	Art	Craft	Design	Cross-over
Putative definition	p.154	p.157	p.160	p.162
Thesis p.o.v.	p.156	p.159	p.161	p.163
Practitioner: p.164	Art	Craft	Design	Cross-over
Agent	p.164	p.166	p.167	-
Agent/Actor	p.165	p.166	p.167	p.167
Actor	p.165	p.166	p.167	-
Output: p.168 *– Maker p.o.v.*	Art	Craft	Design	Cross-over
Medium:	p.170	p.180	p.184	p.191
Agent	p.172	p.180	p.185	p.192
Agent/Actor	p.172	p.180	p.185	p.192
Actor	p.172	p.181	p.185	p.192
Significance of workmanship/3DP	p.173	p.181	p.185	p.193
Message/purpose/function:	p.173	p.182	p.186	p.193
Significance of workmanship/3DP	p.174	p.182	p.186	p.193
Output *– User values.*	Art	Craft	Design	Cross-over
Collector	p.175	= p.175	-	= p.175
Investor	p.175	= p.175	-	= p.175
Curator	p.175	= p.175	-	= p.175
Commissioner	p.176	= p.176	-	= p.176
Other buyer	p.176	p.183	-	= p.176
Critic	p.176	= p.176	-	= p.176
Student/academic	p.176	= p.176	-	= p.176
Intentional Viewer	p.177	= p.177	-	= p.177
Incidental Viewer	p.177	= p.177	-	= p.177
Passer-by	p.177	= p.177	-	= p.177
User Value Grid	p.178	p.183	p.188	= p.178
Effect of 3DP on user Values	p.178	p.183	p.189	= p.178
Process	Art	Craft	Design	Cross-over
Causing making: personal drivers	p.199	p.201	p.205	= p.199
External drivers	p.200	p.202	p.206	= p.199
Making	p.200	p.203	p.206	-
Significance of workmanship/3DP	p.200	p.205	p.206	-

Table 1. Creative Landscape Matrix

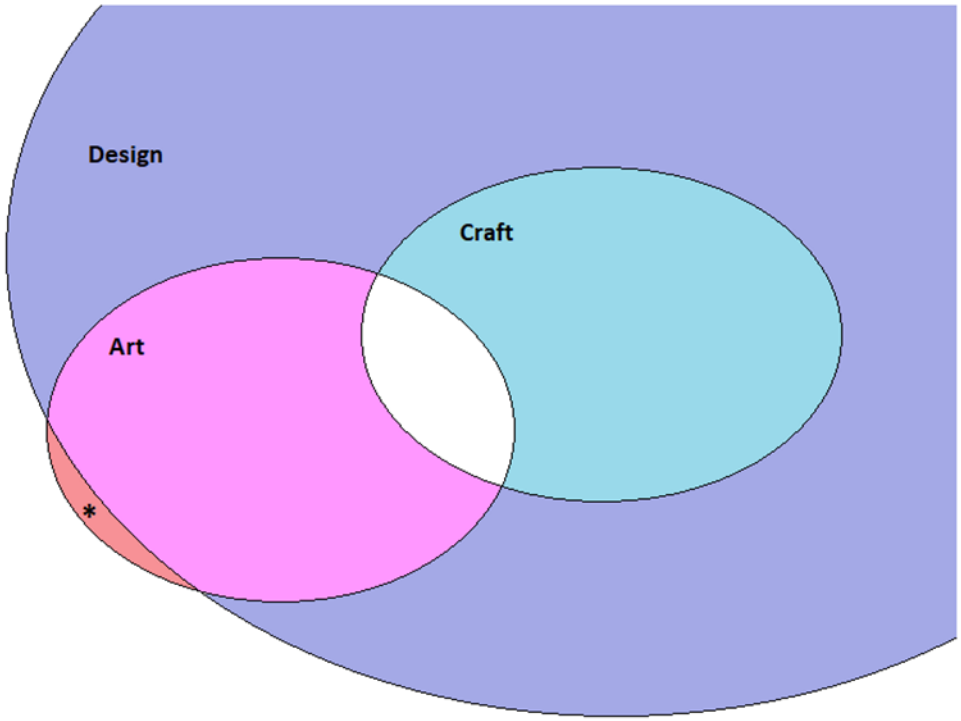


Fig.3.1 The Artistic Domain, within the Creative landscape of making and causing to be Made (from fig.1.1)

Definitions of the Fields

Putative Definitions: As noted earlier, putative definitions are not usually considered rigorous enough for inclusion in a research document, but to reiterate: regardless of what 'objects' actually *are* and the exact definitions of the words we use to describe these 'objects' (either rightly or wrongly) -it is important to understand what the widely held (or putative) beliefs are, regarding what objects *are* and what they are *called.* Tenacious misunderstandings are often self-fulfilling if they prevail for long enough; (the word *nonplussed* being a prime example[53].)

[53] A random straw-poll, of a group of native English-speakers, when asked for the meaning of 'nonplussed', will almost invariably return with the majority claiming it means 'not really bothered', the actual meaning is the reverse of this, it means to be astonished, at the limit of credulity – from the

Within the creative landscape, aesthetic/s is a word which should never be without a qualifier[54], however the terms Craft, Design, and to an extent Art, become lost in translation when the *listener* misinterprets the *speaker's* intended meaning. Generally, people will stand corrected by someone they believe knows better than they – which is essentially *institutional theory* and Danto's understanding of the 'Artworld' (extrapolated to include the *Craftworld* and the *Designworld)*[55]- although this might change with the rising mistrust of experts, another symptom of the post-facts era, when use of the qualifier 'so-called' is used to systematically undermine.

For this research, it is equally important to ontologically analyse *what* is being described by various terms and *how* these terms are generally understood, before assessing the effect of an external factor (3D printing) upon them. For Art and for Design this will largely be based on consensual dictionary definitions, for craft, the 'dictionary' definition will be augmented with some first-hand inquiry (see *human participation*[56])

Definition from the thesis position: In order to identify any effect caused by the addition of an external influence, a benchmark must first be established. For each field under consideration, the position of this thesis will be drawn from a conflation of theories, to suit what this thesis is attempting to demonstrate. Each of these benchmarks will be a datum against which change can be measured and not postulates for new theories.

Art

Putative definition

Art, at primary school level, is painting, drawing and making stuff, usually produced with no purpose other than to impress the intended recipient. It's fair to say that this primitive 'theory' as valid as any other.

French *non plus*, meaning literally 'no more!' Such is the prevailing misunderstanding of this word, avoiding all use of it is the only sensible approach if one is to be understood. Using it, correctly, to convey one's *astonishment* is a futile exercise, as most listeners will assume the speaker means *disinterested*, and those who know what it means are likely to infer that the speaker has probably used it incorrectly. Indeed, using nonplussed, deliberately wrongly, to convey apathy, is probably the best way to be understood by the majority. *Inflammable* suffers a similar fate, it is similarly best avoided in favour of the unambiguous *flammable.*

[54] See definition for the myriad understanding of *aesthetics* page 23

[55] See the responses in 'human participants page 29

[56] ibid

Increased literacy and technological advances have superseded some of the more traditional functions of art. Biblical storytelling and documentary representation were superseded by ubiquitous literacy and the rise of photography. It is broadly accepted that art can be appreciated for itself and nothing more, and that art can be horrible, distressing or simply ‘not very good’ and still be considered art.

While it can be expected that the general populous are likely to subscribe either to an historical theory: that art should look like, and be, recognisable as something similar to existing art, or an institutional theory: that art is whatever the ‘art world’ says it is; those with an interest, ranging from academic to simply passing, can debate the minutiae of the perimeters (and parameters) of such theories and never come up with a satisfactory concord. The Stanford Encyclopaedia of Philosophy emphasises the problem by providing a list of constraints before attempting a definition.

In the ongoing rhetoric, surrounding the nature of art, the perpetual negation of negation has led to Wiess (1956) to suggest that art theory has practically consumed itself or produced what Gault calls a ‘cluster theory’.

Rather than specifying the necessary and sufficient attributes that artistic output must possess, Berys Gualt (2005) suggests that a list of desirable criteria exists, a collection of which would sufficient.

Risatti (p418) insists ‘intent’ at the making stage is a necessary condition, followed by the judgement of the observer, the “the beholder… [must decide which artefacts] …possess sufficient aesthetic qualities to be judged art” and he hopes that these viewers are have been sufficiently “educated in the practice of serious looking”.

Within this broadest of scopes lie may ‘isms’, categories, genres and movements with the 20th century seeing the shift from academic to conceptual, to the point that by the end of the century conceptual art was, “the only authoritative approach left standing” (Metcalf 2000)

It is also worth noting (according to Hutchinson) (2016) that art has long been dominated by two separate themes: Aristotelian ‘representation’ which is concerned with mimesis and skill; the other, Platonian ‘inspiration’ driven from within. Aristotle’s ideas embodied the qualifiable, the empirical, nurtured, tangible aesthetics

– a world view that prized *workmanship*; Plato's ideas are qualifiable, spontaneous, natural, intangible – a world view that prized *Creative Agency.*

Thesis p.o.v.

The definition of art, from the point-of-view of this thesis could be described as Gaultian 'anything goes' with a Wittingsteinian caveat of tenuous 'resemblance' and a nod to Danto'sinstitutional thinking, (but similar to Rissati's reliance on 'beholder's judgement) and requires no further justification - its **purpose** is *being art,* its **function** is *largely irrelevant*. (ie: potentially anything can be art, it should somehow appear to be art and be accepted as such by at least someone who seems to know what they are talking about - but can ultimately be 'used' in whatever manner its owner sees fit). However, this thesis stops short of declaring this point of view as an art theory, (perhaps a theory of artistic output - or the *Artistic Output Model*?)

Art, at pre-secondary (primary) education level, is largely considered to be painting, drawing and making 'stuff', usually produced with no purpose other than to impress the intended recipient. The educational theory behind the application of creative practice at various development stages, is doubtless thorough, rigorous and wide-reaching, however not relevant to the way this activity is generally accepted and understood putatively. It would be fair to say that this rudimentary 'theory' is as valid as any other; if, for many, this notion of art endures, albeit with less emphasis on 'making' and more on painting and drawing.

Increased literacy and technological advances have superseded some of the more traditional functions of art. Biblical storytelling and documentary representation were superseded by printing presses, literacy and the rise of photography. It is broadly accepted that art can be appreciated for itself and nothing more, and that art can be horrible, distressing or simply 'not very good' and still be considered art.

While it can be expected that the general populous are likely to subscribe either to an historical theory: that art should look like, and be, recognisable as something similar to existing art, or an institutional theory: that art is whatever the 'art world' says it is; those with an interest, ranging from academic to simply 'passing', can debate the minutiae of the perimeters (and parameters) of such theories and never come up with a satisfactory concord. The Stanford Encyclopaedia of Philosophy

emphasises the problem by providing a list of constraints before attempting a definition. (Walton, 2007)

In the ongoing rhetoric, surrounding the nature of art, the perpetual negation of negation has led Wiess (1956) to imply that art theory has practically consumed itself, or produced what Gault calls a 'cluster theory'. Rather than specifying the necessary and sufficient attributes that artistic output must possess, Berys Gualt (2000) suggests that a list of desirable criteria exists, a collection of which would be the reason for not being more stipulatory, is because the research enquiry of this document is not concerned with arbitrating any disagreement on what does, or does not, constitute art at a deeper level, [breathe] than the artefact's potential to be considered as a candidate for having the status of 'art' conferred upon it. [artist triage perhaps]

In addition, conferring art status upon any artefact tends to make a statement of acceptable quality, however, the use of 'artistic output'[57] can be used as a classifier rather than an evaluator. The value and quality of art is entirely subjective, and this analytical map of the creative landscape is intended to be ontological.

Craft

Putative definition

The 'engaged observers' interviewed[58] tended to divide craft into three broad categories, non-functional output from professional/skilled makers; functional output from professional/skilled; and less than skilled, hobbyist output – with the latter often derided.

Publicly, at least, the layman tends to be more forgiving about hobbyist output as any visit to parochially staged craft fairs and pop-up shops will attest[59], and such an opinion is entirely in keeping with Ruskin's (1850)[60] romantic doctrines about crafts and roundly denounced by Pye (1968).

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[57] A defined at p 20

[58] See human participant – Chapter one p31

[59] Visitors to the National Crafts and Design Fair in Dublin Dec 2105 (ibid) were more vitriolic regarding amateur craft output (or handi-crafts) than the interviewer witnessed at smaller 'local' fairs and shops, where there is always a greater range of 'hobbyist' work on offer. This may be a symptom of city dwelling cynicism, or a belief that they were out of earshot and unlikely to cause offence, and the reverse reasons may be why amateur work receives more compliments from the less urbane – this is anecdotal abduction at best, but not of significant bearing on this research)

[60] As referred to in Pye (p114)

There are no formal Institutional or Traditional Theories of craft, however the broad thinking of these art theories (see definitions) can be applied. Does it resemble some Craft output seen before and recognised as craft? (Traditional theory) has somebody from the *'Craftworld'* declared this to be craft? (Institutional theory). However, people (those 'engaged observers' again) tend to be more confident in their own opinion, i.e., while institutional theory will tend to trump traditional theory in art (Think 'the Emperor's New Clothes') craft output seems to be more democratic, and people less intimidated to comment on it – they have experienced craft and have certain expectation of how it should be (traditional theory).

As previously stated when discussing Jonathan Keep p.100. The original meaning of the word *craft* (and not the mistranslation attributed to Diderot p.57) described a specific skill[61] - the craft of any occupation or activity is the expert knowledge that a practitioner in that field needs to be properly skilled in that field – it this is how the word continues to be used beyond the creative landscape. However, the understanding of the Craft *Field* has several recurring themes: it deals with artefacts on the scale of an individual human, in that they can be made directly by a person and used directly by a person (or people), the limitation of scale seems to be a celebration of the hand, rather than a constraint. The reverence the hand (Sennet 2007) is certainly a throwback to Ruskin (McCullagh, 1996); it deals with artefacts associated with function beyond their own existence although in varying degrees, as Adams says (2007 – p18) "modern studio craft objects refer obliquely to function without being functional."; and it deals with materiality, what Adams (p1) describes as 'medium-based discipline's. Rissatti (2007) is very specific in his 'sufficient' attributes for 'craft' designation, they relate specifically to function: a craft artefact must either, *cover*, *support* or *contain*, or be a tool for crafting an artefact that covers supports of contains, although he also uses materials and scale to for taxonomical and categorisation purposes; e.g. his reasoning for (almost) considering jewellery as craft is due to its 'bodily scale', however, 'adornment' is not a sufficient application to confer full craft 'status'.

Thesis p.o.v.

A teapot with a blocked stroup (whether deliberate or intentional) does not automatically switch tracks from *Craft* to *Art* because of the aforementioned blockage.

[61] Merriam-Webster https://www.merriam-webster.com/dictionary/craft

It could become the component of an artwork (which may or may not require some dysfunction – ready-made components tend not to have their own backstory); or its dysfunction may form the basis of some ironic Carrollian statement on time, tea and incongruity (note to self – idea for later). What, in this thesis, will differentiate the definition of a craft teapot from any another teapot is primarily the process, which in turn often dictates how a practitioner is understood – they are examined separately in this thesis analysis of the creative landscape.

This thesis recognises the output of a *craftsperson* as *craft*, but the production of craft does not necessarily confer the status of *'craftsperson'* nor does it necessarily demonstrate *craftsmanship*. It is largely the scale of application and process that dictates the validity of the output. The output should allude to a function that is relative to 'people'[62] and its scale should present the *possibility* of man-made (as opposed to *men*-made) It is impossible to precisely define the cross-over point for both, however the difference in *boat*-building and *ship*-building (what-ever the reader imagines this/these might be) is enough.

[62] Man, woman child, human, indoors, visible, 'graspable, conceivable, usable etc.

Design

To DESI'GN. *v. a.* [*deſigno*, Lat.; *deſſiner*, Fr.]
1. To purpoſe; to intend any thing.
2. To form or order with a particular purpoſe. *Stilling fleet.*
3. To devote intentionally. *Clarendon.*
4. To plan; to project; to form in a rude draught. *Wotton.*
5. To make out. *Locke.*

DESI'GN. *ſ.* [from the verb.]
1. An intention; a purpoſe.
2. A ſcheme; a plan of action. *Tillotſon.*
3. A ſcheme formed to the detriment of another. *Locke.*
4. The idea which an artiſt endeavours to execute or expreſs. *Addiſon.*

DESI'GNER. *ſ.* [from *deſign.*]
1. A plotter; a contriver. *Decay of Piety.*
2. One that forms the idea of any thing in painting or ſculpture. *Addiſon.*

Figure 3.1.1 Johnson (1794)

Putative definition

Design can be considered as a scale on which to evaluate how well a potential solution meets the needs it is 'designed' to addressed. A good design does the job well, a poor design does not. Unfortunately, for those who seek glory from design, the

best design is often undetectable. Good design has seamless affordance (i.e., its form makes its application obvious without further instruction)

Johnson's definitions (fig.3.1) are as valid now as ever they were, design (as a verb) is simply coming up with an idea, design as a (noun) is the communication of that idea, ie: the instruction. The *idea* and the *embodiment of the idea* are not the same as the design.

Eg: in Fashion: a fashion designer may have an *idea* for a dress – that idea is her vision for the dress as a finished article. She will *design* the dress (using her imagination, problem solving techniques, heuristic 'rules-of thumb, etc) – the process of designing is the formulation of an idea; the 'design' is the method/medium she uses to communicate her idea, e.g. a drawing and/or a set of instruction. A dressmaker can then embody the idea by following the design[63].

Design text books often start out by defining the difference between the object and the action;

> ***Design*** *(noun): specific plans, drawings or instructions that contain all the necessary information for the manufacture of a product, process or system.*
>
> ***Designing*** *(verb): the process of converting generalised ideas and concepts into a design as defined above.*
>
> Garner (2004 p76)

Ulrich (2005) offers a briefer definition: *Design is conceiving and giving form[64] to artefacts* [sic] *that solve problems.*

Thesis p.o.v.

As a field, design is not really 'taxonomically' equivalent to art or craft, as the Venn diagram (fig1.1) shows. Every deliberate artist artistic action is designed – the results of those actions maybe unpredictable or unknowable. Additionally, design goes far beyond the 'artistic realm', but it always involves either creativity, creative

[63] A perfect example of 'workmanship'

[64] 'giving form' meaning the explicit instruction on how to embody the design – no the actual embodiment process.

agency or both. The word design will be used throughout the thesis and qualified where necessary, however, the Field of *design* to be analysed in the creative landscape is the academic and professional field which Identifies problems and opportunities; envisions an end goal where that problem or opportunity has been addressed; and the creative pathway between identification and vison.

Crossovers

Putative definition

As fig 3.1 shows there are considerable overlaps in the artistic domain; as stated previously, what these overlapping 'sub-sets' are called, is largely irrelevant. The purpose of this investigation is to identify them and describe what they are then assess how they may be affected by new manufacturing technology (namely 3D printing)

Art/Craft – The sense here is the production of non-utility pieces (art) with either craft-materials association, such as ceramics or textiles; or processes eg;, skilled workmanship; or because of the practitioner; some practitioners self-designate themselves in this category other have the designation conferred. Grayson Perry probably resides in this area, the 'artworld' continuously tries to bring him over to their side, (Turner Prize) to he to which he seems to enjoy responding "What me, a potter?" whereas Picasso was a prolific ceramicist, but rarely is he classified in the 'craft' hinterland. However, it is Perry's tapestries that provide the most interesting categorisation questions. It is not controversial to describe tapestry as 'Craft', however, these tapestries are made by machine and the design has been produced an on digitised tablet input-device (essentially an electronic drawing palette). The machine translates the design exactly – no interpretation is involved – (sans *creative agency*, therefore, unadulterated *workmanship*) the designer created the 'design' and remained in control of the process (in that he has the right of veto if the output is not per instruction) – ie: has maintained *creative agency*. The requirement for craftsmanship has certainly been met, however the designer (Perry) is not usually associated with tapestry – this is not his 'craft' – does his lack of expertise move the tapestry from 'craft' to art'? Additionally, because craftsmanship evidently exists, does that make Perry a craftsman (in respect of the Tapestry?) – to apply the rules of craftsmanship being proposed in this thesis – no: craftsmanship can exist without the action of a craftsman – A craftsman must demonstrate workmanship coupled with

creative agency. (Creative Agency extends to control over the workmanship – craftsmanship exists – but the maker must carry out both actions to be considered a *craftsperson*.) Perry argues that the level of skill required to manipulate the software to get it 'output ready' is workmanship[65] however, in this instance the work of physically 'making' the carpet is what is being considered. It is clear that, rather than trying to explain (to whomever) the minutia of this 'cross-over' practice – *Applied art* is a much simpler description.

Thesis p.o.v.

For each of the following landscape subdivisions (practitioner, output and process) a revised version of the fig 3.1 with respect to each is presented. The overlapping areas will be apparent in each. To reiterate, what these 'crossover' regions are called is unimportant. The landscape will map their relative positions, and subsequently, how they are affected when viewed 'through the lens of 3D printing'

[65] even though he actually called it craftsmanship – this is thoroughly addressed in 'crafstmans verses etc' p.xx

Practitioner

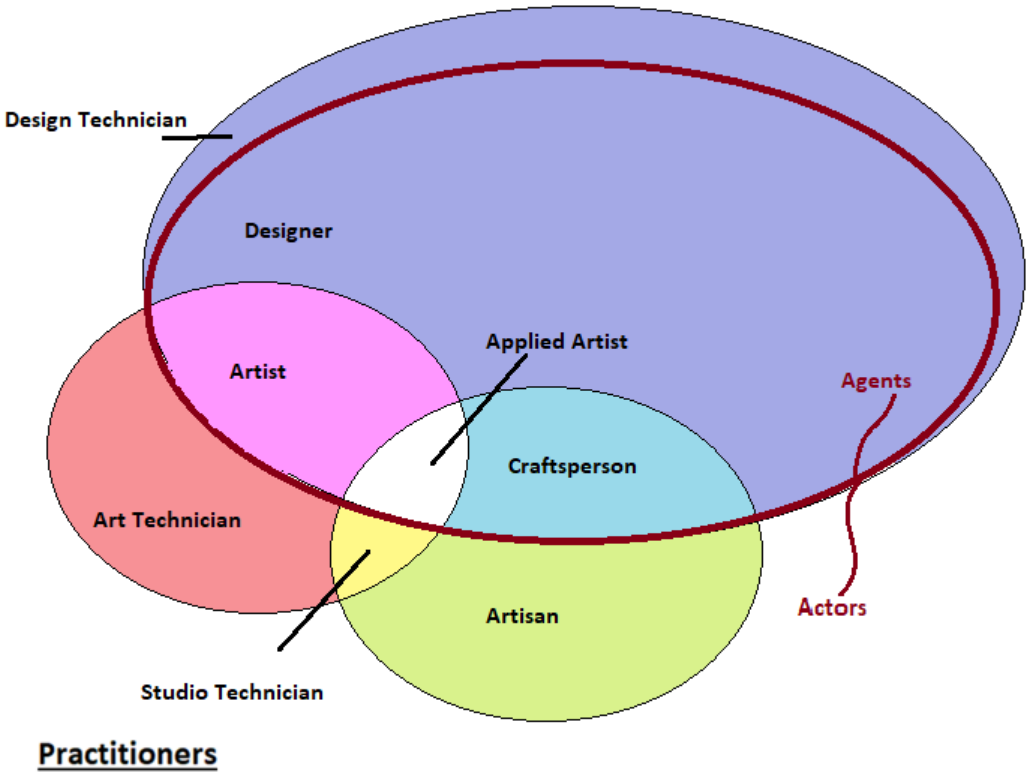

Fig 3.2 Practitioner Venn Diagram

The names in Fig 3.2 are largely arbitrary, in particular the non-agent roles. The red border surrounding the design set, clearly delineates the limit (or extent of) Creative agency in practice, within the Creative landscape. Each field will be assessed as follows:

- *Agents* - those with creative agency who either envision and or design the output. and pass-on instructions for others to either translate or interpret (the designer)
- *Actor/agents:* those who both make the output and, with varying degrees of control, exert creative agency over the final output
- *Actors:* those who carry out the instructions of others to 'make' the final output.

Art practitioner

Agent

The Artist. There is little question that the Artist is attributed with complete control over the final output and it has long been accepted practice that some artists have apprentices to take care of the mundane, from Cennini's 14th century apprentice instruction on preparing, sizing and paining a panel, (OU, 2007) to Jeff Koons claim

“I am basically the idea person. I’m not physically involved in the production”. (Ottmann, 1986) Equally, it is perfectly acceptable for artists to construct their output from prepared components or entirely readymade components in the case of Duchamp. It would seem that the artist has creative agency, however the technicians and apprentices can clearly retain a decree of artistic agency in their process. Therefore, there are two levels of creative agency to understand: one that controls the process and the output and one that is only concerned with the output, regardless of the process. (it could also be considered on a sliding scale rather than two discrete positions) In the latter, the artist will depend on the craftsmanship of their technician (in that they rely on both their workmanship skills, as well as their creative agency) probably because the artist does not have material expertise to a degree that allows them to provide precise instruction. The output in this instance is an artistic collaboration, however, the creative input of the technician is not often credited.

Agent/Actor

The Artist. Despite what the previous paragraph suggests, many artists physically make their art; and, as will be discussed in the next section, the workmanship skills such as resemblance and mimesis, especially from Historical and Academic style painters are admired, expected and often a gauge of how ‘good’ an artist is. However, the ability to accurately copy a scene cannot be considered a demonstration of creative agency - only of skilled workmanship.

Actor

The Performer An artist with no creative agency toward the final output is a contradiction. An artist commissioned to simply translate precise instructions, could at best, be performing, or following a script; without including some aspect of translation the practitioner cannot really be called an artist. An analogy can be drawn with practitioners throughout the ‘Arts’ as opposed to Art in the context of this thesis. An actor on stage, who delivers her role as a precise translation of the writer or director’s instruction, without making any creative interpretations could only be described as a performer, and not an artist. However, such precision may be virtually impossible to achieve, perhaps an Olympic gymnast, scoring perfect tens, would be an example of pure performance (ie: with no interpretive or creative deviations). This does not conflict with the idea of performance artists - performance is the medium,

the artist is still the artist (as long as they retain some of all of the creative agency over the output)

Craft practitioner

Agent

The designer – the person in control of the form of the output. The designer may not be the only creative agent involved in control of making (section IV. Process explains the varied causes of making). If the designer also retains creative agency over the making – the output can be considered craftsmanship – put does not make the designer a 'craftsperson'

Agent/Actor

The designer/maker – the person who controls the form (designer) and physically manipulates the material component to realise the design, by applying workmanship. The combination of workmanship and creative agency in the making of an artefact equated to Craftsmanship, as both are carried out by the same person – that person can be considered a craftsperson.

Actor

While the previous section suggest that an artist without agency is not an artist but merely a performer, the same is necessarily true in craft practice. A craft technician, or an artisan, producing skilled workmanship by following an existing design, is still producing 'craft output'. Workmanship skills are highly prized in craft practice and an artisan, especially one applying traditional skills (wood-turning, shingle-making, blacksmithing, coopering, candle-making etc) is a legitimate craft producer. However, when they produce work that is not of their own design it is *workmanship* not *craftsmanship*[66] *that they are demonstrating*

Design practitioner

The dynamics of design practice differ from the other three fields because agents, by definition, are the designers. Designing is 'making the design' However, in many design practices (eg Architecture) design technician play a major part in making the

[66] Specifically, the practice this thesis calls craftsmanship (workmanship plus creative agency)

design communicable. Therefore, the three aspects of design output that are dictated by agency and action are more thoroughly explored in relation to output, however, within practice there is a forth option – the problem solver, they do not require creative agency to be ‘creative and provide solutions, just a well-defined problem and an end goal.

Agent

The designer, with the creative agency who not only controls the form, but is also capable of identifying problems and envisioning end goals

Problem solver, with algorithmic creativity (see essay – p75) they will look for within a set of parameters, working systematically rather than intuitively.

Agent/Actors

Either of the two design creators from above, who also prepare the communication media of design

Actor

The design technicians who prepare plans, models, prototypes etc. of the ideas created by the ‘agents’

Crossover practitioner

Agent/actor

The crossover practitioner only really exists as an agent/actor because they will either be an artist demonstrating more workmanships skills or a craftsperson shifting their ‘causes of making’ from meeting a need to exploring a concept – to be an actor only in this instance would remove the ‘craftmanship element, and actor only would remove the ‘artist’ aspect. These are the practitioners that Perry (2015) seems to have missed (2015) – see also essay Conflation of Nomenclature p.66

Output

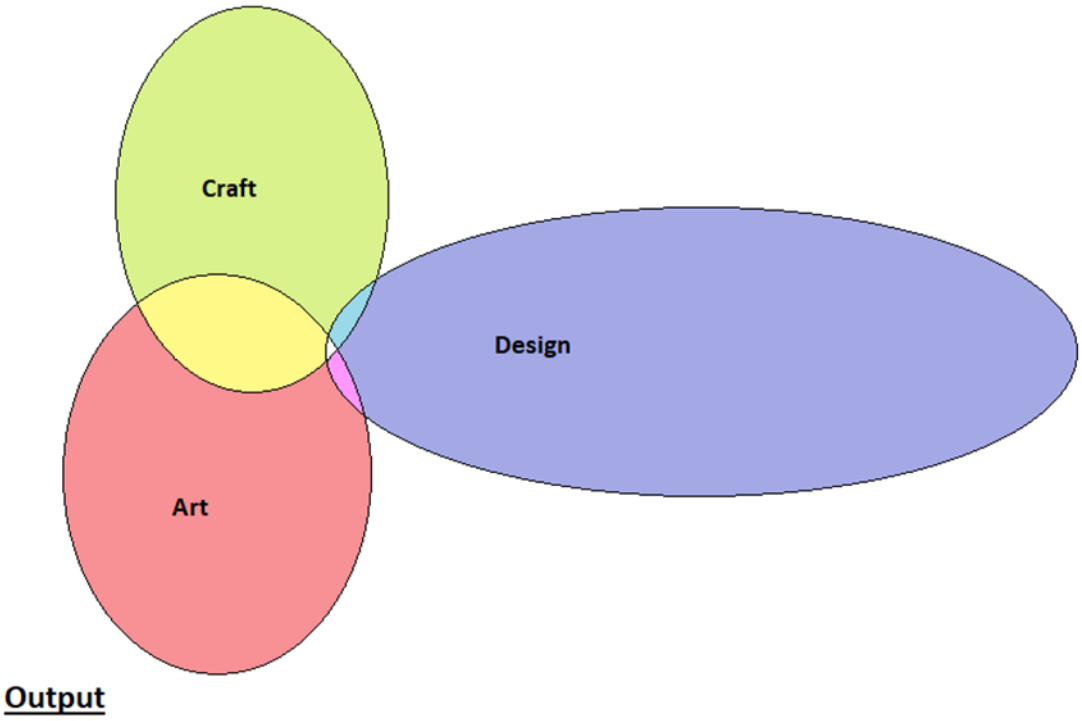

Fig 3.3 Output Venn Diagram

The Output Venn diagram (Fig 3.3) does not delineate the extent of Creative Agency as the design perimeter. (as figs 3.2 and 3.4 do) This diagram presents the putative interaction of the *artefacts* of output in each area. Design output is essentially, the instructions for making, including models, drawings and diagrams, which may, in certain circumstances be regarded as art or craft output (a status often conferred retrospectively). However, it should be reiterated that, despite many Art and Craft practitioners existing within the 'Designer set' (fig. 3.2) and most of their processes being considered 'design' (*verb*) (fig. 3.4) the output of design is not the same as the embodiment of those designs.

For the purpose of this thesis, **Output** is defined previously as: any 'entity' (object or idea) that is attributable to a source, and can be communicated between other entities, via any medium; and that it must have some tangibility or palpability (a Superficial Aesthetic

Constituent parts

Output will be deconstructed into its constituent parts of: the medium, that is, the physical components and the method of delivery; the message (that which is being communicated via the medium); the purpose (being the intended use) and the function (the actual use); and *analysed from three maker points of view: that of the agent, the agent/actor and the actor.*

The output will then be considered from the point of view the user:

It will be based on the non-exhaustive list of: *Collector, Investor, Other Buyer, Commissioner, Student/academic, Critic, Intentional viewer, Incidental viewer and Passer-by* (selected because of their varying degrees of interaction with artistic output and different value perspectives. No other ethnographic or demographic factors are relevant.)

a) *Collector* - a buyer (or borrower) of works to match an existing set/category of pieces.
b) *Investor* - Buying with the prospect of making a return (usually financial)
c) *Other buyer* - Agents, private companies, public bodies.
d) *Commissioner* - Any person or entity (fit to enter into a contract) who instructs another (practitioner) to produce the output at their request and often to their instruction (the expected level of creative agency, is addresses in elsewhere in this thesis)
e) *Student/academic* - Interest will largely be from a research pint of view, with no financial relevance or change of ownership.
f) *Critic* - One who is professionally engaged in the analysis in interpretation of creative output.
g) *Curator* - A custodian and assembler of collections of creative output.
h) *Intentional Viewer* - An engaged enthusiast who actively seeks out creative output
i) *Incidental Viewer* - A member of the public who will visit galleries with no motive other than the visit itself.

j) *Passer-by* - People who see public art on display and hold fleeting opinions as they pass.

User Values

Values will fall into four broad categories of *Use*, (utility), *Exchange*, (economic, relative advantage), *Sign or meaning* (cultural, spiritual, emotional) and *Experience* (aesthetic). These are based largely on categories identified by Suzan Boztepe (2007), she grouped *use* and *exchange* together, but was coming from a solely design perspective, for this mapping it makes more sense to view them as separate values where the use (function or purpose) does not fall into the other three groups. In most groups, it would appear that the meaning of a piece of work influences the value to the user (sign Value) - this does not mean that the exchange valve, were it high enough, wouldn't overtake that value (at least in the case of buyers)

Art Output– *Maker* Point-of-view

Medium

Component parts - The discrete material components of artistic output:

If artistic output is considered the embodiment of an artist's message, then the media used must be considered the method of delivery. Whatever the medium, it must be an assemblage of components. These components, which may be as *elemental* as the artist wishes; from literally elemental, eg: gold, to compounds, eg: iron oxide; to raw state, eg: egg yoke; to prepared materials, eg: canvas or proprietary paint; to commissioned components, eg; glass flasks; or purchased items, such as urinals; to found items, perhaps a tree stump impaled on a fence[67] [does this suggest all art output is in fact some form of collage? Perhaps.]

The subsequent assembly or manipulation of these components, controlled by the artist (however minimal), is the act of creating art from the components.

[67] BBC arts programme

By viewing a *pissior* as a component (rather than the necessity of claiming all art is 'embodied' meaning - Danto, 2014), ready-mades, found art and even mathematical art (which is probably found art) can all be accepted. It allows even the most functional pieces of craft to be accepted as art, contrary to Metcalf's assertion (2000)

The logic of this approach is easier to understand if viewed in the opposite direction: if every prepared element of a piece of art, we were to be deconstructed, then artists working with oil-paints would be required grow their own flax in order to refine their own linseed oil and to produce the fibres from which to weave their canvasses, and probably hunt down squirrels and badgers to fashion brushes from their pelts. Clearly an impractical proposition.

The level of completeness, readiness or even finish of these components, dictates the amount of *workmanship* required to construct or 'make' the final output. However, the level of skill involved in this workmanship should not have a bearing on the artistic message (unless the process is part of the message). Is a painting by artist, who is skilled at stretching canvas over a frame, and carried out this preparative stage themselves, more 'artistically worthy' than the painting made by an artist who buys in a pre-stretched canvas, prepared by someone else? How far into the process can pre-prepared components be used? As long as the external input is workmanship only, then the preparative work cannot compromise the creative agency of the artist.

As previous references to Cennini and Koons demonstrate, it was/is not unheard of to have technicians, or apprentices prepare these elements, or constituent parts, within a studio setting.

It is perfectly acceptable for an artist to keep their hands clean throughout the entire production process (Petry, 2011), although, as subsequent sections will address, the same is not the case in the craft field and largely inconsequential in the design field. However, identification of the discrete material elements (of artistic output) consequently helps reveal the discrete elements of the process - specifically the separation of the making and the instructions for making. It may not seem like a game changer in 'art' because employing a technician or artisan or anyone with greater workmanship skills than the artist/designer, is accepted practice and therefore the separation is obvious. When the artist/designer is also the maker, the two processes are not that easy to identify separately.

Agent

An artist must be the agent of their own creativity, as the preceding paragraphs explain, regardless of the 'workmanship' input from external sources, the fully agent artist, as control over the final output. Where late stage involvement occurs, the technician may apply some creative agency in the way they carry out their instruction, and it is accepted that the technician may not get a collaborative credit for this.(find reference in Petry) However, there is not a conflict here if the work is considered 'component preparation': just as the artist does not give the paint manufacturer instructions on how to make their paint, the artist is only concerned that the colour and the quality is what they requested - only the end result is important,. From the artist p.o.v. the artistic medium is the method of message delivery.

Actor/agent

Some artists question the validity of practice if they haven't executed the physical manifestation of the design themselves - Brigit Mongeon, a sculptor who uses 3D 'technology' in her making process, has deliberated over this and asked "Am I cheating?" She raises valid concerns for those artists who 'make' their art and consider their workmanships skills intrinsic to their work. It should be noted that Mongeon's voice is evidently that of a sculptor, a practice traditionally embedded in a culture of 'hands-on', therefore a certain level of guilt at receiving technological help in the 'making' process is understandable. Additionally, were it not for Versari nomenclating sculpture: Fine Art (ref) then it could likely, now, reside in that middle ground between Art and Craft (frequently referred to as 'Applied Art')

Actor

While it is established that the actor/maker is a *performe*r rather than an *artist*, they still pay vital role in the 'making' of artistic output. While they may not exercise any creative agency over the output, they will be driven my other factors, professional pride, earning money, recognition, further work. These factors may constitute the message the 'performer' is delivering via the medium, but their message is not the same *artistic* message as the artist's, they may have no idea what form the final piece will take or how their contribution will be incorporated.

Significance of workmanship in output medium in art: Those actors that provide the media components subsequently 'assembled' into to artworks by the artists (Creative agents) demonstrate workmanship and as such need to maintain a relative advantage over their 'competitors' However, artists often rely on these 'workmanship providers' to apply a degree of Creative Agency, in particular when the 'Actor's' material knowledge exceeds the artists. Petry (2011, p.8) describes (but doesn't name) the pharmacist, charged by Duchamp to make a sealed glass flask, filled only with Parisian Air. He presented "Air de Paris" to his friend and art collector Walter Arensberg in 1919. The chemist was at liberty to produce an artefact within parameters set out by DuChamp and even though Duchamp may have passed the flask onto Arensberg entirely unchanged, the Chemist only ever had Creative agency over the *component* not the *art work.*

Potential effect of the 3D printer.

If a media component can be made more successfully by 3D printer then those 'providers of workmanship' who are dependent on their *relative advantage* over other 'providers of workmanship' them there is potential for impact, however, workmanship skills alone may not be what gives these component providers the advantage. Their ability to translate an artist's instructions

Message, Purpose and Function.

As the sections on teleology (p.22) and Artistic output (p.20) attest, art need only function, and therefore be appreciated, as itself. If an artefact is intended to be appreciated as art, and it **is** appreciated as art, then its purpose and function are one and the same. However, what it is for (purpose function or both) is not the same as its message. Teleology deals with use (intended and actual) the message deals with how it is understood. An example would be renaissance painters e.g., Holbein: the purpose (and function) of many of their portraits were to allow potential spouses, residing abroad, to view their betrothed in advance. In reality they were often full of different

coded messages understood by different people. It is said that Holbein's overly flattering portrait of Anne of Cleaves lead to her marriage to Henry VIII[68] . The need for resemblance in painting dwindled as photography took-over this function of art, just as literacy reduced the need for its biblical 'story-telling' function, and in the 20th Century appreciation of art became more about 'the concept' (away from Aristotle toward Plato – see page 6 – thesis p.o.v. on definition of art). How the message is understood can either, depend on how well-versed the observer is on the artist and the artist's intentions or how the observer constructs their own meaning based mainly on the superficial aesthetic of the piece.

Significance of workmanship in output *Message, Purpose and Function* in art

Output Workmanship is only relevant to the *message* based on how successfully the artefact communicates the message., or, when the process (and therefore the workmanship is part of the message. Example from Chapter two such as Karin Sanders […] project are an example of this.

Potential effect of the 3D printer. – there can be no impact on the artist's intended message: It is either relevant to the message of not. It may be significant when constructivist methods are applied, however, if a piece of art does not have any distinctive 3D printed superficial aesthetic, then the viewer (relying entirely their own constructed meaning), cannot know it is 3D printed; and if they are informed, then their appreciation is based on the artist's intent. This circular argument therefore eliminates any detrimental effect. Where it may affect the message is if the observer 'discovers' that an artefact was 3D printed when the artist tried to hide the fact. However, this is only relevant from the observer's point-of-view and how they value the work. (see section xxx)

[68] A common and often retold anecdote, although Davis Starkey thinks it unlikely https://www.theguardian.com/artanddesign/jonathanjonesblog/2011/apr/27/holbein-engineer-royal-wedding.

Art Output – *User* Point-of-view

User values

The belief that artists should be skilled, and that skill demonstrated in their output, continues to be held by, at least some, members of the public. The engaged onlooker may ascribe to the notion that art is all concept etc, but a recent article in 'the times' newspaper,[69], on the scientific evidence that, telling viewers an object is 'art' makes the viewer find it more 'beautiful', was greeted with the following comments[70]:

> *Modern artists are too lazy to learn how to paint.*
>
> *...I've always thought abstract artist [sic] can't paint say portraits or landscapes and that's why they paint the way they do. Is it art if you throw paint at a canvas, or are you just lucky it fell in a nice pattern…*

This brings up the idea that the workmanship skills involved in the 'making' is the element that is most important (or at least to these two commentators) - those skills may be draftsmanship, or mimesis or resemblance. However, engaged members of the public are not the only 'users' of art, and workmanships skills are not the only values of import to those various users

a) *Collector* - In the art field, work can be grouped into categories based on artist, medium, genre (geography, style, date, process), therefore the user the values of the collector will be dependent of the parameter of the collection criteria. This does not mean that the investment potential and exclusivity is not considered. The less ephemeral and ethereal, the more likely artistic output is to be collected. The main defining value category of collector will be *sign value* and to varying degrees, *exchange value*
b) *Investor* - The user value for this group will be entirely monetary, however, the 'values' other user put on artistic output will influence the speculative nature of this group. Understanding other users' values will help investors identify stock with the potential to rise in monetary value. There will be cross-over between collector and investor, however the defining value category of investor will be exclusively *exchange value.*

[69] http://www.thetimes.co.uk/edition/comment/art-means-art-wx6z8fbtc

[70] The comments come from members of the public engaged enough to have an opinion, and also to be in the poison of having access to a subscription of the Times online version, as viewing of this article was/is restricted by a pay wall.

c) *Other buyer* - Agents, private companies, public bodies. The value an art agent places on art will be a reflection of the agent's clients, but will ultimately be influenced by the level of commission they receive. Private companies and public bodies will be more concerned with perception, in the case of private companies the art they display may to impress customers or instead to be seen as supporting a particular artist, group of artists or a region. Public bodies will similarly place value in the level of support that they can give a particular community, they will need to demonstrate value for money and have budgetary constraints. Companies and public bodies (that buy art) will often be collectors as well as being aware of the investment value. Disregarding collectors, and investors, corporate and public bodies, as buyers, can be largely defined by their *Use Values,* embodied in the support they give to others.

d) *Commissioner* - The reasons for commissioning art can be varied and there this category of user could be driven by all four value categories. There could be exchange value in investing in the work of an up-and-coming artist, or the use and signs values, described above could apply. Even experiential value could be a factor, perhaps fulfilling a long-held desire.

e) *Curator* - A custodian and assembler of collections of creative output. In their capacity as a user of art, exchange value should be inconsequential, Both the *use value* - largely educational - and the *sign value* should have equal weighting, *Experiential value* must be highest place. Educational use could be considered an experiential value, however, the content created and how its message prevails and is retained is probably different to the interaction with the output.

f) *Critic* - One who is professionally engaged in the analysis and interpretation of creative output. Critic values could be shared between *experience* and *sign* values however how they experience artistic output will influence the value they attribute to the meaning, and while they may have personal value judgements about sign values, they are not relevant their user values in their capacity as a critic.

g) *Student/academic* - As their Interest will largely be from a research pint of view, with no financial relevance or change of ownership, exchange value is irrelevant sign and experience values will be of relevance because how

information is ‘absorbed’ from artistic output, depends on sign value; this, however, is the educational value that the output’s *use*, as a source of information.

h) *Intentional Viewer* - An engaged enthusiast who actively seeks out creative output. The will be motivated by both *sign and experience values* because their prior knowledge makes the artistic output meaningful, and because of their expectation of interacting with the work.

i) *Incidental Viewer* - A member of the public who will visit galleries with no motive other than the visit itself. Purely experiential values; while the interaction with the artistic output may encourage development or sign values, this will be retrospective.

j) *Passer-by* - People who see public art on display and hold fleeting opinions as they pass. *Use value* is the only relevant user value for the passer-by, while experience value may seem important, but there was never an intention to interact so any experience value can only be retrospective.

User Value Grid - Art

Group ↓ ***Value →**	use	exchange	sign	experience
Collector	-	O	X	O
Investor	-	X	-	-
Other buyer	X	O	-	-
Commissioner	X	X	X	X
Curator	O	-	O	X
Critic	-	-	X	O
Student/Academic	X	-	O	O
Intentional Viewer	-	-	X	X
Incidental Viewer	-	-	O	X
Passer-by	X	-	-	-

X Primary value O Secondary value - Not significant

**Use, (utility); Exchange, (economic, relative advantage); Sign or meaning (cultural, spiritual, emotional); and Experience (aesthetic).*

How the lens of 3D printing will affect the user values:

Use: (where an artwork has a function beyond its monetary value, its meaning and the experience the user has upon interaction): Artistic output associated with 3D printing, may encourage greater interaction (or just mild curiosity) in the passer-by, and perhaps broaden the scope of a student's research; however, the effect on other buyers and commissioners will depend on what is driving their actions. G a buyer of art for a banking group maybe tasked with purchasing 'traditional' or 'conventional' art, an association with 3D printing may go beyond their remit.

Exchange: There is some conjecture that the 'multiple replicability' would put art buyers off, (Mongeon, 2016 p.45) Ch 2 (p.120) highlights one flaw in this position – that the workmanship is more important the creative agency; however, to suggest to replicability would put art investors off, suggests that the 3D printing Artist has no integrity. Signed limited edition screen prints are accepted, limited editions of

investment-cast sculptures are accepted, in both cases the artist is at liberty to make more ‘editions’, there is no reason to believe a 3D Printing artist would be more likely to do this. 3D scanning comes into this argument too – but that is even more spurious – any artefact can be scanned – there is no connection to 3D printing in this respect. Dissemination of coded files is where a genuine problem may exist, artists need to take appropriate care when ‘moving’ the code, e.g. to a print bureau, or find secure ways to identify ‘originals’. (as with any other artform)

Sign: The 3D printing lens will have no effect on those users who value art for its cultural, spiritual or emotional meaning: the work either meets the collection criteria, or it doesn’t, the intentional viewer is there on purpose. A new association being conferred on an artefact won’t change its meaning for an *informed* user, incidental users, researchers or curators, who are coming to the source material ‘anew’ (or any *misinformed* user) may form new meanings as they become better informed, however that process of becoming informed is derived from how they *experience* the work.

Experience: how applying the *Lens of 3D Associated Artistic Output* affects the ‘Experience’ value of Art users will depend on expectation and subsequent disappointment, surprise or delight. (eg the engaged public commentators, quoted at the start of this this section.) As, mentioned above (in *sign* value) this will serve to build new meanings.

Where the most important user values are not exchange values, there can be little negative effect on user values when considering *3D Associated Artistic Output* in the field of **Art.** However, **Craft** user-values are more likely to be process and performance based and the effect in that field will differ from this.

Craft output - *Maker* Point-of-view

Medium

In Art, the artist uses their media to communicate their message, in Craft, the medium often defines the practitioner: A ceramicist, a wood turner, a jeweller, a weaver etc. Additionally, because of the expectation of functionality, the material selected must be fit for use (purpose and/or function)

With craft, there is an expectation of skill – the workmanship involved in the manipulation of the medium should be demonstrable. The designer of the craft artefact is expected to have sufficient knowledge of the medium to control the workmanship. For craft output to demonstrate craftsmanship, both material knowledge (in Creative Agency) and Material skill (in workmanship) must be present.

Agent

The designer. In craft, the creative agent provides the instructions on how an artefact is to be formed. They may or may not be responsible for the 'causing to be made'. They may have been presented with a well-identified problem, requiring a solution; they may have identified the problem themselves, or spotted an opportunity. Either way, in order for them to devise a design, using a particular material, with enough detail to control how the final piece is produced – they must have an expertise in the material. The instruction they pass on to the 'provider of workmanship' (which could be themselves, an artisan or a 3D printer) must contain sufficient material expertise to prevent the 'maker' having to employ any creative agency. The designer should also have precise knowledge of the workmanship capabilities of the maker and only present them with that which they are capable of.

Agent/Actor

The Designer/maker has full control over the design (as above) and also executes the design therefore, has the requisite material skills as well as material knowledge. However, this is no guarantee of quality or expertise. The designer who executes his or her own design, will be aware of their own limitations and

design accordingly, it is therefore possible for a designer/maker with rudimentary workmanship skills, to provide *perfect* workmanship, by virtue of a simple design.

Actor

Artisan, Technician. As with art, the technician's roll is to provide *workmanship*. The better their materials skills, the more likely they are to have a relative advantage over other 'workmanship providers'. E.g. large-scale craft producers, such as Nicholas Mosse[71], produce *craft* output, their pieces are hand-thrown by skilled potters, the potters follow the design they have been given, they are employed because of their materials skills.

Significance of workmanship in output medium in craft:

Of all the fields within the *creative landscape,* craft relies most on workmanship, and workmanship is grounded in material manipulation skills. Workmanship sets out the design constraints because it dictates what *can* be done, (Pye 1968, p.17) The relative advantage any craft technician has, is entirely down to their material skills.

Potential effect of the 3D printer.

The 3D printer can have an effect on the designer/maker – possibly the most profound in the Creative landscape – it may provide workmanship skills of a higher standard than the designer maker can provide themselves, but rather than using the 3D printer to replace one of their existing tasks, instead, the superior workmanship will allow them to make more complex designs. Were previously they had allowed their lack of workmanship skills to limit their creative agency, they can now create more elaborate output.

This has long been the case with hand-knitters, moving to 'hand machines'; and increasingly, jewellery designers, who were limited in their Creative agency by their wax carving skills, can design extremely intricate pieces 'virtually' and have the wax models 3D printed. They will still follow the same casting process which may or may not involve a technician. Likewise, woodcarvers who have previously avoided detailed filigree work, can now demonstrate a new level of 'creative agency' knowing that they have the use of Digital manufacturing technology, better able to produce very fine detailed 'workmanship'.

[71] https://nicholasmosse.com/pages/behind-the-scenes

Message, purpose, function

Other than the demonstration of process, or skill, the 'message' of craft is not largely significant. However, the drivers behind the artefact may have a message, but these will fall into the category of purpose and function. Eg. A hand-crafted mug, in a hotel room, with the hotel logo on it: The nature of the piece is being a mug and that is its essential message or how it is understood. Its *purpose* is to enhance the image of the hotel by portraying a particular style/value etc. and also to provide a functioning drinking vessel; its *function* is being a mug, and to promote the hotel and its values. The later function only exists if the user infers the intended message.

Significance of workmanship in output Message, Purpose and Function in Craft.

Workmanship only becomes a factor if the output is not fit for purpose or function. In the case of the hotel mug, if the workmanship were so poor that the mug could not hold liquid, it is non-functional, but it could still promote the hotel, however, if the 'mug' did not function as a mug' it may well promote the wrong image – therefore it has not fulfilled its purpose either.

Potential effect of the 3D printer.

Only the extent to which it can improve on workmanship.

Craft Output - *User* Point-of-view

User values

Across all fields of the Creative Landscape, craftsmanship and workmanship skills are most highly valued in the craft field, (and as discussed in chapter two, rarely differentiated.)

The various users of craft will have the same values art those users of art, however, as an investment in craft is rarely comparable to art, and when it is, it has essentially 'jumped the gap' Additionally the level of engagement is lower, often because of

display concerns. Paintings and photographs can be hung flat on a wall, craft output usually requires floor space.

The other buyer group, for craft will differ the most from art, largely because of the utility of craft output. Mugs can be used as mugs, knitwear can be worn, a turned wooden bowl can be filled. Craft is, generally, more affordable than art and utility pieces tend to offer more value for money. In addition to the user-value, the sign value is also high, craft buyers are supporting local crafts people, and acquires pieces that no else has.

User Value Grid - Craft

Group ↓ ***Value →**	use	exchange	sign	experience
Collector	-	-	X	O
Investor	-	X	-	-
Other buyer	X	-	X	O
Commissioner	-	O	X	X
Curator	O	-	O	X
Student/Academic	-	-	O	O
Intentional Viewer	-	-	X	X
Incidental Viewer	-	-	O	X

X Primary value O Secondary value - Not significant

**Use, (utility); Exchange, (economic, relative advantage); Sign or meaning (cultural, spiritual, emotional); and Experience (aesthetic).*

How the lens of 3D printing will affect the user values:

Use: 3D printing will have no effect on the value of use. If 3D printing affects an artefact's ability to function as intended, it will not be 3D printed.

Exchange: 3D printing may increase exchange value, the current processes do not make better functioning artefacts than traditional or conventional craft practices, therefore a 3D printed artefact is likely to shift into the 'crossover' zone, between art and craft – or shift all the way to art. Therefore, it could increase the exchange value of craft by lifting it out of the craft field.

Sign: The 3D printing lens can have no negative effect on sign value. For those users to whom the sign value of the craft process matters – there will be no reason to engage with process that are beyond their interest. Eg, if a user values woven goods – then 3D printing will be irrelevant. On the flip-side, to those who do not regard the process as important – it is also irrelevant. There could be, of course, users who value what 3D printing means, are excited to see 'craft' produced this way

Experience: How people interact with craft on a superficial level may be affected by 3D printing, but most likely due to the novelty.

Design Output – *Maker* Point-of-view

The idea of design as output is often misunderstood. The proposed region of research that this thesis initially responded to was *"At the Boundaries between Design and Craft",* however, as this chapter in particular has reiterated, there is no boundary between craft and design, and for output there is barely an overlap.

The output of a designer practitioner, and the design process, is a design (noun.) *A design* is a set of instructions on how to reify an abstract idea.

Medium

Design media are those used to communicate embodiment instructions. They may be analogue (a drawing), digital (a CAD file), even audio (a recorded set of vocal

instructions;) models and maquettes, videos and blueprints, dress patterns and architectural plans; prototypes.

Agent

The designer: 'media' output will be either zero or, if they are not going to prepare the communication media themselves, sketch designs for passing on their technician. In cases of design competitions, the 'design output' may not progress past the sketch design stage.

Agent/actor

The independent designer. with no support technician (nor outsources model making etc), therefore the 'idea originator' is the same person who produces the media that communicates the idea.

Actor

The design technician. Translating the designer's ideas into a format that the ultimate maker (builder, knitter, potter) can understand, using the medium they are particularly skilled in.

Significance of workmanship in output medium in Design

The medium is the method used to disseminate embodiment instructions. Before embodiment instructions come sketch designs. In many design offices/studios, larger than individual practices, the designer will come up with the idea, sketch it out (using any of the above listed communication media) then pass it on to the design technician to make working drawings – the specific embodiment instructions, (again using whichever of the above communication methods which are appropriate.) A good technician translates the designer's ideas without applying their own creative agency. Of course, they will have to make their own judgements where parameters are broad, however, much like Duchamp's flask-making pharmacist, the technician is preparing a component of the design, the designer simply 'signing it off' is enough to give complete authorship to the designer.

Potential effect of the 3D printer.

3D printing will have the greatest effect on the design communication process – because the process is so reliant on workmanship (the skill of draftsmanship or

modelmaking); however, the more types of models that designers will be able to present to clients will enhance design communication. Where designers (or their technicians) could previously provide realistically rendered 'virtual' models, now they can give clients physical models which look and feel very similar to the finished products, in a cost effective and timely manner. 3D printing has reduced prototype-turnaround time from weeks to days meaning the iterative design cycle of 'design – prototyping – testing – redesign' is shorter, reducing costs and getting products to market quicker. Smaller design firms can produce the quality of design communication media previously restricted to much bigger and wealthier practices.

Message, Purpose, Function

The *message* **is** the design; the *purpose* of the design output is to communicate the design; but the *function* depends on whether the instructions are carried out. Designs entered in competitions my never 'function' as intended, many public buildings are commissioned this way and often exhibitions are held, either at the time or many years later. Such as 'Imagine Moscow', at the Design Museum, London,[72] where the plans for an array of unbuilt 1920-30 Soviet architecture was displayed as art, or the Gaudí Museum at the Sagrada Familia in Barcelona, that displays reconstructed, original, plaster maquettes, like holy relics[73].

Significance of workmanship in output Message, Purpose and Function in Design

Workmanship skill it vital – the clarity of instruction dictates how successfully the 'message' is delivered, how well it meets its purpose, and the likely hood of the of the design getting the opportunity to function as a design. Along with embodiment instructions, the design must communicate a vision. Each type of medium used must be manipulated with the most appropriate workmanship skills to provide clarity (of instruction and vision). The importance of workmanship is design is such that it influences workmanship further on in the making process. While it has been stated

[72] March 15th – June 14th 2017 https://designmuseum.org/exhibitions/imagine-moscow
[73] http://www.sagradafamilia.org/en/museum/

that workmanship skills place constraints in the designer, poor design instruction can hamper the workmanship of employment.

Potential effect of the 3D printer.

Where 3D prints provide clearer instruction than might otherwise be presented, it will influence design decisions, eg. market testing will be more accurate. it can also reduce geographical barriers; McLuhan's 'Global village' (1964) is becoming a reality. Eg. A designer in in the UK could send different, culturally adapted variations of a product to various locations around the world, for market testing, by simply emailing coded prototypes for printing in-situ.

Design Output- *User* Point-of-view

The list of users discussed for the other output fields does not apply for design output (for the varied reasons, including taxonomical incomparability, discussed previously).

Users

Makers – those who follow the instructions laid out in the design. They range from skilled and semi-skilled *actors* who have a full schematic before they start, through to designer/makers (*actor/agents*) making design decisions prior to each action.

Causers of making – Those with needs to be met, problems to be solved and opportunities to be taken advantage of, (*the client* – who can also be the designer acting on their own creative discontent)

Non-user 'Users' – those who interact with designs in a research or exhibition setting

Group ↓ ***Value →**	use	exchange	sign	experience
Actor	X	-	-	O
Actor/agent	X	-	-	-
Client	X	O	X	O
Student/Academic	-	-	X	X
Intentional Viewer	-	-	X	X
Incidental Viewer	-	-	X	X

X Primary value O Secondary value - Not significant

**Use, (utility); Exchange, (economic, relative advantage); Sign or meaning (cultural, spiritual, emotional); and Experience (aesthetic).*

How the lens of 3D printing will affect the user values:

Use: Any 'making' process, that follows a given design, is made easier the better the end goals are presented. A designer's ability to visually communicate their vision will often determine whether or not a proposal is taken forward, wins a competition, secures funding etc. 3D printing can greatly enhance the quality of design communication

Exchange: The design client can be any one of a vast range of users who *cause* making and while well-communicated designs can raise the exchange value of the design idea, the design output, in itself is not commonly 'sold on' in any way that can be enhanced by 3D printing. When designs (making instructions) are sold by retailers the diffusion model is likely to be high numbers at low process, dissemination of design instructions as a 3D printed model is unlikely to be economical, although promotional models may be useful. An exception would be when buildings are being sold with planning permission and approved working drawings – auxiliary 3D printed models could boost the exchange value; and another would be the designs for 3D printed models themselves. The spirit of open-source will eventually fade away as more people buy desktop 3D printers – certain types (FDM printers) [74] are destined to be toys and corporations such as Disney will want to keep a tight grip on their IP. The publishing and music industries have already been through this, to stop copyright theft, digital music and books are sold at a low unit cost to make theft non-profitable[75], design files for 'Mickey Mice' will go the same way. Bathsheba Grossman has taken a similar approach to the dissemination of her work - page 97

Sign and *Experience:* Design enthusiasts who want to find out more and those yet to be enlightened but curious about design communication, may find that 3D printed design output improves their understanding and experience.

[74] Author's conjecture

[75] Source-formatting protection software exists (eg: Digital Forming: https://home.digitalforming.com/protect-3d-files/) it is not infallible to the determined hacker, but secure enough to lower unit cost output)

Crossover Output – *Maker* Point-of-view

As figure 3.3 shows, there is significant crossover in art and craft output, but very little crossover with design. Design output is presented as art, usually retrospectively. Preliminary sketches and studies for larger workers of art are view with similar regard to final pieces eg; Kandinsky's 'Study for Composition VII (1913)[76], but also entries in architecture competitions, where preliminary sketches are exhibited together and produced in the knowledge that they may only ever 'function' as an artwork rather than as in instruction for making. Some models too, exist in the craft/design crossover space; Anthony Gormley made five, 1:10 scale, Angel of the North, maquettes - one selling in 2008 for more than £2m stg. (Henderson, 2009)

The main 'crossover' in Creative Landscape output, is between Craft and Art, and it has no single, official name. *Applied Art* is the term favoured by many practitioners, but a supercilious, creative landscape hierarchy means people label themselves arbitrarily and in relation those they view as above and below them. Furthermore, definitions of Applied Art, don't tend to differentiate it from Craft, as the flowing from Visual-arts-cork.com says:

> *The term "applied art" refers to the application (and resulting product) of artistic design to utilitarian objects in everyday use. Whereas works of fine art have no function other than providing aesthetic or intellectual stimulation to the viewer, works of applied art are usually functional objects which have been "prettified" or creatively designed with both aesthetics and function in mind. Applied art embraces a huge range of products and items, from a teapot or chair, to the walls and roof of a railway station or concert hall, a fountain pen or computer mouse.*

Indeed, it seems to be broader than just craft – they seem to include most forms of design and decoration. Even architecture.

> *For the sake of simplicity, works of applied art comprise two different types: standard machine-made products which have had a particular design applied to them, to make them more attractive and easy-to-use; and individual, aesthetically pleasing but mostly functional, craft products made by artisans or skilled workers.*

[76] At the Städtische Galerie im Lenbachhaus, Munich

Artistic disciplines that are classified as applied arts, include industrial design, fashion design, interior design, and graphic art and design (including computer graphics), as well as most types of decorative art (eg. furniture, carpets, tapestry, embroidery, batik, jewellery, precious metalwork, pottery, goldsmithing, basketry, mosaic art, and glassware). Illuminated manuscripts and later book illustration are also classified as applied arts. Architecture, too is best viewed as an applied art.

These two passages prove the futility and arbitrariness of trying to apply names to almost any section of the *creative landscape*; in fact, further scrutiny of the above definition (and examples) of applied art, seems to exclude anything which might reside the crossover zone between art and craft.

The essence of the creative outputs that exist in the Art/craft crossover is that it meets the criteria of both: maybe craft output that is appreciated for itself rather that its utility, or artwork with a particular message but made by a practitioner associated with craft, or materials associated with craft, such as clay, but presented by a practitioner recognised as an artist. Ceramicist Michael Moore being a prime example, he allies himself with the craft industry[77], yet produces many pieces with no *functionality* beyond their *purpose* as an artwork,[78] he is recognised as both a craftsperson and an artist.

Medium

Craft media, such as glass, clay, wood, precious metal, textiles are often described, in practice as glass art, ceramic art, textile art etc. These are accurate descriptors for individual practice, they explain that, 'although these materials are associated with craft, please regard this output as art', there is an acknowledgement that the practice (and therefore the output,) resides in this crossover space.

Agent

The artist or designer. As already discussed, in Art, the practitioner has more freedom with their materials, the medium is there to deliver the message, whereas in Craft the practitioner is closely associated with their medium. – mainly because

[77] http://www.craftni.org/directory-details/michael-moore
[78] http://michaelmooreceramics.com/gallery/

there is an expectation of workmanship skill from the 'maker' of the piece, and a detailed knowledge of the material from the 'designer' of the piece. This requirement of workmanship skill is not to the same degree in Art (especially since the early 20th century when resemblance and narrative grew less important that the concept)

Agent/Actor

Probably forming the majority of the practitioners in this section, because a body of practitioners exist, who have workmanship skills, but also want to present work with a message beyond its utility. All of the craft supporting bodies in the British Isles have websites listing registered makers, many of who produce utility pieces alongside works of restricted functionality, their artist statements explain their influences, the drivers or their research and exploration, (and research is key when considering this output.) Suggesting workmanship is not heavily featured.

Actor

Actors within this crossover zone are hard to find. The relationship between artists and technicians is largely accepted as art practice; the relationship between craft designers and craft technicians is usually when processes requiring no creative agency are involved. Because this output (art/craft crossover) is driven by creative agency, there is no opportunity for a provider of 'workmanship'. The agent/actor (ie the designer/maker or artist/maker) may not need to demonstrate workmanship either; output in this region can often be an exploration of material limits, experimentation and research, none of which are processes that require instructions in advance (which workmanship necessarily must.)

Significance of workmanship in output medium in crossover zones

As the previous two paragraphs explain, workmanship is not a requirement nor do 'actors' feature much (if at all)

Potential effect of the 3D printer.

Where traditional craft materials are used, in 3D printers, there may be some scope for its application in this area, currently extruded clay slip could be considered (see Jonathan Keep p.100 and also figs 2.42 - 2.46 (Catherine Scott) p.135)

Message, Purpose, Function

These constituents (message, purpose, function) of the output in the 'Crossover zone' depend largely from which direction the practitioner has come an what has 'caused' the output to be in this area. Has a craftsperson made experimental work or moved away from utility or has a practitioner, usually regarded as an artist begun to experiment with 'craft' materials? There is probably more scope in this section for constructivist approaches to understanding the output, not least because craft is more accessible than art and observers may be more confident in their appraisal and understanding.

Significance of workmanship in output message, purpose and function in crossover zones

Where process is part of the message workmanship may be highly significant, however, this does not mean that the provider will be anyone other than the creative agent; in this zone, there will be the most fluidity of practice, especially where practitioners are experimenting with materials they are not usually associated with.

Potential effect of the 3D printer.

Where a practitioner is experimenting with new materials, new opportunities are presented by the 3D printer, especially in wearables, (or rather the non-wearables designers present as extreme examples of potential wearable), Nervous Systems 'fabric (fig. 2.17) is one example or Bitoniti's 'Molecule' shoes (fig. 2.31)

Crossover Output - *User* Point-of-view

The user-values for the 'crossover' zone, will be identical to those for the Art user values, with some variation in in the experience value, based on what is discussed in *message, purpose, function* above (*There is probably more scope in this section for*

constructivist approaches to understanding the output, not least because craft is more accessible that art and observers may be more confident in their appraisal and understanding.)

Process

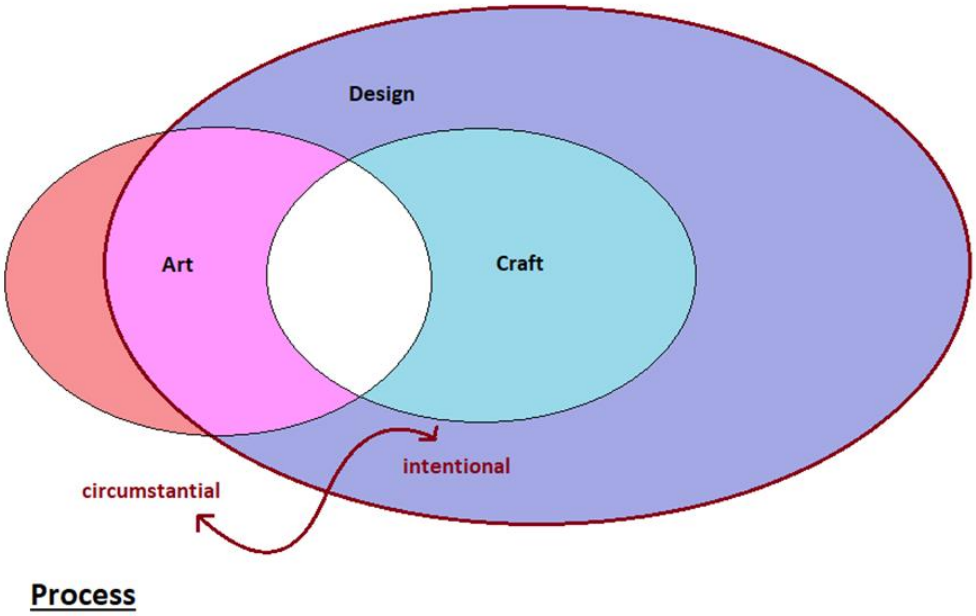

Fig 3.4 Process Venn Diagram

This Chapter is called the *Creative Landscape of* ***Making*** *and* ***Causing to be Made*** it is within the Process section of this analysis that the difference between the two is most relevant. The Venn diagram (fig 3.4) shows how some craft processes and art process are the same, and identifies the design process as intentional actions. It also accounts for some actions, within the art process, as circumstantial; acknowledging 'found art, glitch art, mathematical art' etc., where the 'making' process was carried out without artist intention. Experimental process will also fit the *circumstantial* zone (beyond design); there could be an argument to place a proportion of craft beyond the design/intentional processes boundary, to allow for craft research and experimentation, however, the Venn diagram is a reflection of the Creative Landscape of Making and Causing to be made, which implies a link to output – while experimentation certainly leads to output (see fig 3.7) it does not involve the application of workmanship, which is implicit in craft output, but not art.

However, with in each field, making and its causes must be deconstructed further. It is important to understand that none of the causes nor the application of their associated processes are exclusive.

Causing to be made

Why are artefacts created – what drives the process?

Practitioners (both actors and agents) are driven to 'make' either by *internal* factors (wants and needs) or *external* factors (e.g: social, financial), or both, an artist may be inspired by an external interaction, maybe a news report or a sea view, perhaps a song; that inspiration may manifest itself as 'need' to create. Alternatively, a craftsperson may want to produce a new artwork, but need external financial backing before they can go ahead.

'Causing to make' is driven by the *Creative Agent*, usually, one who envisions and/or designs the output and passes-on instructions for others to either translate or interpret (the designer); however, a *Commissioner* - An alternative instigator of the creative process, could begin the process with Creative Agency but may relinquish it entirely (passing it on the designer or designer/maker), may retain some or may appear to remove it from the process (in a design scenario, where the problem is properly identified and the end goal clearly envisioned – *algorithmic creativity* may be all that is required)

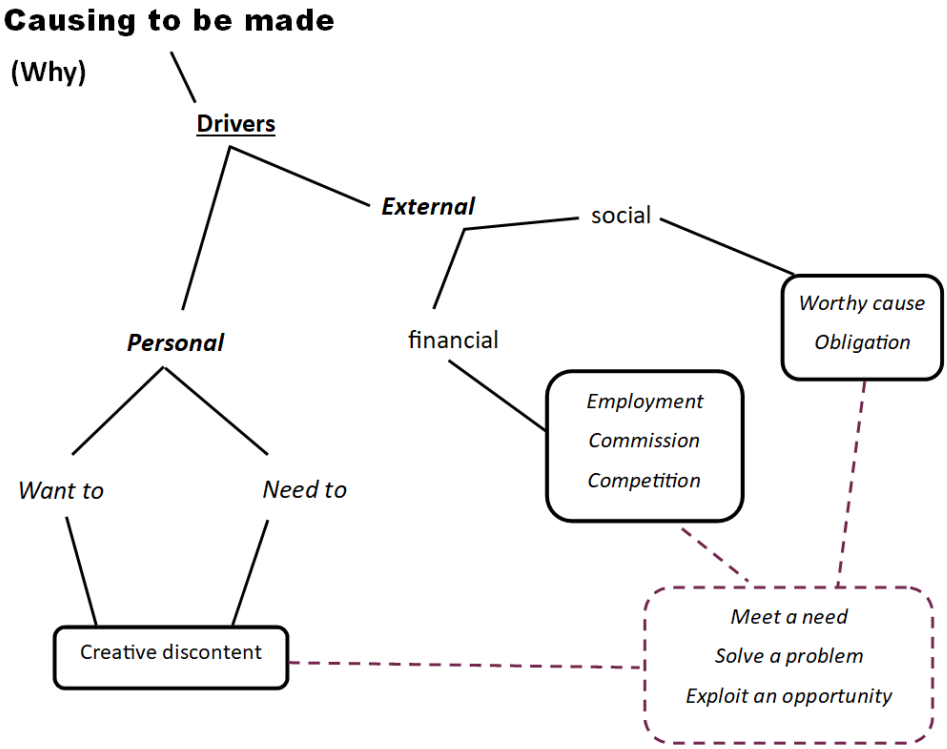

Fig 3.5 Causing to be made 'Spidergram'

As the *Causing to be made* 'spidergram' (fig 3.5) shows, whatever drives the making - *meeting a need, solving a problem* or *exploiting an opportunity* will be at the heart of it. This may seem to contradict the idea that Art's *purpose* is to 'be Art', however, 'need' goes beyond teleology, or rather precedes it; if *teleology* deals with use and function – 'purpose *after* the fact', then *needs* deal with cause, intent and 'purpose *before* the fact'; additionally, needs are entirely subjective.

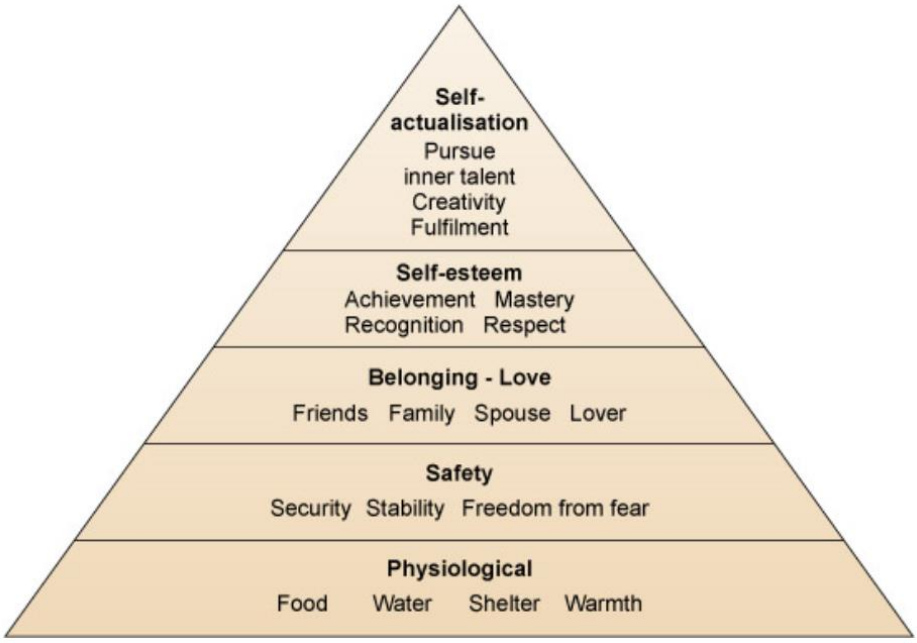

Fig 3.6. Maslow's hierarchy of human needs © Open University 2017

Maslow's Hierarchy of needs (fig 3.6) presents five types of need, which are often grouped into:

- Basic needs: Physiological, Safety
- Psychological needs: Belonging. Love, Self-esteem
- Self-fulfilment needs: Self-actualisation.

These needs, if unmet, are legitimate drivers (or causes) of making, and with the exception of the first two tiers of *Basic needs*, no further 'use, function or purpose' is required.

Making

As previously discussed, the 'instigator' of making (be that Designer or Commissioner) does not necessarily retain *Creative Agency* over the process, and the degrees to which this varies, within the fields of the Creative Landscape, will be discussed below.

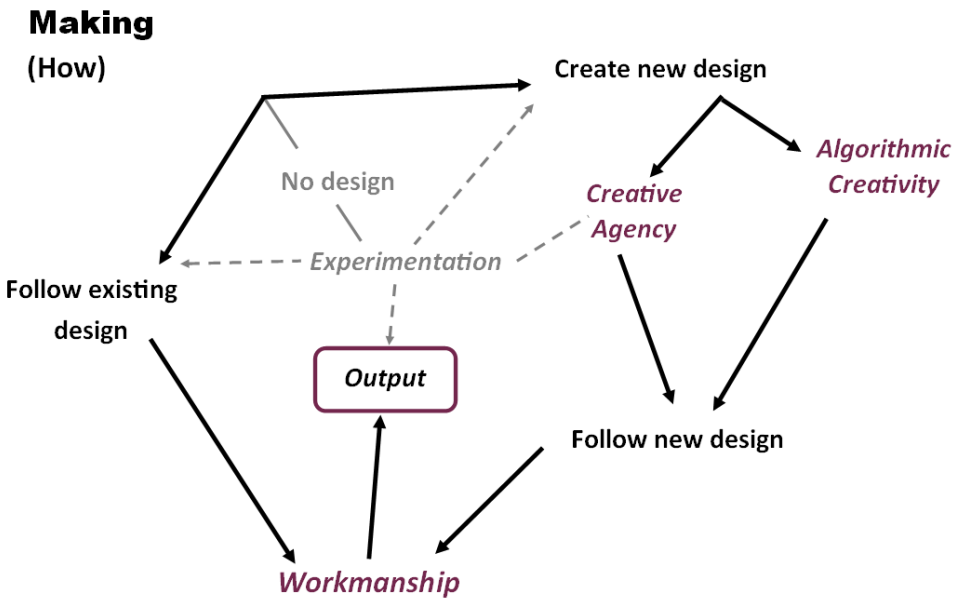

Fig. 3.7 Making 'spidergram'

The *making* 'spidergram' (fig. 3.7) shows two routes to *workmanship*. *Output* follows *workmanship*, however it may follow *experimentation*, although following *experimentation*, the process may then revert to a *workmanship* pathway.

Art Process

Causing to be made

Personal

The personal causes of *making*, for an artist, can easily follow any (and more than one) route, shown on fig 3.5. Unlike *craft*, where there is the expectation of some functionality, or meeting of basic needs (to cover, contain or support), or *design* (in practice) where the basis is problem-solving, the higher-level needs, identified by Maslow (fig.3.6) are considered the legitimate drivers: in particular self-actualisation. Financial drivers will obviously be a factor where an artist depends on their output to support themselves, and artists' basic needs will (probably) override self-esteem needs, causing artists to take on commissions they might otherwise avoid (if they could afford to.)

External

External drivers can bring about interesting combinations of needs, e.g: A wealthy business person may feel the need for respect and owning a particular piece of art may meet that need (Driver: Psychological need), this businessperson may offer a fee for producing this artwork that a struggling artist may feel unable to refuse (driver: basic need.) However, the level of creative agency the 'commissioner' expects to retain versus how much they expect from the Artist (and likewise, how the artist sees this balance) may cause problems in such an interaction. (see *relinquishing creative agency,* p.72)

Making

Beyond what ever has 'caused' art to be made - The *maker* of art will do one of two things: follow their own instructions (applying *Creative agency*) or follow the artist's instructions (applying *workmanship).* The artist is in control of the final output and as previously discussed (in output) the components assembled by the artist, for the final output, are selected by the artist in varying degrees of 'readiness' – while a workmanship provider or art technician, may appear to have creative agency over their work, the parameters set by the artist ensure that the 'actor' has no creative agency over the final output.

Where an art *maker* follows their own instructions, they are both actor and agent; their process may be either workmanship, experimentation, or both. Whichever method they apply, they are makers with *creative agency.*

Effect of 3D printing on Art Process

As this thesis has stated: 3D printers are only capable of workmanship, in that they may, at best, only follow the instructions they are given. This however does not mean that the machines cannot be used as tools in experimental procedures (Shane Hope's work page 119 being an example). Therefore, in the art process, the 3D printer can substitute any action that previously a hand would have done, (but that the 3D printer can now do better), be that the hand of a technician or the hand of the artist. The components of art can be derived from experimentation or

workmanship; the 3D printer can provide expert workmanship, as long as the instructions are 'correct'; it can also act a s a tool for direct experimentation.

However, the use of the 3D printer in art (as demonstrated in chapter two) is unlikely to be that of substitute workmanship, it is more likely to be an exploitation of the 3D printing superficial aesthetics discussed in that chapter. Even the 'coded aesthetic', which exploits the workmanship capabilities to reify virtual art, is not a substitute for existing workmanship – it is a new process (it may be superseded if a better process comes along – in this respect it is as vulnerable as any other workmanship provider)

Craft Process

Causing to be made

Personal

Because there is a presumption of 'functionality' in *craft*, there is a teleological shift from away from *art*. Craft output, that does not sit in the 'crossover' zone with art, (and therefore its making process) is expected to meet a *need.* (Producers of non-functioning or decorative craft are often faced with the question, "What's it for?")[79] However, there are widely held beliefs that much craft is made for the love of making – (addressing psychological and self-fulfilment needs) and much written (from Ruskin through to Sennet) However, what Sennet (and other craft romantics) do not address is the low investment cost of craft and the lack of alternatives. The love of making may spark an interest in beginning, and even developing a level of expertise, other, more basic, needs may be required to sustain or increase the 'making'.

Traditional artisanal craft is/was carried out on a human scale, artefacts are made one at a time or in small batches, there is often no need for large investments in raw materials, no need for expansive storage space or wide-reaching advertising, it is easy to get into the 'business of crafting' with a pair of knitting needles and a few balls of wool. The unexpectedly unemployed may be able to make a few extra

[79] Personal experience of the author.

pounds by expanding a hobby; an occupation that was previously borne out of passion – e.g., wood turning as a hobby - takes on a totally different complexion when it becomes a person's only source of income. Likewise, the son of a son of a son of a woodturner who has been well trained, and has all the best, most specialised equipment, collected and passed on over generations - is in a better position than someone starting out, - they have been nudged[80] into perpetuating the family trade to the extent they have not contemplated anything else, and were they to do so they might realise there is nothing else they can do. Both these practitioners are 'crafting' because there is no viable alternative. The 'craft romantics' seem to ignore 'craft' as a job of work.

An academic who writes about craft, has a passion for craft, and also makes craft for sale may believe they understand the 'drivers' of craft, they may even say that they 'just have to make, to get their hands dirty, and feel the material', but unless they depend on it to make a living, they may not empathise with the needs of craftspeople who do – as Pye made very clear in his 1968 criticism of Ruskin.

External

External drivers also influence the processes of craftspeople. The individual nature of crafts production means that the output is highly customisable. However, this presents its own problems. The workmanship:creative-agency ratio, in a client-craftsperson relationship will not be as obvious as the artist-client relationship. In the latter, *artwork* is being commissioned, therefore that artist's creative agency is implicit – they will have control of the output; however, a craftsperson must be more explicit about the level of control they expect to retain. Eg: were a ceramicist to offer a service that transfers a customer's image onto a plate, the implication is that they are merely providing the 'workmanship' necessary to 'make' the item, and no extra creative input is expected – therefore they have no real control over the output and cannot refuse to put an image or message onto that plate because of any personal views they have over the content; however, if the customer is commissioning a personalised ceramic plate, in the

[80] Nudge theory (Sunstein, Thaler 2008) is the idea that people can be nudged into behaviour in a way that makes them think they are following their own ideas.

particular style of the ceramicist (which would be clearly recognised as such) then there is an implicit agreement that the ceramicist will be using their *Creative Agency* and should therefore have control over the output. In this latter case, the artist should have the right to refuse to add content that they would not want associated with their artistic point of view. This is discussed further in Chapter 2 p.72)

Making

As with art, the *maker* of craft will do one of two things: follow their own instructions (applying Creative agency) or follow the artist's instructions (applying workmanship). As discussed previously, it is the practitioner with the creative agency who controls the output. It has been posited earlier (craft practitioner p.166) that a *craftsperson* is a practitioner who applies both *creative agency* and *workmanship* in their (craft) process to produce their (craft) output; it has also been suggested that the combination of *Creative Agency* coupled with **control** over *workmanship* should be the definition of ***Craftsmanship.***

The implication being that, a craftsperson (by definition) exhibits craftsmanship; but also, that craftsmanship exists when the creative agent is in control of the workmanship whether or not they are physically carrying out the workmanship.

This may seem a convenient caveat to allow a 3D printer's *workmanship* to be a constituent of craftsmanship (and it is) however, the same relationship of Creative Agency + control over workmanship = Craftsmanship, can be applied beyond computer-controlled manufacture.

Thought experiment

- The output is a skilfully thrown, fully functioning, stoneware mug, it has a hand-pulled handle, it is fully glazed on the inside, with the same glaze covering the top half of the exterior.
- The mug has been designed by an expert potter, well-versed and skilled in the ways of ceramics (he is called Frank)

- Frank's business makes many of these mugs – they are all individual because they are formed and glazed, one at a time, as well as undergoing the unpredictability of kiln firing.
- The mug is undoubtedly and example of 'craft' output. Even though the same design is repeated, the potter (Frank) retains creative agency over each one as it is made.

What if someone else follows Frank's design and accurately replicates it, without Frank having any control over the process?

There has certainly been a demonstration of workmanship, but has there been a demonstration of Craftsmanship?

- No, because Frank, who had creative agency over the design, did not have control over the workmanship therefore, no craftsmanship demonstrated by Frank.
- Nor was there any craftsmanship demonstrated by the maker, because they did not have creative agency over the design.
- If the maker works for Frank, in his studio, then Frank, in addition to having control over the design, also has control over the workmanship. In this instance craftsmanship is demonstrated, by Frank (but Frank cannot refer to himself as the *craftsman* –responsible for the mug – there was none) he was the *creative agent*, his employee provided the *workmanship*.
- Incidentally, if the independent maker deviates from Frank's design deliberately, they are applying their own creative agency and therefore demonstrating craftsmanship in the production of the mug. Authorship of the mug design would depend on the degree of deviation. Of course, the independent maker could deviate from the design *unintentionally*, that would not be creative agency, merely poor workmanship.

Effect of 3D printing on Craft Process

The 3D printer (where it has the workmanship capabilities and relative advantage) can replace workmanship in the craft making process. Where the designer (creative agent) remains in control of the output (namely, inputs the proper instructions and either accepts or rejects the output), then craftsmanship can be seen to be demonstrated. As the section on user-values has discussed, different users will be affected by this and others not.

As the thought experiment set out, despite craftsmanship being demonstrated in the process, this does not mean the process was carried out by a *craftsman* (craftsperson).

Craftsmanship can be independent of the craftsman.

There is a certain irony in this statement. In order for a craft designer to develop and communicate designs which allow skilled workmanship to be demonstrate, that will require a craftsperson's knowledge. In all likelihood, a skilled craftsperson would only relinquish workmanship process either to increase output (like Frank, from the thought experiment, probably does) or because of diminished skills or restricted abilities. For example: were an experienced silversmith, who for year, carved their designs out of wax for investment casting, only to be afflicted with arthritis that prevented them from carving, yet they could still operate a computer interface with relative ease, that same silversmith could have their virtual jewellery, produced using a 3D wax printer and have their pieces cast in the same way as before. There could be no dispute that the process involved craftsmanship – even if the jeweller did not carry out the 'workmanship' part of the process. It has been said elsewhere (and by Grayson Gerry, and by Malcom McCullough), that the skill involved in making the digital design is a crafts-skill (or workmanship) in its own right.

Design Process

Causing to be made

Personal

Creative discontent (Roy 2009) is the common term for self-driven design, the designer is usually aware of a problem situation, they will use the tools at their

convenience to deconstruct the problem field, identify and differentiate the symptoms from the problem, and using their personal insight envision how the situation will be once the problem is solved.

External

The discontent belongs to a 'user' other than the designer (user can be a person, a group of people, an organisation, an animal, a country…i.e., the end 'user' is not necessarily an individual or even human – n.b.: User-centred design and human-centred design are often wrongly conflated). The process is largely the same as personally driven design however the designer will not have the same insight and will therefore have to draw on a more extensive set of 'design thinking' tools. Commissioners/clients often do not know what the problem is that needs to be solved, but they are likely to have an idea of how they envision their situation once the 'problem' has been rectified. (Lotz et al, 2016) How well the designer achieves this for their client will depend on how clearly they can define the problem.

Making

As already mentioned in 'Practitioner' p.166 - the designer, is by definition the agent; they devise the solution, meet the need, exploit the opportunity, and communicate their idea by either drafting instructions themselves, or explaining their idea to a design technician who will them 'make' the output that communicates the instruction to make the solution. This could be: plans, maquettes, prototypes etc.. It is important to remember that design output is **not** the 'thing' that has been designed – design is the *idea;* design output is the *instruction.*

Significance of workmanship on Design Process

Workmanship has no relevance in the initial design process, however, the skill-level skill of the workmanship demonstrated in the design output is influential on how well the designers' ideas are communicated.

Although, in *design,* a technician rarely provides only 'workmanship'. For example, an architect may provide sketch designs, enough to gain planning permission and to communicate the design to a client, however these will not be detailed enough to instruct a builder to execute the design. A technician must take the architect's

sketches and turn them into a set of working drawings. The technician is not creating anything new, they are filling the detail of the designer's idea – a different process to the workmanship skills required to communicate the design (eg: model making or draftsmanship)

Potential effect of the 3D printer.

Where designers are embracing new technology, those technicians, who provide only workmanship, are most likely to be affected. An architect who learns to sketch using a CAD package may find that they can then translate their own designs into working drawings and 3D printable models. Technicians with a grasp on the technology can give themselves the advantage of being at the forefront of new design output media methods.

The initial purpose of 3D prints was to speed up the prototyping process, to date (2017) this is what 3D printers are best at, those technicians who make prototypes are at the most immediate risk of losing their jobs to 3D printers. Therefore, it is in the best interest of these 'workmanship providers' to ensure that operating 3D printers becomes part of their standard 'suite' of abilities. 3D printers may even extend careers of model makers/prototypers.

Crossover Processes

Causing to be made

The cause of making process in the art/craft cross over area will be the same as Art because the needs driven practice will not be factor to any extent greater than for art.

Making

Again (as with section on practitioners p.167) the crossover processes only really exists as the actions of an agent/actor because they will either be an artist demonstrating more workmanships skills or a craftsperson shifting their 'causes of making' from meeting a need to exploring a concept – to be an actor only in this instance would remove the 'craftmanship' element, an actor only would remove the 'artist' aspect.

Chapter Five
Conclusion

Overview

This thesis set out to determine the legitimacy of the 3D printer as both Artistic Tool and Artistic Medium; by assessing the Nature and Aesthetics of 3D Printed Artistic Output and the effect that 3D-printing may have on the borders of the Creative Landscape.

The chief research methods where *comparative analysis:* of existing practitioners' processes and output (p.90-120); *physical experimentation*: to establish the existence of an independent aesthetic (p.130 -139); and *deconstruction:* A design thinking technique used to examine the elements of essentially 'compound' terminologies, leading to the mapping of a Creative Landscape Matrix (CLM) see table 1. (below)

The creation of the CLM was necessary because the nomenclature of the Creative Landscape (of *making* and *causing to be made*) did not match the ontology. Of all the terminology used within the creative landscape, and artistic discourse at large, *Craftmanship* was the most troublesome; however, its deconstruction and the subsequent identification of its elements, as **Workmanship** and **Creative Agency**, gave rise to a prosed definition of the term.

The research followed a Pragmatic paradigm, allowing relativist or positivist viewpoints to take the forefront where appropriate (necessary to accommodate thorough mapping of the CLM).

Significant findings and hypotheses

Based on Chapter Two

- **Workmanship** does not require creative agency.
- **Workmanship** combined with **Creative Agency** is different from **workmanship** alone.

This thesis posits a definition for *Craftsmanship* as: the combination of **Workmanship** and **Creative Agency.** These can be provided by two separate entities: the designer, and the maker.

Only when the *designing* and *making* is provided by the same source (a designer/maker) can that person be considered a 'craftsman'

By the same measure, an artefact can be an example of *Craftsmanship* without the involvement of a craftsman.

Based on Chapter Three

- The 3D printer is both an artistic tool and an artistic medium.
- A 3D printed aesthetic can exist beyond and independently of the 3D printer.
- It is too prescriptive to define the artistic output associated with the 3D printer as '3D printed art' or just 'art' that happens to be 3D printed (see p.129)

Therefore, this thesis further hypothesises that: **there exists, a cross-disciplinary *Association* of artistic output, processes and practitioners, whose relationship is understood through the lens of 3D Printing.**

The umbrella term of ***3D Printing Associated Artistic Output*** is a suggested name and Chapter Three, p.143, lists the proposed 'Articles of Association'

Based on Chapter four

- 3D Printers cannot execute any process that requires **Creative Agency** and can *only* disrupt any process that relies upon **Workmanship.**

The disruptive capabilities of the 3D printer on the creative landscape of making and causing to be made.

This thesis, by Identifying *Creative Agency* and isolating *Workmanship*, within the creative process, subsequently identified those actions that may be executed without agency and therefore could be carried out by machine. (automated and/or computerised) without affecting the creative input:

- 3D printers have no **Creative Agency**; *and* with regard to *making:* 3D printers can only provide **Workmanship**.
- Actions that require only **Workmanship** do not *require* **Creative Agency,** *and* any action (process, practice) that requires **Creative Agency** cannot be performed by something (someone) that can only provide **Workmanship.**

therefore

- 3D Printers cannot execute any process that requires **Creative Agency.**

Additionally, by identifying **Creative Agency**, as component of creativity, inalienably beyond the capabilities of the machine, validated the premise that 3D printers cannot *negatively disrupt* processes, within the Creative Landscape of making and causing be made, that require **Creative Agency** (in particular, what this thesis define as *Craftsmanship* – namely **Workmanship + Creative Agency**)

The Creative Landscape Matrix (CLM) as laid out in table 1 (below and p.151) maps out how each element has been cross-referenced in for these analyses and where in this document each analysis can be found.

Field Definition: p.153	Art	Craft	Design	Cross-over
Putative definition	p.154	p.157	p.160	p.162
Thesis p.o.v.	p.156	p.159	p.161	p.163
Practitioner: p.164	Art	Craft	Design	Cross-over
Agent	p.164	p.166	p.167	-
Agent/Actor	p.165	p.166	p.167	p.167
Actor	p.165	p.166	p.167	-
***Output: p.168** – Maker p.o.v.*	Art	Craft	Design	Cross-over
Medium:	p.170	p.180	p.184	p.191
Agent	p.172	p.180	p.185	p.192
Agent/Actor	p.172	p.180	p.185	p.192

Actor	p.172	p.181	p.185	p.192
Significance of workmanship/3DP	p.173	p.181	p.185	p.193
Message/purpose/function:	p.173	p.182	p.186	p.193
Significance of workmanship/3DP	p.174	p.182	p.186	p.193
***Output** – User values.*	Art	Craft	Design	Cross-over
Collector	p.175	= p.175	-	= p.175
Investor	p.175	= p.175	-	= p.175
Curator	p.175	= p.175	-	= p.175
Commissioner	p.176	= p.176	-	= p.176
Other buyer	p.176	p.183	-	= p.176
Critic	p.176	= p.176	-	= p.176
Student/academic	p.176	= p.176	-	= p.176
Intentional Viewer	p.177	= p.177	-	= p.177
Incidental Viewer	p.177	= p.177	-	= p.177
Passer-by	p.177	= p.177	-	= p.177
User Value Grid	p.178	p.183	p.188	= p.178
Effect of 3DP on user Values	p.178	p.183	p.189	= p.178
Process	Art	Craft	Design	Cross-over
Causing making: personal drivers	p.199	p.201	p.205	= p.199
External drivers	p.200	p.202	p.206	= p.199
Making	p.200	p.203	p.206	-
Significance of workmanship/3DP	p.200	p.205	p.206	-

Table 1. Creative Landscape Matrix (CLM)

Negative Disruption

Primarily, only actors can be 'negatively disrupted', that is those 'makers' who do not exercise any *Creative Agency* over the making, and even then, not all actors will be disrupted in this way because of the additional factor of *personal agency*, which is affected by the driver or *cause* of the making.

For example: a person could be knitting two seemingly identical garments, both are being made by following the same pattern, using identical materials and tools – with no deviation, in either case, from the specific instruction. In the production of both garments the knitter is providing **Workmanship** only and exercising no **Creative Agency**.

Garment *one* is being made, by the knitter, purely for the pleasure of the process.

Garment *two* is being made for a knitwear company, the knitter is being paid for their ability to adhere exactly to the design (ie. their **workmanship**) and is

remunerated either for the time taken or for each garment they complete, and it is this remuneration that 'drives' the knitter to 'make',

Each garment takes two days to make, however, it emerges that a knitting machine can make four garments in two days.

The **workmanship** capabilities of the machine will not disrupt the making of garment *one*. However, the making of garment *two* could be disrupted in various ways:

The knitwear company, if paying for the knitter's time, could realise that they could be four times more profitable by getting their garments made by machine than by hand; this could result in the knitter losing their job, (the most negative disruption for the knitter).

The knitter, if paid by the garment, could affect the disruption themselves and beginning to make garments using a knitting machine; this would require financial investment and some training, but ultimately quadrupling their income. (A positive disruption)

These are two ends of a 'disruption scale', there would likely be some compromise on both sides depending on marketing strategies such as a price-minus or a cost-plus approach,[81] (there are also Marxist arguments to be had, regarding the ownership of the means to production – but beyond the scope of this thesis), Additionally, *user values* (see CLM) will also play a more complex part in the external drivers of making, but ultimately it can only ever be the provider of workmanship than will be negatively disrupted.

Positive disruption

From the point of view of the maker, where the drivers of making are external, and the 3D printer offers a relative advantage over existing **workmanship** practice, the machine can be positively or negatively disruptive. Additionally, where a practitioner is experimenting and using the 3D printer as a new medium, it may seem disruptive,

[81] where the retail price is dictated by what the market can bear (price-minus) or what it costs to make (cost-plus).

but if its use is novel, then it is not replacing something existing (hence: not disruptive). Where the machine is disruptive and seemingly negative, there will likely be a positive aspect for someone else (in the knitting example: switching to the machines may be negatively disruptive for the actor (the knitter) but not for the agent (the knitwear company); this is because innovations rarely diffuse successfully if there is no relative advantage (Rogers 2003).

From the point of view of the user, the relevance of the 3D printer's effect on artistic output, is based on value, not just exchange-value but also, use-value, sign-value and experience-value (see p.170). In essence, if the value is affected the 3D printer cannot cause a disruption because the existing 'artefact' will continue to have the relative advantage and therefore a 3D printed alternative will not diffuse (and cannot disrupt); *or* it will not affect value, therefore any disruption will not be negative. Additionally, much 3D printed artistic-output could be considered *radical*, therefore creating its own space in the creative landscape rather than disrupting the existing landscape and its boundaries.

The Future Creative Capabilities of the 3D Printer

It is feasible that machines will appear to be capable of craftsmanship because of their potential for algorithmic creativity combined with workmanship, but algorithmic creativity must be bounded (see page 75, *Deconstructing Creativity* …)

Creative Agency does not require boundaries.

3D Printers may at some point develop the ability to carry out algorithmic creativity, however it is unlikely to displace any existing 'problem-solvers', as much better computers, than any dedicated to running 3D printers, will already be doing that.

Where it does pose a threat of displacement, is to those processes that require only **workmanship**.

As discussed in Chapter 3 (p.68) under *Risk and 3D printing*, and in the previous section on positive disruption, *relative advantage* is the reason that 3D printers have

been slow to defuse as tools within the creative landscape, the converse is also true, it will be because of relative advantage that these machines will diffuse. As relative advantage is gained, it will be different for individual users based on their own requirements.

Beyond prototyping, the current[82] crop of non-industrial 3D printers (domestic, personal, desk-top etc.), offers little or no *relative advantage*, other than for artistic[83] purposes. Most output is either part of a larger process, requires post-printing finishing or made for 'fun' (and prototyping, by its very nature, is part of a grander scheme.)

There is no doubt that the quality and structural integrity of 3D printed output will improve, to the extent that functional, ready to use objects will (eventually) emerge straight from the print-bed. For now, however, the structural integrity of many 'fresh prints' is only suitable for prototyping.

The forward-march of 3D printing is engineering structural integrity *into* the printed artefact and engineering the superficial aesthetics *out* of the printed artefact. As a tool, the 3D printer is rapidly evolving, its potential to disrupt is in enormous: however, its current ability to disrupt is low and beyond its intended use, as a prototyping tool, it has limited functionality.

3D printers that use extruders, are on the wrong side of this evolution, they have a legitimate function is as an artistic medium (and tool). The creative landscape is where they belong, and as Chapter one of this thesis has demonstrated: **there exists, a cross-disciplinary Association of artistic output, processes and practitioners, whose relationship is understood through the lens of 3D Printing.**

[82] Midway through the second decade of the 21st Century

[83] Artistic out-put is largely identified by the maker and interpreted by the viewer; art status is usually conferred by those who believe they know better. There is much 3D printed output that will lay claim to artistry; this thesis neither refutes nor supports these claims but will refer to all that presents itself as such, as 'Artistic Output' Chapter One discussed this in greater depth.

Questions raised for possible future research

- How might the separation of Creative Agency and Workmanship, within the current Creative Landscape, affect commissioned work, specifically, the artistic control of the maker and the expectations of the client?
- Authorship: assessing the level of Creative Agency skilled practitioners use in executing instructions, within and without parametric boundaries?
- With regard to the ‘creative ambitions’ of the 3D printer; could Creative Agency, if understood as separate from Creativity, be a limiting factor for Machine Learning, where Intelligence is only Artificial if it is incapable of Creative Agency?

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